ECOLOGICAL ASSESSMENT

WARKWORTH NORTH

3 MAY 2019

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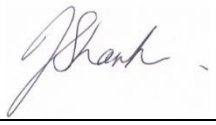
	Jennifer Shanks Botanist (M.Sc., Hons)	
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1 INTRODUCTION

This report has been prepared to inform the Warkworth North Structure Plan and Plan Change, on behalf of Turnstone Capital LP. The boundary for the Structure Plan and Plan Change (Warkworth North Precinct) is shown in Figure 1.1.

The Warkworth North Precinct area includes the Future Urban zoned land bounded by the proposed Puhoi to Warkworth motorway extension in the north-west, the Viv Davie-Martin Drive lifestyle development area to the west, the Mahurangi River to the south, and Hudson Road and State Highway 1 to the east and north-east.

The area proposed to be rezoned as part of the Plan Change more or less applies to the Structure Plan area, with the exception of 141 Carran Road, the western extent of Lot 1 DP 508375, and the existing General Business and Light Industrial zoned land to the east.

Bioresearches were tasked with providing ecological assessments of the properties within the subject area, by describing the vegetation and flora, herpetofauna, avifauna, and freshwater values present, and undertaking an assessment of effects of the proposed Warkworth North Structure Plan and Plan Change.

Ecological assessments were carried out at the properties listed below (Figure 1.2) and the results described in stand-alone sections of this amalgamated report. All ecological reports have been forwarded to Auckland Council ecologists and to Wai Ora-Healthy Waterways for review and comment. In addition, informal discussions surrounding the protection and restoration of vegetation and wildlife habitat, and mitigation of potentially effected watercourses, were carried out during on-site meetings with Council ecologist Jane Andrews on 16 May and on 10 August 2017.

Stubbs Farm:
Centrally located within the Warkworth North Precinct is Stubbs Farm Development Area, which includes the 220 Falls Road (LOT 4 DP 522636, LOT 5 DP 522636; 41.6924 ha), 12 Sanderson Road (LOT 1 DP 522636; 0.3395 ha) and 10 Sanderson Road (LOT 2 DP 522636; 0.4165 ha) properties. This land is zoned “Future Urban” under the Auckland Unitary Plan Operative in part. There are three dwellings on the site and the land is predominantly in production pasture. No part of any property is subject to a Significant Ecological Area (SEA) overlay; however, four clearly defined areas of mixed native and exotic vegetation are present. A major tributary of the Mahurangi River flows from the north-eastern corner in a predominantly south-westerly direction, crossing under Falls Road on the southern boundary (Figure 1.2). Several smaller tributaries flow into this watercourse from the west.

223 Falls Road:
A 9.2 ha rural property south of Falls Road (LOT 1 DP 508375; 8.9655 ha). The land is zoned “Future Urban” under the Auckland Unitary Plan Operative in part (AUP Op) and the site subject to a Significant Ecological Area (SEA) overlay, with SEA_T_2294 taking in riparian forest along the true left bank of the Mahurangi River and surrounding several smaller tributaries on the property. The

SEA status was assessed by Auckland Council in 2012 as meeting three of the five SEA criteria, including *Criterion 2: Threatened Species Ecosystems* (based on presence of long-fin eel, *Anguilla dieffenbachii*), *Criterion 4: Stepping Stones, Migration Pathways and Buffers (i.e. "buffers a protected area and buffers an SEA") and Criterion 5: Uniqueness or Distinctiveness* (due to *Pomaderris hamiltonii* [kumarahou] being recorded at the site; however, see *Section 2.1.2. Assessment of the Botanical Values of the Site* for comments on this *At Risk* plant; application of Criterion 5 is disputed).

A Local Purpose Esplanade Reserve along the Mahurangi River will be vested with Auckland Council at the time of subdivision and native vegetation in the lower catchments of two tributary streams would be protected. A block of land on the western side of the property is Auckland Council property and has recently been subject to works associated within construction of the Mansel Drive bridge and intersection.

102 Hudson Road:

A brief ecological assessment of the 102 Hudson Road property (Lot 16 DP 9212; 1.6018 ha) (currently comprised of 102 and 112 Hudson Road) was undertaken by an experienced ecologist on 24 January 2017. The assessment included a site walkover and assessment of the freshwater environments. Prior to visiting the property, a map of the site was viewed on the Auckland Council GIS viewer, to identify ecologically important features (e.g. Significant Ecological Areas, watercourses, overland flow paths and catchments).

The site lies within the Rodney Ecological District and represents a gently sloping area of grazed pasture at an altitude of 36 – 53 m above sea level. Small isolated patches trees and low growing vegetation exist along the western boundary and two watercourses are present. The property is zoned "Future Urban" under the Auckland Unitary Plan Operative in part and is not subject to any Significant Ecological Area (SEA) overlays.

Other properties (desktop assessments)

Desktop ecological assessments of properties to the north, east and south of those mentioned above (e.g. 141 Carran Road and the General Business and Light Industry) were also undertaken in late 2017.

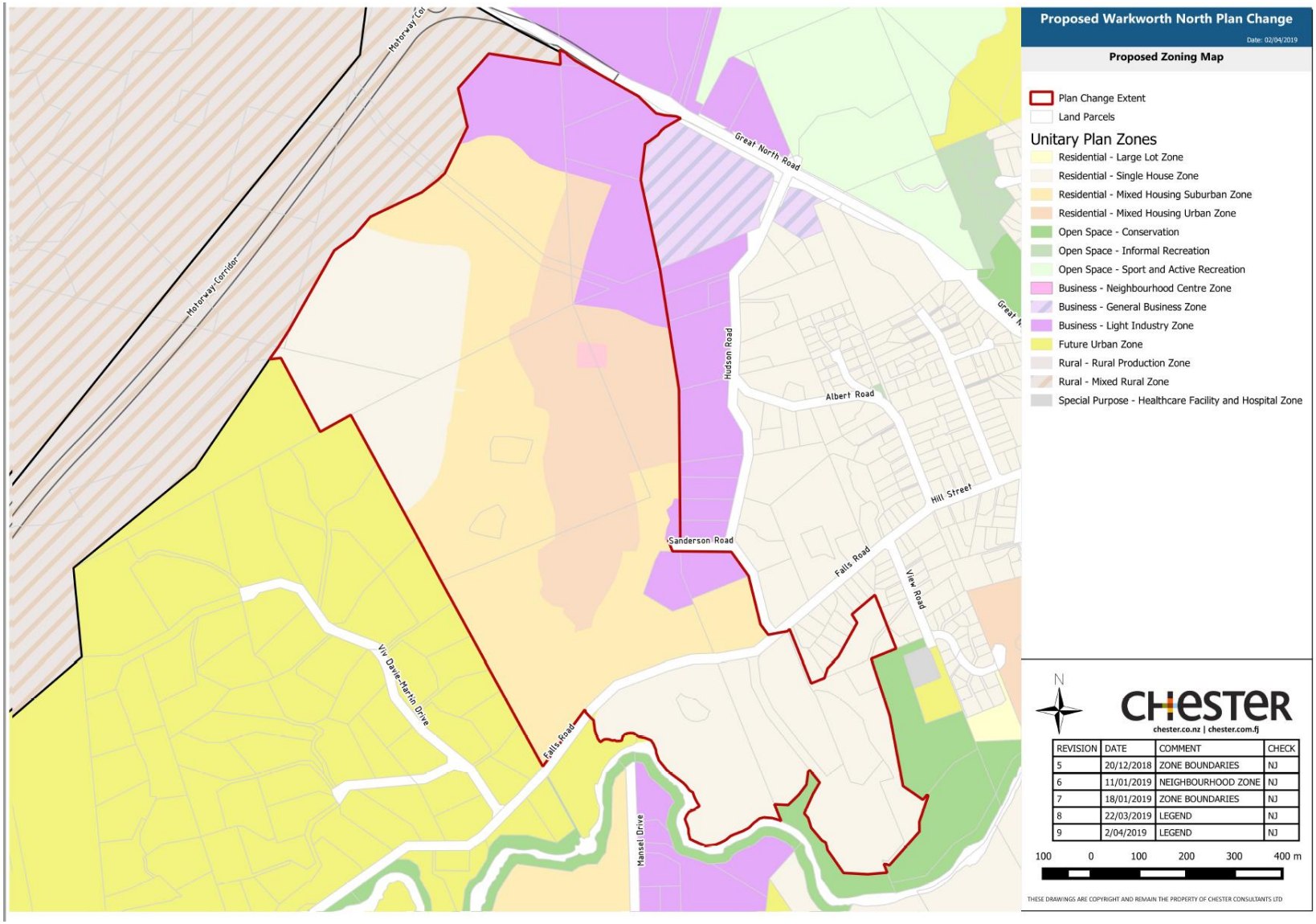

Figure 1.1. Proposed Warkworth North Plan Change area.

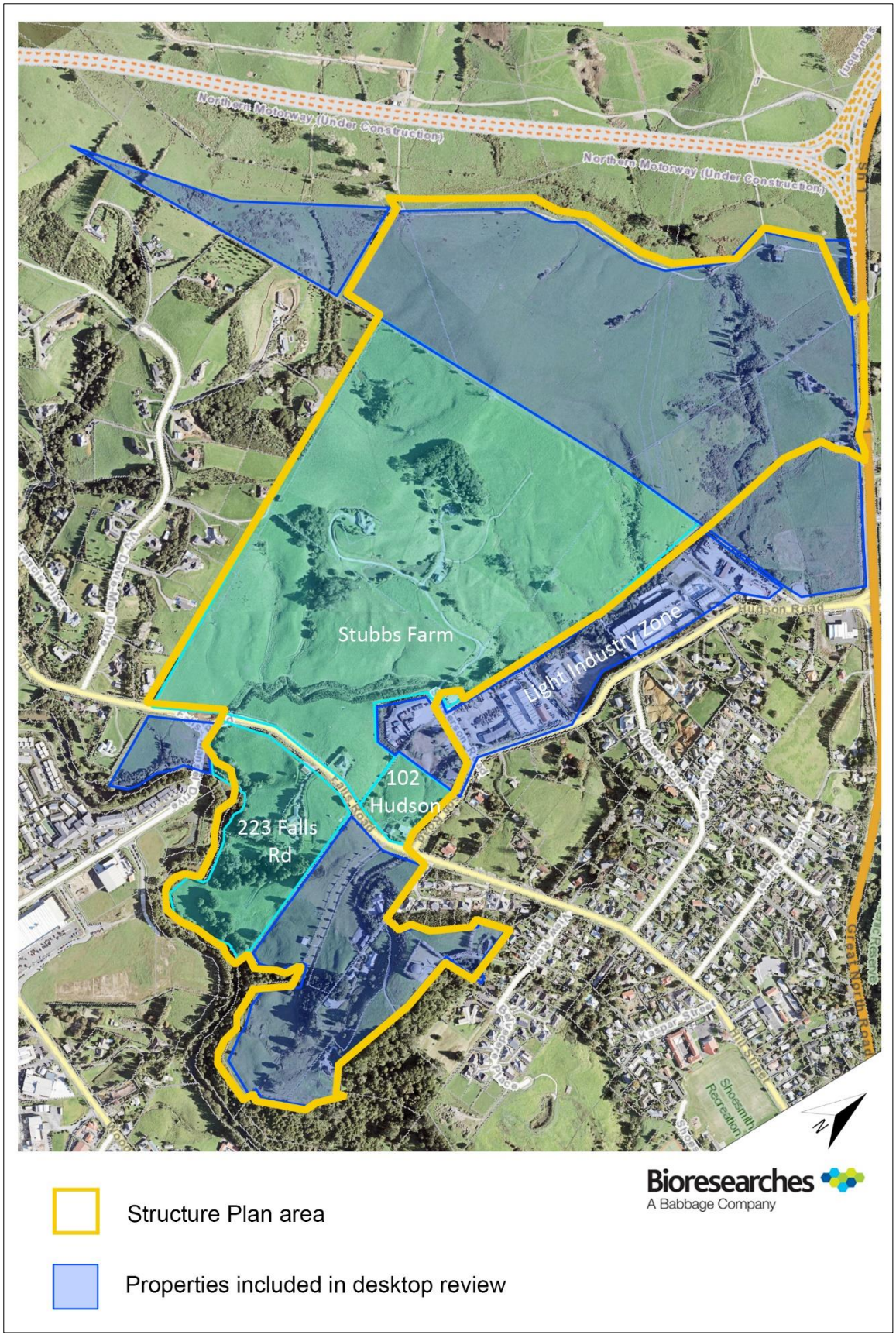

Figure 1.2. Proposed Warkworth North Plan Change showing the specific areas ('properties') assessed.

2 STUBBS FARM

The area comprising Stubbs Farm Development Area (Figures 2.1 & 2.2) includes 220 Falls Road (LOT 4 DP 522636, LOT 5 DP 522636; 41.6924 ha), 12 Sanderson Road (LOT 1 DP 522636; 0.3395 ha) and 10 Sanderson Road (LOT 2 DP 522636; 0.4165 ha). This land is zoned "Future Urban" under the Auckland Unitary Plan Operative in part. There are three dwellings at the site and the land is predominantly in production pasture. No part of any property is subject to a Significant Ecological Area (SEA) overlay; however, four clearly defined areas of mixed native and exotic vegetation are present. A major tributary of the Mahurangi River flows from the north-eastern corner in a predominantly south-westerly direction, crossing under Falls Road on the southern boundary (Figure 2.1). Several smaller tributaries flow into this watercourse from the west.

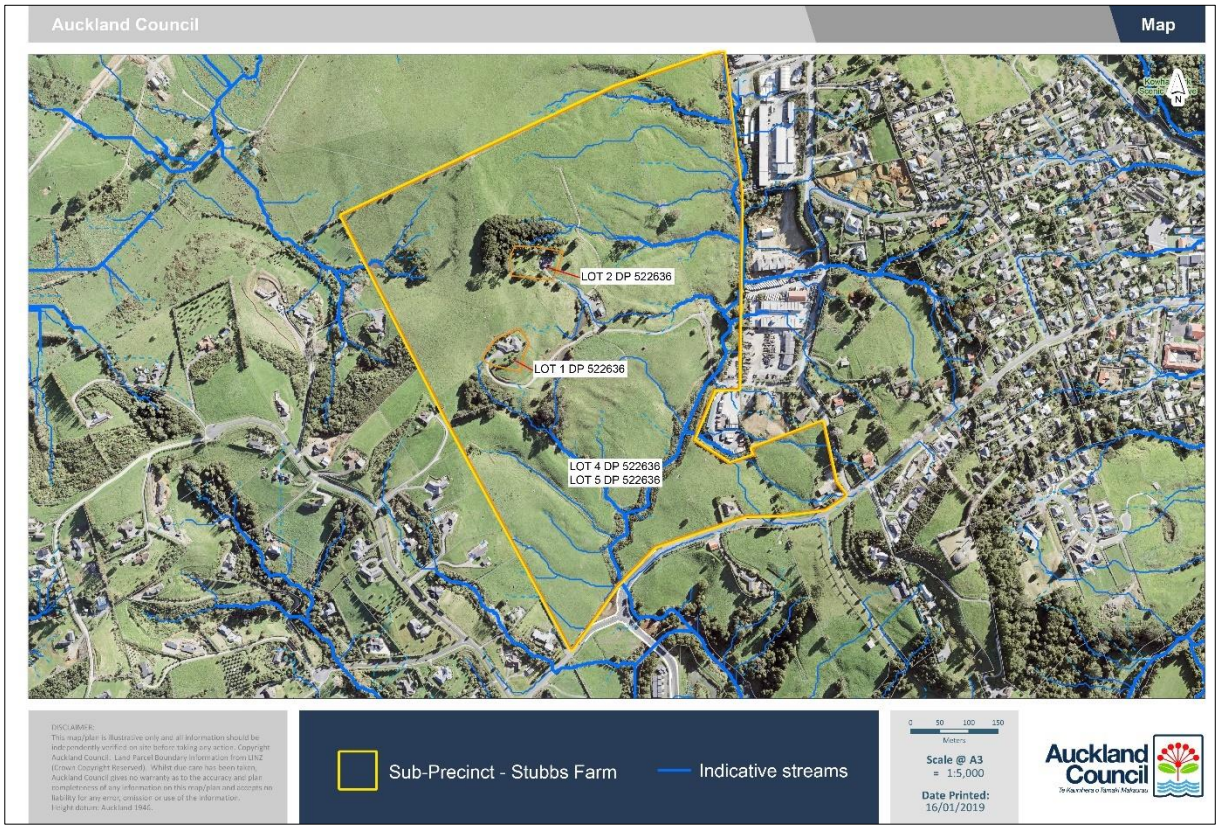

Figure 2.1. Aerial image of Stubbs Farm, Warkworth showing the extent of the site and indicative watercourses.

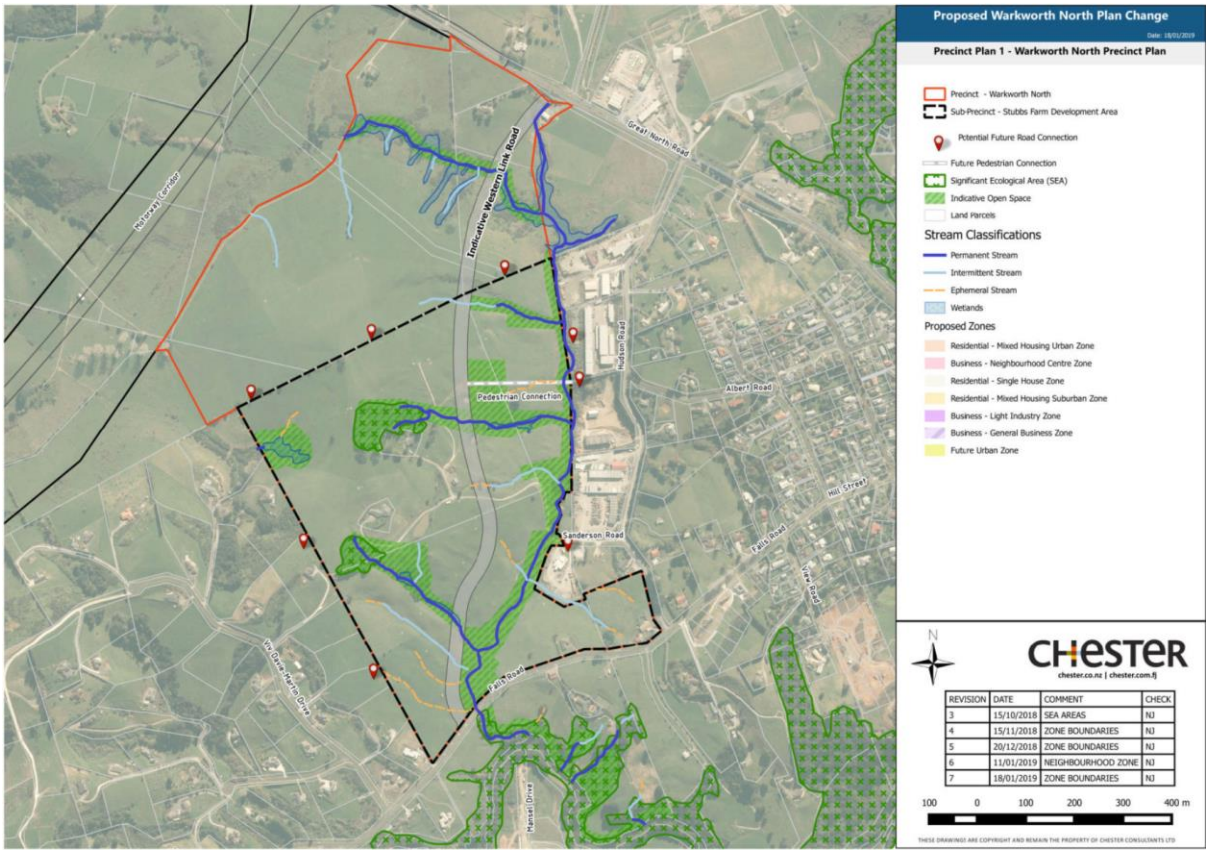

Figure 2.2. Warkworth North Precinct map.

2.1 VEGETATION AND FLORA

The site was walked by an experienced botanist on 9 August 2016. All vegetation at the site was viewed, described and assessed with respect to its botanical values.

2.1.1 Botanical Characteristics

There were four areas of native trees or bush on the site (Figure 2.3) and numerous small wetlands associated with the watercourse and its tributaries. The Mahurangi tributary (main stream) was fenced off and the lower portion of it has been planted with native plants. Other areas are open and grazed except for a small stand of bush (Area 3) near the western house at 12 Sanderson Road. There were also several small farm dams and two ornamental ponds on the property at 12 Sanderson Road. These habitats are described in more detail below.

Figure 2.3. Vegetation cover at the site, including vegetation areas (1 – 4) as described in the text and the location of the Mahurangi tributary.

2.1.1.1 Vegetated areas

The four main areas of vegetation are described from north to south (Figure 2.3).

2.1.1.1.1 Bush to the north-east, above house (Area 1)

This area of bush (c. 1 ha) has a relatively good canopy predominantly of totara (*Podocarpus totara*). The trees are mainly tall, slim specimens to 10 m tall with larger open grown trees around the edges (Plate 2.1). Scattered tall, slim rimu (*Dacrydium cupressinum*), kanuka (*Kunzea robusta*), kauri (*Agathis australis*) and tanekaha (*Phyllocladus trichomanoides*) are found amongst the totara. A small stand of trees to the north east of the house has four medium-sized rimu, a large multi-trunked pohutukawa (*Metrosideros excelsa*) which is assumed to be planted and a double-trunked tanekaha. To the west of the house amongst several large Monterey pines (*Pinus radiata*) is a medium sized kawaka tree

(*Libocedrus plumosa*). The tree has a trunk diameter of c. 25 cm but it is not very tall for its size as it is overtopped by the pines. This species has a National Threat Status of *At Risk – Naturally Uncommon* (de Lange *et al*., 2013).

The area is grazed and therefore the understorey is largely absent apart from seedlings; mainly of weeds such as Chinese privet (*Ligustrum sinense*), arum lily (*Zantedeschia aethiopicum*), woolly nightshade (*Solanum mauritianum*), climbing asparagus (*Asparagus scandens*) and plectranthus (*Plectranthus ciliatus*). In parts, there are young ground ferns such as kiokio (*Blechnum novaezelandiae*), deparia (*Deparia petersenii*) and native sedges (*Carex* sp.) scattered amongst the weedy groundcover. This stand of trees is "treeland" rather than intact native forest.

Two small watercourses originate within the stand of bush and a small pond is located on the northern edge. This is covered in duckweed (*Lemna disperma*) and surrounded with common ground ferns such as *Diplazium australe*, young silver ferns (*Cyathea dealbata*) and clumps of arum lily. There are a few clumps of native sedge along the watercourse below the pond, but this is generally badly pugged and infested with pest plants. The southernmost of the two watercourses is open and choked with taro (*Colocasia esculenta*).

At the confluence of the two watercourses on the eastern side of the bush stand the farm track forms a dam behind which is an open, grazed wetland (Plate 2.2) with mainly exotic rushes (*Juncus effusus*).

A more comprehensive assessment of the vegetation present within Area 1 is provided in Section 3 of this report (*3 Detailed Vegetation Assessment: Stubbs Farm*).

2.1.1.1.2 Northwest corner (Area 2)

A grouping of grazed totara trees stands above a small watercourse with a small farm pond below (c. 0.5 ha). The watercourse is an upper tributary of the Mahurangi River. The trees are of no great age or size and there are scattered tall kanuka (*Kunzea robusta*) amongst them (Plate 2.3). The area is all heavily grazed and pugged and there are few native riparian or wetland plants. In a small boggy area in the upper part of the watercourse are a few spindly manuka (*Leptospermum scoparium*) bushes associated with which are swamp kiokio (*Blechnum minus*) and native rushes including baumea (*Machaerina rubiginosa*) and fan flowered rush (*Juncus sarophorus*). Surrounding the pond are a few gorse bushes and reed sweet grass (*Glyceria maxima*). Across the boundary the watercourse has been fenced and planted with natives. Standing to the east of the totara some distance away is a lone tall kauri tree which appears healthy although the roots have been badly trampled by stock.

2.1.1.1.3 Western bush (Area 3)

The area of totara-dominant bush (c. 0.55 ha) to the west of the second house at 12 Sanderson Road is fenced and has an understorey of native plants which include mapou (*Myrsine australis*), karamu (*Coprosma robusta*), silver fern, hangehange (*Geniostoma ligustrifolium*), twiggy coprosma (*Coprosoma rhamnoides*) and various ground ferns. Other canopy trees besides totara include a large puriri (*Vitex lucens*), titoki (*Alectryon excelsus*), tanekaha, kahikatea (*Dacrycarpus dacrydioides*) and black maire (*Nestegis cunninghamii*). Karaka (*Corynocarpus laevigatus*) forms a subcanopy and there

are seedlings and saplings of canopy trees, particularly puriri, rewarewa and tanekaha. Although Chinese privet seedlings and saplings and climbing asparagus require control, particularly around the edges, this is a healthy stand of forest with good plant diversity. It is recovering/ regenerating native podocarp broadleaved forest.

2.1.1.1.4 Treeland downstream of ornamental pond (Area 4)

Downstream of the southernmost ornamental pond are at least 7 large mature pine trees (*Pinus radiata*) (Plate 2.4). The area is grazed and the only native vegetation are scattered totara and a few shrubs of mahoe (*Melicytus ramiflorus*) and hangehange with silver fern mainly clinging to the steeply incised watercourse banks where they are less easily reached by cattle (Plate 2.5). At the confluence of two small watercourses is a small wetland with some raupo (*Typha orientalis*), exotic reed sweet grass (*Glyceria maxima*), clumps of kiokio and a patch of rautahi (*Carex geminata*). The area is badly pugged, and the wetland may be partly artificial as a fence across the lower end of it appears to be impeding drainage (Plate 2.6).

