Hauhungaroa No 6.
Whareroa Village Subdivision

Ecological Characteristics of The North Side Development Area and Adjoining Whareroa Stream Riparian Habitat.

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1 INTRODUCTION

The following report describes the ecological characteristics of two areas at Whareroa on the southwestern side of Lake Taupo – the c.19 ha North Side Development Area in which a residential subdivision is proposed, and the adjoining riparian habitat of the lower part of Whareroa Stream. The latter area is part of a wider riparian zone extending upstream to State Highway 32 that is subject to a Waikato Valley Authority Soil and Water Conservation Plan (WVA No. 2948/434720).

The aim was to document the avifauna, vegetation and flora, and other wildlife utilising both areas and to assess their relative ecological values.

Field surveys were undertaken on 26 July and 16/17 August 2005 in fine weather conditions.

The locations of the two survey areas – "North Side Development Area" and "Whareroa Stream Riparian Habitat" – are shown in Figures 1, 2 and 3. Colour plates are shown in Section 7.

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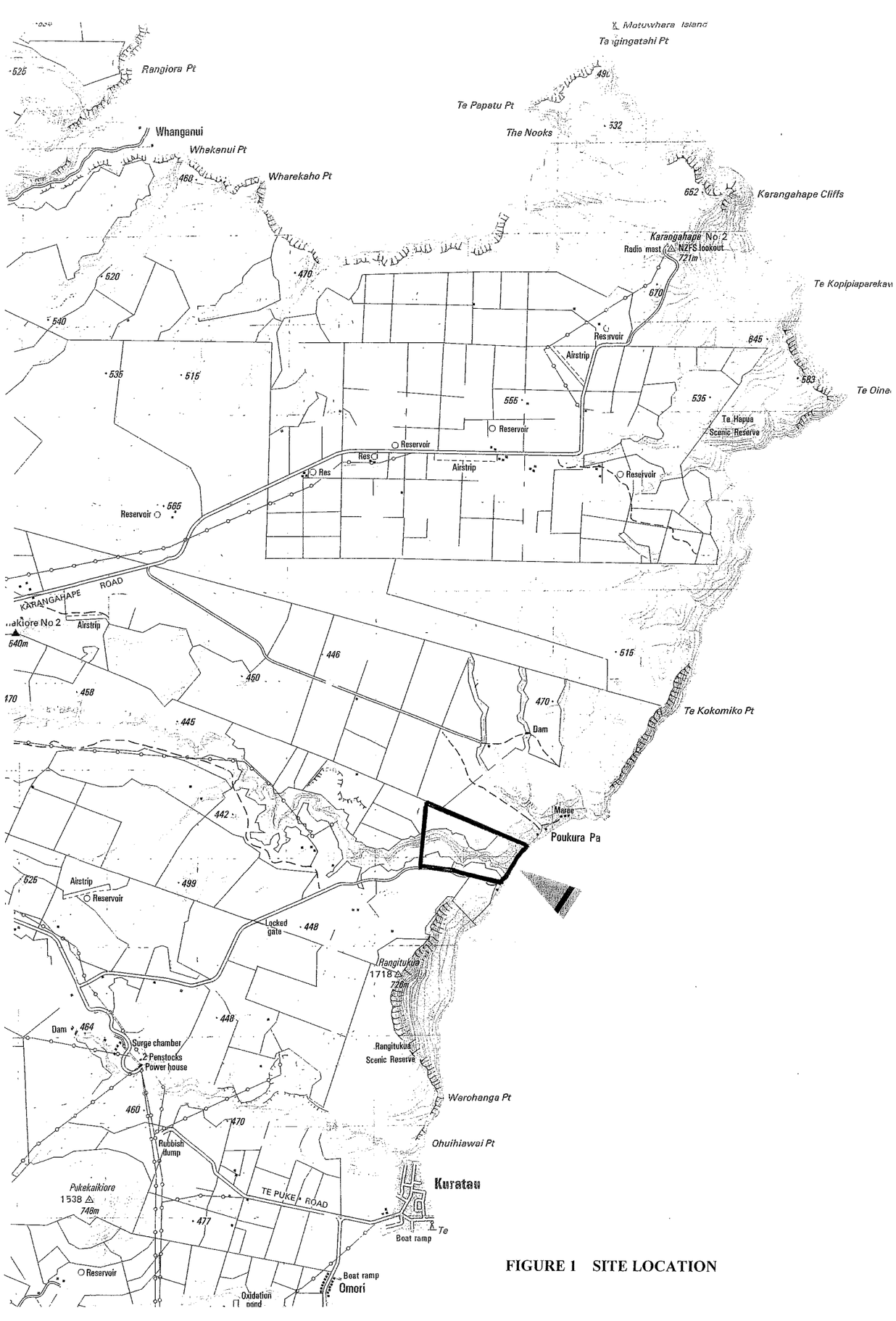

FIGURE 1 SITE LOCATION

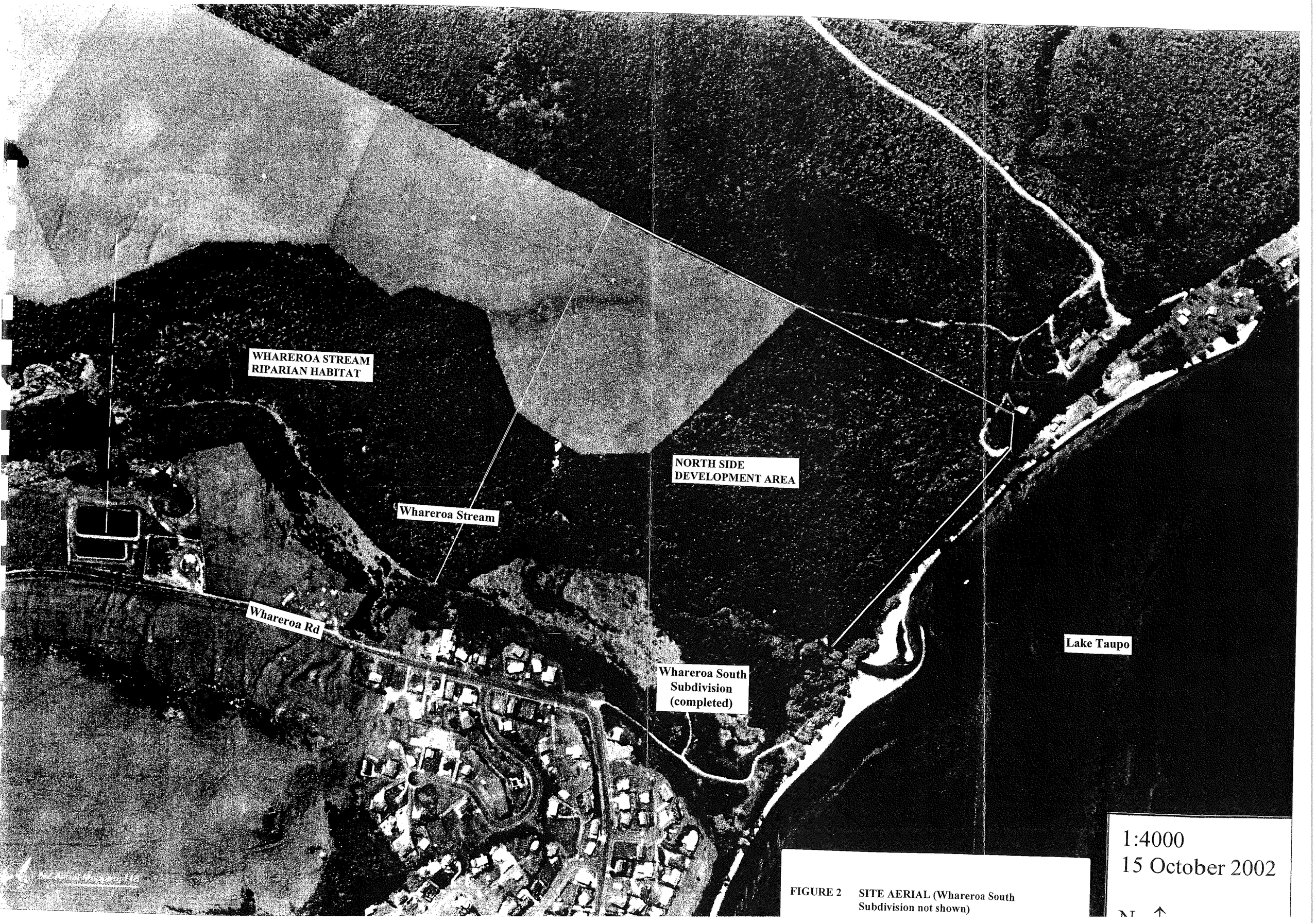

FIGURE 2 SITE AERIAL (Whareroa South Subdivision not shown)

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15 October 2002

2 NORTH SIDE DEVELOPMENT AREA

2.1 Vegetation and Flora

2.1.1 Introduction

The proposed subdivision would be located on high ground on the northern side of Whareroa Stream, close to the southwestern shore of Lake Taupo. The edges of the site - the steep slopes up from the stream ("stream scarp"), and from the lake ("lake scarp") - are excluded from the proposal, except that an access road would be constructed through the stream scarp from a bridge over the Whareroa Stream about 200 m upstream from its mouth.

The study area, including the lake scarp and stream scarp down to the approximate centre line of the stream meanders, is c. 22 ha. in extent.

Approximately 25% of the study area, the high ground in the northwest, is currently in pasture. The remaining 75% – the rest of the high ground and the two flanking scarps - carries native scrub. Immediately to the south, on the Whareroa Stream valley floor, there is new roading for the last stage of the recently developed Whareroa South subdivision.

The high ground where the subdivision would be placed is mainly of level or gently lakewards-sloping terraces. Two topographical features in it are notable. The first is a grassed depression c. 200 m in diameter in the pasture in the northwest (part of it lies across the study area boundary here); its southern edge, above the stream scarp, has a large vertical-walled dry-floored washout. There is no evidence on the floor of the depression of erosion by surface water.

The second notable feature of the high ground is a lakewards-facing short steep slope (the "internal scarp") within the scrub. It apparently begins c. 100 m northwards beyond the study area, and trends in a southwesterly direction (i.e. more or less parallel to the lake shore 50 m or so before reaching the top of the stream scarp). For much of its length it is clearly defined, and is breached by half a dozen or so narrow shallow gullies that come down from the higher ground. Some are these are only a few metres long but at least one reaches back west for c. 100 m.

A short way north of where the track crosses the internal scarp this feature is actually ditch-like, for at least 20 m of its course. Further north, outside the study area, where the track descends to Poukura Pa, the form of a lakeward-facing scarp has been regained.

The local geology is probably a complex one, and it seems possible that the character of the present vegetation has partly been determined by geology – for example, the roots of a large kanuka can extend down for more than a metre and might be able to exploit more nutrient-rich ash layers that relatively shallow-rooted trees could not. However, no probing or sampling of the soil was undertaken.

Between the internal scarp and the top of the lake scarp the ground is near horizontal and has numerous rounded pieces of pumice to c.25 cm diameter and also (generally smaller) pieces of a heavy black and white banded andesite (?).The latter are also present here and there in the paddocks to the west. No larger pieces of rock at the surface, or outcrops, are present.

2.1.2 Vegetation

A sketch map of the study area, based on a colour aerial photograph (date flown 15 October 2002) is shown in Figure 4, and the captions for its vegetation/topography zones **1-5** are elaborated on as follows.

1. <u>Pasture</u>

This is without any large relic native trees (such as kanuka, *Kunzea ericoides*) or surface dimpling indicative of the former presence of forest. On this higher ground in Whareroa Station any such vegetation [in this case, scattered large cabbage trees, *Cordyline australis*, and some medium-sized totara (*Podocarpus totara*)] is some 8 km away to the west, almost to SH 32.

On the floor of the large depression in the pasture, towards the washout, and also higher near the western boundary of the scrub, there are several low hummocky depressions c. 5 m in diameter that are possibly aggregations of cleared rocks.