2.1.1.2 Riparian vegetation

2.1.1.2.1 Mahurangi Tributary

A tributary runs along most of the eastern boundary of the property at 12 Sanderson Road and then diagonally crosses 220 Falls Road to the south-western boundary. Within 220 Falls Road the riparian margins are fenced and planted—in accordance with the conditions on the Watercare water take consent for the Warkworth Town Supply—with common pioneer natives, principally kanuka, flax (*Phormium tenax*) and cabbage trees (*Cordyline australis*). The planting is estimated to be between 3 and 5 years old (Plate 2.7).

Within 12 Sanderson Road the riparian edge is fenced off 10 – 20 m from the watercourse with a two-wire electric fence and steel waratahs. Within this riparian zone is mostly rank grass with blackberry (*Rubus fruticosus*), gorse (*Ulex europaeus*) and pampas (*Cortaderia selloana*).

Along the floodplain is creeping buttercup (*Ranunculus repens*) and Mercer grass (*Paspalum distichum*) (Plate 8). Towards the southern end just upstream of the accessway are willows (*Salix fragilis*) growing in the watercourse in several clumps and a few cabbage trees here and there. On the opposite bank (true left) behind an industrial area the watercourse bank is steeper, supporting numerous clumps of pampas, gorse and overgrown barberry (*Berberis glaucocarpa*).

2.1.1.2.2 Side tributaries of the Mahurangi tributary

All the side tributaries of the Mahurangi tributary are grazed outside the fenced riparian zone. Apart from the northernmost tributary they support very little native vegetation and are generally vegetated with pasture grasses and exotic weeds such as weak rush (*Juncus effusus*). There are occasional patches of the weedy native fan-flowered rush.

The northern tributary is a larger watercourse that supports some relict native vegetation at its lower end. Although it is heavily grazed and pugged there are several patches of manuka to c. 2.5 m tall, several rather spindly young totara and a young kahikatea. Apart from this there are a few clumps of fan-flowered rush.

2.1.1.2.3 Ornamental ponds

There are two ornamental ponds, the upper one opposite the implement shed and the other across the driveway to the south of it. The upper pond is surrounded by a mixture of amenity planting including willows (*Salix* sp.), flax, eucalypts (*Eucalyptus* sp.), laurel magnolia (*Magnolia grandiflora*), kapuka (*Griselinia littoralis*), kohuhu (*Pittosporum tenuifolium*), rhododendron (*Rhododendron* sp) and various young deciduous trees. The lower pond is mainly surrounded by mown grass and ornamental amenity planting.

2.1.1.2.4 Individual native trees

In addition to the lone kauri tree mentioned in *Section 2.1.1.1.2* there were other individual mature rimu, totara and kahikatea trees scattered about the site.

2.1.2 Assessment of the Botanical Values of the Site

All the bush areas are relatively small (≤ 1 ha) and most are unfenced. The majority of both properties is heavily grazed, and most areas of bush represent treeland rather than diverse native forest or scrub. The mature trees do however have ecological value, as they provide habitat and food for native fauna and are contributing to the ecological values of the wider landscape.

Botanically, the best quality area of vegetation is Area 3—despite its relatively small size and requirement for weed control—since it is fenced and has a good native understorey and groundcover layer. Areas 2 and 4 are degraded due to the effects of grazing. Area 1 has some significant weed issues; however, if it were fenced and the weed issues addressed it would quickly regenerate a native understorey and with time its ecological values would increase. It is the largest area of treeland on the site.

All the watercourses are predominantly vegetated with exotic pasture and pest plants except for the lower reach of the Mahurangi tributary, which has been planted relatively recently in common native pioneer species. As a result, their current botanical values are low but will improve with time.

Those individual mature native trees on-site that are healthy and have good form, do have botanical, ecological and amenity values. The vegetation associated with the farm ponds and ornamental ponds has some amenity value but is generally of lower ecological quality.

2.1.3 Assessment of Effects on the Botanical Values of the Site

It is recommended that the two largest and best quality areas of native vegetation/ treeland (Areas 1 and 3) be retained since they contribute both to the visual amenity and ecological value of the site. As such, Areas 1, 3 and 4 are proposed as "Open Space". Area 1 also contains a nationally *At Risk* kawaka tree. The trees in Area 2 and Area 4 are predominantly totara of medium size and age, a single tall kauri and scattered specimens of rimu and kahikatea. The trees in Area 4 should be retained where practicable, but trees in Area 2 would require removal under the proposal. The loss of these trees in Area 2 would have low effects on the local botanical and ecological values of the site given their isolated location and lack of supporting understorey. However, any loss of vegetation (including individual mature native trees that are scattered about the site) would require mitigation, as they are sources of seed and will be contributing in a cumulative way to the habitat and food available to native fauna. Mitigation would involve compensatory planting elsewhere on-site.

The botanical values of the riparian and wetland vegetation are currently low, and these sites would benefit from weed control and restoration planting as part of the overall plan for the site.

2.1.4 Recommendations and Conclusions

2.1.4.1 Native bush areas

The trees and native bush in Areas 1 and 3 should be retained on-site as botanically they contain a range of mature native trees, including an *At Risk* tree species (kawaka), and they represent the best quality vegetation on the-site (Figure 2.4). Area 1 would require stock-proof fencing to allow the native understorey and groundcover layers to regenerate. It would also benefit from edge (buffer) planting which would hasten the regeneration process. Both Area 1 and Area 3 would require weed control and Area 1 would also require riparian planting of the watercourses and wetland areas following weed removal.

Area 4 is dominated by the large mature pine trees and botanically, their values are low. Ideally the watercourse that connects Area 3 to the Mahurangi tributary should be fenced and receive riparian and wetland restoration planting. This would result in the formation of a forest-wetland environmental gradient or ecotone. Ecotones provide a variety of habitats for fauna and flora, resulting in increased biodiversity and species abundance.

Where practicable, native trees scattered across the site (i.e. those that are healthy and with good form) should be retained as part of the overall landscape concept.

Any removal of native trees should be mitigated through replacement planting of the same species, employing an ecological compensation ration (ECR). This ratio is calculated in such a way as to replace the basal area of the trees that are lost within c. 20 years. Generally, the ECR would require three to six healthy young trees to be planted for each tree that is lost; however, the number of replanted trees will vary accordingly with the size of the tree being lost and the growth rate of each species.

2.1.4.2 Riparian areas

The main stream on the 220 Falls Road property represents a significant tributary of the Mahurangi River and its entire riparian zone should be permanently fenced to a standard that is stock-proof (e.g. seven-wire post and batten). Riparian restoration planting should be undertaken in the upper reach to provide connections with the existing planting downstream at the site and mature riparian vegetation that exists on the southern side of Falls Road (e.g. at 223 Falls Road). Restoration of the riparian areas would involve the removal of willows and other pest plants prior to planting with native species.

Fencing and restoration planting of the smaller tributaries of this watercourse, particularly the two tributaries that flow through Area 1, Area 3 and the northern-most tributary, would provide valuable ecological connections and biodiversity benefits.

Figure 2.4. Highest value sites recommended for vegetation and riparian restoration/ protection.

2.2 HERPETOFAUNA

Herpetofauna (reptiles and amphibians) comprise a significant component of New Zealand's terrestrial fauna. Over 100 endemic taxa are currently recognised (van Winkel*, et al*. 2018) and more than 80% are considered *Threatened* or *At Risk* of extinction (Hitchmough *et al*. 2016). All indigenous reptiles and amphibians are legally protected under the Wildlife Act 1953, and vegetation and landscape features that provide significant habitat for native herpetofauna are protected by the Resource Management Act 1991. Statutory obligations require management of resident reptile and amphibian populations where they or their habitats are threatened by disturbance or land development.

In response to the current proposal, a baseline assessment of herpetofauna values has been undertaken. The assessment was based on a desktop assessment and a site visit in August 2016. Desktop investigations involved a review of the Department of Conservation's *Herpetofauna* database (accessed August 2016), as well as Bioresearches Group's herpetofauna records, for all herpetofauna detected within a 5 km radius of the subject site. An experienced herpetologist visited the site on 5 August 2016 to visually assess the habitat for native reptiles and carry out a search to reveal animals and/ or sign (e.g. scats, sloughed skin) by searching foliage and lifting logs and debris.

2.2.1 Desktop Assessment

Twelve (12) reptile and amphibian taxa are known to occur in the Rodney Ecological District, including five skinks, four geckos and three frogs (Table 2.1). Six of these taxa have been reported from sites within 5 km of site; based on a review of historical lizard records held by the Department of Conservation's *Herpetofauna* database and Bioresearches Group Ltd. The corresponding New Zealand Conservation Threat Status (NZCTS) for each taxon has been provided in Table 2.1. Threat status generally correlates with significance of occurrence at sites where species are identified. That is, the higher the threat status of a taxon, the higher the significance of occurrence at any specific site.

Three introduced species (*Lampropholis delicata*, *Ranoidea aurea* and *Ranoidea raniformis*) are likely to be present at the property; however, these species are not afforded legal protection. In particular, the plague skink is highly invasive, abundant in the Auckland Region and is regarded as having a detrimental ecological impact in areas where it establishes in New Zealand. As a result, it has been classified as an "Unwanted Organism" by the Ministry for Primary Industries (previously Ministry of Agriculture and Fisheries) under the Biosecurity Act (1993) and has not been considered further in this LMP; outside of noting its presence.

In addition, a desktop assessment, using aerial imagery to identify potential lizard habitat, and a visual assessment during a site visit, indicated that suitable habitat was available for at least three additional native lizard species (e.g. elegant gecko, pacific gecko and ornate skink) (Table 2.1).

Table 2.1. Herpetofauna recorded from the Rodney Ecological District, including Conservation Threat Status and presence within 5 km of Stubbs Farm (✓- known; ? – likely; x – absent).

Common name	Species name	Threat Category & status*	≤5 km from site
Scincidae			
Copper skink	*Oligosoma aeneum*	Not Threatened	✓
Ornate skink	*Oligosoma ornatum*	At Risk – Declining	?
Moko skink	*Oligosoma moco*	At Risk – Declining	x
Shore skink	*Oligosoma smithi*	At Risk – Naturally Uncommon	x
Plague skink	*Lampropholis delicata*	Unwanted Organism	✓
Diplodactylidae			
Forest gecko	*Mokopirirakau granulatus*	At Risk – Declining	✓
Pacific gecko	*Dactylocnemis pacificus*	At Risk – Relict	?
Elegant gecko	*Naultinus elegans*	At Risk – Declining	?
Raukawa gecko	*Woodworthia maculata*	Not Threatened	x
Leiopelmatidae			
Hochstetter's frog	*Leiopelma* aff. *hochstetteri* "Northland"	At Risk – Declining	✓
Hylidae			
Green & golden bell frog	*Ranoidea aurea*	Introduced & Naturalised	✓
Southern bell frog	*Ranoidea raniformis*	Introduced & Naturalised	✓

*Hitchmough *et al*. (2016)

2.2.2 Site Assessment

A herpetologist searched the site for lizards for approximately two hours (i.e. from 10:30 hours to 13:00 hours) on 5 August 2016. A large proportion (c. 80%) of the site was considered unsuitable for native lizards given the extent of managed pasture, intensive grazing regime and lack of suitable refuge structures (e.g. inorganic or organic debris). Search effort was focussed in the understorey and leaf litter layer within vegetation areas 1 – 4, where suitable lizard habitat was identified (e.g. decaying logs, rotting fence posts, rocks, corrugated iron sheets and flaking bark on tree trunks; Plates 2.8 and 2.9). No dedicated attempts were made to survey for arboreal geckos (e.g. nocturnal spotlight searches) although diurnal searches through low-growing foliage were undertaken on an *ad hoc* basis. Brief searches of the waterbodies (ornamental ponds and standing water) and surrounding vegetation were searched for introduced frogs.

No lizards or introduced frogs were detected on-site. The introduced plague skink (*Lampropholis delicata*) was recorded at the neighbouring 223 Falls Road property earlier that same day (5 August 2016) and is known from Sec 4 SO 476652, Hudson Road to the immediate north; therefore, it is almost certainly present at Stubbs Farm.

An assessment of lizard habitat availability revealed that although the vegetated areas on-site appeared to offer habitat for indigenous species (skinks and geckos), the habitat quality in each area varied considerably and from a landscape perspective, the habitat is discontinuous and isolated by

grazed pastureland. Despite this, native lizard populations are known to persist in small, isolated habitat patches. Considering the presence of suitable habitat for terrestrial skinks and arboreal geckos and the proximity of historical gecko records to the site, it is likely that at least two species of indigenous lizard (e.g. forest gecko and copper skink) may be resident on-site.

2.2.3 Assessment of Potential Effects on Native Lizards

The limited search effort failed to detect any native lizards but considering that the search was limited and undertaken outside of the recognised survey period, a precautious approach has been taken with respect to the assessment of effects (i.e. it assumes that native lizard populations are present within the established vegetation areas on-site).

Any lizard populations on-site are likely to persist almost exclusively within the heavily vegetated areas (Areas 1, 3, and 4). The patches of vegetation are isolated from each other by intensively grazed pasture, and lizard dispersal pathways may exist only as vegetation alongside the smaller tributaries; although, this habitat is very limited. Irrespective of the quality, the removal of any vegetation from within Areas 1, 3 and 4 would have more than minor effects on the quality and quantity of habitat for resident lizards.

The clearance of trees and vegetation—including 'poor quality' low-lying scrub and weedy or exotic species—in the Auckland Region may result in more than minor effects to native lizards that are known to utilise such habitats. Careless removal of canopy trees, debris and shelter structures by dragging or rolling debris and burying shelter structures such as logs, rock and wood piles can cause significant injury or mortality to resident lizards and can result in the loss of habitat and resources (e.g. food and refuge sites), as well as the consequent displacement of lizards into already occupied adjacent areas.

It is recommended that all vegetation within Areas 1, 3 and 4, and the riparian vegetation along the north-eastern tributary be retained where practicable. A mitigation and management plan specific to lizard initiatives (e.g. Lizard Management Plan; LMP) should be prepared if future development requires the removal of habitat that may support protected lizards. This LMP would need to be compiled by a DOC-authorised herpetologist. Where no lizard habitat is removed, mitigation recommendations provided under the *Vegetation* and *Freshwater* sections of this report, in addition the mammalian pest control, would have overarching benefits for native lizards.

2.3 AVIFAUNA

The avifauna (bird species) of the wider area were identified from a brief desktop assessment that involved a review of Robertson *et al.* (2007) and listing all bird species recorded within the 10 km^2 grid squares applying to the wider surrounding area from Orewa to Wellsford. In addition, field investigations (e.g. recording opportunistic sightings and undertaking dedicated five-minute bird counts) were carried out to document bird species utilising specific habitats at the site (Figure 2.5). Field surveys were undertaken on a single site visit on 5 August 2016.

The objective of the bird survey was to document diversity and provide information on the indicative abundance (conspicuousness) of birds utilising the property in its existing state (e.g. working farm in mid-winter 2016). Survey conditions, including temperature, wind, cloud cover and noise, were recorded.

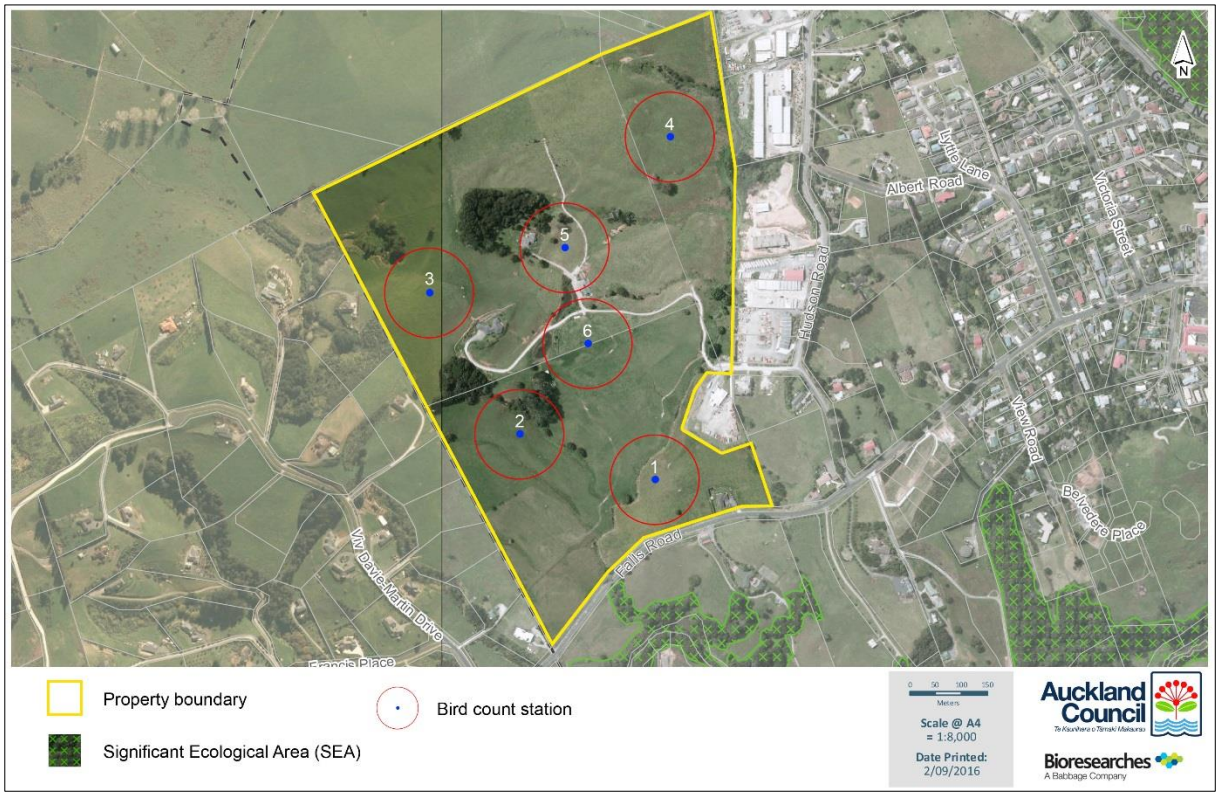

Figure 2.5. Aerial image of Stubbs Farm, Warkworth showing the location of five-minute bird count locations (n = 6).

2.3.1 Species Diversity

A total of 44 terrestrial species (Table 2.2) have been recorded for the wider Warkworth area. The avifauna consists of 20 endemic and native species, and 24 introduced species. Of those species, one is considered *Nationally Vulnerable* (North Island kaka) while two are considered to be *At Risk* (New Zealand pipit and red-crowned parakeet) (Robertson *et al*. 2013).

Table 2.2. Terrestrial birds recorded from 10 km^2 grids squares applying to the wider surrounding area from Orewa to Wellsford (Robertson *et al.* 2007), and species recorded at Stubbs Farm, Warkworth on 5 August 2016. Names as per Gill *et al*. (2010).

Common name	Species name	NZ Status	Recorded on-site
Australian brown quail	*Coturnix ypsilophora australis*	Introduced	
Australian magpie	*Gymnorhina tibicen*	Introduced	
Barbary dove	*Streptopelia risoria*	Introduced	
California quail	*Callipepla californica brunnescens*	Introduced	
Canada goose	*Branta canadensis*	Introduced	
Chaffinch	*Fringilla coelebs*	Introduced	
Common myna	*Acridotheres tristis*	Introduced	✓
Common pheasant	*Phasianus colchicus*	Introduced	
Common starling	*Sturnus vulgaris vulgaris*	Introduced	
Eastern rosella	*Platycercus eximius*	Introduced	✓
Eurasian blackbird	*Turdus merula merula*	Introduced	✓
Eurasian skylark	*Alauda arvensis*	Introduced	✓
European greenfinch	*Carduelis chloris*	Introduced	
Grey warbler	*Gerygone igata*	Endemic	✓
Goldfinch	*Carduelis carduelis britannica*	Introduced	✓
Hedge sparrow (dunnock)	*Prunella modularis*	Introduced	
House sparrow	*Passer domesticus domesticus*	Introduced	
Kookaburra	*Dacelo novaeguineae novaeguineae*	Introduced	
Mallard	*Anas platyrhynchos*	Introduced	✓
Morepork	*Ninox n. novaeseelandiae*	Native	
New Zealand pigeon	*Hemiphaga novaezelandiae*	Endemic	
New Zealand pipit	*Anthus n. novaeseelandiae*	Endemic	
North Island fantail	*Rhipidura fuliginosa placabilis*	Endemic	✓
North Island kaka	*Nestor meridionalis septentrionalis*	Endemic	
North Island robin	*Petroica longipes*	Endemic	
North Island tomtit	*Petroica macrocephala toitoi*	Endemic	
Paradise shelduck	*Tadorna variegata*	Endemic	✓
Peafowl	*Pavo cristatus*	Introduced	
Pukeko	*Porphyrio melanotus*	Native	✓
Red-crowned parakeet	*Cyanoramphus novaezelandiae*	Endemic	
Redpoll	*Carduelis flammea*	Introduced	
Rock pigeon	*Columba livia*	Introduced	
Sacred kingfisher	*Todiramphus sanctus*	Native	✓
Silvereye	*Zosterops lateralis lateralis*	Native	✓
Shining cuckoo	*Chrysococcyx lucidus lucidus*	Native	
Song thrush	*Turdus philomelos*	Introduced	✓
Southern black-backed gull	*Larus dominicanus*	Native	✓
Spur-winged plover	*Vanellus miles novaehollandiae*	Native	✓
Swamp harrier	*Circus approximans*	Native	
Tūi	*Prosthemadera n. novaeseelandiae*	Endemic	
Welcome swallow	*Hirundo neoxena neoxena*	Native	✓
White-faced heron	*Egretta novaehollandiae*	Native	✓
Wild turkey	*Meleagris gallopavo*	Introduced	
Yellowhammer	*Emberiza citrinella*	Introduced	✓

2.3.1.1 Opportunistic sighting and five-minute count results

A total of 18 species were recorded opportunistically, comprising two endemics, seven natives, and nine introduced species (Table 3). The most common (conspicuous) species recorded during five-minute counts were welcome swallow (26.5% of all records) followed by song thrush (10.2%), and pukeko, blackbird, and skylark (8.2% each). Environmental conditions and count results are shown in Tables 2.3 and 2.4 below.

All species utilising the site at the time of the visit are considered *Not Threatened* or *Introduced* by the New Zealand Conservation Threat Status (Robertson *et al*. 2013).

Table 2.3. Environmental variables recorded at each five-minute bird count station (n = 6) at Stubbs Farm (5 August 2016).

	Bird Count Station					
Variable	**1**	**2**	**3**	**4**	**5**	**6**
Start time	10:30	11:00	11:30	12:10	12:30	12:45
Cloud cover (%)	50%	60%	65%	50%	95%	95%
Wind	Moderate, NW	Moderate, NW	High, NW	Light, NW	Moderate, NW	Moderate, NW
Temperature	Cool (c. 10°C)	Cool (c. 10°C)	Cold (c. 9°C)	Cool (c. 12°C)	Cool (c. 10°C)	Cool (c. 10°C)
Precipitation	none	Light drizzle	none	none	Light drizzle	Rain
Noise	Moderate - road	Moderate - road	Moderate - dogs	none	none	none

Table 2.4. Percentage occurrence results – presence in each count. The five species with the highest occurrence are highlighted in bold.

	STATION							
	1	**2**	**3**	**4**	**5**	**6**	**TOTAL**	**% occurrence**
Common myna			2	1			3	6.1
Blackbird	1			2		1	4	**8.2**
Black-backed gull	1						1	2.0
Eastern rosella				2			2	4.1
Fantail			1			2	3	6.1
Goldfinch						1	1	2.0
Mallard		2					2	4.1
Paradise shelduck	2		1				3	6.1
Pukeko	1			1	2		4	**8.2**
Skylark	1	1	1	1			4	**8.2**
Song thrush	1			3		1	5	**10.2**
Spur-winged plover		1					1	2.0
Welcome swallow		3	2		3	5	13	**26.5**
White-faced heron						1	1	2.0
Yellowhammer	1					1	2	4.1

2.3.2 Assessment of Effects on Birds

The avifauna recorded at the site was typical of the surrounding agricultural landscape and the variety of habitats found within it (e.g. open managed pasture, small patches of vegetation, wetlands, and riparian margins). Half of the species recorded on-site were endemic or native; however, introduced species were certainly more abundant. The bird count data showed that welcome swallows formed a large component of the local avifauna, which probably reflects their abundance at the ornamental ponds and open water bodies on-site.

Several habitat types, including open pasture, riparian vegetation, regenerating scrubland, native bush, and mixed native and exotic treeland provide habitat for the variety of local birdlife, as well as other native species as they move through the landscape (e.g. tui, swamp harrier). Heavily vegetated areas and treeland would provide roosting, nesting and food (e.g. berries) resources for common native birds. Below the canopy, the dense undergrowth associated with some bush patches provides foraging and dispersal habitat for smaller native passerines (e.g. silvereye, grey warbler, and fantail). Open areas (e.g. farm paddocks and clearings) would likely provide habitat for ground-foraging species such as pukeko and paradise shelduck as they move through the landscape. The site is unlikely to support or provide resources for threatened species such as kaka and red-crowned parakeet; however, New Zealand pipit may intermittently visit the open pastures on-route to more favourable sites.

Even though the vegetation patches on-site are small and physically isolated from each other, this does not mean that they have reduced ecological value. Indeed, habitat mosaics and forest patches with larger edge-to-area ratios can support a higher biodiversity than larger contiguous forests. Therefore, the removal of any vegetation would reduce both the quantity and quality of available habitat for native birds, but such effects are likely to be no more than minor in the context of the wider landscape. Where clearance of native trees and scrubland is unavoidable, correct protocols should be followed to ensure the protection of all native birds (including their eggs and nests), as these are protected under the Wildlife Act (1953). Clearance of these habitats should be undertaken outside of the main native bird-breeding season (September – December inclusive) to avoid disturbance or harm to nesting birds.

Mitigation initiatives (e.g. pest control and restoration planting) as part of the proposal would provide significant benefits for local bird communities (e.g. enhanced protection and improved habitat quality).

2.4 FRESHWATER

An assessment of the freshwater environment and associated values at the site was undertaken by an experienced freshwater ecologist in August 2016. Prior to visiting the properties, a map of the site was created from the Auckland Council GIS viewer, which defined the overland flow paths of the watercourses and contours for the site (Figure 2.6).

One main watercourse (Mahurangi River tributary) was identified which ran along the majority of the eastern boundary of the site in a north-south direction before cutting across the southern section of the site. A further seven notable watercourses were identified and ran in a general west-east direction before draining into the Mahurangi River tributary. An additional notable watercourse was identified in the upper northwest section of the property which flowed in an east-west direction and drained into the Mahurangi River Left Branch Tributary (Figure 2.6). The site has been intensively farmed and numerous artificial ponds have been constructed both within and outside of watercourses. Due to the historic land use the hydrology of the land has been significantly altered.

A site assessment was undertaken on 5 August 2016, during which the presence and extent of water was noted, and measurements and reference photos were taken. The quality of the instream habitats and notes on the riparian and catchment information were also recorded. Habitat characteristics were recorded including the size of any pools, as well as the presence of continuously flowing water. The watercourses were classified under the Auckland Unitary Plan Operative in part (AUP Op), to determine, in accordance with the definitions in the Plan, the ephemeral, intermittent, or permanent status of these watercourses (*2.8 Appendix II*).

In situ basic water quality measurements (temperature, dissolved oxygen and conductivity) were undertaken within suitable locations using a Yellow Springs Instruments (YSI) Professional Series combined DO/ temperature/ conductivity meter.

Rainfall within the area of the site in the preceding week before the survey was moderate and sustained, while the rainfall in the preceding four weeks was similar with one additional significant rainfall event (> 55 mm) (Auckland Council Environmental Monitoring Site: Mahurangi Satellite Dish) (Figure 2.7).

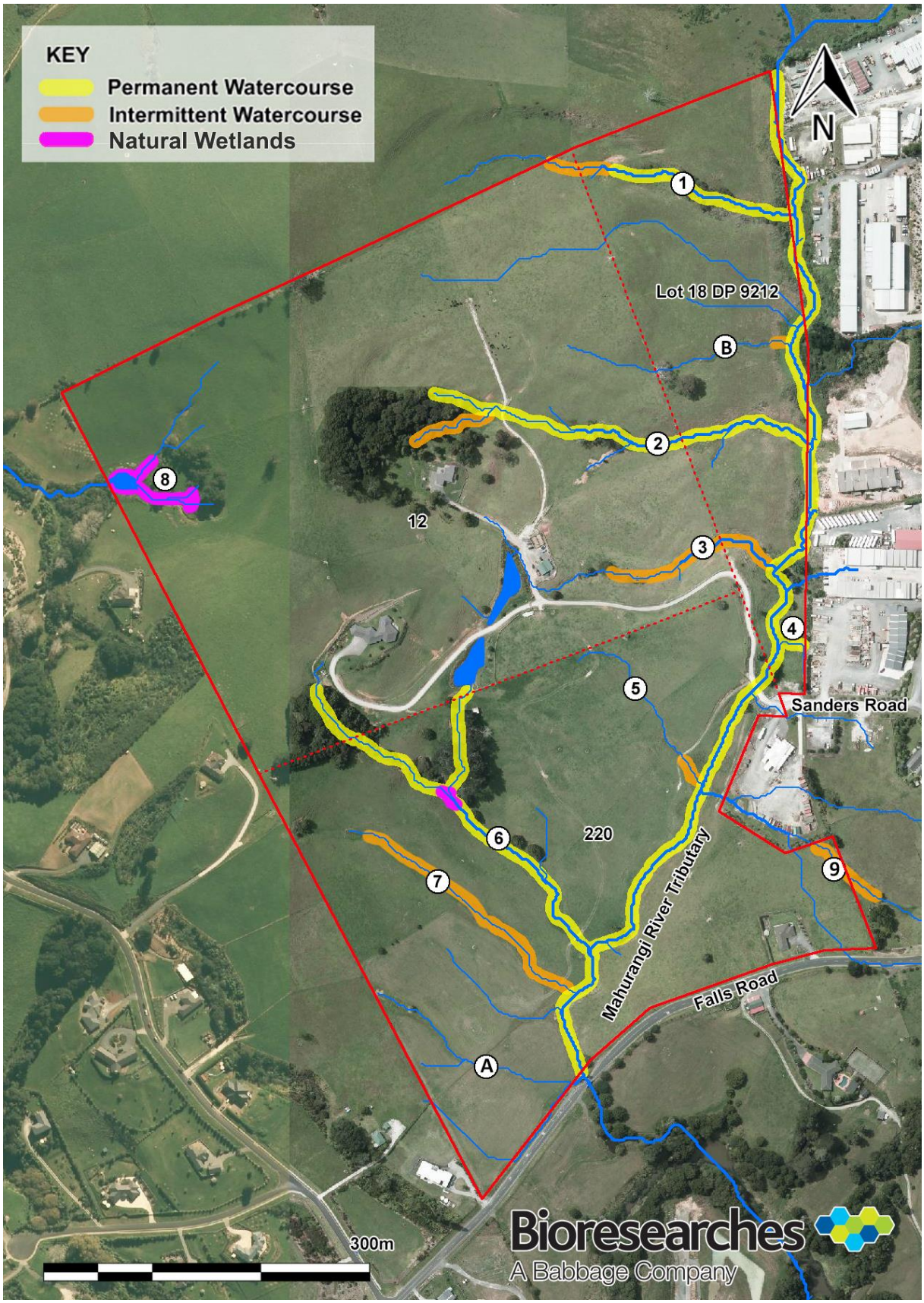

Figure 2.6. Watercourses and their classifications within Stubbs Farm, Warkworth.

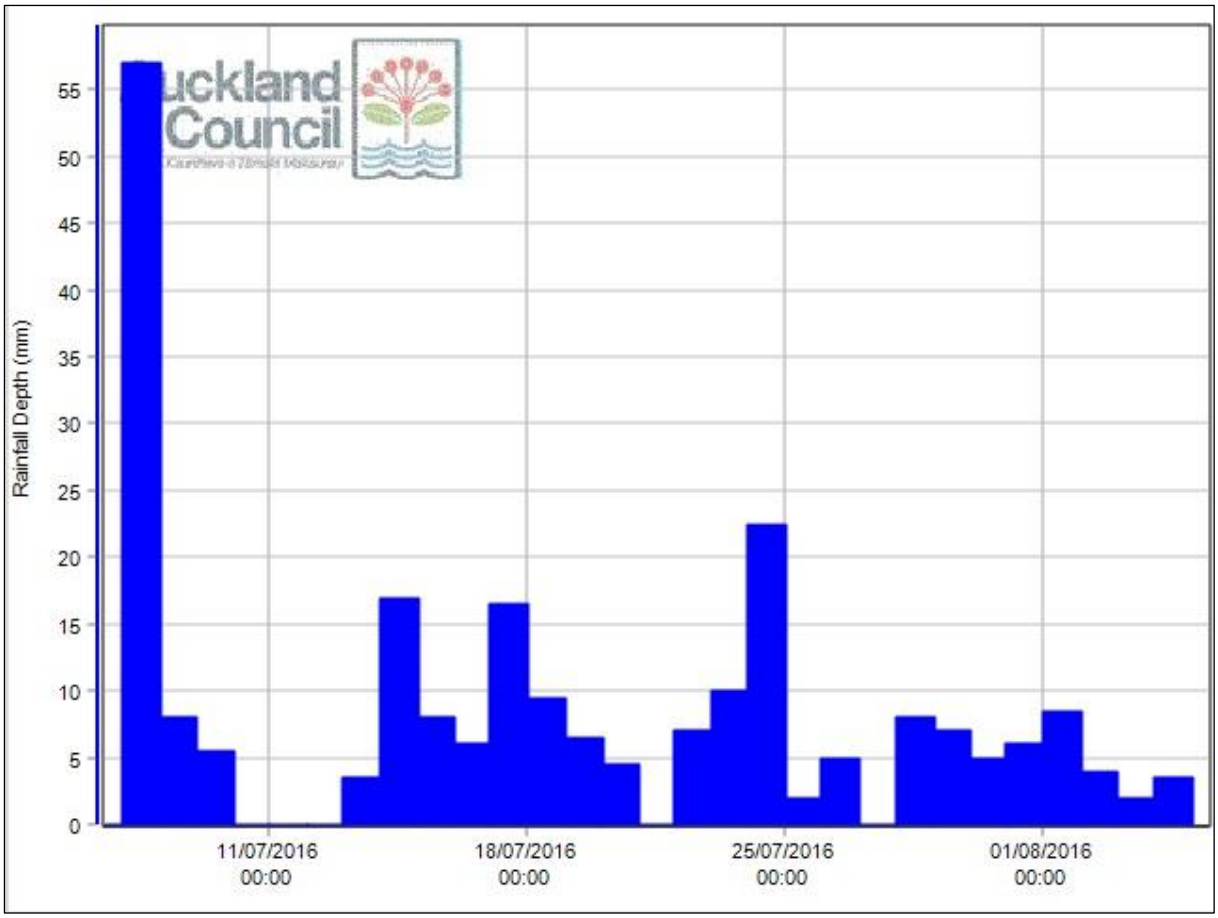

Figure 2.7. Totalled daily rainfall depth (mm) at the Mahurangi Satellite Dish between 06/07/16 – 05/08/16.

2.4.1 Mahurangi River Tributary

The Mahurangi River tributary originated north of the site and ran for approximately 1 km within the site predominantly on the eastern boundary, before flowing under Falls Road. The lower reach (lower 700 m) of the watercourse had a well-defined channel and fast flowing water (Plate 2.11). The average width and depth were 1.2 m and 0.35 m respectively, with a maximum depth of >1 m. The substrate consisted of silt and bubbling was present in some places, indicative of anaerobic processes. The level of shading was low. The riparian margin downstream of the Sanderson Road crossing has been relatively recently planted out and fenced off (Plate 2.12). The Sanderson Road crossing consisted of two culverts, both measuring 800 mm in diameter and 4 m long. Upstream of the Sanderson Road crossing, the riparian vegetation was also fenced off but consisted of long grasses and willows (Plate 2.13). Macrophytes recorded within the reach were relatively common and consisted of water cress (*Nasturtium officinale*), water purslane (*Ludwigia palustris*) and swamp lily (*Ottelia ovalifolia*). Water quality measurements within the lower reach reflected the winter conditions and showed a water temperature of 12.8˚C, which is indicative of an 'excellent' temperature (Biggs *et al.,* 2002). Dissolved oxygen concentration and saturation were high, at 8.9 mg/L and 84%, respectively, indicative of no stress for aquatic fauna (Davies-Colley *et al.,* 2013). The conductivity level was 'good' (145 µS/cm), indicative of unlikely enriched waters (Biggs *et al.*, 2002).

Along the upper reach (upper 300 m) water flow became sluggish and the access to the flood plain increased. The riparian margin, while still fenced off, became boggier and dominated by reed sweet grass on the true right bank and exotic scrub and weed on the true left bank (Plate 2.14). The average width and depth was 1.3 m and 0.6 m respectively. Water quality measurements within the upper reach reflected the winter conditions and showed a water temperature of 12.9˚C, which is indicative of an 'excellent' temperature (Biggs *et al*., 2002). Dissolved oxygen concentration and saturation were moderate, at 6.9 mg/L and 64% respectively, indicative of occasional minor stress for aquatic fauna (Davies-Colley *et al*., 2013). The conductivity level was 'good' (146 µS/cm), indicative of unlikely enriched waters (Biggs *et al*., 2002).

Due to the presence of continuously flowing water, both the upper and lower reach of the Mahurangi River Tributary were classified as permanent under the AUP Op (Figure 2.5). The watercourse was considered to have a moderate value due to the riparian vegetation, good access to the flood plain and the presence of root mats.

2.4.2 Watercourse 1

Watercourse 1 originated from the northern neighbouring property, Pt Allot 95 PSH, and ran for approximately 235 m before draining into the Mahurangi River tributary. The watercourse lacked a well-defined channel in most sections and had an average width and depth of 0.54 m and 0.09 m, respectively. The upper 50 m of the watercourse within the site contained small pools of surface water. No flowing water was evident within the upper reach. A trickle flow became evident below a cattle crossing and increased within the middle reach (130 m) (Plate 2.15). Along the lower reach (last 55 m) the water flow became diffuse and the land became boggy (Plate 2.16). Throughout the entire watercourse the substrate consisted of silt, and extensive pugging was evident from cattle access. Riparian vegetation consisted of managed pasture with a small patch of scrub and weeds along the lower reach. Shading was very low and no macrophytes were recorded. Water quality measurements within the reach reflected the winter conditions and showed a water temperature of 13.5˚C, which is indicative of an 'excellent' temperature (Biggs *et al*., 2002). Dissolved oxygen concentration and saturation were moderate, at 6.5 mg/L and 63%, respectively, indicative of occasional minor stress for aquatic fauna (Davies-Colley *et al.,* 2013). The conductivity level was 'good' (92 µS/cm), indicative of unlikely enriched waters (Biggs *et al*., 2002).

Due to the lack of flowing water the upper 50 m of Watercourse 1 within the site was classified as intermittent under AUP Op (Figure 2.5). Due to the presence of continuously flowing water, the remaining watercourse below the crossing, was classified as permanent under the AUP Op. If another classification survey was undertaken later in the season, after a period of dry weather, it is expected that sections of the permanent watercourse would be classified as intermittent under the AUP Op.

Both reaches of Watercourse 1 were considered to have a low ecological value predominantly due to the lack of riparian vegetation, hydrologic heterogeneity and habitat for native fauna.

2.4.3 Watercourse 2

Watercourse 2 originated from within the site, from two short tributaries, and ran for approximately 310 m from the confluence before draining into the Mahurangi River tributary. The true right tributary ran for approximately 80 m to the confluence, lacked a well-defined channel in places, had high shading and no flowing water was evident. A trickle flow was evident in the true left tributary, which was being fed by a small artificial stock pond. The true left tributary ran for approximately 60 m to the confluence and had an average width and depth of 0.15 m and 0.01 m, respectively. Shading was moderate to high and stock had access to both tributaries. At the confluence, the water flow became diffuse and the land boggy. Immediately below the confluence a road crossing with a hanging culvert (200 mm diameter, 3 m long) was present. Directly below the culvert a pool had formed measuring 1.2 m long by 0.9 m wide and 0.35 m deep.

Downstream of the pool the watercourse had a defined channel and a trickle flow was evident (Plate 2.17). The lower reach of the watercourse had an average width and depth of 0.55 m and 0.03 m, respectively. The substrate consisted of silt and terrestrial vegetation grew within the watercourse. Extensive pugging was evident throughout the watercourse and the riparian vegetation consisted of managed pasture with very low shading. No macrophytes were recorded. Water quality measurements within the reach reflected the winter conditions and showed a water temperature of 13.8˚C, which is indicative of an 'excellent' temperature (Biggs *et al*., 2002). Dissolved oxygen concentration and saturation were moderate, at 7.21 mg/L and 70% respectively, indicative of occasional minor stress for aquatic fauna (Davies-Colley *et al*., 2013). The conductivity level was 'fair' (166 µS/cm), indicative of slightly enriched waters (Biggs *et al*., 2002). Within the Mahurangi River tributary riparian margin the watercourse became diffuse and formed a boggy wetland before draining into the river.

Due to the lack of flowing water the true right tributary was classified as intermittent under the AUP Op (Figure 2.5). Due to the presence of continuously flowing water, the remaining watercourse was classified as permanent under the AUP Op. If another classification survey was undertaken later in the season, after a period of dry weather, it is expected that sections of the permanent watercourse would be classified as intermittent under the AUP Op.

Watercourse 2 was considered to have a low ecological value predominantly due to the lack of riparian vegetation, hydrologic heterogeneity and habitat for native fauna.

2.4.4 Watercourse 3

Watercourse 3 originated from a large artificial pond (Plate 2.18), measuring approximately 50 m by 20 m, and ran for 260 m before draining into the Mahurangi River tributary. Eight meters downstream of the pond a driveway/ road crossed the watercourse. No culvert was evident. Approximately 40 m downstream of the driveway a cattle crossing crossed the watercourse. Upstream of the cattle crossing the watercourse had no surface water and contained terrestrial vegetation. Downstream of the cattle crossing the watercourse channel became more defined with steep eroded banks in places (Plate 2.19). A trickle flow was evident along some sections of the watercourse but became diffuse in some areas. The watercourse had an average width and depth of 0.25 m and 0.03 m respectively. The substrate consisted of silt and evidence of pugging was extensive. The riparian vegetation consisted of managed

pasture and provided no shading. Macrophytes were recorded in small numbers and included water cress, water purslane and forget-me-not (*Myosotis laxa*), although terrestrial vegetation was common throughout the watercourse. Water quality measurements within the reach reflected the winter conditions and showed a water temperature of 14.9˚C, which is indicative of an 'excellent' temperature (Biggs *et al*., 2002). Dissolved oxygen concentration and saturation were moderate, at 7.1 mg/L and 71% respectively, indicative of occasional minor stress for aquatic fauna (Davies-Colley *et al*., 2013). The conductivity level was 'fair' (200 µS/cm), indicative of slightly enriched waters (Biggs *et al*., 2002).

Due to the presence of terrestrial vegetation as well as the absence of surface water and substrate sorting the upper reach of the watercourse was classified as ephemeral under the AUP Op (Figure 2.5). The remaining watercourse was classified as intermittent under the AUP Op.

Watercourse 3 was considered to have a low ecological value predominantly due to the lack of riparian vegetation, hydrologic heterogeneity and habitat for native fauna.

2.4.5 Watercourse 4

Watercourse 4 originated from the industrial properties on the eastern boundary of the site and ran for approximately 23 m before draining into the Mahurangi River tributary. The watercourse formed a straightened channel with an average width and depth of 0.25 m and 0.05 m respectively (Plate 2.20). The substrate consisted of silt and the riparian vegetation consisted of long grasses and weeds, which provided no shading. No macrophytes were recorded. Water quality measurements within the reach reflected the winter conditions and showed a water temperature of 14.1˚C, which is indicative of an 'excellent' temperature (Biggs *et al*., 2002). Dissolved oxygen concentration and saturation were high, at 7.7 mg/L and 75%, respectively, indicative of no stress for aquatic fauna (Davies-Colley *et al*., 2013). The conductivity level was 'fair' (233 µS/cm), indicative of slightly enriched waters (Biggs *et al*., 2002).

Due to the presence of continuously flowing water, Watercourse 4, was classified as permanent under the AUP Op (Figure 2.5). If another classification survey was undertaken later in the season, after a period of dry weather, it is expected that the watercourse would be classified as intermittent under the AUP Op.

Watercourse 4 was considered to have a low ecological value predominantly due to the lack of riparian vegetation, hydrologic heterogeneity and habitat for native fauna.

2.4.6 Watercourse 5

Watercourse 5 originated within the site and ran for approximately 180 m before draining into the Mahurangi River tributary. The upper 150 m of the watercourse lacked a defined channel, had no flowing water and contained terrestrial vegetation. The lower 30 m reach had a defined channel, which was heavily eroded and pugged (Plate 2.21). The lower channel average width and depth measured 0.2 m and 0.02 m respectively. There was not enough water to undertake water quality measurements.

Due to the presence of terrestrial vegetation as well as the absence of surface water and a well-defined channel, the upper reach of the watercourse was classified as ephemeral under the AUP Op (Figure 2.5). The remaining watercourse was classified as intermittent under the AUP Op.

Watercourse 5 was considered to have a low ecological value predominantly due to the lack of riparian vegetation, hydrologic heterogeneity and habitat for native fauna.

2.4.7 Watercourse 6

Watercourse 6 originated from within the site, from two tributaries, and ran for approximately 200 m from the confluence before draining into the Mahurangi River tributary. The true right tributary ran for approximately 175 m to the confluence and had an average width and depth of 0.4 m and 0.07 m, respectively. The channel was well-defined and heavily eroded and pugged in places (Plate 2.22). The channel banks became increasingly steep and incised further upstream from 1 m to 2-4 m. A few pools were present along the true right tributary, the two largest pools measuring 1.2 m long, 1 m wide, 0.16 m deep and 1.3 m long, 0.6 m wide and 0.4 m deep. The substrate consisted of silt and bedrock. Riparian vegetation consisted of cattle damaged native bush which provided a high amount of shading. Flowing water was present within the tributary at the time of the survey.

The true left tributary originated from a large artificial pond, measuring approximately 45 m by 20 m, and ran for 105 m to the confluence. The true left tributary had an average width and depth of 0.4 m and 0.03 m, respectively. The substrate consisted entirely of silt. The channel had steep banks with evidence of extensive pugging (Plate 2.23). The riparian margin consisted of bare ground, managed pasture and mature pine trees, which provided a high amount of shading. Flowing water was present at the time of the survey.

At the confluence, water flow became diffuse and the land boggy. Downstream of the confluence the watercourse had an average width and depth of 0.35 m and 0.1 m, respectively (Plate 2.24). Small pools were present along the lower reach and had an average size of 0.7 m long by 0.3 m wide and 0.12 m deep. The substrate consisted of silt and much of the watercourse was choked with terrestrial vegetation. The riparian vegetation consisted of managed pasture which provided no shading along the lower reach. Water quality measurements within the reach reflected the winter conditions and showed a water temperature of 12.5˚C, which is indicative of an ‘excellent’ temperature (Biggs *et al.,* 2002). Dissolved oxygen concentration and saturation were high, at 8.4 mg/L and 79%, respectively, indicative of no stress for aquatic fauna (Davies-Colley *et al*., 2013). The conductivity level was ‘good’ (141 µS/cm), indicative of unlikely enriched waters (Biggs *et al*., 2002).

Due to the presence of continuously flowing water, Watercourse 6, was classified as permanent under the AUP Op (Figure 2.5). If another classification survey was undertaken later in the season, after a period of dry weather, it is expected that the entire watercourse, or sections of, would be classified as intermittent under the AUP Op.

The watercourse was considered to have a low to moderate ecological value. The moderate value is due to the true right tributary having moderate riparian margins and moderate hydrologic heterogeneity.

2.4.8 Watercourse 7

Watercourse 7 originated within the site and ran for approximately 265 m before draining into the Mahurangi River tributary. The upper 30 m of the watercourse lacked a defined channel, had no flowing water and contained terrestrial vegetation. The lower 235 m reach had a more defined channel, although much of the lower reach was choked with terrestrial vegetation (Plate 2.25). The entire watercourse had a silt substrate and the riparian vegetation consisted of pasture which provided no shading. The lower reach had been fenced off and water cress was present within the watercourse. The lower channel average width and depth measured 0.3 m and 0.05 m, respectively. Water quality measurements within the reach reflected the winter conditions and showed a water temperature of 13.6˚C, which is indicative of an 'excellent' temperature (Biggs *et al*., 2002). Dissolved oxygen concentration and saturation were high, at 8.5 mg/L and 82%, respectively, indicative of no stress for aquatic fauna (Davies-Colley *et al*., 2013). The conductivity level was 'good' (99 µS/cm), indicative of unlikely enriched waters (Biggs *et al*., 2002).

Due to the presence of terrestrial vegetation as well as the absence of surface water, substrate sorting and a well-defined channel, the upper reach of the watercourse was classified as ephemeral under the AUP Op (Figure 2.5). The remaining watercourse was classified as intermittent under the AUP Op.

Watercourse 7 was considered to have a low ecological value predominantly due to the lack of riparian vegetation, hydrologic heterogeneity and habitat for native fauna.

2.4.9 Watercourse 8

Watercourse 8 consisted of a large artificial pond, measuring approximately 15 m in diameter, which was fed by four smaller watercourses (Plate 2.26). These watercourses contained terrestrial vegetation throughout and had no flowing water present, although some surface water was present, particularly where extensive pugging was evident.

Due to the presence of terrestrial vegetation as well as the absence of surface water and substrate sorting, the watercourses associated with Watercourse 8 were classified as ephemeral under the AUP Op (Figure 2.5).

The watercourses associated with Watercourse 8 were considered to have a low ecological value predominantly due to the lack of riparian vegetation, hydrologic heterogeneity and habitat for native fauna.

2.4.10 Remaining Watercourses

The remaining watercourses and tributaries within the site (Figure 2.5) contained terrestrial vegetation and lacked well defined channels (Plate 2.27). There was no evidence within the watercourses of substrate sorting through flow processes. Additionally, no flowing water was evident, although small amounts of surface water were present, predominantly in areas where pugging had occurred and after sustained moderate to high rainfall in the four weeks preceding the site survey. These watercourses were classified as ephemeral under the AUP Op.

2.4.11 Assessment of Effects on Freshwater Ecosystems

Any works within close-proximity of a watercourse or artificial pond may have moderate adverse effects on the freshwater ecological values through sediment runoff if not appropriately managed. The proposal for Open Space zoning along watercourses 1 – 6 would provide a level of mitigation for the potential effects of sedimentation in both the short- and long-term, through riparian vegetation buffer protection. Where works are undertaken within watercourses or artificial ponds, this is likely to result in sedimentation, habitat disturbance, and injury or mortality to native fish. Similarly, reclamation of permanent or intermittent watercourses would have a high ecological effect (more than minor) on freshwater values, if not appropriately managed or mitigated through compensatory restoration elsewhere. Compensation would be addressed at the resource consenting stage. In addition, where appropriate stormwater management is set in place to mitigate water runoff from impermeable surfaces (e.g. roads), the effects on local watercourses would be considered no more than minor.