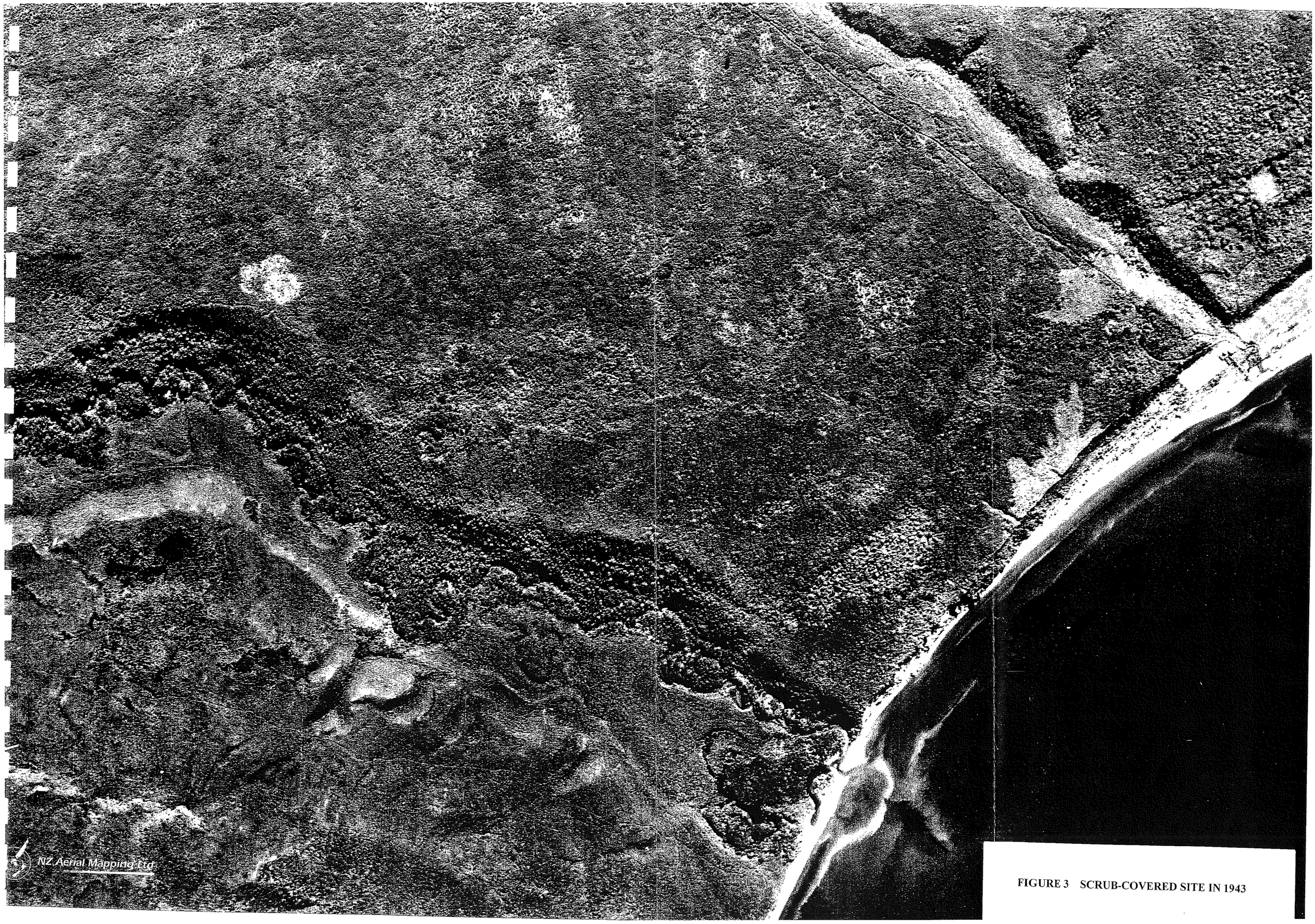

FIGURE 3 SCRUB-COVERED SITE IN 1943

1. Pasture
2. Low scrub of bracken and shrubs
3. Tall scrub of fivefinger and kanuka
4. Scrub of steep slope above stream
5. Scrub of steep slope above Lake

large depression

washout

track

fivefinger dominant

internal scarp

kanuka dominant

stream scarp

Lake scarp

willows

Whareroa Stream

Whareroa South Subdivision

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15 October 2002

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FIGURE 4 NORTH SIDE VEGETATION AREAS

NZ Aerial Mapping Ltd

2. Low scrub of bracken and shrubs

Low scrub occupies the northeastern part of higher ground. Much of it is a thick cover of 1.5 m tall bracken (*Pteridium esculentum*). From the bracken emerge single individuals and small groups of native scrub trees, principally: fivefinger (*Pseudopanax arboreus*), kohuhu (*Pittosporum tenuifolium*), karamu (*Coprosma robusta*), kanuka, koromiko (*Hebe stricta*) and tutu (*Coriaria arborea*). The larger fivefinger, kanuka and kohuhu reach c. 5 m tall and 15 cm dbh (diameter at breast height). Manuka (*Leptospermum scoparium*) is present infrequently, as individuals of only c. 3 m tall and 5 cm dbh. Tree ferns are lacking.

Present mostly near the paddock edge are 2-3 m tall individuals of broom (*Cytisus scoparius*), Himalayan honeysuckle (*Leycesteria formosa*) and blackberry (*Rubus ulmifolius*); gorse (*Ulex europaeus*) is infrequent. Several small to medium-sized radiata pines (*Pinus radiata*) are present towards the northern boundary but the species has not invaded further. (The aerial photograph shows that radiata pines are spreading considerably north and west in the scrub outside the study area from their source at Poukura Pa).

A recent machine-made track c. 2 m wide runs in this vegetation in a southeasterly direction from the paddock edge, crossing the internal scarp and then turning southwest (this last part of the track is not shown on Figure 4; also, note that the aerial photo shows an older parallel track to the north). Above the scarp the track is being re-vegetated principally by juvenile lupins (*Lupinus arboreus*), in such abundance as to suggest they have originated from the seed bank. Present in much smaller quantity are some native herbs, *Gnaphalium sphaericum*, *Geranium potentilloides*, and *Pelargonium inodorum*. For some reason, seedlings of lupin and indeed of plants in general are more or less lacking below the scarp along the remainder of the track.

The cut made at the scarp shows c. 20 cm of thin humus and dark grey silty-sandy ash over fine pumice lapilli, this latter material coarsening downwards over the next metre and more into fist-sized chunks. No charcoal was seen here (or anywhere else in the study area).

3. Tall scrub of fivefinger and kanuka

Tall scrub, dominated by kanuka and/or fivefinger, covers the rest of the higher ground. The sharpness of the junction with the low scrub suggests an old fire boundary or at least the edge of some kind of vegetation clearing. No fire scars were seen on the larger trees (mostly fivefinger) along this boundary.

As in the pasture and low scrub zones, no sign of any older and taller vegetation was seen. Stumps and large root mounds are lacking. If forest ever occurred here it would seem to have been lost a long time ago, presumably through burning in pre-European times, to be replaced by a mosaic of scrub types. Perhaps the most recent long-lived scrub phase has been one dominated by bracken.

At any rate, it is obvious that the individual canopy trees of this tall scrub are considerably older than those of the low scrub. Kanuka, fivefinger and kohuhu generally share dominance, with the former usually emergent at least a metre or two over the latter two species, but in some places (in particular, the upper central part of this scrub, as annotated on Figure 4) one or other is more strongly dominant. A 15 m tall 18 cm dbh kanuka at the internal scarp, pushed over in the forming of the new track, was ring-counted about a metre above its base. It showed 65 rings.

In general, the kanuka are largest towards the southwestern corner of the high ground near the large washout, where they reach c. 13-16 m tall and 20-30 cm dbh. Here they have narrow crowns and are generally in healthy state, with only a few dead or fallen individuals present. The fivefinger canopy trees and the (usually less frequent)) kohuhu are generally 6-10 m tall and 10-15 cm dbh. Quite a number of the fivefinger are multi-trunked and reach c. 30 cm in basal diameter.

Insect damage to the foliage of the fivefinger is conspicuous, and in the fivefinger-dominant area (Figure 4) a fair number of canopy individuals are dead or dying. Possums may have contributed to this damage too, and a number of trapped carcasses were found at the fenceline by the large washout. Also, until recently, there seems to have been an infestation of wild pigs here, and the ground surface in most places has been furrowed and hummocked by these animals. However, no fresh sign of pigs or

possums was seen and although a 1080 poison drop had occurred here (and in the covenanted land further upstream) just before the second survey, no newly killed animals were seen.

The understorey is quite diverse in character from place to place, though with a limited range of species (refer 2.1.3). In drier well-lit situations, such as along the top of the internal scarp, there is a relatively dense understorey made up of *Cyathodes fasciculata* (and some *C. juniperina*), with *Gautheria antipoda* and *G. paniculata*. On slightly damper ground there is an increased amount of koromiko, rangiora (*Brachyglottis repanda*), hangehange (*Geniostoma ligustrifolium*) and juvenile plants of fivefinger.

The drier ground may be mostly clothed in houndstongue fern (*Phymatosorus pustulatus*) and hookgrass (*Uncinia distans*). In the very southwest corner of the higher ground, for no obvious reason, these two species are joined by an abundance of the scrambler *Lycopodium volubile*. In slightly damper and more shaded conditions bryophytes such as *Plagiomnium novae-zelandiae* and *Ptychomnion auriculare* become plentiful, especially on humus pads, around the base of the trees, and on ground-embedded pieces of pumice. Among them quite commonly is *Asplenium hookerianum*, while *Hymenophyllum scabrum* and kidney fern (*Trichomanes reniforme*) were seen only in the dampest and most sheltered places. Other ferns are present rather sporadically or locally, except that kiokio (*Blechnum novae-zelandiae*) forms a few dense groups at the internal scarp foot. Mamaku tree fern (*Cyathea medullaris*) is present only as (near) trunkless young individuals, mostly in the small gullies that descend down to the internal scarp. No trunked specimens of wheki tree fern (*Dicksonia squarrosa*) or wheki-ponga (*Dicksonia fibrosa*) were seen.

Epiphytes are lacking from the trees of this scrub except that the climbing fern *Phymatosorus scandens* and the filmy ferns *Hymenophyllum revolutum* and *H. sanguinolentum* occur locally (mostly along the internal scarp) on the lower trunks of some of the trees, particularly *Cyathodes fasciculata*. Spleenwort (*Asplenium flaccidum*) and *Pyrrosia eleagnifolia* do not occur as epiphytes but are present on the ground, the spleenwort being particularly common along the lip of the lake-scarp.

Only three native grasses, *Poa anceps*, *Deyeuxia avenoides* and *Cortaderia fulvida*, were seen. Species of *Carex*, *Morelotia* and *Gahnia* are absent, and *Lepidosperma australe* was seen only outside the study area, in low scrub on compacted pumice by the track leading down to Poukura Pa.

Except for fivefinger, regeneration of potential forest-canopy species is negligible, that is, seedlings of podocarps, rewarewa (*Knightia excelsa*), and kamahi (*Weinmannia racemosa*) are very infrequent. Kanuka is not regenerating anywhere in abundance but where the canopy is open there is usually a scatter of slow-growing small saplings, these often having started life on the sides of pumice chunks. Except for the occasional seedling, rewarewa is confined (as a few barely adult trees) to the southeast corner of the tall scrub above the stream-scarp. Only half a dozen or so seedlings of rimu (*Dacrydium cupressinum*) and kahikatea (*Dacrycarpus dacrydioides*) were seen. No radiata pines occur in this tall scrub

From the foot of the internal scarp for at least 50 m towards the top of the lake scarp the ground is distinctly more rocky (pieces of pumice and hard volcanic rock) and the scrub generally becomes reduced in stature, although scattered tall kanuka do occur here. Closer to the top of the lake scarp the kanuka are slender and infrequent, and the fivefinger trees of the canopy (some of which are multi-stemmed and c. 7 m tall, 50 cm basal diam.) are accompanied by thickets of bracken, *Cyathodes fasciculata*, *Gaultheria* spp., koromiko, hangehange and *Coprosma lucida*. There are also some large shrubby individuals of tutu.

On the ground along the lip of the lake scarp, at the bases of the fivefinger and mingimingi, hanging spleenwort and *Poa anceps* are in abundance, pendent over the undercut top of the scarp face. Wherever sufficient light gets to this undercut there are small colonies of woodrush (*Luzula picta*). Immediately below, under the bushes at the top of the scarp, the ground is densely carpeted with houndstongue fern.

Two exotic species are in fair quantity in this tall scrub. The first is Himalayan honeysuckle; which forms a fairly light but continuous 1.5 - 3 m tall understorey in the general vicinity of the fivefinger-dominated zone and also in the kanuka-dominated southwest corner of the property beyond the large washout. The second is

blackberry, which is locally plentiful in the damper open areas in the latter part of the site.

4. Scrub of steep slope above stream

The vegetation on the steep slope above Whareroa Stream (the "stream scarp") and along the stream floodplain was not investigated closely. A climb was made up through it approximately where it is proposed to construct an access road. Here there is an abundance of medium-sized fivefinger trees (to c. 8 m tall), the kanuka being relatively slender and infrequent. (The view from the valley floor shows the kanuka increasing in frequency and stature back west along the scarp, while the fivefinger increases in size to form a subcanopy, this being densest on the higher part of the scarp). Steep open places near the scarp top have an abundance of houndstongue fern, *Poa anceps* and kiokio, among thickets of tutu, koromiko, fivefinger, *Cyathodes* spp. and *Gaultheria* spp.

The scarp foot/floodplain junction was investigated in the general locality of where the stream crossing might be located. On this relatively fertile and damp site there is a rather disturbed tall kanuka forest, the individuals of which reach 16 m tall and 30 cm dbh. The broken understorey, mainly of fivefinger and kohuhu, contains some dense climbing growths of *Parsonsia capsularis* and *Muehlenbeckia australis*. Blackberry, Himalayan honeysuckle and the fern *Polystichum vestitum* are abundant. The stream bank is clothed with toetoe (*Cortaderia fulvida*). Further towards the stream mouth, crack willow (*Salix fragilis*) becomes plentiful (showing as pale green on the aerial photo). The largest of them, close to the shore on the southern side, is c. 12 m tall and 80 cm basal diam. There is no kowhai (*Sophora tetraptera*) here, the largest native tree being a single cabbage tree of 12 m tall and 60 cm basal diam.