2.5 Conclusions and Recommendations

- The vegetation present at the site, while of low to moderate botanical value, does provide ecological values in the context of the wider surrounding landscape as habitat and food resources for native fauna. Areas 1, 3, and 4 provide vegetative buffers for the headwaters of tributaries flowing into the Mahurangi River, and vegetation in these areas would be retained under the Open Space zoning.

- Protection/ restoration and fencing of native vegetation and riparian areas (Figure 2.3) would ensure that key areas of native vegetation and their riparian connections to the Mahurangi River are protected. Since the vegetated areas generally occur in steeper parts of the site, their retention is unlikely to present significant constraints to future development of the site.

- Where habitat removal is unavoidable, appropriate fauna management and mitigation processes (e.g. pre-clearance bird nesting surveys, Lizard Management Plan) should be prepared and implemented to ensure no net loss of biodiversity. Clearance of vegetation should be undertaken outside of the main native bird-breeding season (September – December inclusive) to avoid disturbance or harm to nesting birds.

- An Ecological Restoration Planting Plan and Weed Management Plan should be developed for the site to be implemented alongside future development processes. Hygiene protocols for kauri dieback disease will need to be implemented at all stages due to the presence of kauri within the SEA. General protocols can be found at ***www.kauridieback.co.nz***

- Any construction or earthworks in close proximity to a watercourse (within 10 m) should be timed to avoid predicted heavy rain and should incorporate standard sediment controls (TP90 – Erosion and Sediment Control: Guidelines for Land Disturbing Activities in the Auckland Region), as a minimum, to prevent sediment runoff into any watercourses. All bare ground exposed by site works should be stabilised and replanted with appropriate vegetation as soon as practicable.

- Where degradation, reclamation or culverting of intermittent and permanent watercourse cannot be avoided, due to engineering or planning constraints, the adverse ecological effects would be appropriately mitigated or compensated for through offsetting in accordance with Policy E3.3 (4) of the AUP Op. Compensation would be addressed at the resource consenting stage.

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2.7 PLATES

Plate 2.1. Totara treeland on the western side of Area 1

Plate 2.2. Totara treeland above an open grassy wetland on the eastern side of Area 1 at the confluence of two small streams. Note taro in the upper wetland.

Plate 2.3. Area 2 with totara and kanuka above a farm pond.

Plate 2.4. Mature pines with totara below them in Area 4

Plate 2.5. Native shrubs and small trees cling to the steeply incised stream banks between Area 3 and Area 4. Note the severe pugging of the soils caused by cattle.

Plate 2.6. Grazed wetland area at the confluence of two small watercourses to the west of Area 4

Plate 2.7. Southern Mahurangi tributary with riparian restoration planting.

Plate 2.8. Northern Mahurangi tributary with open grassy floodplain and weedy riparian zone

Plate 2.9. Northern tributary showing scattered manuka, kanuka and a single kahikatea with gorse and exotic grasses and rushes.

Plate 2.10. Lower tributary below Area 1 showing its grazed and degraded state.

Plate 2.11. Lower reach of the Mahurangi River Tributary.

Plate 2.12. Riparian margin of the Mahurangi River Tributary downstream of the Sanders Road crossing.

Plate 2.13. Riparian margin of the Mahurangi River Tributary upstream of the Sanders Road crossing.

Plate 2.14. Upper reach of the Mahurangi River Tributary.

Plate 2.15. Middle reach of Watercourse 1.

Plate 2.16. Lower reach of Watercourse 1 where the water flow becomes diffuse.

Plate 2.17. Lower reach of Watercourse 2.

Plate 2.18. Artificial pond upstream of Watercourse 3.

Plate 2.19. Lower reach of Watercourse 3.

Plate 2.20. Watercourse 4.

Plate 2.21. Lower reach of Watercourse 5.

Plate 2.22. True right tributary of Watercourse 6.

Plate 2.23. True left tributary of Watercourse 6.

Plate 2.24. Lower reach of Watercourse 6.

Plate 2.25. Watercourse 7.

Plate 2.26. Watercourse 8 showing an ephemeral watercourse leading to the artificial pond.

Plate 2.27. Lower south-eastern section of the site showing a few ephemeral reaches.

2.8 APPENDICES

Appendix I: Native and Exotic Plant Species Recorded at 220 Falls Road and 12 Sanderson Road, Warkworth, August 2016.

Native Species

Botanical Name	Common Name
Agathis australis	Kauri
Alectryon excelsum	Titoki
Astelia hastata	Perching lily
Blechnum minus	Swamp kiokio
Blechnum novaezelandiae	Kiokio
Blechnum parrisiae	Rasp fern
Carex banksiana	Fine leaved hook grass
Carex lessoniana	Rautahi
Carex uncinata	Hook grass
Coprosma arborea	Tree coprosma
Coprosma rhamnoides	Twiggy coprosma
Coprosma robusta	Karamu
Cordyline australis	Cabbage tree
Corynocarpus laevigatus (p)	Karaka
Cyathea dealbata	Silver tree fern
Cyathea medullaris	Black ponga
Cyperus ustulatus	Giant umbrella sedge
Dacrycarpus dacrydioides	Kahikatea
Dacrydium cupressinum	Rimu
Deparia petersenii	Deparia
Dicksonia squarrosa	Wheki ponga
Diplazium australe	Diplazium
Gahnia lacera	Cutty grass
Geniostoma ligustrifolium	Hangehange
Griselinia littoralis (p)	Puka
Houheria populnea (p)	Houhere/lacebark
Juncus sarophorus	Fan flowered rush
Knightia excelsa	Rewarewa
Kunzea robusta	Kanuka
Lastreopsis glabella	Smooth shield fern
Lemna disperma	Duckweed
Leptospermum scoparium	Manuka
Libocedrus plumosa	Kawaka
Machaerina rubiginosa	Baumea
Melicytus ramiflorus	Mahoe
Metrosideros excelsa	Pohutukawa
Metrosideros perforata	Small white rata

Myrsine australis	Mapou
Nestegis cunninghamii	Black maire
Oplismenus imbecilis	Native forest grass
Phormium tenax (p)	Harakeke/flax
Phyllocladus trichomanoides	Tanekaha
Piper excelsum	Kawakawa
Pittosporum tenuifolium (p)	Kohuhu
Pneumatopteris pennigera	Gully fern
Podocarpus totara	Totara
Pseudopanax lessonii	Houpara
Rhopalostylis sapida	Nikau
Schoenus tendo	Kauri sedge
Typha orientalis	Raupo
Vitex lucens	Puriri

Exotic Species

Botanical Name	Common name
Agapanthus praecox	African lily
Apium nodiflorum	Water celery
Asparagus scandens	Climbing asparagus
Colocasia esculenta	Taro
Cortaderia selloana	Pampas
Crataegus monogyna	Hawthorn
Eucalyptus sp.	Eucalypt
Glyceria maxima	Reed sweet grass
Juncus effusus	Weak rush
Leycesteria formosa	Himalayan honeysuckle
Ligustrum lucidum	Tree privet
Ligustrum sinense	Chinese privet
Magnolia grandiflora	Laurel magnolia
Paspalum distichum	Mercer grass
Pinus radiata	Monterey pine
Plectranthus ciliatum	Plectranthus
Ranunculus repens	Creeping buttercup
Rhododendron ponticum	Rhododendron
Rubus fruticosus	Blackberry
Salix fragilis	Crack willow
Selaginella kraussiana	African clubmoss
Solanum mauritianum	Woolly nightshade/tobacco plant
Syzygium smithii	Monkey apple
Ulex europaeus	Gorse
Zantedeschia aethiopica	Arum lily

Appendix II. Stream classification under the Auckland Unitary Plan Operative in part.

STREAM DEFINITIONS

Stream or River

A continually or intermittently flowing body of fresh water, excluding ephemeral streams, and includes a stream or modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal except where it is a modified element of a natural drainage system).

Ephemeral reaches

Stream reaches with a bed above the water table at all times, with water only flowing during and shortly after rain events.

A river reach is ephemeral where it meets at least three of the following criteria:

- it lacks a well-defined channel, so that there is little or no ability to distinguish between the bed and banks
- it contains no surface water, if no rain has occurred in the previous 48 hours
- it contains terrestrial vegetation
- there is clearly visible organic debris on its floodplain from flood flows
- there is no evidence of substrate sorting through flow processes

Intermittent Stream

Stream reaches that cease to flow for some periods of the year.
Includes:

- reaches with stable natural pools having a depth at their deepest point of not less than 150mm and a total pool surface area that is 10m² or more per 100m of river or stream bed length and
- reaches without stable pools

Permanent River or Stream

The continually flowing reaches of any river or stream.

3 DETAILED VEGETATION ASSESSMENT: STUBBS FARM

Auckland Council has emphasised a requirement for neighbourhood parks within the Stubbs Farm area of the Structure Plan for the provision of recreational areas (e.g. picnic areas, playgrounds). A detailed investigation into the intrinsic ecological value of the vegetation in the largest remnant bush block (Area 1; Figure 3.1) was undertaken, which included assessing the vegetation quality under the SEA criteria, classification of the ecosystem type (present and potential) and assessing the effects of vegetation clearance to support a small open area of parkland adjacent to the bush; integrating public recreation, visual amenity and wildlife conservation.

Figure 3.1. Vegetation cover at the site, including vegetation areas (1 – 4) and the location of the Mahurangi tributary.

3.1 DESCRIPTION OF THE EXISTING VEGETATION

This subject area of bush (c. 1 ha) has a relatively dense canopy predominantly of tōtara (*Podocarpus totara* var. *totara*) (Plate 3.1). In the western end of the bush (Figure 3.2, A), the tōtara are less dense, but have matured into large specimens and host a number of epiphytic plants and lichens. Towards the eastern end, the trees are mainly tall, slim specimens to 10 m tall with larger open grown trees around the edges. Scattered tall, slim rimu (*Dacrydium cupressinum*), kānuka (*Kunzea robusta*), kauri (*Agathis australis*) and tānekaha (*Phyllocladus trichomanoides*) are found amongst the tōtara. Rātā vines (*Metrosideros perforata*) cover the trunks of several of the canopy trees in this section. A small stand of trees to the north east of the house has four medium-sized rimu, a large multi-trunked pōhutukawa (*Metrosideros excelsa*) which is assumed to be planted and a double-trunked tānekaha. To the west of the house amongst several large Monterey pines (*Pinus radiata*), plus one medium sized and one large kawaka tree (*Libocedrus plumosa*). The smaller kawaka has a trunk diameter of c. 250 mm but it is not very tall for its size as it is overtopped by the pines; however, the second tree is considerable larger and appears to be older. Although it is difficult to be certain, the difference in age of the trees and their position would strongly suggest that they are self-seeded and are not cultivated specimens. This species has a National Threat Status of At *Risk – Naturally Uncommon* (de Lange *et al*., 2013).

Historic and present grazing has resulted in a depauperate understorey throughout all areas except the riparian margins (Figure 3.2, C). Despite this, a moderately diverse range of native seedlings were identified near the riparian margins and at the base of large trees in Area A, where they were protected from trampling. The seedlings could be from historic seed banks; however, the birdlife present and nearby native seed sources indicate that there is ongoing seed dispersal into the forest. There are also a number of weeds such as Chinese privet (*Ligustrum sinense*), arum lily (*Zantedeschia aethiopicum*), woolly nightshade (*Solanum mauritianum*), climbing asparagus (*Asparagus scandens*) and African clubmoss (*Selaginella kraussiana*) throughout. In parts, there are young ground ferns such as kiokio (*Blechnum novaezelandiae*), deparia (*Deparia petersenii*) and native sedges (*Carex* sp.) scattered amongst the groundcover.

Two small watercourses originate within the stand of bush; at the confluence of the two watercourses on the eastern side of the bush stand the farm track forms a dam behind which is an open, grazed wetland with mainly exotic rushes (*Juncus effusus*).

Plate 3.1. From left to right: View of totara stand and clear understory; one of several seedlings found near trunk bases, and a photo of one of the largest totara on the western edge of remnant.

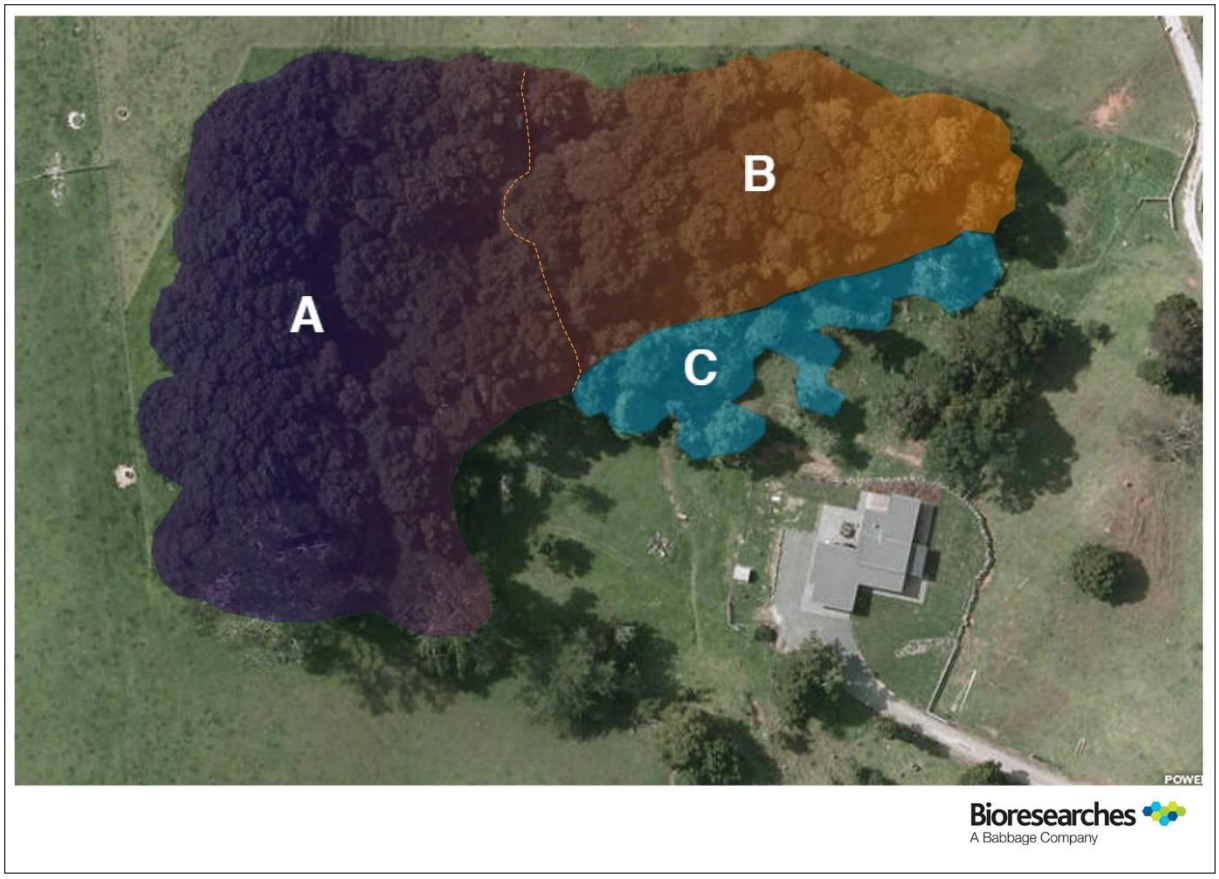

Figure 3.2. Overview of vegetation areas within the remnant (Area 1). Areas 'A' and 'B' have significant overlap, but exhibit a strong size gradient (represented by the colour gradient, i.e. purple to orange) with large mature tōtara in section A and a collection of tall but slender pole tōtara, rimu, tānekaha, kauri, and kānuka in section B. The dotted Section C is the only area with a dense understory and follows the watercourse beneath.

3.1.1 Significant Ecological Area (SEA) Criteria

Under Schedule 3 of the Auckland Unitary Plan, an area shall be considered a significant ecological area (SEA) if it meets *one or more* of the following five factors:

1. Representativeness
2. Threat status and rarity
3. Diversity
4. Stepping-stones, migration pathways and buffers
5. Uniqueness or distinctiveness

Based on the vegetation survey, we propose the ecosystem meets the following criterion:

2. Threat status and rarity

Under which, an area is considered an SEA if it meets one or more of the following sub-factors:

a) Any habitats native to Auckland that have been assessed under the IUCN classification system as threatened

b) Any habitats that support occurrences of a plant, animal, or fungi that has been assessed by the Department of Conservation and determined to be nationally threatened or at risk, or Regionally Critical, Endangered and Vulnerable, and in Serious or Gradual Decline
c) Contains any indigenous vegetation that occurs in Land Environments New Zealand Category IV where less than 20% remains
d) Any indigenous vegetation or habitat of indigenous fauna that occurs within an indigenous wetland or dune system.
e) Any habitats that support an occurrence of a plant, animal, or fungi that is locally rare or
    i. Has been assessed by the Department of Conservation and determined to have a national conservation status of Naturally Uncommon, Range Restricted or Relict.

Stubbs Farm contains a forest remnant that supports two healthy kawaka (*Libocedrus plumosa*) of reproductive maturity, which appear not to be planted. *Libocedrus plumosa* has both male and female reproductive cones on the same plant (monecious), and so both individuals may reproduce (Allan, 1982; Tomlinson *et al*. 1993). *Libocedrus plumosa* has been classified by the Department of Conservation (de Lange *et al.,* 2013) as *Naturally Uncommon*; therefore, the supporting ecosystem qualifies for protection as a Significant Ecological Area under the criterion 2E(i).

Figure 3.3. Kawaka (*Libocedrus plumosa*), classified by the Department of Conservation as *Naturally Uncommon*, and by the IUCN as a vulnerable species.

3.1.2 Ecosystem Classification

Ecosystems can be classified by their climate, landform, soil characteristics, and their vegetation community composition. Classification allows the prioritization of conservation efforts and guides the restoration of degraded systems. A national ecosystem classification system has been developed by the Department of Conservation (Singers & Rogers, 2014), and has since been adapted for the Auckland Region (Singers *et al.* 2017). The following ecosystem classifications have been determined using the Auckland classification system.

3.1.2.1 Current Classification

This remnant patch occurs on a moderately steep hill in pastoral land with a south-facing aspect. Tōtara is the dominant colonizing species but is joined within the southern end by occasional kanuka, rimu, and kauri in the canopy tier. The edge of the remnant supports two kawaka, one of medium height and one large specimen. Kawaka is a naturally uncommon species, and is classified as threatened (de Lange *et al.,* 2013). To the north of the remnant, the tōtara are mature and are estimated to be approximately 100 years old. Some of these are multi-stemmed spreading trees with trunks measuring over 1400 mm DBH and host a range of lichen flora. At the lower (southern) end of the remnant, the tōtara are much smaller (200 – 400 mm DBH, i.e. 'pole size'). Although this area has the most diverse canopy with rimu and kauri restricted to this area, none of the trees in the southern remnant portion have reached maturity. Due to significant past and present grazing pressures there is an open sub-canopy throughout, except around the streams that border the forest. Based on the landform and dominant vegetation, the current ecosystem classification is diagnosable as an anthropic tōtara forest (AVS1, Singers *et al.*, 2017); however, the emerging seedling tier indicates that this ecosystem is temporary.

3.1.2.2 Future Ecosystem Classification

When determining the ecological value of an ecosystem, it is important to consider the probable future community composition and habitat type. Cattle grazing has had an obvious and significant impact on the diversity and abundance of seedlings and saplings; however, there remains a number of seedlings near the stream margins and immediately surrounding the tree basal regions. The seedling flora is moderately diverse and reflects a flora characteristic of a kauri podocarp broadleaved forest (WF11), including karaka, karamu, and puriri (Plate 3.2). This suggests that seed dispersers are successfully inputting native seed material into this fragment from the nearby kauri forests within this property and from the kauri podocarp broadleaved forests covenanted on the neighbouring sections. Therefore, the exclusion of cattle is expected to facilitate a transition from an anthropic tōtara forest system into a functioning kauri podocarp broadleaved forest with minimal additional intervention. Kauri podocarp broadleaved forests were historically common in this area; however, due to logging they are now classified as Endangered under the IUCN classification system (Singers *et al.,* 2017).

Plate 3.2. Some of the taxa that indicate the ecosystem type would shift to a WF11 forest if protected. From left to right: karamu seedling, mapou seedling, karaka sapling, *Coprosma* seedling

3.2 NATIVE FAUNA

3.2.1 Summary of the Resident Fauna

3.2.1.1 Avifauna

A detailed assessment of the local avifauna (birds) at Stubbs Farm is provided in *Section 2.3 Avifauna* and the results indicated that 44 species of birds were known to occur in the wider surrounding landscape. Eighteen of those, including two endemics, seven natives and nine introduced species, were reported to be utilising the bush fragments on-site (Appendix II). Two additional indigenous species—tūi (*Prosthemadera novaeseelandiae*) and kererū (*Hemiphaga novaeseelandiae*)—were recorded in the remnant during the site visit on 25 July 2017. Therefore, this remnant bush patch is considered to provide suitable habitat (i.e. roosting and nesting sites, and food resources) for c. 45.5% of all local bird species.

3.2.1.2 Herpetofauna

A baseline assessment of herpetofauna values at Stubbs Farm in August 2016 indicated that at least two species of indigenous lizards—including *Oligosoma aeneum* and *Mokopirirakau granulatus*—could be present in the remnant forest patches on-site (*Section 2.2 Herpetofauna*). An introduced plague skink (*Lampropholis delicata*) was opportunistically observed beneath a decaying log in the bush remnant on 25 July 2017; however, no dedicated reptile surveys have been undertaken at Stubbs Farm. Considering the age of the remnant, the vegetation species composition (i.e. tōtara-dominated) and knowledge that many species of native lizards can persist in fragmented and degraded habitats, the remnant bush block is considered to offer important habitat for local reptiles within the existing agricultural-dominated landscape.

3.2.1.3 Terrestrial Invertebrates

A brief search for terrestrial invertebrates revealed the presence of several common taxa, including but not limited to Turbellaria (flatworms), Gastropoda (e.g. *Oxychilus cellarius*), Diplopoda and Chilopoda, Araneae (e.g. *Hexathele hochstetteri*), Isopoda, Amphipoda and a variety of Coleopterans. The presence of the terrestrial snail, *Amborhytida dunniae* (*At Risk – Declining* B (2/1)) (Mahlfeld *et al.,* 2012), within the bush block is considered likely given its presence in several forested sites nearby (D. van Winkel, *pers. obs*)—however, it was not detected during the brief site visit on 25 July 2017.

3.2.2 Freshwater fauna

Two small watercourses originate in the bush block and form tributaries that drain into the Mahurangi River to the east. A detailed assessment of the watercourse characters and values is provided in *Section 2.4 Freshwater* and concluded that the watercourses were considered to have a low ecological value, predominantly due to the lack of riparian vegetation, hydrologic heterogeneity and lack of accessible and permanent habitat for native fauna (e.g. fish and invertebrates).

3.3 Ecological Value and the Effects of Vegetation Removal

3.3.1 Ecological Value

This forest remnant is small but sits within a larger network of similar forest patches. Despite appearances, the collective value of these patches forms important habitat and resources for native fauna. Intense and prolonged grazing has transformed the forest type into an anthropic tōtara forest, where only the least palatable taxa have survived. Although this ecosystem type is common and novel, the forest also supports the uncommon kawaka. Furthermore, the range of native seedlings surrounding protected areas beneath tree branches, around tree trunks and within the riparian areas show the remnant is increasing in diversity and transitioning into the rare and ecologically significant kauri podocarp broadleaved forest system.

Ecosystem services provided by this forest are beneficial and will become more crucial with future urban developments. The dense canopy provides a moderate to high level of shading and cooling to the area, providing suitable habitat for forest-dwelling flora and fauna. In addition to cooling the forest interior, forests patches such as this one have been found to decrease the ambient temperature in the surrounding areas. Urban housing provides large areas of light-reflective non-permeable surfaces. These increase the ambient temperature relative to vegetated areas. This phenomenon is known as the ‘urban heat island effect’. The retention of forest patches within urban areas helps to decrease temperatures and has positive impacts on energy consumption and human health. The shading and vegetation also has considerable positive effects on water quality by assisting in the stabilization of the stream banks, cooling of water, filtering of debris and provides an increased habitat area.

The trees and native bush qualify as SEA under the AUP Op SEA criteria and since botanically, they contain a large number of mature native trees, including an *At Risk* tree species (kawaka), the majority should be retained. Area A would require stock-proof fencing to allow the native understorey and groundcover layers to regenerate. It would also benefit from edge (buffer) planting which would hasten the regeneration process. Area B has a diverse assemblage of native trees; however, they are significantly younger than those found in Area A and where vegetation alteration is required to create an open recreational area, the ecological effects would be significantly lower in Area B compared to Area A.

3.3.2 Vegetation Removal Effects

If an area of bush is to be developed in future, Area B would be the least environmentally costly; although a representative sample of taxa should be maintained (Figure 3.4). We propose that the larger individuals (Figure 3.4; Table 3.1) are retained to provide shading for the proposed recreational

area (picnic area), increase the aesthetic value of the area and provide a localized seed source to repopulate Area A. Area C is a riparian margin, and joins another stream on the northern section of Area B at a confluence on the eastern edge of the remnant.

Therefore, the native vegetation surrounding both streams should be retained and enriched with further riparian buffer planting to a distance of 5 – 10 m from the stream edges. All retained bush and replanted areas would require weed control and vertebrate pest management.