The shallow water of an oxbow near the proposed stream crossing is filled with *Carex virgata* and toetoe.

Further southwards on the valley floor, between the stream and the western end of the new roading, there is good-quality tall kanuka/fivefinger-kohuhu scrub. The abandoned meanders within this scrub are all dry and deeply shaded by the kanuka

now, and their floors carry mostly kiokio. The largest kanuka (to c. 15 m tall 25 cm dbh) seem to be preferentially located on the walls of these meanders (rather than on the floor on the level pieces of ground above).

This area is fenced off and presumably is to be retained as a riparian strip, adjoining the down valley end of the covenanted riparian strip of Whareroa Stream (refer 3.1).

The aerial photo shows that most of the valley floor, before the recent making of roading and clearing for house sections, was occupied by adventive grasses and a low scrub probably mainly of broom and Spanish heath.

5. Scrub of steep slope above Lake

The lake scarp and the shoreline, being outside the study area (or at least, being excluded from the proposed development) were not investigated closely. As viewed from the beach the foot of the scarp is mostly edged with blackberry, koromiko and tutu among which stand numerous medium-sized crack willows. The scrub on the slope above seems to be mostly of smallish fivefinger and kohuhu; no large emergent kanuka were seen. Scattered along its lower part are a few medium-sized radiata pines (not visible on the aerial photo because the scarp is in shadow there).

Immediately in front of the willows and blackberry along the foot of the scarp the sandy beach-rear terrace carries a strip a metre or two wide entirely of multi-stemmed individuals of *Haloragis erecta*. Lakewards, on the innermost of the several recently formed low ridges of pumice and sand, there is a line of what is perhaps *Polygonum hydropiper* (all plants dead) and, on the front part of this ridge, where the sand is damp, there is an abundance of new rosettes of two species of willowherb (*Epilobium cinereum* and *E. pallidiflorum*).

Running between the *Haloragis*-dominated inner zone and the *Polygonum* ridge is a linear shallow-water depression, and particularly at its northern end, where it reaches almost to the *Haloragis* zone, there are vigorously expanding patches of *Crassula sinclairii* in its shallow water. In a similar situation along the sands at the stream

mouth, 20 metres or so before the lake edge is reached, the crassula is accompanied by the two *Epilobium* spp. and a few small colonies of *Isolepis ? sepulchralis*.

2.1.3 Flora

77 native higher-plant species were recorded

2.1.3.1 Ferns & Fern-allies

Asplenium bulbiferum - hen and chickens fern. Local in the southwest corner of the tall scrub beyond the large washout .

Asplenium flaccidum - hanging spleenwort. Abundant along the lips of the internal scarp and lake scarp; not seen as an epiphyte.

Asplenium hookerianum. Small plants are common along the foot of the internal scarp at tree bases among thick growths of bryophytes; larger ones are occasional along the top of the stream scarp and generally throughout the tall scrub of the high ground.

Asplenium lamprophyllum. Seen once on a tree base in the tall scrub of the high ground.

Asplenium oblongifolium - shining spleenwort. As above.

Asplenium polyodon. Uncommon, seen on the ground in the southwest corner of the tall scrub of the high ground, not an epiphyte.

Blechnum discolor. Uncommon in the tall scrub of the high ground.

Blechnum novae-zelandiae – kiokio. Abundant in the tall scrub on the stream scarp, seen on the high ground mostly only along the foot of the internal scarp and in a minor gully more or less central there.

Blechnum vulcanicum. Common locally in the rather dry and low stature scrub that occurs in places on the stream scarp in the extreme southeast.

Ctenopteris heterophylla. Occasional at the bases of some of the larger trees in the tall scrub of the high ground.

Cyathea medullaris – mamaku. A few juveniles here and there in the tall scrub on the high ground, most of them in the minor gully.

Dicksonia fibrosa - wheki-ponga. One or two small plants at the foot of the stream scarp.

Dicksonia squarrosa – wheki. Except for a few seedlings, seen only at the foot of the stream scarp.

Grammitis sp. One hand-sized colony on a humus clump at the foot of the internal scarp.

Histiopteris incisa - water fern. Seen once in the tall scrub of the high ground.

Hymenophyllum revolutum. Occasional at the bases of *Cyathodes fasciculata* and fivefinger trees along the top of the internal scarp, usually with *H. sanguinolentum* but less abundant.

Hymenophyllum sanguinolentum. See above.

Hymenophyllum scabrum. At a few places along the central part of the internal scarp, and in the mouths here of the small gullies, on embedded pumice boulders or at the bases of *Cyathodes fasciculata* treelets.

Lycopodium volubile. Clothing the floor to the depth of 30 cm or so in the tall kanuka scrub beyond the large washout, much less common along the top of the stream scarp, and not present on the high ground.

Paesia scaberula. Uncommon in the tall scrub of the high ground not a pasture weed.

Pellaea rotundifolia. One vigorous colony in the tall kanuka scrub beyond the large washout, and another just below the internal scarp.

Phymatosorus pustulatus - houndstongue fern. Forming dense colonies at numerous places in the tall scrub, as along the internal scarp and beyond the large washout, but absent from this scrub over large areas too.

Pneumatopteris pennigera. A few large and healthy (but trunkless) plants in the narrow gully centrally on the high ground; also seen at the foot of the stream scarp.

Polystichum richardii agg. Local in the tall scrub of the high ground.

Polystichum vestitum. Dominant ground cover in the rather disturbed damp ground at the foot of the stream scarp; a few plants in the tall scrub of the high ground.

Pteridium esculentum – bracken. Co-dominant in the low scrub and sometimes present in the understorey of the tall scrub too.

Pteris tremula. A few small plants in the tall scrub of the high ground.

Trichomanes reniforme - kidney fern. Seen at one place, at the mouth of one of the short damp shady small gullies that come down across the internal scarp,

2.1.3.2 Gymnosperms

Podocarpus totara – totara. A couple of 3 m tall saplings in open scrub near the stream mouth close to the lake shore.

2.1.3.3 Dicot Trees & Shrubs

Brachyglottis repanda – rangiora. A few healthy plants in the tall scrub of the high ground; larger spreading individuals common along the internal scarp towards its southern end.

Coprosma lucida – karamu. In the tall scrub, mostly near the lake-scarp, to c. 3 m tall.

Coprosma robusta – karamu. Common throughout the low and high scrub areas, probably forming part of the canopy on the lake-scarp.

Coriaria arborea – tutu. Common throughout the low and high scrub areas. At the top of the stream scarp in the southeast corner of the study area some of the tutu in the canopy are 5 m tall and c. 40 cm basal diam.

Cyathodes fasciculata - mingimingi. Common in the tall scrub of the high ground in places where there is sufficient light, such as along the internal scarp and along the top of the lake-scarp; no individuals seen larger than c. 3 m tall 5 cm dbh.

Cyathodes juniperina – mingimingi. Usually with *C. fasciculata*, but much smaller (often as spreading bushes to c. 1 m tall) and less frequent.

Dracophyllum subulatum – monoao. A single suppressed 2 m tall treelet at one place on the top of the stream-scarp. This species was not seen in the general district as a scrub weed, the roadside patches being of low kanuka, Spanish heath, broom, bracken, fivefinger and toetoe.

Fuchsia excorticata - tree fuchsia, kotukutuku. Common at the foot of the stream scarp between the tall kanuka of the floodplain and the fivefinger scrub of the scarp itself.

Gaultheria antipoda. Occasional in the tall scrub wherever there is sufficient light, becoming plentiful in the lower-stature scarp along the top of the lake scarp.

Gaultheria paniculata. As above, but less frequent. There are hybrids between the two species.

Geniostoma ligustrifolium – hangehange. Common locally in the tall scrub of the high ground, particularly near the top of the lake-scarp, and in the tall kanuka scrub beyond the large washout in the southwest of the study area.

Hebe stricta – koromiko. Common wherever the scrub is low enough or the canopy sufficiently open.

Hoheria sexstylosa – lacebark. Young plants seen in the damp tall kanuka scrub on the stream floor.

Knightia excelsa – rewarewa. Except for a few seedlings and saplings rewarewa occurs in the study area only at the southeast corner of the higher ground and on the stream scarp here, where there are three or four young bushy canopy trees c. 8 m tall and 15 cm dbh. All around Lake Taupo this species commonly succeeds kanuka, being wind-dispersed and having some moderate degree of shade tolerance.

Kunzea ericoides – kanuka. Conspicuous as an emergent over some of the high ground and canopy-forming over much of the rest of the tall scrub, mostly to c. 12 m tall and 15 cm dbh, but in places, such as along the internal scarp and west of it, to c. 16 m tall and 25 cm dbh. Trees of latter stature form a more or less continuous canopy along the stream floodplain. On the stream scarp the kanuka are of this size near the large washout, but are smaller and less common in the lakewards direction, and the species seems to be entirely lacking from the lake- scarp.

Leptospermum scoparium – manuka. A few smallish individuals in the low scrub.

Melicytus ramiflorus – mahoe. Only a couple of young plants seen in the tall scrub of the high ground.

Myrsine australis – mapou. Mostly as understorey individuals to c. 2 m tall in the southwest corner of the tall scrub beyond the large washout. Seemingly absent from the groups of fivefinger, kohuhu etc. in the low scrub, and not reaching the canopy anywhere.

Olearia rani – heketara. One young individual c. 3 m tall in the scrub of the high ground.

Pittosporum tenuifolium (incl. *P. colensoi*) – kohuhu. Common throughout the scrub areas, the largest individuals of the tall scrub on the high ground being c. 12 m tall and 20 cm dbh.

Pseudopanax arboreus - fivefinger, whauwhaupaku. Abundant throughout the scrub areas, flowering and fruiting at the time of survey and giving nectar and fruit for silvereye, bellbirds and tui especially. Dominant over part of the high ground, though the individuals there are not especially large (a fair number of them are dead or dying).

Pseudopanax crassifolius - lancewood, horoeka. One sapling seen in the low scrub. Possibly there are additional adults in the tall kanuka scrub of the stream floodplain.

Weinmannia racemosa – kamahi. One small subcanopy individual seen, in the tall scrub of the high ground.

2.1.3.4 Dicot Herbs & Climbers

Acaena anserinifolia. Small, unthrifty patches at a few places in the tall scrub of the high ground.

Clematis sp. (*C. forsteri* or *C. paniculata*) – puawananga. A few juvenile growths in open places in the tall scrub of the high ground.

Crassula sinclairii. Plate-sized colonies (none of them fertile) are quite on damp sand near the stream mouth.

Epilobium cinereum. Common along the tops of the inner sandy beach ridges.

Epilobium pallidiflorum. With *E. cinereum* and as common, but new plants are most plentiful on damper sand towards the stream edge and inter-ridge depressions.

Geranium potentilloides. A few plants among the lupin and mullein on the higher part of the recently made track through the low scrub.

Gnaphalium sphaericum. As above, but more abundant.

Haloragis erecta. Here and there on the edges of the low scrub.

Hydrocotyle dissecta. One small colony seen on a pad of humus in the tall scrub of the high ground.

Parsonsia capsularis. Abundant in the disturbed tall kanuka on the stream floodplain towards the stream mouth, not seen on the high ground.

Pelargonium inodorum. A few plants among the lupin and mullein on the higher part of the recently made digger-track through the low scrub..

Ranunculus reflexus – maruru. Common on pig-disturbed hummocks in the tall scrub of the high level ground; no flowering or fruiting individuals seen.

Stellaria parviflora. Common though not especially vigorous on pads of humus around the bases of the larger trees (particularly kanuka) of the tall scrub of the high ground, and also in other places of low competition, such as the undercut face of the top of the lake-scarp.

2.1.3.5 Monocots

Acianthus fornicatus. The study area's only orchid, a few plants at one place in the tall scrub of the high ground.

Astelia solandri. kowharawhara. Occasional on the ground along the stream-scarp, not seen as an epiphyte.

Astelia fragrans. Seen once on the stream-scarp; probably common along the stream's floodplain.

Cordyline australis - cabbage tree, ti. One emergent individual seen in the tall scrub of the high ground. From a distance it seemed not to be any older than the fivefinger around it, but its basal size was not checked. Cabbage trees, young or old, are absent from the low scrub within the study area and from the extensive scrub beyond to the north.

Cortaderia fulvida – toetoe. Abundant along the stream edge. A few suppressed tussocks seen in the scrub of the high ground.

Deyeuxia avenoides. Mostly among bryophyte growths around the bases of trees on the face of the internal scarp.

Dianella nigra - blueberry, turutu. Occasional healthy tussocks in the tall scrub of the high ground, especially along the top of the internal scarp, but not dominant here or anywhere else.

Luzula picta – woodrush. Scattered narrow-leaved colonies on the short face immediately below the lip of the lake-scarp, wherever the overhanging growths of spleenwort and *Poa anceps* allow.

Phormium tenax - flax, harakeke. A few suppressed individuals at places along the top of the stream-scarp; possibly of local occurrence along the stream's floodplain, but only sited right at the Lake shore under willows.

Poa anceps. Forming thick hanging or hummocked colonies a metre or so in diameter in open places such as occur locally along the scarp tops.

Uncinia distans – hookgrass. Common in much of the tall scrub of the high ground.

Uncinia uncinata – hookgrass. Only seen once, a large healthy tussock in the tall scrub of the high ground.

2.1.4 Assessment of Significance of North Side Vegetation

The study area is located in the Taupo Ecological District (E.D.). The southwestern boundary of this E.D. runs lakewards along the Kuratau River then turns south to take in a narrow strip of lake-edge terrain until Turangi and the Tongariro River is reached. In this way it comprises mostly level terraced ground whose soil is formed mainly from deposits of Taupo Pumice. It also includes several rocky rhyolite domes (in the immediate vicinity of the study area: Pukekaikiore and Rangitukua).

The study area falls within the jurisdictions of Environment Waikato and the Taupo District Council. A "guideline document" recently prepared for Environment Waikato (Wildland Consultants Ltd, 2002) offers a mechanical procedure for assessing "significance" and for determining whether this significance ranks at local, regional, national or international level.

With respect to the study area, the only two of the eleven "Significance Criteria" of Table 1 of the above-cited document that might apply are Criterion 4 and Criterion 9.

Criterion 4 is concerned with whether the study area might be indigenous vegetation or habitat that is under-represented (10 % or less of its known or likely original extent remaining) in its Ecological District.

Material relevant to Criterion 4 is as follows. The pre-European vegetation around the western side of Lake Taupo is known to have been composed largely of scrub and bracken – refer Figures 5 and 6 showing the forest edges of the district as they were in the late 19th C. (Kerry-Nicholls, 1884; Anon. 1908). Three influences -fire, poverty of the soil, and distance from sources of forest seed, have acted together to maintain these communities and prevent forest reestablishment. So this scrubby vegetation, although undistinguished with respect to plant diversity and perhaps without any unique features, has long been characteristic of an extensive part of its E.D., and it has been substantially depleted in the last 50 years by the large-scale clearances for farming and by the creation of subdivisions at Pukawa, Omori, Whareroa and Kuratau.

An assessment of post-1840 vegetation change in the Waikato Region (i.e. under jurisdiction of Environment Waikato), was carried out by Leathwick *et al.* (1995). In their Tables 2 and 5, the summaries for Ecological Districts, they found for the Taupo E.D (at least, as far as they sampled it), that slightly more than half of the 1840 cover was secondary forest, scrub etc. (Most of this is shown on their Map 4 as secondary vegetation on plateaux - Taupo Basin). The other type of scrub at 1840 in the Taupo E.D. they classed as "secondary vegetation on [rhyolite] domes - Taupo Basin". Both these kinds of secondary vegetation would have contained tall kanuka, fivefinger, bracken, tutu, etc., similar to that of the study area.

"Secondary forest and scrub" today is estimated by Leathwick *et al.* (1995) to cover only 8.1 percent of the Taupo E.D, that is, it has been reduced to c. 16 % of its 1840 coverage. But for the subtype "on plateaux-Taupo Basin" this reduction would be proportionally more severe because it has generally been cleared, while much of the scrub of the rocky rhyolitic domes has been retained. Therefore the remaining amount of good-quality scrub "on plateaux-Taupo Basin" in the Taupo E.D. would fall below 10% of its pre-European cover, that is, below what is often taken to be a reasonable lower limit for the extent of reduction of any particular type of native vegetation in an E.D.

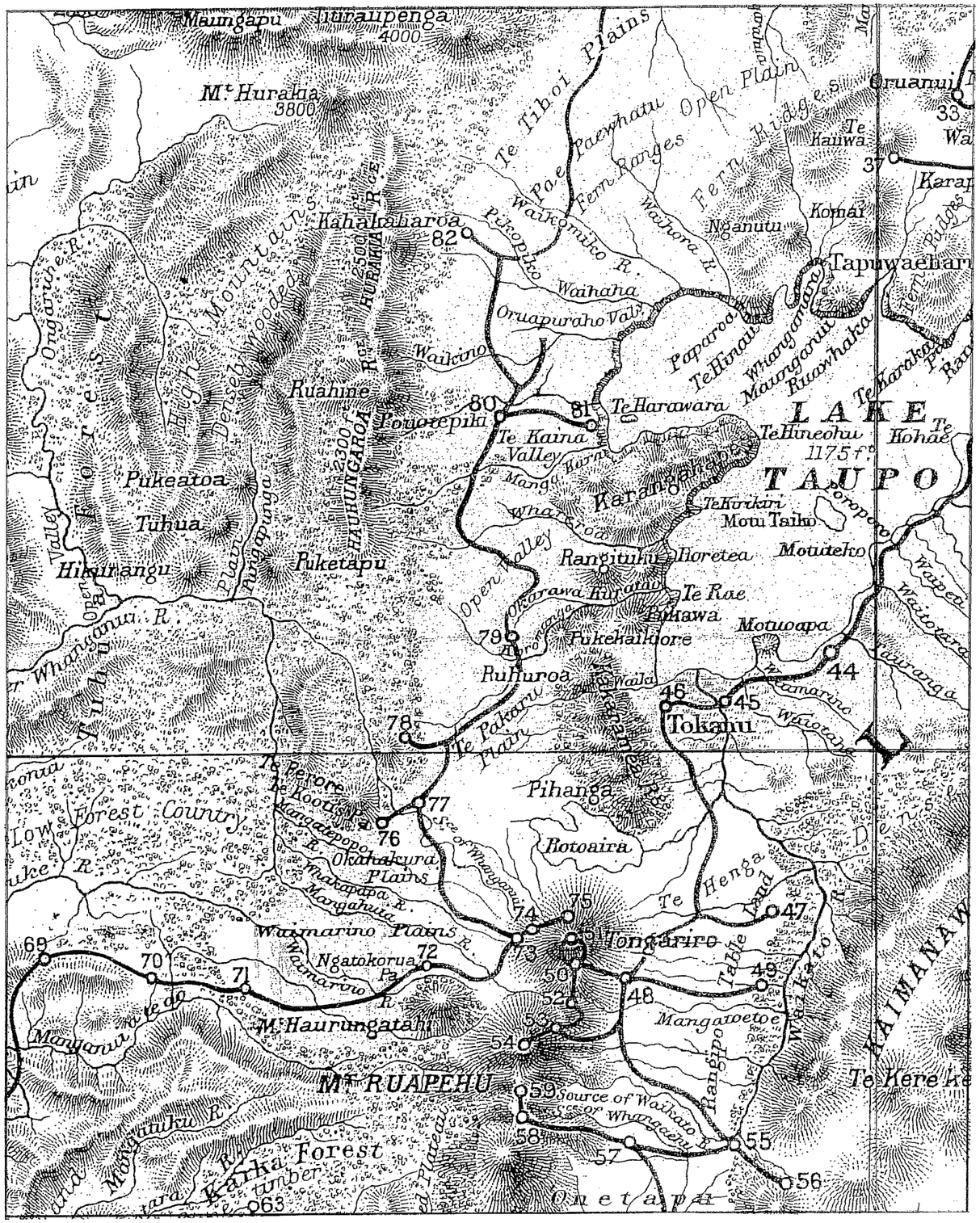

FIGURE 5 FOREST EDGES SHOWN IN KERRY-NICHOLLS, 1884

HE TONGARIRO TIM
R COMPANY, LTD.

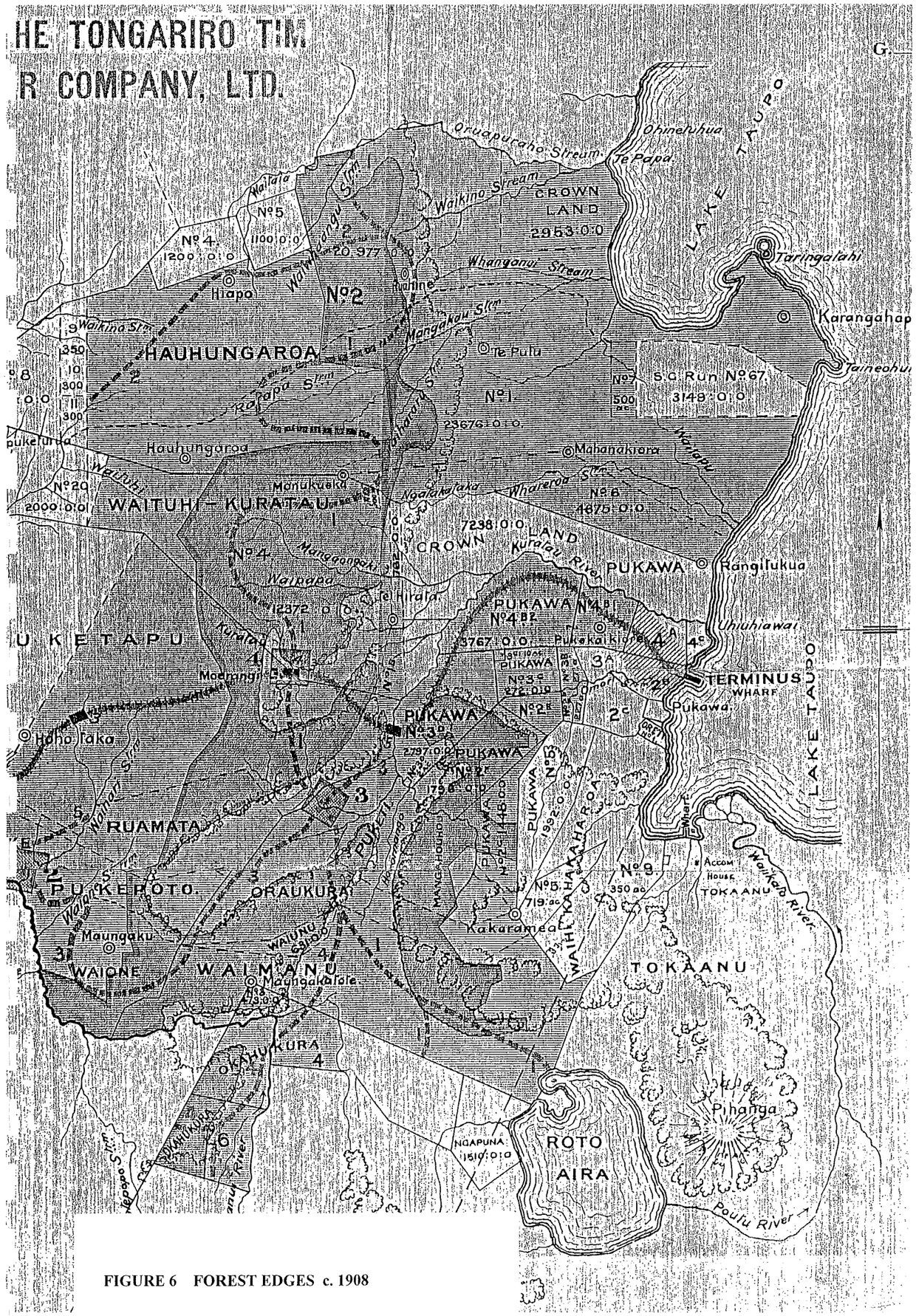

FIGURE 6 FOREST EDGES c. 1908

Criterion 9 of the Environment Waikato "guideline document" concerns Representativeness. "It is an area of indigenous vegetation ... that is a healthy representative example of its type because its structure, composition and ecological processes are largely intact [this can be taken to mean that the topography is largely undisturbed and that exotic species are present in only minor degree], and if protected from the adverse effects of plant and animal pests and of adjacent landuse [it] can maintain its ecological sustainability over time".

Table 1 on Representativeness further states: "*Representative areas are sites (sic) that are the best examples of sites that form a network covering the full range of landforms, soil sequences, vegetation and fauna (sic) communities within an Ecological District. The reality for many landscapes, particularly throughout much of the Waikato, is that a 'representative example' will be the larger and most diverse remaining examples of indigenous vegetation and habitats.*"

In the absence of a full Protected Natural Areas (P.N.A) survey, it is difficult to apply this Criterion objectively, but it would seem that whenever a kind of vegetation or habitat type has clearly been depleted to the 10% level within an E.D, most or all of the remaining healthy examples should be given Representativeness. That is, there would need to be a good reason not to give the study area this attribute.

In isolation, the North Side Development Area's vegetation is likely to rate as "locally significant", but it is part of and contiguous with a significantly larger area which in total would be "regionally significant". The nearby Whareroa Stream Riparian Habitat would itself rate as being "regionally significant" because its habitat is protected under a Department of Internal Affairs conservation covenant.

There seem to be no unique or otherwise noteworthy botanical features in the study area. All of its higher-plant species are reasonably common within the Taupo E.D. (although those in its shoreline herb communities noted as important in DoC 1994 may be becoming depleted).

Special attention was paid during the survey of the site to locating any colonies of the two species of mistletoe (*Ileostylus micranthus* and *Tupeia antarctica*), which occur in similar shoreline scrub between Omori and the Waihi. None was seen.

Overall, no rare or endangered plants or important plant communities identified as notable in the Taupo Basin (DoC, 1994) were recorded in the proposed subdivision area.