Figure 3.4. Aerial photograph of the remnant bush block, showing the location of notable trees and watercourses, and the area of younger vegetation that could be removed to create a recreational parkland.

Table 3.1. Information on notable trees. DBH – diameter at breast height.

Reference No.	Species	c. Height (m)	DBH (mm)
1	*Libocedrus plumosa*	8	250
2	*Libocedrus plumosa*	15	550
3	*Podocarpus totara*	20	1000
4	*Podocarpus totara*	20	640
5	*Podocarpus totara*	20	566
6	*Podocarpus totara* with *Metrosideros perforata*	20	475
7	*Podocarpus totara*	20	451
8	*Kunzea robusta*	20	390
9	*Podocarpus totara*	20	853
10	*Agathis australis*	10	267

Typically, any removal of native trees should be mitigated through replacement planting of the same species, employing an ecological compensation ration (ECR). This ratio is calculated in such a way as to replace the basal area of the trees that are lost within c. 20 years. Generally, the ECR would require three to six healthy young trees to be planted for each tree that is lost; however, the number of replanted trees will vary accordingly with the size of the tree being lost and the growth rate of each species. Within the context of this property, the vegetation communities have been shaped by cattle grazing and are not representative of the communities that would naturally occur here. Therefore, replacing "like for like" would reinforce the anthropogenic influences and delay the regeneration.

Instead, we recommend a replacement planting scheme that increases the total ecological worth of the remnant to achieve a net biodiversity gain. Any kānuka or tānekaha felled should be replaced with three to six trees of the same species around the outer 5 m (the edge) of Area A. However, given the strong dominance of tōtara in Areas A and B, it is unnecessary and counter-productive to undertake planting of further tōtara saplings. Instead, we recommend planting that in addition to the planting of the riparian margin (5 - 10 m from the stream edges), a secondary 5 - 10 m buffer between Area A and Area B should be planted. This buffer will protect the interior of the retained forest from increased light and wind, expedite the regeneration.

The revegetation should reflect the plant communities naturally occurring in the Kauri Podocarp Broadleaved forest type. All plants should be eco-sourced from within the ecological region.

Recommended replacement species lists for the riparian margins and forest buffer are provided in *Section 3.6 Appendix IV.*

3.4 SUMMARY

- The vegetation in the remnant block is currently considered anthropic tōtara forest (AVS1, Singers *et al.,* 2017) but would be classified as Kauri podocarp broadleaved forest—an Endangered ecosystem under the IUCN classification system (Singers *et al.,* 2017)—if left to regenerate naturally.

- The remnant block qualifies as SEA, under the AUP Op SEA criterion "*Threat status and rarity*", due to the presence of a large number of mature native trees and *At Risk—Naturally Uncommon* tree species (kawaka).

- The vegetation also provides ecological values in the context of the wider surrounding landscape as habitat and food resources for native fauna (e.g. birds, lizards and terrestrial invertebrates). The vegetation also provides a buffer for the headwaters of tributaries flowing into the Mahurangi River.

- There are two relatively discrete areas of vegetation within the remnant block (Area A and Area B). Area A supports old established native trees (predominantly tōtara) and this area should be protected and enhanced through stock-proof fencing and buffer edge planting. Area B has a diverse assemblage of native trees; however, they are significantly younger than those found in Area A. Where vegetation alteration is required to create an open recreational/ picnic area to compliment the proposed structure plan change proposals, Area B offers the least environmentally costly option and would allow the successful integration of public recreation, visual amenity and wildlife conservation initiatives.

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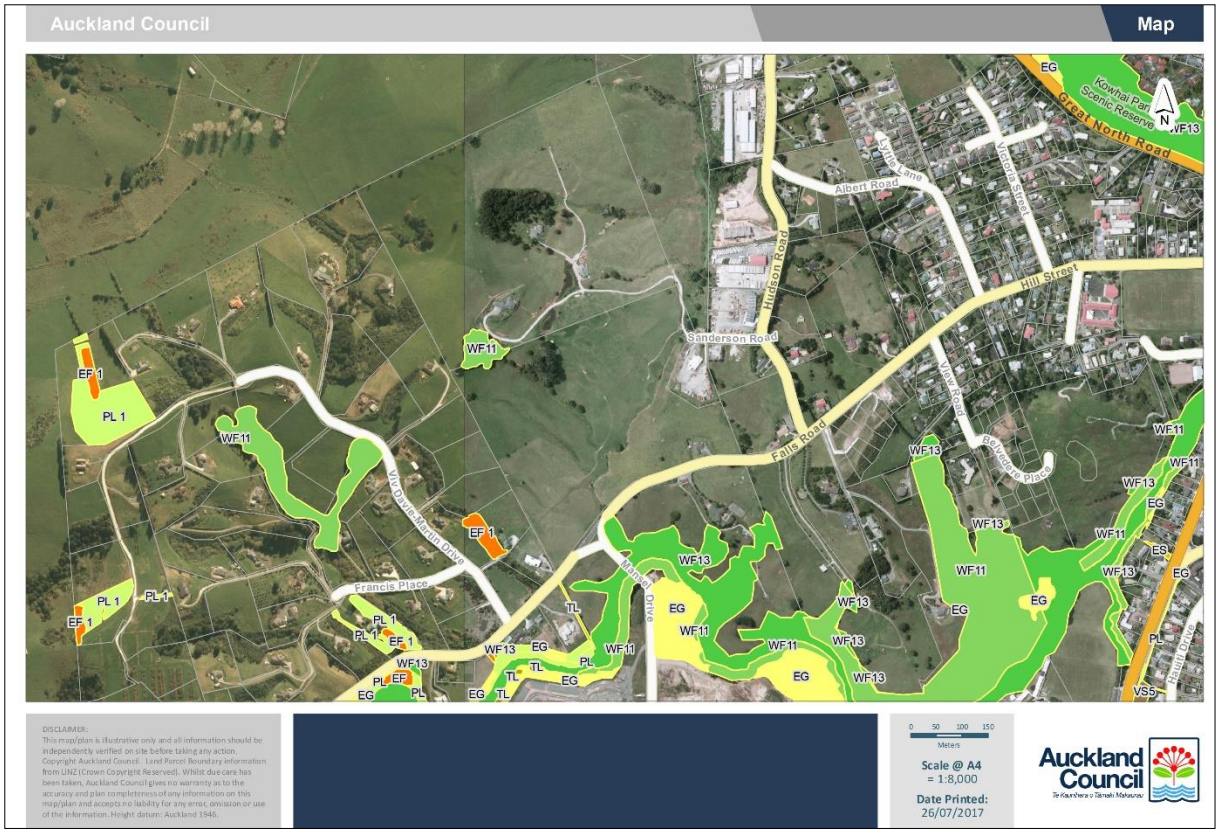
3.6 APPENDICES

Appendix I: Ecosystem types at Stubbs Farm, Warkworth (Singers *et al*. 2017).

Note that the largest remnant bush block currently has no ecosystem classification.



Appendix II. Terrestrial birds recorded from the wider surrounding area, from Orewa to Wellsford (Robertson et al. 2007), and species recorded at Stubbs Farm on 05-08-2016 and 25-07-2017. Names as per Gill et al. (2010).

Common name	Species name	NZ Status	Recorded on-site
Australian brown quail	*Coturnix ypsilophora australis*	Introduced	
Australian magpie	*Gymnorhina tibicen*	Introduced	
Barbary dove	*Streptopelia risoria*	Introduced	
California quail	*Callipepla californica brunnescens*	Introduced	
Canada goose	*Branta canadensis*	Introduced	
Chaffinch	*Fringilla coelebs*	Introduced	
Common myna	*Acridotheres tristis*	Introduced	✓
Common pheasant	*Phasianus colchicus*	Introduced	
Common starling	*Sturnus vulgaris vulgaris*	Introduced	
Eastern rosella	*Platycercus eximius*	Introduced	✓
Eurasian blackbird	*Turdus merula merula*	Introduced	✓
Eurasian skylark	*Alauda arvensis*	Introduced	✓
European greenfinch	*Carduelis chloris*	Introduced	
Grey warbler	*Gerygone igata*	Endemic	✓
Goldfinch	*Carduelis carduelis britannica*	Introduced	✓
Hedge sparrow (dunnock)	*Prunella modularis*	Introduced	
House sparrow	*Passer domesticus domesticus*	Introduced	
Kookaburra	*Dacelo novaeguineae novaeguineae*	Introduced	
Mallard	*Anas platyrhynchos*	Introduced	✓
Morepork	*Ninox n. novaeseelandiae*	Native	
New Zealand pigeon	*Hemiphaga novaezelandiae*	Endemic	✓
New Zealand pipit	*Anthus n. novaeseelandiae*	Endemic	
North Island fantail	*Rhipidura fuliginosa placabilis*	Endemic	✓
North Island kaka	*Nestor meridionalis septentrionalis*	Endemic	
North Island robin	*Petroica longipes*	Endemic	
North Island tomtit	*Petroica macrocephala toitoi*	Endemic	
Paradise shelduck	*Tadorna variegata*	Endemic	✓
Peafowl	*Pavo cristatus*	Introduced	
Pukeko	*Porphyrio melanotus*	Native	✓
Red-crowned parakeet	*Cyanoramphus novaezelandiae*	Endemic	
Redpoll	*Carduelis flammea*	Introduced	
Rock pigeon	*Columba livia*	Introduced	
Sacred kingfisher	*Todiramphus sanctus*	Native	✓
Silvereye	*Zosterops lateralis lateralis*	Native	✓
Shining cuckoo	*Chrysococcyx lucidus lucidus*	Native	
Song thrush	*Turdus philomelos*	Introduced	✓
Southern black-backed gull	*Larus dominicanus*	Native	✓
Spur-winged plover	*Vanellus miles novaehollandiae*	Native	✓
Swamp harrier	*Circus approximans*	Native	
Tūi	*Prosthemadera n. novaeseelandiae*	Endemic	✓
Welcome swallow	*Hirundo neoxena neoxena*	Native	✓
White-faced heron	*Egretta novaehollandiae*	Native	✓
Wild turkey	*Meleagris gallopavo*	Introduced	
Yellowhammer	*Emberiza citrinella*	Introduced	✓

Appendix III. Plant species list for the remnant bush block at Stubbs Farm, Warkworth

Native flora

Species	Common name	Height tier	Area
Aristotelia serrata	makomako	Subcanopy	C
Asplenium flaccidum	drooping spleenwort	Epiphyte	A, B
Astelia hastata	kahakaha	Epiphyte	A
Blechnum novae-zealandiae	kiokio	Ground tier fern	C
Blechnum parrisiae	rasp fern	Ground tier fern	A,B,C
Chrysothrix candelaris	lichen	Epiphyte	A,B
Coprosma arborea	mamangi	Ground tier shrub	A,B
Coprosma areolata	thin-leaved coprosma	Ground tier shrub	A,B
Coprosma rhamnoides	twiggy coprosma	Ground tier shrub	A,B
Coprosma robusta	karamu	Seedling	A
Cordyline australis	cabbage tree, ti kouka	Subcanopy, seedling	C
Corynocarpus laevigatus	karaka	Subcanopy, seedling	C
Cyathea dealbata	silver fern	subcanopy	A,C
Cyathea medullaris	mamaku	Subcanopy	C
Dacrydium cupressinum	rimu	Canopy	B
Deparia petersenii	Japanese lady fern	Ground tier	B, C
Dicksonia squarrosa	wheki	Subcanopy	C
Knightia excelsa	rewarewa	Edge tree	C
Kunzea robusta	kanuka	Canopy	A, B
Libocedrus plumosa	kawaka	Edge canopy tier	A, C
Melicytus ramiflorus subsp. *ramiflorus*	mahoe	Subcanopy	C
Metrosideros perforata	white rata	Epiphyte	B
Microsorum scandens	fragrant fern, mokimoki	Epiphyte	B
Myrsine australis	red mapou	Seedling	A, B, C
Oplismenus hirtellus subsp. *imbecillis*	basket grass	Ground cover	A, B, C
Phyllocladus trichomanoides	tanekaha	Canopy	B
Podocarpus totara var. *totara*	tōtara	Canopy	A, B, C
Pteris tremula	shaking brake	Lowest tier	C
Pyrrosia eleagnifolia	leather-leaf fern	Epiphyte	A, B, C
Ramalina celastri	lichen	Epiphyte	A, B
Rhopalostylis sapida	nikau	Subcanopy	C
Usnea angulata	lichen	Epiphyte	A, B, C
Vitex lucens	puriri	Seedling	A

Exotic flora			
Species	**Common name**	**Height tier**	**Area**
Alocasia brisbanensis	elephants ears, aroid lily	Ground tier	C
Asparagus scandens	climbing asparagus	Epiphyte, ground cover	A, B, C
Hedychium gardnerianum	kahili ginger	Ground cover	C
Ligustrum sinense	Chinese privet	seedling, small tree	A, B
Pinus radiata	radiata pine	Canopy	A
Rubus fruticosus	blackberry	seedling	A,B
Selaginella kraussiana	African clubmoss	ground cover	B, C
Solanum mauritianum	woolly nightshade	Small tree, sapling	A, C
Solanum nigrum	black nightshade	Ground tier	C
Syzygium smithii	monkey apple	Subcanopy	C
Zantedeschia aethiopica	arum lily	Ground tier	A, C

Appendix IV: Recommended Replacement Species

Riparian margins

A buffer of 5-10 m around the stream edges should be planted in two stages to protect the water quality. You will need to prepare the site by clearing weeds before planting can commence. The first stage establishes nurse vegetation using plants that cope well with the drier open areas created by the removal of some of the canopy. Stage two plants less tolerant species between the original plants after shelter has been established.

Species	Common name	Stream edge	Lower bank	Upper bank	Planting stage
Carex secta	Pūrei	✓	✓		1
Carex virgata	swamp sedge	✓	✓		1
Carex germinata	ruatahi	✓	✓		1
Phormium tenax	harakeke		✓	✓	1
Austroderia fulvida	toetoe		✓	✓	1
Veronica stricta var. *stricta*	hebe, koromiko			✓	1
Piper excelsum subsp. *excelsum*	kawakawa			✓	2
Coprosma robusta	karamu			✓	1
Leptospermum scoparium	manuka		✓	✓	1
Geniostoma ligustrifolium	hangehange			✓	2

Forest Buffer

As with wetland species, it is ideal to undertake plantings within forests win two stages: an initial stage to establish shelter with tolerant plants, and a follow up enrichment planting. There may an overlap of some plants within the enhancement of this property because a good level of shade has already been established by the tōtara present. The following species are recommended for planting in this area:

Species	Common name	Planting stage
Kunzea robusta	Kunzea robusta	1
Leptospermum scoparium	manuka	1
Melicytus ramiflorus	mahoe	1
Coprosma robusta	karamu	1
Pseudopanax arboreus	five-finger	1
Geniostoma ligustrifolium	hangehange	1
Myrsine australis	mapou	1
Corynocarpus laevigatus	karaka	1
Vitex lucens	puriri	1
Pseudopanax crassifolious	lancewood	2
Coprosma grandifolia	kanono	2
Agathis australis	kauri	2

Dysoxylum spectabile	kohekohe	2
Knightia excelsa	rewarewa	2
Dacrydium cupressinum	rimu	2
Hedycarya arborea	pigeonwood	2

4 223 FALLS ROAD

4.1 INTRODUCTION

At the southwestern extent of the Structure Plan area is the rural property 223 Falls Road (LOT 1 DP 508375; c. 9 ha). The land is zoned "Future Urban" under the Auckland Unitary Plan Operative in part (AUP Op) and the site subject to a Significant Ecological Area (SEA) overlay, with SEA_T_2294 taking in riparian forest along the true left bank of the Mahurangi River and surrounding several smaller tributaries on the property (Figure 4.1). The SEA status was assessed by Auckland Council in 2012 as meeting three of the five SEA criteria, including *Criterion 2: Threatened Species Ecosystems* (based on presence of long-fin eel, *Anguilla dieffenbachii*), *Criterion 4: Stepping Stones, Migration Pathways and Buffers* (i.e. "buffers a protected area and buffers an SEA") and *Criterion 5: Uniqueness or Distinctiveness* (due to *Pomaderris hamiltonii* [kumarahou] being recorded at the site; however, see *Section 2.1.2. Assessment of the Botanical Values of the Site* for comments on this *At Risk* plant; application of *Criterion 5* is disputed).

A Local Purpose Esplanade Reserve along the Mahurangi River will be vested with Auckland Council at the time of subdivision and the native vegetation in the lower catchments of two tributary streams would be protected. An extension of Mansel Drive runs through the western extent of this property and the land to west is destined for Auckland Council ownership.

Bioresearches were tasked with providing an ecological assessment for the property (providing descriptions of the vegetation and flora, herpetofauna, avifauna, and freshwater ecosystems present at the site) and to undertake an assessment of effects of the proposal on the ecological values of the site. Investigations into the presence of long-tailed bats were not undertaken as part of this assessment due to inappropriate time of year to survey for this species.

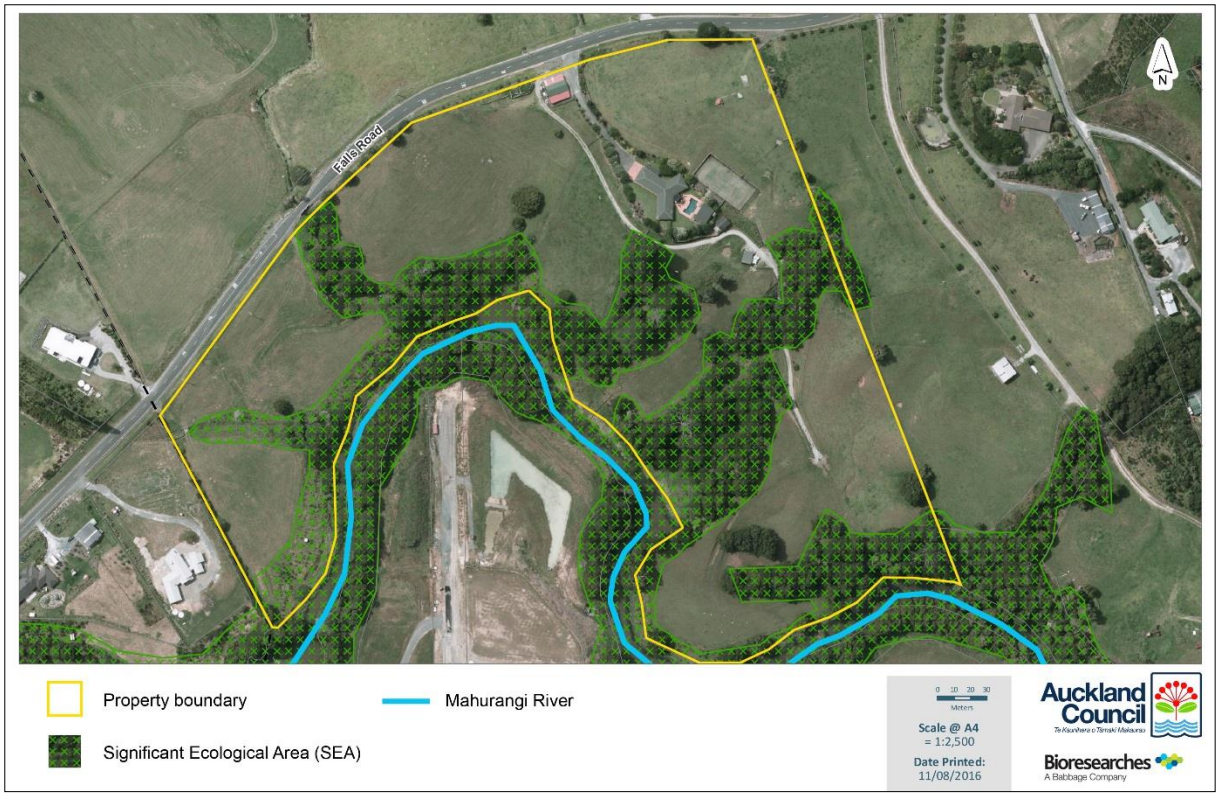


Figure 4.1. Aerial image of the 223 Falls Road, Warkworth property showing the extent of the Auckland Council Significant Ecological Area (SEA) overlay.

4.2 VEGETATION AND FLORA

The main vegetation type at the site is totara (*Podocarpus totara*) dominant forest, much of which has been fenced off for between 10 and 20 years (Simon Ryburn *pers. comm*.). Outside the riparian vegetation along the Mahurangi River there are four main areas of native vegetation at the site (Figure 2). These areas are described in *Sections 4.2.1 – 4.2.4* below. *Section 4.9 Appendix I* lists the native and exotic plant species recorded.

Figure 4.2. Areas 1 -4 of native vegetation at 223 Falls Road, Warkworth.

4.2.1 Area 1: South east corner

Totara dominant forest lies on a steep southern scarp above the river. Amongst it are two large mature pine trees (*Pinus radiata*). The canopy is broken in some places and here there are tall tree ferns (*Cyathea medullaris*), mapou (*Myrsine australis*) and sapling puriri (*Vitex lucens*). The understorey is variable, being only rough grass along the top edge of the scarp and very weedy along the foot of the scarp along the river terrace. Weeds include tradescantia (*Tradescantia fluminensis*), montbretia (*Crocosmia x crocosmiiflora*), Chinese privet (*Ligustrum sinense*), and quite number of monkey apple saplings (*Syzygium smithii*). There are a range of native understorey and groundcover plants however, including mahoe (*Melicytus ramiflorus*), twiggy coprosma (*Coprosma rhamnoides*), nikau *(Rhopalostylis sapida*), tree coprosma (*Coprosma arboreus*), tree ferns and kanuka (Plate 4.1). Rosy maidenhair (*Adiantum hispidulum*) is quite common as are native sedges and other ground ferns. A feature of this area of vegetation is the thickets of taurepo or NZ gloxinia (*Rhabdothamnus solandri*),

growing on the steep bouldery banks (Plate 4.2). Taurepo is not a *Threatened* or *At Risk* species. Animal browsing of hangehange (*Geniostoma ligustrifolium*) and nikau was noted.

A small tributary flows to the river through the vegetation with kiokio (*Blechnum novaezelandiae*) and *Blechnum membranaceum* along its banks and a good sized kahikatea (*Dacrycarpus dacrydioides*) nearby. This damp south facing habitat is quite diverse, though obviously regenerating following past damage from grazing (Plate 4.3).

4.2.2 Area 2: Vegetation along the eastern tributary

This vegetation surrounds the easternmost of two tributaries that flow through the middle of the site. Although it is generally totara dominant, it also contains a large kauri (*Agathis australis*) and numerous tall kanuka with tree ferns surrounding an open wetland area above the river (Plate 4.4). The wetland contains mainly creeping buttercup (*Ranunculus repens*) and reed sweet grass (*Glyceria maxima*) lower down near the river, however higher up is a good patch of native rautahi (*Carex lessoniana*). Arum lily (*Zantedeschia aethiopica*) and African clubmoss are also much in evidence. The riverbanks show signs of recent flooding and willows (*Salix fragilis*) grow within the river channel. The totara canopy is broken or sparse in a number of places and restoration planting with native shrubs has taken place around the edges and in major canopy gaps. Species planted include akeake (*Dodonaea viscosa*), cabbage trees, kanuka, flax (*Phormium tenax*), kohuhu (*Pittosporum tenuifolium*) and karamu (*Coprosma robusta*). A large mature pine stands on the southern side of the stream with sparse groundcover under it containing predominantly Chinese privet seedlings, montbretia and African clubmoss (*Selaginella kraussiana*). There are a few native sedges and young cabbage trees (*Cordyline australis*) here too. Once again there are signs of animal browse.

4.2.3 Area 3: Totara stand above the farm track

A stand of totara occurs on a steep slope above the farm track (Figure 4.2). This vegetation is unfenced and there is no understorey here at all (Plate 4.5). The trees are of medium size but are unremarkable from a botanical standpoint.

4.2.4 Area 4: Vegetation along the western tributary.

This vegetation surrounds the westernmost of the two tributaries that flow through the middle of the site (Plate 4.6). The canopy vegetation is a mixture of relict totara trees, tall kanuka, several pine trees and some young cypress trees (*Cupressus* sp). The edges of the area have been planted with native shrubs as described for Area 2. Near the top of the area within the stream banks is an infestation of ornamental bamboo (*Phyllostachys* sp.) and periwinkle forms some extensive mats on the ground. Further downstream the stream channel is choked with arum lily. In all the vegetation within this area is a mixture of exotic and native species with quite a weedy character.

4.2.5 Riparian vegetation along the Mahurangi River.

The narrow band of vegetation along the Mahurangi River generally falls within the proposed Local Purpose Esplanade Reserve. The key feature of this vegetation is totara stands and individual totara trees of medium to large size. Much of this vegetation is fenced off along the top of the river bank and restoration planting (as described earlier for Areas 2 and 4) has been undertaken between the relict totara trees. Many of these plants are well established (Plate 4.7).

4.2.6 Assessment of the botanical values of the site

The key botanical values of the site lie in the mature totara trees and a scattering of other native trees found mainly within the fenced off areas of vegetation within Areas 1, 2 and 4 and along the Mahurangi River. Although there are significant weed issues in these areas they still have moderate botanical values. Areas 1 and 2 are considered to have the highest values due to there being a more intact native canopy present and a native understorey, at least in parts of them. The stand of totara trees in Area 3 has lower values because it lacks an understorey and the canopy also lacks diversity. Fencing would likely result in the establishment of a native understorey. Area 4 has many exotic trees and some significant weed issues and therefore, its botanical values are also lower than Areas 1 and 2.

Restoration planting along the river and within areas 2 and 4 is reasonably well established although the plants are quite widely spaced and will take a few more years to achieve canopy closure. There remain several open areas along the river in Areas 2 and 4 and in other parts of the proposed esplanade strip that would benefit from weed control and native restoration planting.

Council SEA underlying data records indicate the presence of *Pomaderris hamiltonii* (Regionally *At Risk—Sparse*; Stanley *et al.* 2005) within the SEA; however, closer examination of the plant records (NZPCN and NZ Virtual Herbarium) reveal that the plant has not been recorded in this area but rather elsewhere around Warkworth outside of this SEA. Therefore, this assessment does not consider SEA_T_2294 to meet *Criterion 5: Uniqueness or Distinctiveness*.

4.2.7 Assessment of effects on indigenous vegetation

The vegetation on the property is mostly comprised of individual trees or stands of totara of moderate size and age, surrounded by grazed pasture with no native understorey. Due to the maturity of the trees, they are considered to have moderate botanical value.

Both the SEA status and proposed esplanade reserve would protect the riparian vegetation along the Mahurangi River and the tributary streams on the property, thereby retaining vegetative connectivity along the site's watercourse systems. The potential effects of the current proposal on indigenous vegetation are likely to be negligible.

4.2.8 Biosecurity

The presence of a large mature kauri tree within Area 2 means that hygiene protocols for kauri dieback disease will need to be implemented and strictly observed. Initially this requires any personnel

accessing the site to ensure all footwear, vehicles and equipment is clean and free of soil both entering and leaving the site or otherwise to remain at least 30 m from the tree. A 30 m exclusion zone should be established and clearly demarcated with an exclusion fence around the tree where development activities are proposed. No personnel, vehicles or machinery should enter the exclusion zone unless full cleaning and disinfection is carried out both entering and leaving the exclusion zone. Any disturbance of soil within the exclusion zone should be avoided and no pruning of the tree should occur without full consultation with the Auckland Council Biosecurity Team.

4.3 HERPETOFAUNA

Herpetofauna (reptiles and amphibians) comprise a significant component of New Zealand's terrestrial fauna. Over 100 endemic taxa are currently recognised (van Winkel *et al*., 2018) and more than 80% are considered *Threatened* or *At Risk* of extinction (Hitchmough *et al*. 2016). All indigenous reptiles and amphibians are legally protected under the Wildlife Act 1953, and vegetation and landscape features that provide significant habitat for native herpetofauna are protected by the Resource Management Act 1991. Statutory obligations require management of resident reptile and amphibian populations where they or their habitats are threatened by disturbance or land development.

In response to the current proposal, a baseline assessment of herpetofauna values has been undertaken. The assessment was based on a desktop assessment and a site visit in August 2016. Desktop investigations involved a review of the Department of Conservation's *Herpetofauna* database (accessed August 2016), as well as Bioresearches Group's herpetofauna records, for all herpetofauna detected within a 5 km radius of the subject site. An experienced herpetologist visited the site on 5 August 2016 to visually assess the habitat for native reptiles and carry out a search to reveal animals and/ or sign (e.g. scats, sloughed skin) by searching foliage and lifting logs and debris.

4.3.1 Desktop Assessment

Twelve (12) reptile and amphibian taxa are known to occur in the Rodney Ecological District, including five skinks, four geckos and three frogs (Table 4.1). Six of these taxa have been reported from sites within 5 km of the 223 Falls Road property; based on a review of historical lizard records held by the Department of Conservation's *Herpetofauna* database and Bioresearches Group Ltd. The corresponding New Zealand Conservation Threat Status (NZCTS) for each taxon has been provided in Table 1. Threat status generally correlates with significance of occurrence at sites where species are identified. That is, the higher the threat status of a particular taxon, the higher the significance of occurrence at any particular site.

Three introduced species (*Lampropholis delicata*, *Ranoidea aurea* and *R. raniformis*) are likely to be present at the property; however, these species are not afforded legal protection. In particular, the plague skink is highly invasive, abundant in the Auckland Region and is regarded as having a detrimental ecological impact in areas where it establishes in New Zealand. As a result, it has been classified as an "Unwanted Organism" by the Ministry for Primary Industries (previously Ministry of Agriculture and Fisheries) under the Biosecurity Act (1993) and has not been considered further in this LMP; outside of noting its presence.

In addition, a desktop assessment, using aerial imagery to identify potential lizard habitat, and a visual assessment during a site visit, indicated that suitable habitat was available for at least three additional native lizard species (e.g. elegant gecko, pacific gecko and ornate skink) (Table 4.1).

Table 4.1. Herpetofauna recorded from the Rodney Ecological District, including Conservation Threat Status and likely presence at 223 Falls Road (✓- known; ? – likely; x – absent).

Common name	Species name	Threat Category & status*	≤ 5 km from site
Scincidae			
Copper skink	*Oligosoma aeneum*	Not Threatened	✓
Ornate skink	*Oligosoma ornatum*	At Risk – Declining	?
Moko skink	*Oligosoma moco*	At Risk – Declining	x
Shore skink	*Oligosoma smithi*	At Risk – Naturally Uncommon	x
Plague skink	*Lampropholis delicata*	Unwanted Organism	✓
Diplodactylidae			
Forest gecko	*Mokopirirakau granulatus*	At Risk – Declining	✓
Pacific gecko	*Dactylocnemis pacificus*	At Risk – Relict	?
Elegant gecko	*Naultinus elegans*	At Risk – Declining	?
Raukawa gecko	*Woodworthia maculata*	Not Threatened	x
Leiopelmatidae			
Hochstetter's frog	*Leiopelma* aff. *hochstetteri* "Northland"	At Risk – Declining	✓
Hylidae			
Green & golden bell frog	*Ranoidea aurea*	Introduced & Naturalised	✓
Southern bell frog	*Ranoidea raniformis*	Introduced & Naturalised	✓

* Hitchmough *et al*. (2016)

4.3.2 Site Assessment

A herpetologist searched the property for lizards for approximately two hours (i.e. from 08:30 am to 10:30 am) on 5 August 2016. The site generally lacked an abundance of suitable terrestrial refuge sites for native skinks but some decaying logs, fence posts, rocks, and corrugated iron sheets located in pasture were lifted (Plates 4.8 and 4.9), and flaking bark on tree trunks searched beneath. No dedicated attempts were made to survey for arboreal geckos (e.g. nocturnal spotlight searches)—other than brief searches through low-hanging totara foliage—due to unsuitable environmental conditions at this time of year (low temperatures and rainfall in winter).

No indigenous lizards were detected on-site; however, a single introduced plague skink was observed basking on a fallen tree trunk that was lying amongst rank grass (Figure 4.5).

In regard to suitable habitat for native lizards, the site visit revealed large areas of contiguous native forest canopy (dominated by totara and kanuka), areas of dense rank grassland (Plate 4.10), and some areas of dense scrubland (Plate 4.11) that could potentially support indigenous skinks and geckos.

Considering this abundance of potential habitat and the proximity of historical gecko records to the site, it is likely that at least two species of indigenous lizard (e.g. forest gecko and copper skink) are resident at the property.

Figure 4.5. Aerial image of the 223 Falls Road, Warkworth property showing the location of a plague skink (*Lampropholis delicata*) recorded on 5 August 2016.

4.3.3 Assessment of Effects on Native Lizards

The clearance of trees and vegetation—including 'poor quality' low-lying scrub and weedy species that provide habitat for many native lizard species in the Auckland Region—may result in direct adverse effects to native lizards if not managed appropriately. Careless removal of canopy trees, debris and shelter structures by dragging or rolling debris and burying shelter structures such as logs, rock and wood piles can cause significant injury or mortality to resident lizards and can result in the loss of habitat and resources (e.g. food and refuge sites), as well as the consequent displacement of lizards into already occupied adjacent areas. In addition, habitat clearance can remove ecological linkages (e.g. corridors) that lizards rely upon to navigate the landscape, which can lead to population fragmentation and long-term isolation.

The vegetation forming the ecological corridor (riparian margin) along the Mahurangi River, including the 'fingers' of vegetation that extend into the property (e.g. Areas 1 – 4), are likely to provide habitat for protected lizards for the reasons previously outlined. Therefore, any removal of vegetation/ habitat as part of any proposed development would require appropriate mitigation and management, including but not limited to a lizard rescue-relocation programme, habitat enhancement, and long-

term habitat protection, to avoid disturbing, injuring, or killing protected lizards during development and/ or construction (Wildlife Act 1953 and Resource Management Act 1991, s.6C) and offset the loss of habitat. Mitigation and management options should be outlined in a site-specific Lizard Management Plan (LMP), compiled by a DOC-authorised herpetologist.

4.4 AVIFAUNA

The avifauna (bird species) of the wider area were identified from a brief desktop assessment that involved a review of Robertson *et al.* (2007) and listing all bird species recorded within the 10 km^2 grid squares applying to the wider surrounding area from Orewa to Wellsford. In addition, field investigations (e.g. recording opportunistic sightings and undertaking dedicated five-minute bird counts) were carried out to document bird species utilising specific habitats at the site (Figure 4.6). Field surveys were undertaken on a single site visit on 5 August 2016.

The objective of the bird survey was to document diversity and provide information on the indicative abundance (conspicuousness) of birds utilising the property in its existing state (e.g. working farm in mid-winter 2016). Survey conditions, including temperature, wind, cloud cover and noise, were recorded.

Figure 4.6. Aerial image of the 223 Falls Road, Warkworth property showing the location of five-minute bird count locations.

4.4.1 Species Diversity

A total of 44 terrestrial species (Table 4.2) have been recorded for the wider Warkworth area. The avifauna consists of 20 endemic and native species, and 24 introduced species. Of those species, one is considered *Nationally Vulnerable* (North Island kaka) while two are considered to be *At Risk* (New Zealand pipit and red-crowned parakeet) (Robertson *et al*. 2013).

4.4.1.1 Opportunistic and five-minute count results

A total of 24 species were recorded opportunistically, comprising three endemics, six natives, and 15 introduced species (Table 4.3) and the most common (conspicuous) species during five-minute counts were blackbird followed by yellowhammer and common myna. Environmental conditions and count results are shown in Tables 4.3 and 4.4 below.

All species utilising the site at the time of the visit are considered *Not Threatened* or *Introduced* by the New Zealand Conservation Threat Status (Robertson *et al*. 2013).

Table 4.2. Terrestrial birds recorded from 10 km^2 grids squares applying to the wider surrounding area from Orewa to Wellsford (Robertson *et al.* 2007), and species recorded at 223 Falls Road, Warkworth on 5 August 2016. Names as per Gill *et al*. (2010).

Common name	Species name	NZ Status	Recorded on-
Australian brown quail	*Coturnix ypsilophora australis*	Introduced	
Australian magpie	*Gymnorhina tibicen*	Introduced	✓
Barbary dove	*Streptopelia risoria*	Introduced	
California quail	*Callipepla californica brunnescens*	Introduced	
Canada goose	*Branta canadensis*	Introduced	✓
Chaffinch	*Fringilla coelebs*	Introduced	✓
Common myna	*Acridotheres tristis*	Introduced	✓
Common pheasant	*Phasianus colchicus*	Introduced	✓
Common starling	*Sturnus vulgaris vulgaris*	Introduced	✓
Eastern rosella	*Platycercus eximius*	Introduced	✓
Eurasian blackbird	*Turdus merula merula*	Introduced	✓
Eurasian skylark	*Alauda arvensis*	Introduced	✓
European greenfinch	*Carduelis chloris*	Introduced	✓
Grey warbler	*Gerygone igata*	Endemic	✓
Goldfinch	*Carduelis carduelis britannica*	Introduced	✓
Hedgesparrow (dunnock)	*Prunella modularis*	Introduced	
Housesparrow	*Passer domesticus domesticus*	Introduced	✓
Kookaburra	*Dacelo novaeguineae*	Introduced	
Mallard	*Anas platyrhynchos*	Introduced	✓
Morepork	*Ninox n. novaeseelandiae*	Native	
New Zealand pigeon	*Hemiphaga novaezelandiae*	Endemic	
New Zealand pipit	*Anthus n. novaeseelandiae*	Endemic	
North Island fantail	*Rhipidura fuliginosa placabilis*	Endemic	✓
North Island kaka	*Nestor meridionalis septentrionalis*	Endemic	
North Island robin	*Petroica longipes*	Endemic	
North Island tomtit	*Petroica macrocephala toitoi*	Endemic	
Paradise shelduck	*Tadorna variegata*	Endemic	
Peafowl	*Pavo cristatus*	Introduced	
Pukeko	*Porphyrio melanotus*	Native	✓
Red-crowned parakeet	*Cyanoramphus novaezelandiae*	Endemic	
Redpoll	*Carduelis flammea*	Introduced	
Rock pigeon	*Columba livia*	Introduced	
Sacred kingfisher	*Todiramphus sanctus*	Native	✓
Silvereye	*Zosterops lateralis lateralis*	Native	
Shining cuckoo	*Chrysococcyx lucidus lucidus*	Native	
Song thrush	*Turdus philomelos*	Introduced	✓
Southern black-backed gull	*Larus dominicanus*	Native	✓
Spur-winged plover	*Vanellus miles novaehollandiae*	Native	✓
Swamp harrier	*Circus approximans*	Native	✓
Tūi	*Prosthemadera n. novaeseelandiae*	Endemic	✓
Welcome swallow	*Hirundo neoxena neoxena*	Native	✓
White-faced heron	*Egretta novaehollandiae*	Native	
Wild turkey	*Meleagris gallopavo*	Introduced	
Yellowhammer	*Emberiza citrinella*	Introduced	✓

Table 4.3. Environmental variables recorded at each five-minute bird count station at 223 Falls Road (5 August 2016).

	Station			
Variable	**1**	**2**	**3**	**4**
Start time	08:30	09:00	09:25	10:00
Cloud cover (%)	10%	40%	50%	30%
Wind	Moderate, NW	calm	Moderate, NW	Moderate, NW
Temperature	Cool (c. 10°C)	Cool (c. 9°C)	c. 12°C	12°C
Precipitation	none	none	Light drizzle	none
Noise	Moderate - road	Moderate - road	none	Moderate – road

Table 4.4. Percentage occurrence results – presence in each count. The three species with the highest occurrence are outlined in boxes.

STATION						
	1	**2**	**3**	**4**	**TOTAL**	**% occurrence**
Common myna	4				4	9.5
Blackbird	3	1		4	8	19.0
Black-backed gull			1	2	3	7.1
Chaffinch	1			1	2	4.8
Eastern rosella			3		3	7.1
Fantail		1		1	2	4.8
Grey warbler			1		1	2.4
Kingfisher				1	1	2.4
Mallard		2			2	4.8
Pukeko			2		2	4.8
Skylark	1			1	2	4.8
Song thrush				2	2	4.8
Starling		1			1	2.4
Tūi			1		1	2.4
Welcome swallow	1				1	2.4
Yellowhammer	2	5			7	16.7

4.4.2 Assessment of Effects on Birds

Habitat considered suitable for native birds was present on the property as regenerating scrubland and native bush, riparian vegetation, and large isolated clusters of native and exotic trees. Almost all vegetation on the property is designated as SEA and the majority is fenced from stock. The patches of bush are all contiguous with riparian vegetation that buffers the Mahurangi River along the southern property boundary, forming an ecological corridor for wildlife (including birds) through the landscape. Totara is the dominant tree species across much of the site and would provide roosting, nesting and feeding (e.g. berries) resources for common native birds. Below the canopy, the dense undergrowth associated with some bush patches provides foraging and dispersal habitat for smaller native

passerines (e.g. silvereye, grey warbler, and fantail). Open areas (e.g. farm paddocks and clearings) would likely provide habitat for ground-foraging species such as pukeko and paradise shelduck as they move through the landscape.

Habitat on the property is unlikely to support or provide resources for threatened species such as New Zealand pipit, kaka and red-crowned parakeet; however, these species may intermittently pass through site on-route to more favourable sites (e.g. larger tracts of native forest vegetation or expansive open pastures).

Vegetation removal as part of any future proposed development would reduce both the quantity and quality of available habitat for native birds, but these effects are likely to be minor in the context of the wider landscape given that the ecological corridor along the Mahurangi River will be retained. The site currently does not offer important habitat for rare or threatened species and any associated mitigation initiatives (e.g. pest control and planting) would provide benefits (e.g. enhanced protection and improved habitat quality) for local bird communities.

Where clearance of native trees and scrubland is unavoidable, correct protocols should be followed to ensure the protection of all native birds (including their eggs and nests), as these are protected under the Wildlife Act (1953). Clearance of these habitats should be undertaken outside of the main native bird-breeding season (September – December inclusive) to avoid disturbance or harm to nesting birds.

4.5 FRESHWATER

Four main watercourses run in a general north-south direction through the site and drain directly into the Mahurangi River.

Prior to the field survey a map of the site was created, from the Auckland Council GIS viewer, which defined the overland flow paths of the watercourses and contours for the site (Figure 4.7).

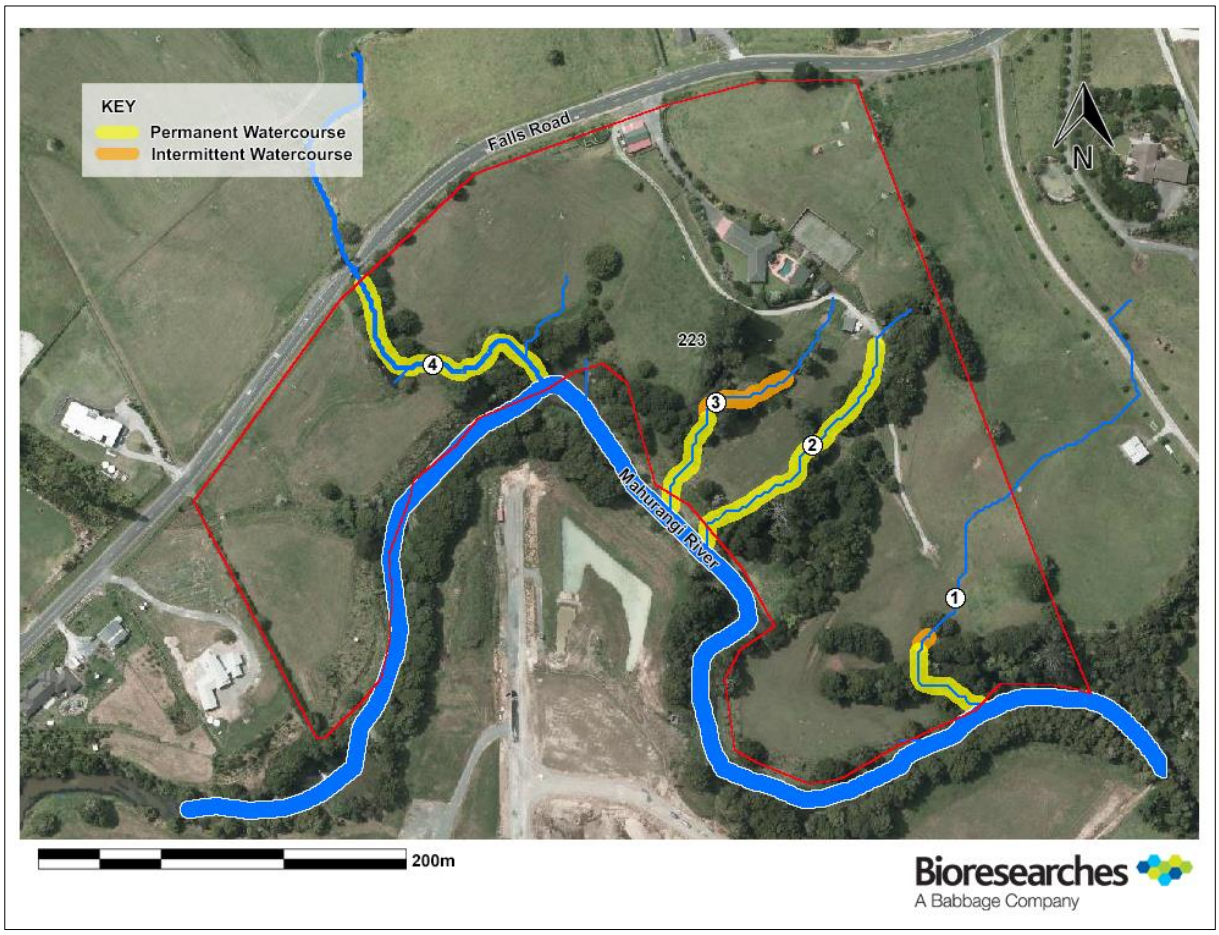


Figure 4.7. Watercourses and their classifications (AUP Op) within 223 Falls Road, Warkworth.

A site assessment was undertaken on 5 August 2016 by an experienced freshwater ecologist. During the site assessment, the presence and extent of water was noted, measurements and reference photos were taken, and notes were made on the quality of the instream habitats. Riparian and catchment information was also noted. Habitat characteristics were recorded including the size of any pools, as well as the presence of continuously flowing water. The watercourses were classified under the Auckland Unitary Plan Operative in part (AUP Op), to determine, in accordance with the definitions in this plan, the ephemeral, intermittent, or permanent status of these watercourses (*Section 4.9 Appendix III*).

In situ basic water quality measurements (temperature, dissolved oxygen and conductivity) were undertaken within suitable locations using a Yellow Springs Instruments (YSI) Professional Series combined DO/ temperature/ conductivity meter.

Rainfall within the area of the site in the preceding week before the survey was moderate and sustained, while the rainfall in the preceding four weeks was similar with one additional significant rainfall event (> 55 mm) (Auckland Council Environmental Monitoring Site: Mahurangi Satellite Dish) (Figure 4.8).

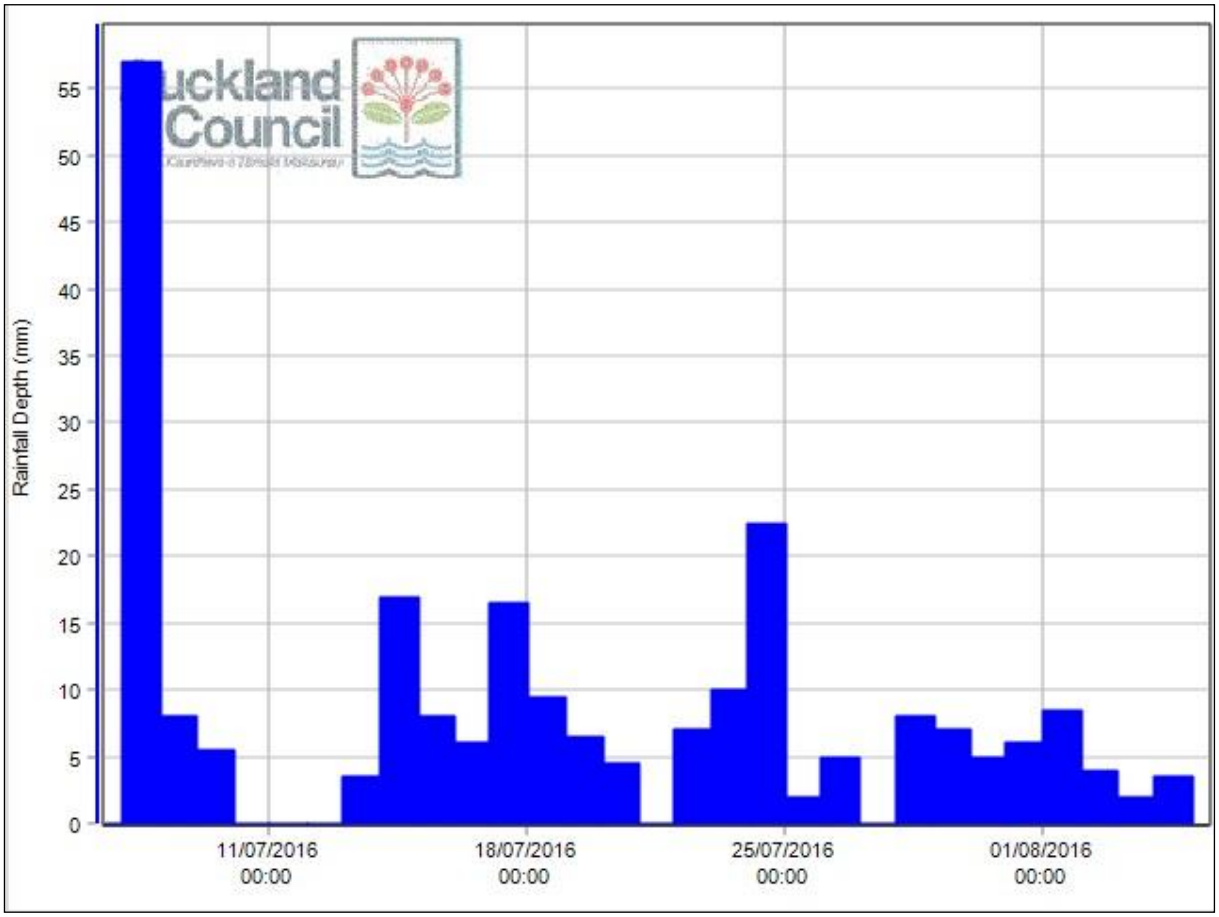


Figure 4.8. Totalled daily rainfall depth (mm) at the Mahurangi Satellite Dish between 06/07/16 – 05/08/16.

4.5.1 Watercourse 1

Watercourse 1 originated in the neighbouring property, 215 Falls Rd, and ran for approximately 250 m within the site before draining into the Mahurangi River. The upper reach of the watercourse lacked a well-defined channel, contained no surface water and had terrestrial vegetation within the flow path (Plate 4.12). The lower 60 m of the watercourse had flowing water at the time of the survey. This lower reach had a defined channel (Plate 4.13) with an 8 m high cascade (Plate 4.14). The substrate along the lower reach consisted of silt and bedrock, the level of shading was high and the riparian margin was fenced off. No macrophytes were recorded. Water quality measurements within the reach reflected the winter conditions and showed a water temperature of 13.7˚C, which is indicative of an 'excellent' temperature (Biggs *et al.*, 2002). Dissolved oxygen concentration and saturation were high, at 9.8 mg/L and 95%, respectively indicative of no stress for aquatic fauna (Davies-Colley *et al.,* 2013). The conductivity level was 'good' (76µS/cm), indicative of unlikely enriched waters (Biggs *et al.,* 2002).