2.2 Wildlife

2.2.1 Introduction

Replicated (n = 3) five-minute bird counts were undertaken and pre-set recorders deployed to assess the presence of nocturnal species. Searches for reptiles were undertaken and the presence of mammals was noted.

2.2.2 Methods

Standard, but replicated, five-minute bird counts were undertaken at nine stations (Figure 7) providing a total of 27 individual counts. All birds seen and/or heard were recorded. The air temperature at each station was measured using a quartz digi-thermo (-10 to +110°C) thermometer, wind speed and barometric pressure were measured with a Silva Alba Windwatch and observations aided by Nikon 10 x 42 binoculars.

Pre-set recorders were deployed on the nights of 26 July and 16 August 2005. The recording systems consist of two Sony TCM–818 recorders, each of which is activated by a pre-set, wind-up, 6 hour mechanical timer. Each system contains a microphone power pack serving an AKG (C562CM) boundary layer microphone that is mounted on a hinged 0.5 m x 1.0 m board set vertically. The systems are housed in Pelican cases.

The recorders (Figure 7) were set as follows:

26 July 2005 (sunset c.1730 hours)

Recorder I	1800 – 1855 hours
Recorder II	1900 – 1955 hours

16 August 2005 (sunset c.1740 hours)

Recorder I	1900 – 1955 hours
Recorder II	2000 – 2055 hours

The recorders were deployed for a second night (on 16 August) because of possible heavy showers during the 1800 – 2000 hours period on 26 July that may have affected the frequency of nocturnal activity.

Reptiles were searched for under fallen logs and general plant debris and specifically under loose bark that was frequent on kanuka trees. Evidence of the presence of other animals was also recorded.

2.2.3 Habitat

The details of the vegetation and flora of the area have been described in Section 2.1. Aside from the grazed pasture, there were generally three broad habitat types – lower regenerating scrub in the northern part of the block, a gently sloping southern area that consisted of taller fivefinger and kanuka, and the upper, steeper kanuka and fivefinger-clad slopes of the Lake frontage and on the southern side adjoining the Whareroa Stream.

The taller vegetation has a relatively open understorey with considerable pig damage in places, whereas the lower northern scrub is quite dense. Low native scrub is present in the adjoining property on the northern side while the western perimeter abuts grazed pasture. The survey area is contiguous with broadly similar habitats to both the north (low scrub) and west (riparian kanuka and fivefinger) and is a relatively small part of a larger contiguous area of Lake edge vegetation that extends to Tangingatahi Point, about ten kilometres to the north. The northern vegetation includes Te Hapua Bay Scenic Reserve (S.R.) (234 ha) that is described as fivefinger – kohuhu forest and pine plantation (DoC, 1994). Just south of Whareroa is the Rangitukua S.R., a 210.6 ha area containing kamahi forest, kanuka forest, kowhai – kanuka forest, fivefinger – kohuhu forest, bracken fern-land, cliff or outcrop rock-land and raupo reed-land. (DoC, 1994). A roughly contiguous Lake-edge zone of native vegetation, some of which contains Lake-side settlements (Kuratau, Omori, Pukawa and Waihi), is then present to Tokaanu, about 12 km to the south, and further south to Lake Rotoaira.

Conditions during the five-minute counts were as follows.

There was no wind or rain and other noise was not important. Overcast conditions prevailed at Stations 1 to 6 but sun was on the canopy for 5 to 15 minutes at Stations 7 to 9 inclusive. Counts were undertaken between 1010 and 1514 hours. The average air temperature was 10.7°C (SD = 0.7; range 9.6 – 12.0°C) and the average barometric pressure 97.4 kPa (kilopascals; 974 millibars; SD = 0.2; range 972 – 976 kPa).

2.2.4 Avifauna

2.2.4.1 Species Diversity

Species recorded during the survey are listed in Table 2.2.1. A total of 12 species was recorded, four endemics, three native and five introduced. No threatened species was recorded and, based on the habitat types, none is likely to utilise the area on a regular basis.

TABLE 2.2.1 SPECIES RECORDED IN THE NORTH SIDE DEVELOPMENT AREA DURING THE FIELD SURVEY

COMMON NAMES	SCIENTIFIC NAME
australian magpie	*Gymnorhina tibicen*
bellbird; korimako †	*Anthornis melanura melanura*
blackbird	*Turdus merula*
chaffinch	*Fringilla coelebs*
fantail; piwakawaka •	*Rhipidura fuliginosa placabilis*
goldfinch	*Carduelis carduelis*
grey warbler; riroriro †	*Gerygone igata*
silvereye; tauhou •	*Zosterops lateralis lateralis*
song thrush	*Turdus philomelos*
tui †	*Prosthemadera novaeseelandiae novaeseelandiae*
welcome swallow •	*Hirundo tahitica neoxena*
whitehead; popokatea †	*Mohoua albicilla*

• native species : naturally found in New Zealand.
† endemic species : natural range is New Zealand only.

(NONE OF THE ABOVE IS A THREATENED SPECIES)

There were no significant preferred food trees within the survey area for New Zealand pigeon (*Hemiphaga novaeseelandiae novaeseelandiae*; kereru) and no pigeons were recorded. New

Zealand pigeon has been recorded from both Te Hapua Bay S.R. in the north and Rangitukua S.R. to the south on a seasonal basis (DoC, 1994) and it was relatively common in the Pukawa residential area on 17 August 2005 where it was mainly feeding on kowhai leaves. New Zealand pigeon may visit this area on an intermittent basis and will feed on young kanuka leaves (pers. obs.) – it is a threatened species (Hitchmough, 2002) with a rating of "gradual decline" (i.e. chronically threatened) mainly as a result of recruitment failure.

New Zealand falcon (*Falco novaeseelandiae*; karearea) has also been reported from the above Scenic Reserves (DoC, 1994) and may occur over the site on an intermittent basis. It is also a threatened species with a rating of "gradual decline". No suitable breeding habitats (i.e. cliff ledge, slip face, under rock overhang, under fallen log, high in tall trees) are present within the survey area but intermittent hunting by falcon may occur over the site. No NZ falcons were observed during any of the field surveys or site visits.

The only other threatened species likely is the migratory long-tailed cuckoo (*Eudynamys taitensis*; koekoea) which is also considered to be in "gradual decline" although the database is stated to be poor. Long-tailed cuckoo in the North Island mainly lays its eggs in the nests of whitehead, a species which was recorded within the site. Adults return to New Zealand in about early October and egg laying occurs in November – December.

Morepork (*Ninox novaeseelandiae novaeseelandiae*; ruru) was not recorded but occurred in the Whareroa Riparian area – it would also utilise the North Side Development habitat at times.

Overall the regular avifauna is likely to be dominated by common native and endemic species as follows:-

abundant	• fantail • grey warbler • silvereye • welcome swallow
common	• bellbird • tui
locally common	• whitehead

(Heather & Robertson, 2000)

2.2.4.2 Percentage Occurrence

The frequency of each species in the total number of individual counts (n = 27) is shown below as a percentage –

100.00	bellbird
	silvereye
77.8	tui
70.4	fantail
62.9	grey warbler
48.1	blackbird
	song thrush
40.7	australian magpie
37.0	chaffinch
14.8	welcome swallow
7.4	whitehead
3.7	goldfinch

The five most frequently occurring species (bellbird, silvereye, tui, fantail and grey warbler) are all endemic or native birds. The most common introduced species, blackbird and song thrush, occurred in less than 50% of the counts.

2.2.4.3 Five-minute Counts

The five-minute count results are shown in Table 2.2.2 averages of three replicate counts per station and provide an indication of relative abundance or conspicuousness.

Although average diversity appeared biased towards native species (5.22) as opposed to introduced species (2.44) the difference was not statistically significant.

There was, however, a significantly higher average number of native individuals recorded (24.63) than introduced individuals (2.37) (chi-squared = 18.4; $p<0.001$) and overall the avifauna was clearly dominated by native species and individuals.

TABLE 2.2.2 **NORTH SIDE DEVELOPMENT AREA – FIVE-MINUTE BIRD COUNT RESULTS (averages of three replicate counts per station)**

	STATION									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**mean**
australian magpie	2.00	3.67	0.67	0.67	–	1.00	–	–	–	0.89
bellbird •	4.67	3.33	3.67	2.00	5.67	5.00	4.00	4.33	3.67	4.04
blackbird	1.00	0.33	–	–	1.00	1.00	0.67	–	–	0.44
chaffinch	–	–	0.33	1.33	0.33	–	0.67	–	0.67	0.37
fantail •	–	0.33	3.67	5.00	2.00	1.33	2.67	1.67	1.33	2.00
goldfinch	–	–	–	–	–	–	0.33	–	–	0.04
grey warbler •	–	1.00	1.33	2.00	0.33	1.67	1.33	1.33	1.67	1.18
silvereye •	8.33	19.00	18.00	20.00	14.67	15.33	62.00	12.00	14.33	14.85
song thrush	1.00	–	–	0.33	1.33	1.33	0.67	–	1.00	0.63
tui •	2.33	2.33	1.33	1.00	1.33	0.67	1.33	–	2.00	1.37
welcome swallow •	0.33	0.67	4.00	–	–	–	0.33	–	–	0.59
whitehead •	–	–	–	–	–	–	–	5.33	–	0.59
TOTAL NATIVE (•) SPECIES	4	6	6	5	5	5	6	5	5	5.22
TOTAL NATIVE INDIVIDUALS	15.66	26.66	32.00	30.00	24.00	24.00	21.66	24.66	23.00	24.63
TOTAL INTRODUCED SPECIES	3	2	2	3	3	3	4	0	2	2.44
TOTAL INTRODUCED INDIVIDUALS	4.00	4.00	1.00	2.33	2.66	3.33	2.34	–	1.67	2.37

The most abundant species were also the most frequent but silvereye clearly dominated as summarised below –

average count	
14.85	silvereye
4.04	bellbird
2.00	fantail
1.37	tui
1.18	grey warbler
0.89	australian magpie
0.63	song thrush
0.59	welcome swallow
	whitehead
0.44	blackbird
0.37	chaffinch
0.04	goldfinch

The two most abundant species were silvereye and bellbird which were clearly attracted to the fruiting and flowering fivefinger respectively, followed by fantail.

2.2.4.4 Nocturnal Recordings

No nocturnal species were recorded during a total of 3 hours 40 minutes of survey but morepork would utilise this area. Long-tailed cuckoo may also occur but this survey was probably too early to record their presence with adults returning in about early October.

2.2.5 Reptiles

No reptiles were located during searches of debris piles, under fallen logs and branches, and under loose kanuka bark.

2.2.6 Other Wildlife

Occasional possum pellets were noted in the Station 1 to 6 areas. Rabbits were also occasional at the pasture – native vegetation margins and pig rooting was common in the southern section of the block. A range of additional animal pests can be anticipated. No community-based (landcare group) pest control occurs in this area but it is treated with 1080 poison.

2.2.7 Conclusions

The North Side Development Area contains mainly tall fivefinger-kanuka habitat but also an area of low regenerating scrub in its northern section. That habitat supports an avifauna that is dominated by common native and endemic species and individuals. A moderate diversity of species was recorded but the average number of native/endemic individuals was relatively high. That was mainly the result of abundant silvereye that were attracted to the fruiting fivefinger. Some species were also clearly involved in pre-breeding activities and were more conspicuous as a result.

No threatened species was recorded but intermittent use of the habitat by long-tailed cuckoo is probable, especially as its host species, whitehead, was recorded in this area. No other significant wildlife was recorded.

Overall the avifauna is likely to be similar to that in Lake edge areas to both the north and south of the Development Area and any especially notable features would seem unlikely based on this survey.

3 WHAREROA STREAM RIPARIAN HABITAT

3.1 Vegetation and Flora

3.1.1 Introduction

The Whareroa Stream rises in the hill country on the eastern side of the Hauhangaroa Range at c. lat. 38 deg. 50 min. and runs to Lake Taupo c. 14 km away in an incised course through terraced country now almost entirely in pasture. Presumably because this stream is important for trout-spawning its steep scrub-covered sides have been put under a Department of Internal Affairs conservation covenant. The lakeward end of this riparian covenant, c. 500 m long and 250 m wide, was the subject of this survey.

On its southern side, on the terrace where the sewage treatment plant of Whareroa Village sits, there is cleared rough grassland and patches of low scrub, this latter dominated by exotic species like broom (*Cytisus scoparius*) and Spanish heath (*Erica lusitanica*), but also with bracken (*Pteridium esculentum*) and kanuka (*Kunzea ericoides*). On the corresponding terrace on the northern side of the valley is the pasture of Whareroa Station.

3.1.2 Vegetation

A sketch map of the study area, based on a colour aerial photograph (date flown 15 October 2002) is shown in Figure 8, and the captions for its vegetation/topography zones **1** and **2** are elaborated on as follows.

1. Tall scrub of fivefinger and kanuka

Although the stream is quite fast-flowing it has a meandering course, and the average width of the presently flood-prone segments is c. 50 m. This zone is dense and impenetrable in places, much of its undergrowth being blackberry, Himalayan honeysuckle and bracken.

The stream comes in hard against the northern side of the valley for approximately the first (upstream) half of its course through the 500 m long study area, creating bare

1. Scrub of tall kanuka and fivefinger on steep slopes north of stream and up onto level ground
2. Mixed scrub on south side of stream including floodplain vegetation

covenanted area extends upstream

pine plantation

vehicle track

red beech

low scrub - bracken, broom, spanish heath on slope to houses

1

2

NZ Aerial Mapping Ltd

FIGURE 8 WHAREROA STREAM RIPARIAN VEGETATION AREAS

1:4000
15 October 2002

N ↑

near-vertical faces 5 m or more in extent, the older and more stable parts of which are clothed with kiokio (*Blechnum novae-zelandiae*). Elsewhere the stream is flanked by usually fairly narrow floodprone segments whose tops are about 2 metres above the streambed. They carry low scrub and open areas of adventive grasses, toetoe (*Cortaderia fulvida*), and *Carex geminata.* The scrub species here are bracken, blackberry, Himalayan honeysuckle (*Leycesteria formosa*), tutu (*Coriaria arborea*), koromiko (*Hebe stricta*), toetoe, kiokio and kanuka. Crack willow (*Salix fragilis*) is present on some of the segments, accompanied mainly by blackberry and Himalayan honeysuckle.

The metre or so high near-vertical stream banks are composed of fine alluvium and are not especially suitable for the growth of smaller rheophytic plants, but in the former MAF fish trap area there are some colonies of creeping willowherb (*Epilobium pedunculare).*

Older vegetation of the valley floor is dominated by kanuka, the individuals of which may reach c. 15 m tall and 25 cm dbh. Cabbage trees (*Cordyline australis*) are a feature of the higher ground to the south but only a few comparable in size to the kanuka grow close to the stream. The kanuka have long trunks and their short narrow canopies are generally unthrifty being broken-topped and clad in *Usnea* lichen. Fallen kanuka of this size are numerous. Kohuhu is the most abundant tree in the generally rather sparse subcanopy, but tree fuchsia (*Fuchsia excorticata*) and lacebark (*Hoheria sexstylosa*) are also present. Tree ferns are represented locally by rather small individuals of wheki (*Dicksonia squarrosa*) and wheki ponga (*D. fibrosa*). Much of the cover between the kanuka trees is of blackberry or Himalayan honeysuckle, while sheets of *Parsonsia capsularis* and *Muehlenbeckia australis* are present wherever there is a subcanopy tree to climb on.

On the northern side of the valley there is level ground against the fence and pasture above slopes that generally descend fairly steeply for 30 metres or so to the stream, though in some places there are intervening shelves 5-10 metres wide.

The level ground in from the fenceline is widest (c. 150 m) in the east. It mostly carries a scrub of tall kanuka (to c. 15 m tall 20 cm dbh) whose canopy density varies

considerably from place to place. An understorey of kohuhu and fivefinger, to c. 8 m tall, stands over an often dense lower layer of shrubs (hangehange, *Coprosma lucida*, fivefinger, *Cyathodes fasciculata*); some damper places though are infested with Himalayan honeysuckle and blackberry. Wherever the latter two species are not present the groundcover is dominated by houndstongue fern and *Uncinia distans*, with lesser amounts of *Asplenium flaccidum* and *A. hookerianum*. Some places, for no obvious reason, are blanketed with *Lycopodium volubile* (perhaps as a recolonist after pig-rooting?).

Particularly towards the west and near the fenceline there are areas of dense blackberry and bracken rather than scrub.

As the ground steepens to the south the kanuka thin out though they are generally of somewhat greater size than those upslope. The kanuka higher on the slope are mostly healthy, but down towards the stream many are decrepit, and fallen ones are common. Higher on the slope fivefinger forms a tall understorey, but downslope it is more or less replaced by a layer of ferns, particularly kiokio and *Polystichum vestitum*, and also both species of wheki tree-fern (individuals of these to c. 1.5 m tall). *Astelia fragrans* is abundant on the several shelving areas part of the way downslope, particularly where the kanuka is dying out.

Along the western part of the stream's course through the study area the very steep slope above the bare near-vertical faces here have a 2-3 m tall scrub of slender-stemmed outward-growing individuals of fivefinger and *Cyathodes* spp., over a thick ground cover of houndstongue fern, hanging spleenwort, *Uncinia distans* and bryophytes.

2. Mixed scrub

Between the present-day actively meandering zone (part of **1**. above) and the slope up to the sewage ponds and Whareroa Road there is a lakewards-broadening band of former floodplain segments. In the time since the stream left them behind there has been relatively little vegetation development, for example, there are no especially large kanuka here, nor any young podocarps. This may partly be explained by

microclimatic factors (especially winter low temperatures and cold air ponding), while the absence of podocarps would be due to distance from seed sources.

The present-day scrub cover on this zone towards the stream is one in which kohuhu and kanuka c. 3-6 m tall stand among a dense shorter growth mostly of bracken, broom, koromiko, tutu, *Coprosma robusta*, *Cyathodes fasciculata* and *C. juniperina* and Himalayan honeysuckle. There are infrequent individuals of manuka *(Leptospermum scoparium*), *Coprosma propinqua* and *Coprosma "tayloriae"*. The absence of fivefinger in the canopy is presumably because the site is too cold for it. The ground cover is composed of kiokio, *Uncinia uncinata* and *U. distans*, *Astelia fragrans*, *Dianella nigra*, *Polystichum vestitum* and *Poa anceps*.

The apparent youthfulness of this scrub is belied by the several dozen or so large cabbage trees (to c. 11 m tall and 30 cm dbh) it contains, the greater number of them being sited towards the south side of this zone, where the ground begins to rise up to the sewage ponds terrace.

The scrub on the slope up to the ponds is generally similar in its composition to on the valley floor except that bracken and young kanuka provide a larger amount of the cover. An unexpected record here (see Figure 8 for location) was a cluster of three young red beech trees (*Nothofagus fusca*), the largest being c. 15 m tall and 25 cm dbh.

It is notable that, except for the two divaricating species of *Coprosma* and manuka, "frost-flat" species, e.g. monoao (*Dracophyllum subulatum*) and mountain toatoa (*Phyllocladus alpinus*), are absent.

3.1.3 Flora

62 native higher-plant species were recorded

3.1.3.1 Ferns & Fern-allies

Asplenium bulbiferum - hen and chickens fern
Asplenium flaccidum - hanging spleenwort
Asplenium hookerianum

Asplenium oblongifolium - shining spleenwort.

Asplenium polyodon

Blechnum discolor

Blechnum novae-zelandiae - kiokio

Blechnum vulcanicum

Ctenopteris heterophylla

Dicksonia fibrosa - wheki-ponga

Dicksonia squarrosa - wheki .

Histiopteris incisa - water fern .

Hymenophyllum revolutum

Hymenophyllum sanguinolentum

Hymenophyllum scabrum

Lycopodium volubile

Paesia scaberula

Phymatosorus pustulatus - houndstongue fern

Pneumatopteris pennigera

Polystichum richardii agg.

Polystichum vestitum

Pteridium esculentum - bracken

3.1.3.2 Dicot Trees & Shrubs

Brachyglottis reparida - rangiora

Coprosma lucida - karamu

Coprosma propinqua

Coprosma robusta - karamu

Coprosma "tayloriae"

Coriaria arborea - tutu

Cyathodes fasciculata - mingimingi

Cyathodes juniperina - mingimingi

Fuchsia excorticata - tree fuchsia, kotukutuku

Gaultheria antipoda

Geniostoma ligustrifolium - hangehange

Hebe stricta - koromiko

Hoheria sexstylosa

Kunzea ericoides - kanuka

Leptospermum scoparium - manuka

Melicytus ramiflorus - mahoe

Myrsine australis - mapou

Nothofagus fusca - red beech

Pittosporum colensoi - kohuhu

Pseudopanax arboreus - fivefinger, whauwhaupaku

3.1.3.3 Dicot Herbs & Climbers

Clematis sp. (C. forsteri or C. paniculata) - puawananga

Epilobium pedunculare

Lagenifera minima

Muehlenbeckia australis

Parsonsia capsularis

Pelargonium inodorum

Ranunculus reflexus – maruru

Rubus schmidelioides

Stellaria parviflora

3.1.3.4 Monocots

Astelia fragrans

Cordyline australis - cabbage tree, ti

Cortaderia fulvida - toetoe

Deyeuxia avenoides

Dianella nigra - blueberry, turutu,

Lepidosperma australe

Phormium tenax - flax, harakeke

Poa anceps

Rytidosperma gracile

Uncinia distans - hookgrass

Uncinia uncinata – hookgrass

3.1.4 Assessment of Significance of Riparian Vegetation

The assessment of vegetation in the North Side Development Area is presented in 2.1.4 and concluded that, relative to the Environment Waikato guideline document, the vegetation would comply with two criteria – an under-represented vegetation type and an area of representative vegetation. In isolation it would probably rate as "locally significant" but is part of a "regionally significant" area.

That conclusion would apply to the Whareroa Stream Riparian vegetation with the same caveat regarding the representativeness criterion (i.e. that in the absence of a full Protected Natural Areas (PNA) survey, an objective application of this criterion is difficult) except that it is subject to a Department of Internal Affairs conservation covenant and is therefore "regionally significant" automatically.

The riparian vegetation did not contain any unique or noteworthy botanical features and all of its higher-plant species are relatively common within the Taupo Ecological District.

No species of mistletoe (*Ileostylus micranthus*) and (*Tupeia antarctica*) which occur in the Omori to Waihi area were located.

No rare or endangered plants or important plant communities identified as notable in the Taupo Basin (DoC, 1994) were recorded.

3.2 Wildlife

3.2.1 Introduction

Replicated (n = 3) five-minute bird counts were undertaken, as within the North Side Development Area, and a pre-set recorder was deployed to assess the presence of nocturnal species. Searches for reptiles were undertaken and the presence of mammals was noted.

3.2.2 Methods

The same methodology as outlined in Section 2.2.2 was employed. Five-minute counts were undertaken at nine stations (Figure 9) providing a total of 27 individual counts.

A pre-set recording system was deployed on the night of 16 August 2005 (Figure 9) and consisted of the device described in Section 2.2.2.

16 August (sunset c.1740 hours)

Recorder I	1900 – 1955 hours
Recorder II	2000 – 2055 hours

3.2.3 Habitat

Details of the vegetation and flora are presented in Section 3.1.

The two main habitat types were the regenerating scrub on the valley floor (stream floodplain) and the emergent kanuka over, mainly, fivefinger on the northern slopes and flat areas above Whareroa Stream.

The floodplain vegetation is dominated by bracken, kohuhu, low kanuka, and weedy species with only a few larger emergents eg. cabbage tree, red beech, tree-fern. In contrast the northern vegetation contains abundant tall emergent kanuka, some of which are very lichenised and have very sparse crowns, and a fivefinger-dominated understorey that ranges from sparse to dense. In places the fivefinger canopy is virtually closed, especially in the upper northeastern part of the survey area. Pig damage was severe in that area and sporadic throughout. A summary of other, broadly similar, habitats in the local area is given in Section 2.2.3.

Conditions during the five-minute counts were as follows. On 16.8.05 (Stations 1 – 4 inclusive) conditions were cloudy (no rain) with zero to full sun on the canopy and occasional westerly wind gusts of up to 2 kts down the valley. On 17.8.05 conditions were clear with zero wind and full sun on the canopy. Other noise was not important. Counts were undertaken between 1030 and 1537 hours with an average air temperature of 10.6°C (SD =