Due to the presence of continuously flowing water, the lower 50 m of Watercourse 1, was classified as permanent the AUP Op (Figure 4.7). A 10 m length upstream of the permanent section was classified as intermittent. The permanent section of the watercourse was considered to have a moderate to high ecological value due to the; hydrologic heterogeneity, high shading, good access to the flood plain and the presence of instream debris. The remaining section of the watercourse was considered to have a low ecological value predominately due to the lack of water and low shading.

4.5.2 Watercourse 2

Watercourse 2 originated from within the site and ran for approximately 180 m before draining into the Mahurangi River. The watercourse had a defined channel with deeply incised banks in some places (Plate 4.15). The substrate consisted of silt, bedrock and large cobbles/ boulders (Plate 4.16). High shading was present along the whole watercourse and the majority of the riparian margin was fenced off. No macrophytes were recorded. Water quality measurements within the reach reflected the winter conditions and showed a water temperature of 13.8˚C, which is indicative of an 'excellent' temperature (Biggs *et al*., 2002). Dissolved oxygen concentration and saturation were high, at 9.2 mg/L and 90%, respectively indicative of no stress for aquatic fauna (Davies-Colley *et al.,* 2013). The conductivity level was 'fair' (163µS/cm), indicative of slightly enriched waters (Biggs *et al*., 2002). Within the Mahurangi River riparian margin the watercourse became diffuse and formed a boggy wetland before draining into the river.

Due to the presence of continuously flowing water, the entire watercourse below the upper crossing, was classified as permanent the AUP Op (Figure 4.7). Upstream of the permanent section the watercourse was considered ephemeral. If another classification survey was undertaken later in the season, after a period of dry weather, it is expected that sections of the permanent watercourse would be classified as intermittent the AUP Op.

The permanent section of the watercourse was considered to have a moderate ecological value predominately due to the high shading, substrate variability and the presence of instream debris.

4.5.3 Watercourse 3

Watercourse 3 originated from within the site and ran for approximately 160 m draining into the Mahurangi River. Although the watercourse was situated within a steep-sided gully (2-4 m), the majority of the watercourse lacked a well-defined channel (Plate 4.17). The upper reach was choked with weeds and no running water was evident along the upper reach, but numerous small pools of water had formed. Further downstream the pools became larger and a trickle flow became evident which increased in strength further downstream. Along the watercourse, the substrate consisted of silt, a high level of shading was present and the riparian margin was fenced off. No macrophytes were recorded. Water quality measurements within the reach reflected the winter conditions and showed a water temperature of 12.6˚C, which is indicative of an 'excellent' temperature (Biggs *et al.,* 2002). Dissolved oxygen concentration and saturation were high, at 9.3 mg/L and 88%, respectively indicative of no stress for aquatic fauna (Davies-Colley *et al*., 2013). The conductivity level was 'fair' (150µS/cm),

indicative of slightly enriched waters (Biggs *et al.,* 2002). Within the Mahurangi River riparian margin the watercourse became diffuse and formed a boggy wetland before draining into the river.

Due to the presence of continuously flowing water, the lower reach (approximately 60 m) of Watercourse 3, was classified as permanent under the AUP Op (Figure 4.7). Upstream of the permanent section (approximately 60 m) the watercourse was classified as intermittent under the AUP Op. Further upstream the watercourse was classified as ephemeral. If another classification survey was undertaken later in the season, after a period of dry weather, it is expected that the permanent section of the watercourse would be classified as intermittent under AUP Op.

The permanent and intermittent section of the watercourse was considered to have a low to moderate ecological value predominately due to the low water flow and lack of hydrologic heterogeneity.

4.5.4 Watercourse 4

Watercourse 4 originated north of the site and forms a significant tributary of the Mahurangi River. The watercourse runs for approximately 140 m within the site before draining into the Mahurangi River. The watercourse had a wide (3-4 m) defined channel with steep sided banks (Plate 4.18). The hydrologic heterogeneity was high with runs, pools and cascades. The substrate consisted of silt, cobble and bedrock. Moderate to high shading was present along the watercourse and the majority of the riparian margin was fenced off. No macrophytes were recorded. Water quality measurements within the reach reflected the winter conditions and showed a water temperature of 12.3˚C, which is indicative of an 'excellent' temperature (Biggs *et al.,* 2002). Dissolved oxygen concentration and saturation were high, at 10.3 mg/L and 98%, respectively indicative of no stress for aquatic fauna (Davies-Colley *et al.*, 2013). The conductivity level was 'good' (143µS/cm), indicative of unlikely enriched waters (Biggs *et al.,* 2002).

Due to the presence of continuously flowing water, Watercourse 4, was classified as permanent under the AUP Op (Figure 4.7). Watercourse 4 was considered to have a high ecological value.

4.5.5 Remaining Watercourses

The remaining watercourses within the Site (Figure 4.7) contained terrestrial vegetation and lacked well defined channels. There was no evidence within the watercourses of substrate sorting through flow processes. Additionally, no flowing water was evident, although small amounts of surface water were present, predominantly in areas where pugging had occurred and after sustained moderate to high rainfall in the four weeks preceding the site survey. These watercourses were classified as ephemeral under the AUP Op.

4.5.6 Assessment of Effects on Freshwater Ecosystems

Any works in proximity to or within a watercourse may have moderate adverse effects on the freshwater ecological values through sedimentation, habitat loss and injury or mortality to native fish. However, under the proposal watercourses 1 – 4 (including their riparian margins) fall within SEAs and

areas proposed as Esplanade Reserve within an Open Space zoning, and thus there are unlikely to be any direct effects on watercourses. Where appropriate stormwater management is set in place to mitigate water runoff from impermeable surfaces (e.g. roads), the effects on local watercourses would be considered no more than minor.

4.6 CONCLUSIONS AND RECOMMENDATIONS

- The trees present at 223 Falls Road are mature and of moderate size and age, and therefore, have moderate botanical value. Where access the SEA is required, hygiene protocols for kauri dieback disease would need to be implemented. General protocols can be found at ***www.kauridieback.co.nz***

- The areas of vegetation and habitat that buffer the Mahurangi River (riparian margin) and those that are fenced from stock are considered to provide moderate to high ecological values for local terrestrial wildlife. That is, the vegetation provides foraging, refuge and dispersal sites for birds and lizards within a significant ecological corridor that exists along the length of the Mahurangi River. Managed pasture does not provide important habitat for native lizards but does offer intermittent roosting and feeding areas for common native birds such as pukeko and paradise duck.

- Any future works in close proximity to a watercourse (within 10 m) should be timed to avoid predicted heavy rain and should incorporate standard sediment controls (TP90 – Erosion and Sediment Control: Guidelines for Land Disturbing Activities in the Auckland Region), as a minimum, to prevent sediment runoff into any watercourses. All bare ground exposed by site works should be stabilised and replanted with appropriate vegetation as soon as practicable.

- Where degradation, reclamation or culverting of intermittent and permanent watercourse cannot be avoided, due to engineering or planning constraints, the adverse ecological effects would be appropriately mitigated or compensated for through offsetting in accordance with Policy E3.3 (4) of the AUP Op. Compensation would be addressed at the resource consenting stage.

4.7 REFERENCES

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4.8 PLATES

Plate 4.1. Regenerating understorey plants in Area 1 above the Mahurangi River.

Plate 4.2. Thicket of taurepo on a steep bank in Area 1

Plate 4.3. Totara along the upper edge of Area 1 above the river.

Plate 4.4. Open swampy area in Area 2 beside the Mahurangi River. Totara, kauri and kanuka in the background

Plate 4.5. Totara treeland in Area 3

Plate 4.6. Totara canopy with edge planting of native shrubs and a pine tree in the lower western part of Area 4.

Plate 4.7. Riparian vegetation along the Mahurangi River in the south eastern part of the site showing mature totara with restoration planting between (right). On the left is the lower edge of Area 1.

Plate 4.8. Corrugated iron debris, forming potential lizard refuge habitat.

Plate 4.9. Woody debris and flaky bark on trees that may provide refuge sites for native lizards (skinks and geckos).

Plate 4.10. Areas of rank grass—despite their apparent low ecological value—can provide suitable habitat for protected skinks.

Plate 4.11. Understorey scrub, rank grass and leaf litter that may offer suitable habitat for native lizards.

Plate 4.12. Upper ephemeral reach of Watercourse 1.

Plate 4.13. Defined channel along the lower reach of Watercourse 1.

Plate 4.14. Eight metre cascade along the lower reach of Watercourse 1.

Plate 4.15. Defined channel and incised banks of Watercourse 2.

Plate 4.16. Large cobbles/boulders within Watercourse 2.

Plate 4.17. Watercourse 3 showing high banks, diffuse watercourse and weeds.

Plate 4.18. Watercourse 4, showing a wide channel and hydrologic variation.

Plate 4.19. Upper reach of Watercourse 5.

4.9 APPENDICES

Appendix I: Native and Exotic Plant Species Recorded Within SEA_T_2294 at 223 Falls Road, Warkworth

Native Species

Botanical Name	Common name
Adiantum hispidulum	Rosy maidenhair fern
Agathis australis	Kauri
Aristotelia serrata	Wineberry/makomako
Astelia hastata	Perching lily
Austroderia fulvida (p)	toetoe
Blechnum filiforme	Thread fern
Blechnum membranaceum	Lance fern
Blechnum novaezelandiae	kiokio
Blechnum parrisiae	Rasp fern
Carex banksiana	Fine leaved hook grass
Carex lessoniana	rautahi
Carex uncinata	Hook grass
Clematis sp	Puawhananga
Coprosma arborea	Tree coprosma
Coprosma rhamnoides	Twiggy coprosma
Coprosma robusta	karamu
Cordyline australis	Cabbage tree
Corynocarpus laevigatus (p)	karaka
Cyathea dealbata	Silver tree fern
Cyathea medullaris	black ponga
Dacrycarpus dacrydioides	kahikatea
Deparia petersenii	Deparia
Dicksonia squarrosa	Wheki ponga
Dodonaea viscosa (p)	Akeake
Geniostoma ligustrifolium	Hangehange
Griselinia littoralis (p)	Puka
Haloragis erecta	Shrubby haloragis
Houheria populnea (p)	Houhere/lacebark
Kunzea robusta	Kanuka
Lastreopsis glabella	Smooth shield fern
Melicytus ramiflorus	Mahoe
Myoporum laetum (p)	Ngaio
Myrsine australis	Mapou
Phormium tenax (p)	Harakeke/flax
Phyllocladus trichomanoides	Tanekaha
Pittosporum crassifolium (p)	Karo
Pittosporum eugenioides (p)	Tarata
Pittosporum tenuifolium (p)	Kohuhu

Pneumatopteris pennigera	Gully fern
Podocarpus totara	Totara
Pyrrosia eleagnifolia	Leather fern
Rhabdothamnus solandri	Taurepo/NZ gloxinia
Rhopalostylis sapida	Nikau
Schefflera digitata	Pate/seven finger
Sophora microphylla	Kowhai
Vitex lucens	Puriri

Exotic Species

Botanical Name	**Common name**
Apium nodiflorum	Water celery
Asparagus scandens	Climbing asparagus
Cortaderia selloana	Pampas
Crataegus monogyna	Hawthorn
Crocosmia x crocosmiiflora	Montbretia
Delairea odorata	German ivy
Eriobotrya japonica	Loquat
Glyceria maxima	Reed sweet grass
Ligustrum lucidum	Tree privet
Ligustrum sinense	Chinese privet
Phyllostachys sp.	Ornamental bamboo
Pinus radiata	Monterey pine
Plectranthus ciliatum	Plectranthus
Ranunculus repens	Creeping buttercup
Salix fragilis	Crack willow
Selaginella kraussiana	African clubmoss
Solanum mauritianum	Woolly nightshade/tobacco plant
Syzygium smithii	Monkey apple
Tradescantia fluminensis	Tradescantia
Vinca major	Periwinkle
Zantedeschia aethiopica	Arum lily

Appendix II: Department of Conservation Wildlife Act Authority

Department of Conservation
Te Papa Atawhai

Wildlife Act Authority for wildlife not located on public conservation land

National Permit Number: 37604-FAU
File Number: NHS-12-03

THIS AUTHORITY is made this day of

PARTIES:

The Director General of Conservation (the Grantor)

Bioresearches Group Limited (the Authority Holder)

BACKGROUND

A. The Director General of Conservation is empowered to issue authorisations under the Wildlife Act 1953.

B. The Authority Holder wishes to exercise the authorisation on the Land subject to the terms and conditions of this Authority.

OPERATIVE PARTS

In exercise of the Grantor's powers under the Conservation legislation the Grantor **AUTHORISES** the Authority Holder under Section 53 of the Wildlife Act 1953 subject to the terms and conditions contained in this Authority and its Schedules.

SIGNED on behalf of the Grantor by

John Galilee
Acting Conservation Partnerships Manager
acting under delegated authority dated 29 August 2013 in the presence of:

Witness Signature:
Witness Name: Annette Foster
Witness Occupation: DOC officer
Witness Address: 10 Beaumont St Auck 1010

A copy of the Instrument of Delegation may be inspected at the Director-General's office at 18-22 Manners Street, Wellington

1

SCHEDULE 3

SPECIAL CONDITIONS.

Relocation and habitat enhancement

1. The Authority Holder is only permitted to release lizards:
    a. That are classified as Not Threatened or At Risk species under the current threat classification system, and
    b. Into release site(s) that support habitat that is assessed by a qualified herpetologist as being of similar or better habitat compared to the source location, and being capable of supporting that lizard species, and,
    c. Into release site(s) that are within five hundred (500) metres of the development footprint or with consultation and agreement with the relevant DOC Services Manager), and
    d. Into release site(s) where habitat for that species of lizard is enhanced using accepted techniques such as provision of extra refuges suitable for the species or long-term predator control, and that this enhancement is undertaken and approved prior to the relocation taking place, and
    e. Into release site(s) where the site has long-term security from development or modification, for example Council or DOC- managed Reserves, legal protection through covenanting or legal protection through District Plan rule provisions).

2. The Services Manager(s) are to be contacted immediately for further advice if lizard species classified as Threatened are located within the footprint of the proposed development or within the proposed release site. This permit does not permit movement of Threatened species. A separate application to translocate Threatened species may be required.

3. The Services Manager(s) are to be contacted immediately for further advice if any of the conditions outlined in 1) above are not able to be met.

4. Where Threatened lizards are found within the footprint of the site during lizard salvage operations during construction, the Authority Holder shall contact the Services Manager(s) and transfer the lizard(s) to an approved lizard holding facility until a suitable release site is identified by DOC.

5. The Authority Holder must engage with the relevant tangata whenua prior to any relocation of lizards taking place in their rohe. Advice on engagement with tangata whenua should be sought from the Department of Conservation, Services Manager(s).

6. Any salvage operation for lizards shall be accompanied by a Lizard Management Plan that outlines, as a minimum, capture and handling techniques to be applied, the proposed relocation release site, management of the release site including provision for protection of relocated lizards, provision of post-release monitoring, and actions that will be followed in the event that Threatened lizard species are found within the development footprint.

7. Subject to holding an appropriate captive permit, the Authority Holder may hold any of the removed lizards in captivity for up to twelve (12) months then release them within five hundred (500) metres of the site where they were originally found once a Lizard Management Plan has been prepared and approved by DOC. The relevant DOC Services Manager must be notified within 48 hours if any lizards are placed into captivity.

8. Any offspring born in captivity must be released, together with the original animals collected, in accordance with the requirements of 1) above.

Lizard capture and handling

9. Lizards must only be handled by people who are appropriately trained and experienced in lizard capture and handling, or under direct supervision of someone who is. Only non-destructive search methods may be used unless the Area is to be impacted and is the subject of a consented or permitted activity under the Resource Management Act 1991 or Conservation Act 1987.

10. Capture and handling of lizards must use techniques that minimise the risk of infection or injury to the animal.

11. If traps are used they must be covered to protect lizards from exposure and minimise stress. A small amount of damp leaf litter, or similar material, should be placed in the bottom to provide hiding places and reduce the risk of desiccation. Traps should be secured onto a secure surface to avoid disturbance from predators. Traps may be baited. All traps **must** be checked at least every 24 hours.

12. Lizard capture, handling and relocation should be undertaken at a suitable time of year when lizards are active, as advised by an experienced herpetologist

Reporting

13. A report is to be submitted in writing to the Director-General of Conservation, Services Manager, Auckland District Office as well as the Warkworth District Office, by 01 July each year for the life of this permit, summarising outcomes in accordance with the Lizard Management Plan. Each report must:
    a. include the species and number of any animals collected and released, and the GPS location (or a detailed map) of the collection point(s) and release point(s).

    b. include completed Amphibian and Reptile Distribution System (ARDS) cards (http://www.doc.govt.nz/conservation/native-animals/reptiles-and-frogs/species-information/herpetofauna-data-collection/ards-card/) to Herpetofauna, Department of Conservation, National Office, PO Box 10420 Wellington 6143 or herpetofauna@doc.govt.nz for all herpetofauna sightings and captures.

Appendix III. Stream classification under the Auckland Unitary Plan Operative in part.

STREAM DEFINITIONS

Stream or River

A continually or intermittently flowing body of fresh water, excluding ephemeral streams, and includes a stream or modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal except where it is a modified element of a natural drainage system).

Ephemeral reaches

Stream reaches with a bed above the water table at all times, with water only flowing during and shortly after rain events.

A river reach is ephemeral where it meets at least three of the following criteria:

- it lacks a well-defined channel, so that there is little or no ability to distinguish between the bed and banks
- it contains no surface water, if no rain has occurred in the previous 48 hours
- it contains terrestrial vegetation
- there is clearly visible organic debris on its floodplain from flood flows
- there is no evidence of substrate sorting through flow processes

Intermittent Stream

Stream reaches that cease to flow for some periods of the year.
Includes:

- reaches with stable natural pools having a depth at their deepest point of not less than 150mm and a total pool surface area that is 10m² or more per 100m of river or stream bed length and
- reaches without stable pools

Permanent River or Stream

The continually flowing reaches of any river or stream.

5 102 HUDSON ROAD

5.1 INTRODUCTION

A brief ecological assessment of the 102 Hudson Road property (LOT 2 DP 527699; c. 1.5 ha) (hereafter the "site") was undertaken by an experienced ecologist on 24 January 2017. The assessment included a site walkover and assessment of the freshwater environments. Prior to visiting the property, a map of the site was viewed on the Auckland Council GIS viewer, to identify ecologically important features (e.g. Significant Ecological Areas, watercourses, overland flow paths and catchments).

The site lies within the Rodney Ecological District and represents a gently sloping area of grazed pasture at an altitude of 36 – 53 m above sea level. Small isolated patches trees and low growing vegetation exist along the western boundary and two watercourses are present, as indicated by the Auckland Council GIS viewer (Figure 1).

The property is zoned "Future Urban" under the Auckland Unitary Plan Operative in part and is not subject to any Significant Ecological Area (SEA) overlays.

5.2 TERRESTRIAL ECOLOGY

The site is almost completely in managed pasture apart from a small group of native totara (*Podocarpus totara*) trees along the western boundary (Plate 5.1), growing either side of a watercourse. A number of trees in the south-western corner have been felled, as evidenced by cut and stacked logs (Plate5.2). Terrestrial vegetation (e.g. kikuyu grass, *Rumex* sp*., Rubus fruticosus*) was found growing within the channel of the most northern watercourse, while *Juncus edgariae,* Arum-lily (*Zantedeschia aethiopica*) and *Nasturtium officinale*—species associated with wetted areas—were present in the southern watercourse.

No native birds were observed during the site visit; however, common native and exotic birds are likely to utilise existing features (e.g. totara trees, open pasture and watercourses) for roosting, foraging and dispersal pathways at least intermittently.

Brief searches for lizards failed to detect any indigenous species but a single plague skink (*Lampropholis delicata*) was found beneath a plank of wood lying amongst pasture grass.


Plate 5.1. Extent of the native vegetation on-site—totara trees growing alongside Watercourse 2.

5.3 FRESHWATER ECOLOGY

During the site assessment, the presence and extent of water was noted, reference photos were taken and notes were made on the quality of the instream habitats. Riparian and catchment information was also noted. Habitat characteristics were recorded including the size of any pools, as well as the presence of continuously flowing water. The watercourses were classified under the Auckland Unitary Plan Operative in part (AUP Op) to determine, in accordance with the definitions in this plan, the ephemeral, intermittent, or permanent status of these watercourses.

Rainfall at the site in the preceding week before the survey was low, with one notable rainfall event on the 23 January 2017 (17 mm), while the rainfall in the preceding four weeks was relatively low (Auckland Council Environmental Monitoring Site: Mahurangi Satellite Dish) (Figure 5.1).

5.3.1 Watercourse 1 (northern watercourse/ overland flow path):

This watercourse was approximately 65 m in length with gently sloping banks covered in pasture grass. It contained no running or surface water, lacked a well-defined channel and terrestrial vegetation was present throughout the entire length of the watercourse (Plate 5.2; Figure 5.2).

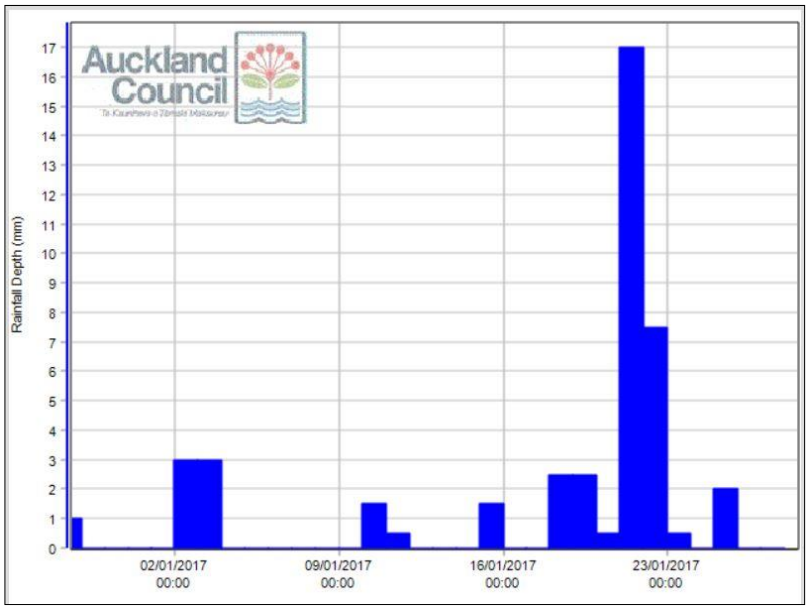

Figure 5.1. Totalled daily rainfall depth (mm) at the Mahurangi Satellite Dish between 28/12/2016 – 28/01/2017.

Plate 5.2. Watercourse 1 (northern watercourse/ overland flow path)

5.3.2 Watercourse 2 (southern watercourse)

This watercourse was approximately 76 m in length. In the upper reaches of this watercourse, an exposed and broken ceramic pipe (possibly storm water or water treatment) was located (Plate 5.3) and appeared to be leaking water. Below this pipe the channel was poorly defined and surface water was observed pooling in stock pug marks (Plate 5.4). The watercourse then widened to form a c. 4 m-wide wetted area, which supported kikuyu grass, dock (*Rumex* sp.) and rushes (*Juncus* sp.) (Plate 5.4), and a small wooden bridge was present over the watercourse (suggesting the watercourse remains wet for a large part of the year). The banks of the watercourse steepened slightly downstream of the bridge, before the watercourse

widened again forming another wetted area (c. 3 m wide) (Plate 5.5). This area supported a slightly higher diversity of plants, including Arum-lily (*Zantedeschia aethiopica*) and aquatic or semi-aquatic watercress (*Nasturtium officinale*) (Plate 5.6). The presence of *Nasturtium* indicates the watercourse remains wet for much of the year. The watercourse then passed under the property boundary fence where it formed a distinct channel (c. 1.5 m wide; c. 0.5 m deep) that ran into the neighbouring paddock and eventually drained into the Mahurangi River.

Watercourse 2 contained no running water although surface water was present along much of its length.

Plate 5.3. Watercourse 2 (southern watercourse). Images showing the broken pipe in the upper reaches (left) and water pooling in pug marks downstream (right).

Plate 5.4. Watercourse 2 (southern watercourse) showing the c. 4 m wide wetted area (left) and the small bridge (right).

Plate 5.5. Watercourse 2 (southern watercourse) showing the lower reaches (left) and *Nasturtium* (watercress) (right).

5.3.3 Summary

Overall the ecological values of the site are low. The vegetation is predominantly common exotic pasture species, pest plants and common native wetland plants. The terrestrial wildlife values are also low (both species and habitat diversity) although common exotic and native species of birds and lizards may utilise the site intermittently.

Watercourse 1 was classified as ephemeral (Figure 5.2) and considered to have a low ecological value predominantly due to the lack of water and lack of riparian vegetation, resulting in negligible habitat for native fauna. Works in or alteration to this ephemeral watercourse is a permitted activity (AUP Op, E3: (A53)). Watercourse 2, although classified as intermittent (Figure 5.2), was also considered to have low ecological value. This watercourse supports some species of plants generally associated with aquatic environments (e.g. watercress); however, its degraded condition—predominantly due to riparian vegetation grazing and erosion caused by stock—has reduced both water quality and habitat available for native fauna. Where degradation, reclamation or culverting of an intermittent watercourse cannot be avoided, due to engineering or planning constraints, the adverse ecological effects would be appropriately mitigated or compensated for through offsetting in accordance with Policy E3.3 (4) of the AUP Op.