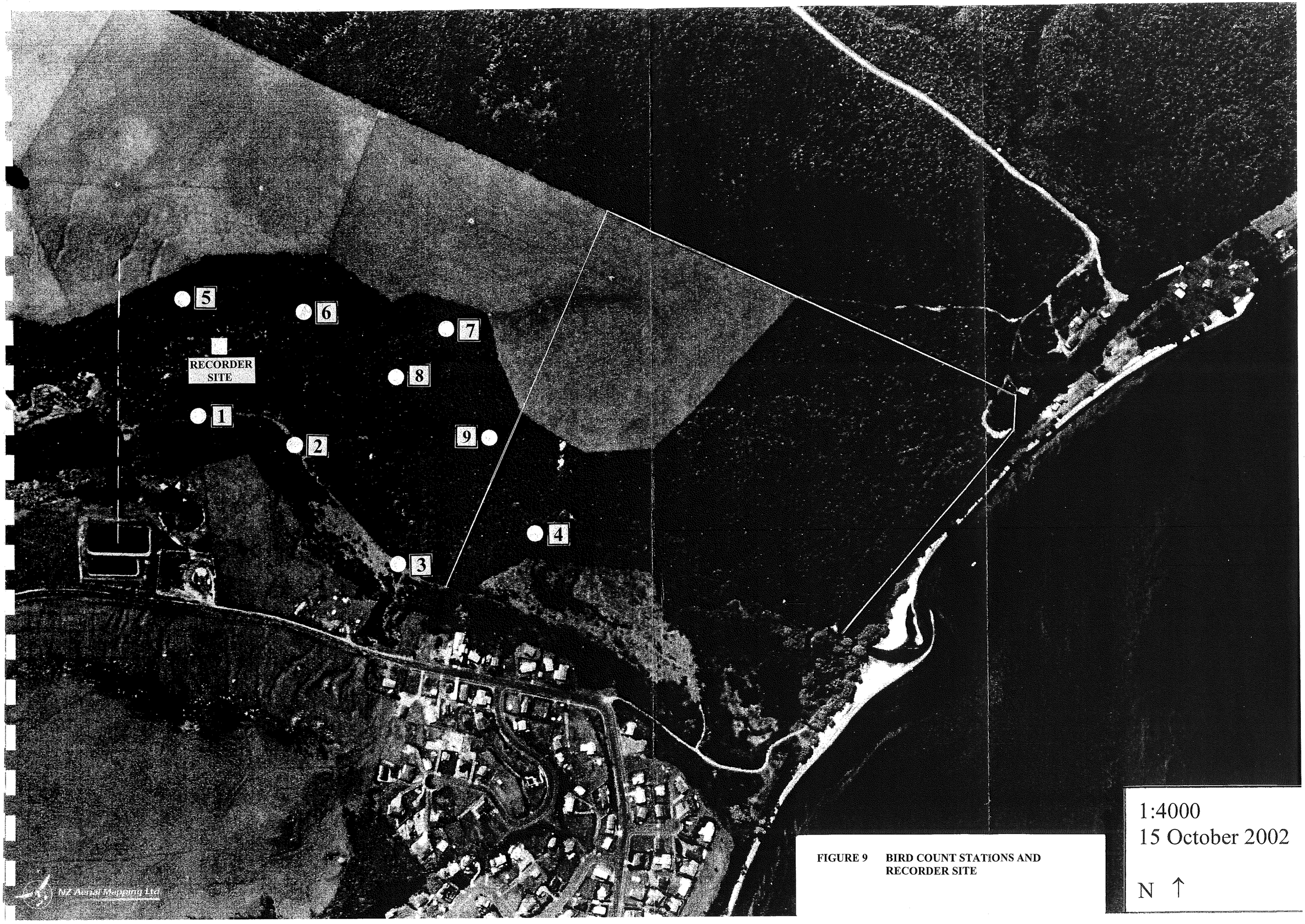

FIGURE 9 **BIRD COUNT STATIONS AND RECORDER SITE**

1:4000
15 October 2002

N ↑

1.5; range 9.2 – 13.6°C) and average barometric pressure 97.9 kPa (kilopascals; 979 millibars; SD = 0.3; range 975 – 983).

3.2.4 Avifauna

3.2.4.1 Species Diversity

The species recorded during the field survey are shown in Table 3.2.1. A total of 16 species was recorded, four endemics, six native and six introduced. No threatened species were recorded and, based on the habitat types, it is unlikely that any would utilise this area on a regular basis. California quail, masked lapwing and paradise shelduck were present adjacent to the survey area but were not recorded in the five-minute counts. Although not a typical forest species, white-faced heron was recorded in the five-minute counts and was using the tall, emergent kanuka for roosting.

Other notable species which may occur within this area on an occasional basis include New Zealand pigeon (*Hemiphaga novaeseelandiae novaeseelandiae*; kereru), New Zealand falcon (*Falco novaeseelandiae*; karearea) and long-tailed cuckoo (*Endynamys taitensis*; koekoea) All these are threatened species which are discussed in more detail in Section 2.2.4.1.

The regular avifauna is likely to be dominated by common native and endemic species as follows:-

abundant
- australasian harrier
- fantail
- grey warbler
- masked lapwing
- silvereye
- welcome swallow

common
- bellbird
- morepork
- paradise shelduck
- tui

(Heather & Robertson, 2000)

TABLE 3.2.1 SPECIES RECORDED IN THE WHAREROA RIPARIAN AREA DURING THE FIELD SURVEY

COMMON NAMES	SCIENTIFIC NAME
australasian harrier •	*Circus approximans*
australian magpie	*Gymnorhina tibicen*
bellbird; korimako †	*Authornis melanura melanura*
blackbird	*Turdus merula*
california quail ✱	*Callipepla californica brunnescens*
chaffinch	*Fringilla coelebs*
fantail; piwakawaka •	*Rhipidura fuliginosa placabilis*
grey warbler; rironiro †	*Gerygone igata*
housesparrow	*Passer domesticus*
masked lapwing • ✱	*Vanellus miles novaehollandiae*
morepork; ruru • ✱	*Ninox novaeseelandiae novaeseelandiae*
paradise shelduck; putangitangi † ✱	*Tadorna variegata*
silvereye; tauhou •	*Zosterops lateralis lateralis*
song thrush	*Turdus philomelos*
tui †	*Prosthemadera novaeseelandiae novaeseelandiae*
white-faced heron •	*Ardea novaehollandiae novaehollandiae*

- • native species : naturally found in New Zealand.
- † endemic species : natural range is New Zealand only.
- ✱ not recorded in the five-minute counts.

(NONE OF THE ABOVE IS A THREATENED SPECIES)

3.2.4.2 Percentage Occurrence

The frequency of each species in the total number of individual counts (n = 27) is shown below as a percentage –

100.0	bellbird
	silvereye
	tui
96.3	grey warbler
92.6	fantail
40.7	chaffinch
37.0	australian magpie
	blackbird
18.5	australasian harrier
	song thrush
7.4	white-faced heron
3.7	housesparrow

The five most frequently occurring species (bellbird, silvereye, tui, grey warbler and fantail) are all endemic or native birds. The remainder of the species occurred in less than 41% of the counts.

3.2.4.3 Five-minute Counts

The five-minute counts results are shown in Table 3.2.2 as averages of the three replicate counts per station and provide an indication of relative abundance or conspicuousness.

Average species diversity was biased towards native species (5.44) as opposed to introduced species (2.44) but that difference was not statistically significant.

In contrast the average number of native individuals (25.59) was significantly higher than the average number of introduced individuals (2.04) (chi-squared = 20.0; $p<0.001$). Overall the avifauna was dominated by native species and individuals.

TABLE 3.2.2 WHAREROA RIPARIAN FIVE-MINUTE BIRD COUNT RESULTS (averages of three replicate counts per station)

	STATION									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**mean**
australasian harrier	1.00	0.67	–	–	–	–	–	–	–	0.19
australian magpie	–	–	–	–	1.67	0.67	1.33	0.67	0.67	0.56
bellbird	3.67	3.00	2.33	4.33	4.00	2.67	2.33	1.67	3.00	3.00
blackbird	0.33	1.00	0.67	–	1.00	0.67	–	1.00	0.67	0.59
chaffinch	0.67	0.33	1.67	1.00	–	1.67	–	0.33	–	0.63
fantail	1.00	3.00	3.00	2.33	2.33	3.33	0.67	1.67	2.33	2.18
grey warbler	4.00	4.00	3.00	3.33	2.00	3.33	1.33	2.33	1.67	2.78
housesparrow	0.67	–	–	–	–	–	–	–	–	0.07
silvereye	7.00	6.67	6.33	14.00	19.67	6.00	17.00	10.33	7.00	10.44
song thrush	–	–	–	–	–	1.00	–	0.33	0.33	0.18
tui	8.00	7.33	6.67	7.33	10.00	4.00	9.00	6.00	4.33	6.96
white-faced heron	–	–	–	–	0.33	0.67	–	–	–	0.11
TOTAL NATIVE (•) SPECIES	6	6	5	5	6	6	5	5	5	5.44
TOTAL NATIVE INDIVIDUALS	24.67	24.67	21.33	31.32	38.33	19.33	30.33	22.00	18.33	25.59
TOTAL INTRODUCED SPECIES	3	2	2	1	2	4	1	4	3	2.44
TOTAL INTRODUCED INDIVIDUALS	1.67	1.33	2.34	1.00	2.67	4.01	1.33	2.33	1.67	2.04

The most abundant species were also the most frequent with silvereye clearly dominant.

average count	
10.44	silvereye
6.96	tui
3.00	bellbird
2.78	grey warbler
2.18	fantail
0.63	chaffinch
0.59	blackbird
0.56	australian magpie
0.19	australasian harrier
0.18	song thrush
0.11	white-faced heron
0.07	housesparrow

The two most abundant species were silvereye and tui that were attracted to the fruiting and flowering fivefinger respectively, followed by bellbird, grey warbler and fantail. Tui was also clearly engaged in breeding activities and was especially conspicuous as a result.

3.2.4.4 Nocturnal Recordings

A morepork was recorded calling between 1900 and 1955 hours. The survey is likely to have been too early in the year to assess the presence of long-tailed cuckoo with adults arriving about early October.

3.2.5 Reptiles

No reptiles were located during searches of debris piles, under fallen logs and branches, and under loose kanuka bark. The most common organism under the latter was a native bush cockroach.

3.2.6 Other Wildlife

Possum pellets were rare but present, and there had been a recent 1080 poison drop throughout the area. Rabbits were occasional at the forest – pasture margins and pig rooting was sporadic throughout but severe in a few patches. A range of additional animal pests can be anticipated. The area is not subject to any community-based (landcare group) pest management initiative.

3.2.7 Conclusions

The avifauna of the Whareroa Riparian habitat was similar to that in the North Side Development Area in that it was dominated by native and endemic birds. The diversity of birds was moderate but abundance was relatively high mainly as a result of high numbers of both silvereye and tui.

No threatened species was recorded but long-tailed cuckoo is probable during the spring – summer period. No other significant wildlife was recorded.

The avifauna of the Whareroa Riparian Area, especially on the northern slope, is likely to be similar to that of large areas to both the north and south of Whareroa.

4 AVIFAUNAL COMPARISON

This section compares the avifaunal characteristics of the two survey areas recorded during these surveys.

4.1 Species Diversity

Species recorded using the Stream Riparian Habitat but not the North Side Development Area were as follows:

australasian harrier
california quail
housesparrow
masked lapwing
morepork
paradise shelduck
white-faced heron

All those species would also use the North Side Development Area at times. That habitat consists of open pasture, low scrub and native fivefinger – kanuka forest.

Species recorded in the North Side Development Area but not in the Stream Riparian Habitat were as follows :

goldfinch
welcome swallow
whitehead

Similarly all those species would also use the Riparian Habitat at times; it also contains a range of habitats from low scrub and stream margins to tall kanuka with fivefinger.

Overall the species diversity of birds using the two areas can be expected to be the same. Similarly there is unlikely to be any difference in the use of either area by the three threatened

species noted as possible (i.e. New Zealand pigeon, New Zealand falcon and long-tailed cuckoo) if indeed those birds do occur in the general Whareroa area.

4.2 Percentage Occurrence

The percentage occurrence data for the two areas are summarised below and annotated to show where the differences are significant.

	NORTH SIDE DEVELOPMENT AREA	WHAREROA STREAM RIPARIAN HABITAT
bellbird	100.0	100.0
silvereye	100.0	100.0
tui	77.8	100.0
fantail	70.4	92.6
grey warbler	62.9	96.3 **
blackbird	48.1	37.0
song thrush	48.1	18.5 ***
australian magpie	40.7	37.0
chaffinch	37.0	40.7
welcome swallow	14.8	–
whitehead	7.4	–
goldfinch	3.7	–
australasian harrier	–	18.5
white-faced heron	–	7.4
housesparrow	–	3.7

** chi-squared = 7.0 $p<0.01$
*** chi-squared = 13.2 $p<0.001$

The percentage occurrence of the nine species common to the counts in both areas was similar overall with only two significant differences. Grey warbler occurred more frequently in the Riparian Habitat and fantail also appeared slightly more frequently which may suggest a superior supply of invertebrate food in that area. Song thrush occurred more frequently in the North Side Development Area which may reflect the influence of the open pasture in its northwestern corner. Whereas the occurrence of blackbird and song thrush was the same in

that area, the percentage occurrence of blackbird was significantly the higher (chi-squared = 6.2; $p<0.05$) in the Riparian Habitat.

4.3 Five-minute Counts

A comparative summary of the overall average results for species diversity and relative abundance is as follows :

	NORTH SIDE DEVELOPMENT AREA	WHAREROA STREAM RIPARIAN HABITAT
TOTAL NATIVE SPECIES	5.22	5.44
TOTAL NATIVE INDIVIDUALS	24.63	25.59
TOTAL INTRODUCED SPECIES	2.44	2.44
TOTAL INTRODUCED INDIVIDUALS	2.37	2.04

Overall, the average numbers of native and introduced species and individuals were essentially the same in each area.

The individual average counts are summarised below for comparative purposes.

	NORTH SIDE DEVELOPMENT AREA	WHAREROA STREAM RIPARIAN HABITAT
silvereye	14.85	10.44
bellbird	4.04	3.00
fantail	2.00	2.18
tui	1.37	6.96 ✱
grey warbler	1.18	2.78
australian magpie	0.89	0.56
song thrush	0.63	0.18
blackbird	0.44	0.59
chaffinch	0.37	0.63
welcome swallow	0.59	–
whitehead	0.59	–
australasian harrier	–	0.19
white-faced heron	–	0.11
housesparrow	–	0.07
goldfinch	0.04	–

✱ chi-squared = 3.8 $p<0.05$

The only statistically significant difference in the individual species abundance estimates was that tui was more common in the Whareroa Stream Riparian Habitat. That was also the

overall impression gained during the field survey. There appeared to be a high frequency of territorial defence occurring and high altitude, hovering flights by up to eight individuals were frequent. The number of individuals observed was considerably higher than the number observed in the North Side Development Area.

Aside from the average numbers of tui, the abundance of the species common to both areas in the surveys was essentially the same. With the exception of whitehead, the species that were recorded in only one area can be considered as incidental and relatively minor components of the avifauna. The whitehead group recorded is likely to have been within a breeding territory (late winter) and is probably a more significant component of the avifauna along the Lake edge forest of the North Side Development Area.

The results of five-minute counts (9 stations; 27 individual counts) completed at Kuratau (Bioresearches, 2005) on 2 August and 16 August 2005 can also be compared with the counts from the two areas at Whareroa. One survey area at Kuratau was underdeveloped scrub dominated by fivefinger while the other was the established residential subdivision.

	WHAREROA		KURATAU		
	NORTH SIDE	**RIPARIAN**	**SCRUB**	**RESIDENTIAL**	
TOTAL NATIVE SPECIES	5.22	5.44	5.44	4.89	nsd
TOTAL NATIVE INDIVIDUALS	24.63	25.59	26.48	25.44	nsd
TOTAL INTRODUCED SPECIES	2.44	2.44	2.89	3.89	nsd
TOTAL INTRODUCED INDIVIDUALS	2.37	2.04	5.22	12.52	**

nsd = no significant difference

** chi-squared = 12.83 $p<0.01$ ($n = 3$)

The above results are based on a total of 108 individual five-minute counts.

Based on chi-squared tests there is no significant difference between the four areas regarding the numbers of native species, native individuals and introduced species.

There is a significant difference in the number of introduced individuals with the established residential area at Kuratau having the highest average number.

The average number of introduced individuals in the Kuratau scrub is not significantly different from the average numbers in either area at Whareroa (chi-squared = 1.07 and 1.38).

The average number of introduced individuals in the Kuratau residential area is significantly higher than the averages in the Whareroa North Side Development Area and Whareroa Riparian Habitat (chi-squared = 6.92 and 7.54 respectively; $p<0.01$).

The average number of introduced individuals in the Kuratau residential area is not significantly different from that in the Kuratau scrub at the 0.05 level of probability but is significantly higher at the 0.1 (90%) level (chi-squared = 3.0).

Therefore based on the five-minute count data the established residential area at Kuratau is utilised by a higher number of introduced birds but the number of introduced species within that area is the same as in undeveloped scrub. More importantly the numbers of both native species and native individuals remain the same despite the obvious reduction in the total cover of native vegetation in the developed area.

The reason for the Kuratau subdivision's relatively low impact on the native birds, albeit common species, is likely to be the development and/or retention of native trees within the residential area and its proximity to areas of undeveloped native scrub, together with the establishment of some exotic tree species that provide nectar and fruit.

4.4 Conclusions

Overall, the surveys indicated that both the North Side Development Area and the Whareroa Stream Riparian Habitat supported a similar avifauna in terms of diversity and abundance. No threatened species were recorded in either area but intermittent use of both areas by three species (NZ pigeon; NZ falcon; long-tailed cuckoo) cannot be discounted.

All the species of birds recorded during the surveys are common or abundant and, overall, both areas would have moderate value, rather than high or outstanding value, as wildlife habitats. The avifauna of large adjacent areas of Lake edge forest is also likely to be similar to those recorded during this survey.

The survey results indicated that there was no significant difference between the average number of native/endemic species or individuals in the developed Kuratau residential area as compared with both undeveloped areas surveyed at Whareroa.

The only significant difference between the five-minute count results in the Kuratau residential and Whareroa undeveloped areas was that the average number of introduced individuals was higher in the residential area but not to the detriment of the native avifauna.

BIORESEARCHES

Consulting Biologists & Archaeologists - Est. 1972

5 NORTH SIDE DEVELOPMENT AREA SUMMARY CONCLUSIONS

5.1. The vegetation survey identified five broad vegetation zones as follows –

- pasture
- low scrub of bracken and shrubs
- tall scrub of fivefinger and kanuka
- scrub of steep slope above Whareroa Stream
- scrub of steep slope above Lake Taupo.

In contrast the "Whareroa Stream Riparian Habitat" consisted of a tall scrub of fivefinger and kanuka, and mixed scrub.

5.2. No rare or endangered plant species or plant communities identified by the Department of Conservation as notable in the Taupo Basin were recorded.

5.3. No nationally threatened plant species were recorded.

5.4. Based on the Environment Waikato guidelines to assess significant indigenous vegetation and habitats of indigenous fauna in the Waikato Region, the North Side Development Area would be "locally significant" if viewed in isolation but is part of and contiguous with a "regionally significant" area of vegetation. The Whareroa Stream Riparian Habitat automatically rates as "regionally significant" because it is subject to a Department of Internal Affairs conservation covenant. A similar rationale would apply to that area as applies to the North Side Development Area if that covenant did not exist.

5.5. The Development Area's avifauna is dominated by common native and endemic species and is similar to that in the Whareroa Stream Riparian Habitat survey area. No threatened species was recorded in either area but long-tailed cuckoo in particular is probable during the spring – summer period.

5.6. Overall based on these surveys, the Development Area would have moderate wildlife value rather than high or outstanding values, and would be similar to large adjacent areas of Lake edge habitat.

5.7. A comparison with similar surveys undertaken at Kuratau indicated that there was no significant difference between the average numbers of native/endemic species or individuals in the established Kuratau residential area as compared with those in both the North Side Development Area and the Whareroa Stream Riparian Habitat.

5.8. The only significant difference between the five-minute count results in the Kuratau residential area and the undeveloped areas at Whareroa was that the average number of introduced individuals was higher in the residential area but not to the detriment of the native avifauna. That indicates that provided appropriate areas of native vegetation habitat are maintained and/or established, possibly supplemented by plantings of exotic trees and shrubs, the change from undeveloped to a residential area does not necessarily diminish the native avifauna.

BIORESEARCHES

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7 PLATES

PLATE 1 VIEW FROM HIGH POINT ON THE SITE
TOWARDS THE SOUTH EAST

PLATE 13 FLOODPLAIN SCRUB AT WESTERN EXTENT OF SURVEY AREA - SOUTHERN SIDE OF WHAREROA STREAM - TOWARDS WEST

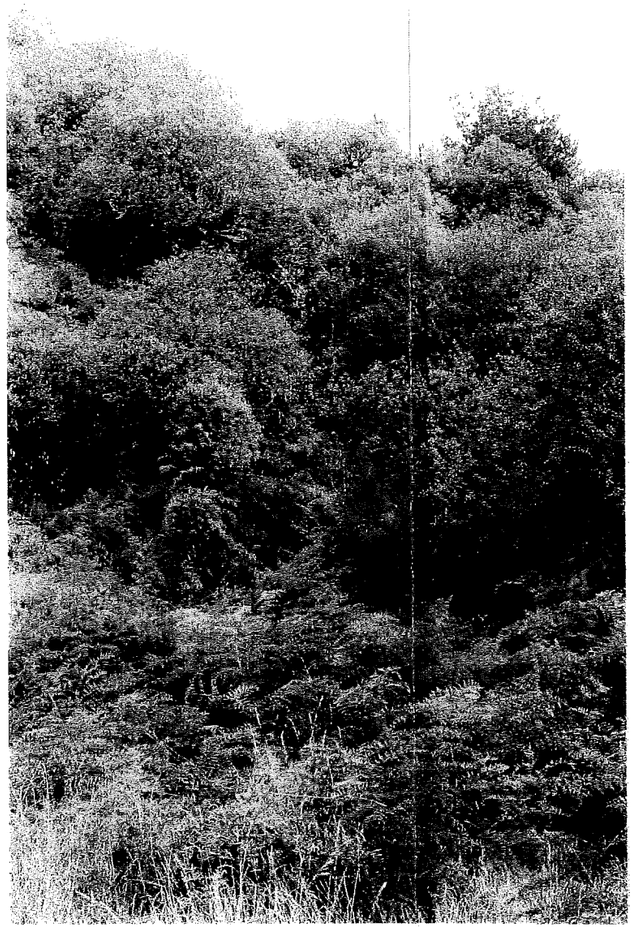

PLATE 14 AS PLATE 13 TOWARDS NORTH

PLATE 15 AS PLATE 13 TOWARDS SOUTHERN ESCARPMENT

PLATE 16 NORTHERN RIPARIAN SLOPE FROM THE SOUTHERN SIDE OF WHAREROA STREAM AT FORMER TROUT TRAP SITE

PLATE 17 AS PLATE 16

PLATE 18 SCRUB VIEWED TOWARDS EAST ON SOUTHERN SIDE OF WHAREROA STREAM MIDWAY ALONG SURVEY AREA

PLATE 22 NORTHERN RIPARIAN SLOPE FROM SOUTHERN SIDE OF VALLEY

PLATE 23 AS PLATE 22 - WASHOUT AT RIGHT

PLATE 24 WHARAROA STREAM

PLATE 25 SITE'S LAKE FRONTAGE NORTHEAST OF WHARAROA STREAM MOUTH

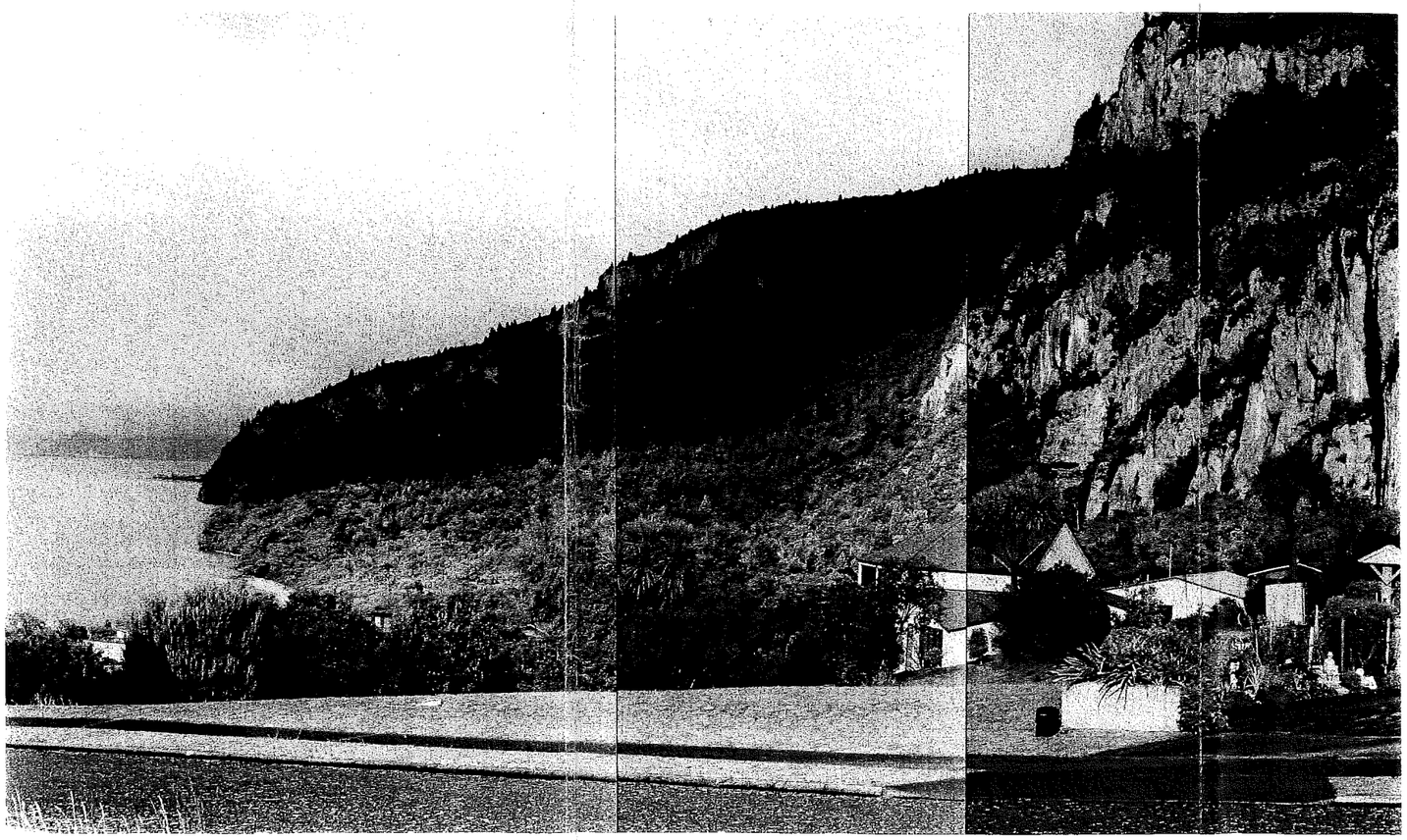

PLATE 26 RANGITUKUA SCENIC RESERVE ON THE SOUTHERN SIDE OF WHARAROA RESIDENTIAL AREA