Figure 5.2. Aerial photograph of the 102 Hudson Road, Warkworth property showing the location and classification of watercourses, and accompanying images

6 ECOLOGICAL ASSESSMENT: PROPOSED STRUCTURE PLAN CHANGE

6.1 INTRODUCTION

The Warkworth North Structure Plan area includes the Future Urban zoned land bounded by the proposed Puhoi to Warkworth motorway extension in the north-west, the Davie-Martin Drive lifestyle development area to the west, the Mahurangi River to the south, and Hudson Road and State Highway 1 to the east and north-east.

The area proposed to be rezoned as part of the Plan Change more or less applies to the Structure Plan area, with the exception of 141 Carran Road, the western extent of Lot 1 DP 508375, and the existing General Business and Light Industrial zoned land to the east.

Detailed ecological investigations were undertaken on three of the properties within the structure plan area—Stubbs Farm, 102 Hudson Road and 223 Falls Road—in 2016/2017 (detailed elsewhere in this report). In addition, a desktop ecological assessment of the entire Warkworth North Structure Plan area, including legal properties outside of those mentioned above (i.e. to the north, east and south of Stubbs Farm Estate) (Table 6.1) was undertaken to provide a comprehensive overview of the ecological values of the subject area.

Table 6.1. The legal properties within the subject area

• 91 Falls Road (Lot 2 DP 336399) • 93 Falls Road (Lot 1 DP 336399) • 215 Falls Road (Lot 1 DP 209013) • 220 Falls Road (Lot 2 DP 355193) – Stubbs Farm Estate • 223 Falls Road (Lot 2 DP 210933) • Lot 2 DP 209013 Falls Road • Lot 3 DP 209013 Falls Road • 16 View Road (Lot 1 DP 204539) • 20 View Road (Lot 1 DP 62696) • 14 Hudson Road (Lot 1 DP 102732) • 24 Hudson Road (Lot 2 DP 149967) • 26 Hudson Road (Lot 1 DP 149967) • 30 Hudson Road (Lot 21 DP 9212)	• 60 Hudson Road (Lot 20 DP 9212) • 66 Hudson Road (Lot 1 DP 166853) • 74 Hudson Road (Lot 2 DP 166853) • 76 Hudson Road (Lot 2 DP 402541) • 78 Hudson Road (Lot 1 DP 402541) • 86 Hudson Road (Lot 1 DP 375015) • 102 Hudson Road (Lot 16 DP 9212) – Stubbs Farm Estate • Sec 4 SO 476652 Hudson Road • 11 Sanderson Road (Lot 2 DP 375015) • 12 Sanderson Road (Pt Allot 52 Psh of Mahurangi) – Stubbs Farm Estate • Lot 18 DP 9212 Sanderson Road – Stubbs Farm Estate • 27 State Highway 1 (Lot 1 DP 405448) • Pt Lot 1 DP 180823 State Highway 1 • Sections 15, 17, 20, 24 SO 495251 • 141 Carran Road (SECT 20 SO 495251, SECT 21 SO 495251, SECT 22 SO 495251)

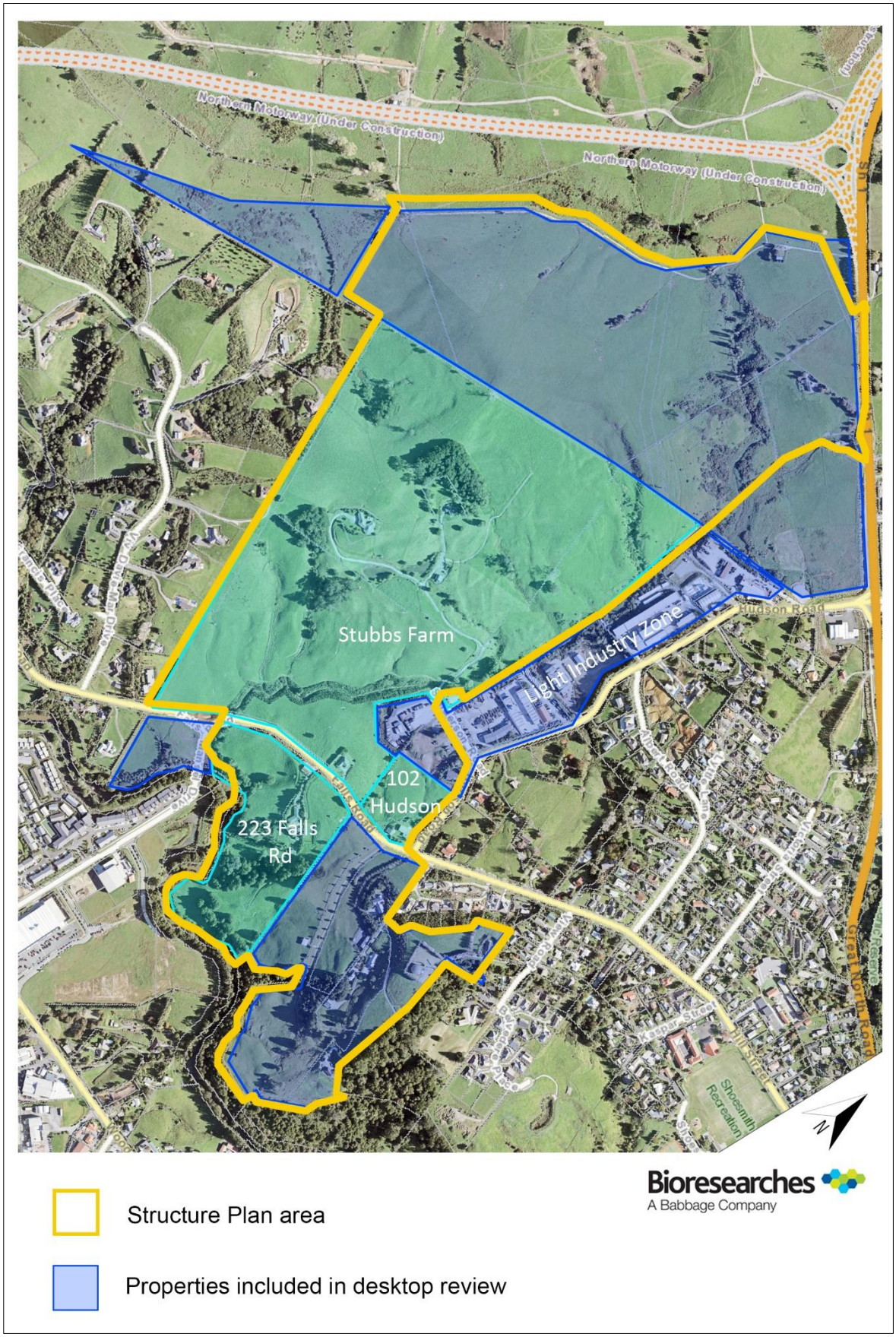

Figure 6.1. Warkworth North Structure Plan area showing properties include in the detailed (light blue) and desktop (darker blue) assessments.

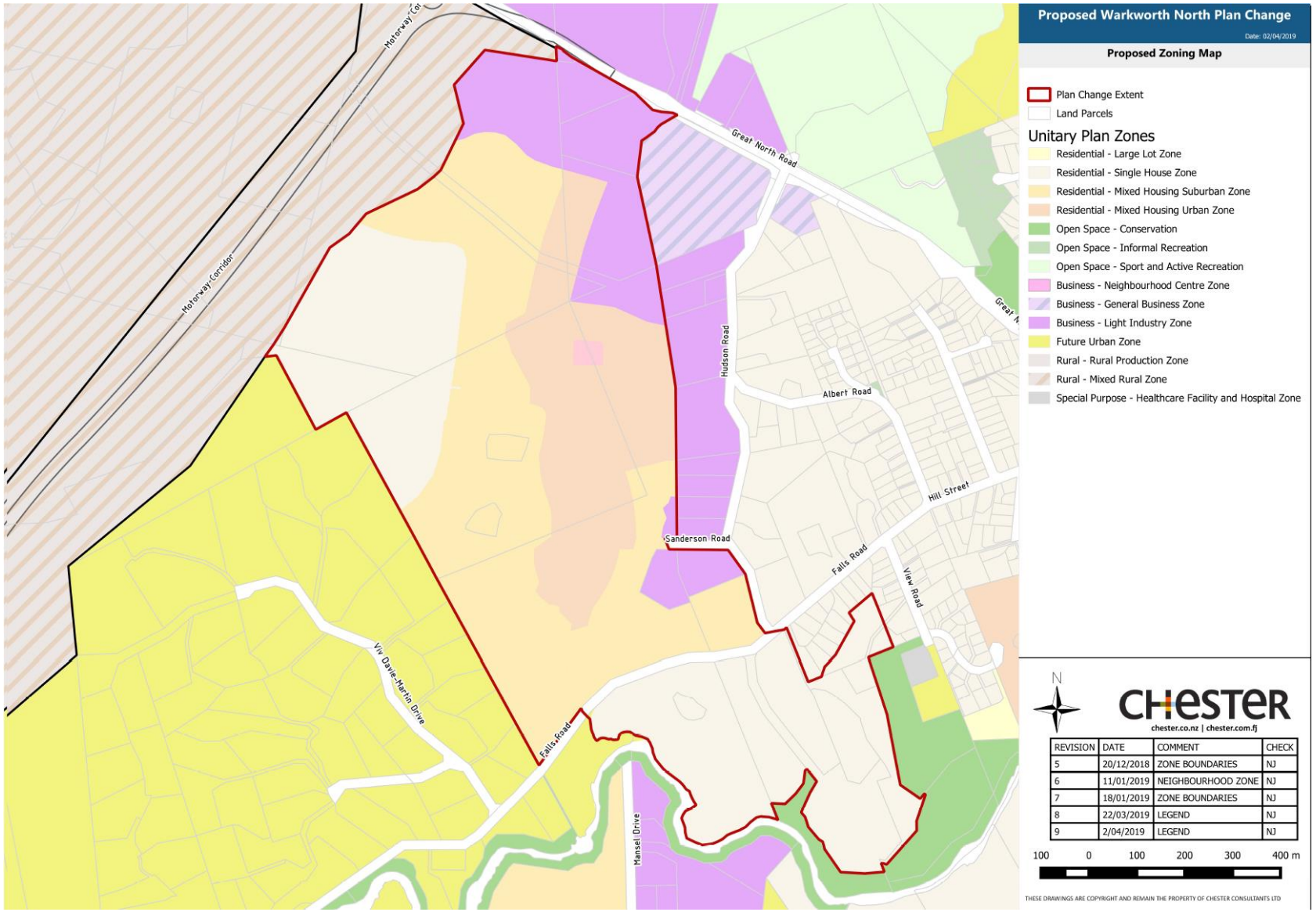

Figure 6.2. Plan Change area, Warkworth North.

6.2 DESKTOP ECOLOGICAL ASSESSMENT

A desktop assessment of the ecological values of the properties by reviewing high quality aerial images of the subject area, as well as GIS layers and overlays available on the *Auckland Council GeoMaps* and *Google Earth* websites. A field assessment of all watercourses with the structure plan area was carried out to classify the streams under the AUP Op criteria. Site photographs and field notes collected during the Stubbs Farm Ecological Assessment (*Section 2*) were also revisited to gather information on the wider surrounding landscape.

6.2.1 Terrestrial Ecology

6.2.1.1 North

The properties to the north of Stubbs Farm are predominantly covered in managed pasture with small isolated patches of weedy or young regenerating native vegetation. These vegetated areas are generally found in association with shallow gullies or along watercourses and fence-lines (i.e. hedgerows). The ecological value of these northern properties is generally low; however, the most important ecological features are the regenerating buffer planting and totara trees on the southern boundary of Sec 4 SO 476652, Hudson Road Warkworth 0984 (Bioresearches, 2015) and the regenerating riparian vegetation at 141 Carran Road (SECT 15 SO 495251, SECT 17 SO 495251, SECT 24 SO 495251), both of which would provide foraging and potentially nesting habitat for common native birds.

6.2.1.2 South

To the south of Stubbs Farm, vegetation is restricted to a wide riparian margin that bounds the Mahurangi River and as ornamental trees and shrubs surrounding residential properties and small paddocks. A Significant Ecological Area (SEA) (SEA_T_2294) overlay covers the margins of the Mahurangi River on the 215 and 233 Falls Road properties, and this area is considered to have moderate to high ecological values for local wildlife and should remain intact (*Section 4*). The habitat values in the western extent of Lot 1 DP 508375 are limited, considering recent earthworks involved with the Mansel Drive bridge construction and associated activities. Thus, the ecological values in this area are confined to the riparian margins and in-stream habitats of the Mahurangi River.

6.2.1.3 East

Terrestrial ecological assessments of the areas to the east of Stubbs Farm, on the General Business and Light Industrial zoned land, were not undertaken given the extent of existing industrial activities and obvious absence of suitable vegetation and habitat for native fauna. The only exception being the area of weed dominated scrub/ shrubland bounding a small intermittent watercourse on 60 Hudson Road, Warkworth 0984 (Lot 20 DP 9212). This property was not visited but it is likely that the ecological values in this area are likely to be low and influenced by adjacent industrial activities.

6.2.1.4 Arboricultural Value

The most significant areas of vegetation/ tree land are present on Stubbs Farm and 223 Falls Road properties, but individual trees or small stands of trees are also sparsely scattered throughout

managed pasture or present along intermittent or ephemeral watercourses (Plate 6.1). Most of these trees are exotic (e.g. *Eucalyptus* sp., *Salix* sp. or *Pinus radiata*) and are either amenity trees or serve the purpose of providing shade to livestock. Thus, these trees have negligible ecological value. Individual mature rimu, kauri, totara and kahikatea trees area also present and where these are to be removed, mitigation via compensatory native planting (i.e. replacement equivalent to basal wood area) would occur. Replanting with native fruit and nectar producing species would provide higher value to wildlife by offering natural food resources.

To ensure optimal planning solution, individual or small stands of trees outside of the existing bush retention areas would be removed. The ecological effects of removing such trees would be no more than minor. It is acknowledged that the removal of vegetation or trees within 20 m of streams or wetlands is a Restricted Discretionary activity, requiring a resource consent.

Plate 6.1. Selection of individual trees or small stands of trees present within the Structure Plan area.

A review of the Auckland Council Notable Tree GIS layer indicated that no trees listed in *Appendix 3.4: Schedule of Notable Trees of Auckland* are present in the proposed NWSP area. Two notable trees are present nearby, at 60 Hudson Road (zoned Business – Light Industry) and 86 Falls Road (zoned Residential – Single House) (Table 6.1; Figure 6.1). These trees would not be affected by the proposed structure plan change.

Table 6.1. Schedule of Notable Trees of Auckland relevant to the Structure Plan area.

ID	Botanical Name	Common Name	Auckland district	Number of Trees	Location/Street Address	Legal Description
2050	*Sequoia* sp	Redwood	Rodney	1	60 Hudson Road, Warkworth	Lot 20 DP 9212
2350	*Sequoia sp.*	Redwood	Rodney	1	86 Falls Road, Warkworth	Lot 23 DP 9212

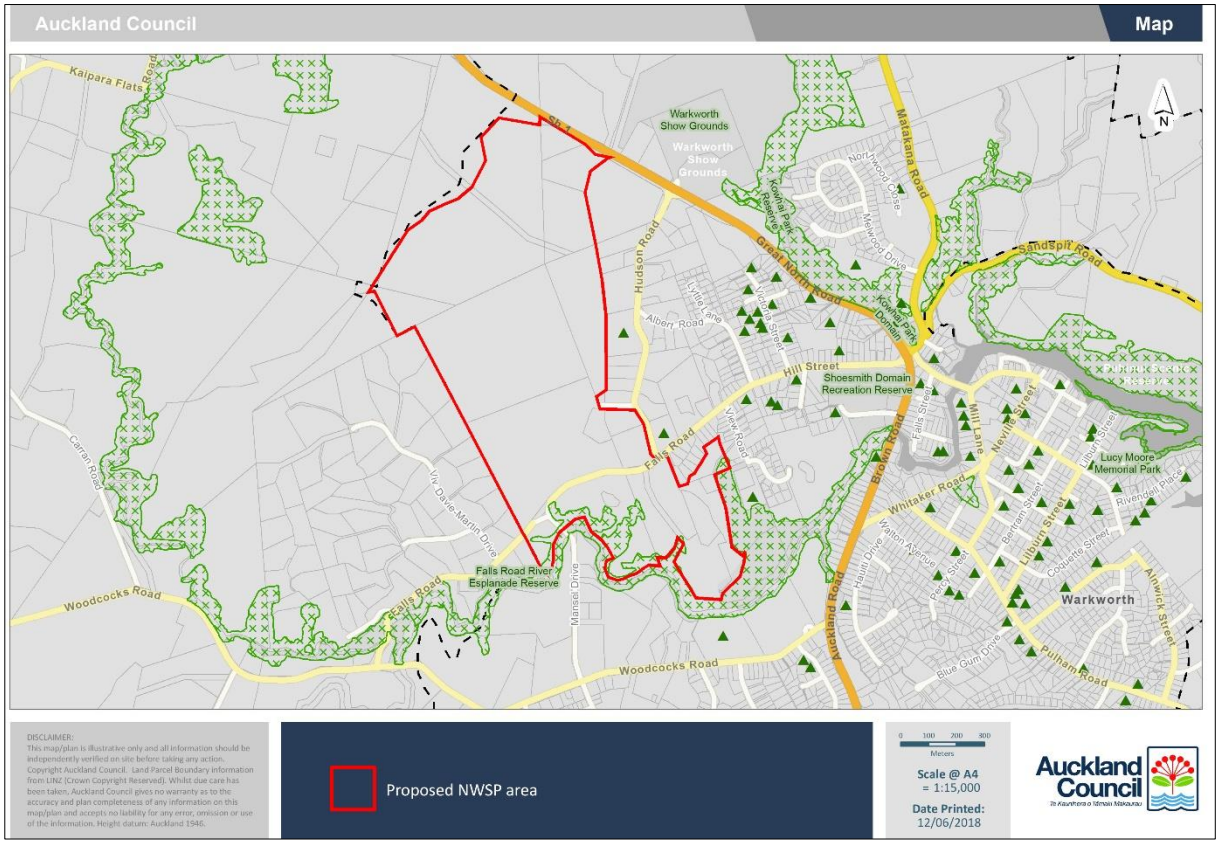

Figure 6.1. Notable trees present within the proposed NWSP area and immediate surrounds.

6.2.2 Freshwater Ecology

Several watercourses—tributaries of the Mahurangi River—are present within the Warkworth North Structure Plan area. The ecological works for this project span August 2016 to September 2018. Initially, all watercourses were classified in accordance with definitions in the Proposed AUP but the classifications have since been revised and classified under the revised definitions contained in the Auckland Unitary Plan Operative in part (AUP OP) (i.e. ephemeral, intermittent, permanent) (Appendix I).

The stream assessment was repeated on 11 May and 23 August 2018, during which the presence and extent of water was noted, and measurements and reference photos taken. The quality of the instream habitats and notes on the riparian and catchment information were also recorded. Habitat characteristics were recorded including riparian vegetation, aquatic habitat, as well as the presence of continuously flowing water. Watercourse classifications are shown in Figure 6.2.

To ensure consistency between Bioresearches and Auckland Council's watercourse classifications, maps were compared with those produced by Morphum Environmental Ltd. for Auckland Council in January to March 2018. At a meeting with Colleen Brent (Stormwater Specialist, Waterways Planning, Auckland Council) on 6 June 2018, minor discrepancies were discussed—most of which were the result of Morphum Environmental's modelled transition points, compared to Bioresearches ground-truthed assessment. Following this meeting, Council Ecologists accompanied Bioresearches on site (23 August 2018) to discuss any further discrepancies. Auckland Council are now in agreement with Bioresearches watercourse classifications, which provide an accurate reflection of the watercourses present and their classifications within the proposed NWSP area. The streams, as classified, and agreed are shown in Figure 6.2 below.

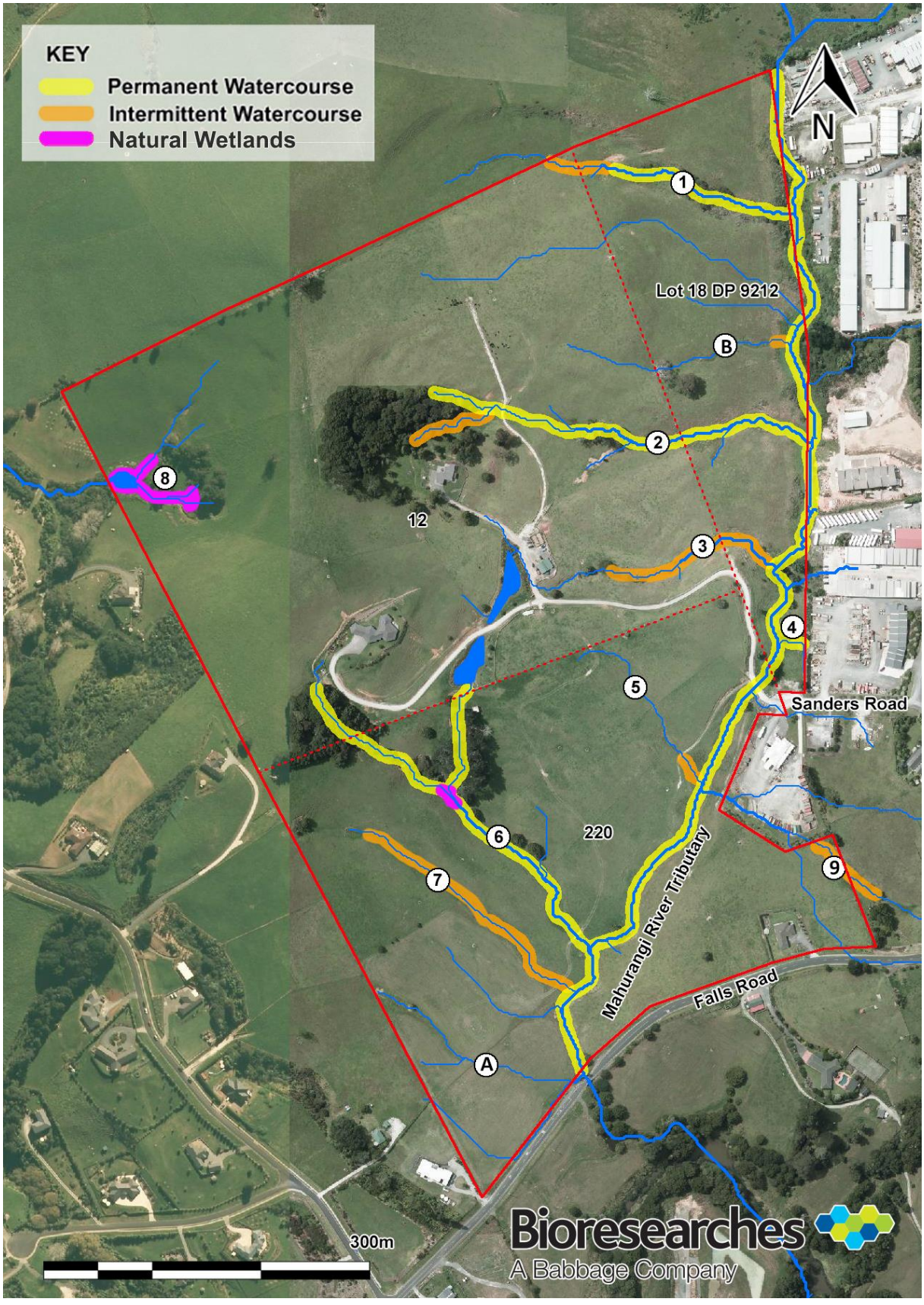

Figure 6.2. Overview map showing watercourse classifications and locations of main wetlands.

The presence of watercourses at the subject site does not preclude future development but since *"new reclamation or drainage, including filling over a piped stream"* (including intermittent and permanent streams) is a non-complying activity (AUP Op, E3.4.1. A49) a resource consent would be required for any in-stream works. The AUP Op requires that "*permanent loss* [of watercourses] *is minimised and significant modification or diversion of lakes, rivers, streams and wetlands are avoided",* where practicable. Where adverse effects cannot be *"avoided, remedied or mitigated, it may be appropriate that the residual adverse effects be offset by providing environmental benefits either onsite or offsite*" (AUP Op, E3.1).

6.2.3 Wetland Identification

A number of wetlands have been identified in the proposed WNSP area and the extents are shown in Figure 6.3 Wetlands were delineated using the following methods, adapted from James (2014):

- Draft maps of wetland boundaries were created from satellite images.
- Ground surveys focussed on assessing the dominance of wetland plants, as vegetation is the best indicator to assess wetland boundaries and considering topography (e.g. presence of a clear bank edge). It is recognised that variability in the edge extents of the wetlands would vary with season and that this delineation exercise was undertaken mid-May when the ground was saturated.
- The extents of the wetlands were then mapped.

All the wetlands identified within the proposed WNSP area were highly modified (induced/ naturalised) or artificial due to livestock access (e.g. trampling, grazing) and the vegetation in all wetlands is dominated by exotic plants.

A number of the streams also contained areas of degraded wetland margins. Namely; Watercourses 1, 3 and 6 (Figure 6.2). It is of Bioresearches opinion that these wetland margins have been induced by farming practices (i.e. cattle access) and rather they represent pugged floodplains, as such they are artificial in nature. It is considered that if the riparian margins of these areas were planted and fenced then these areas would dry up considerably, a defined channel would form, and no induced wetland margin would exist.

Aerial photographs of all identified wetlands are provided below (Figures 6.4 – 6.8).

Figure 6.3. Extent and location of wetlands within the proposed NWSP area.

Figure 6.4.

Figure 6.5.

Figure 6.6.

Figure 6.7.

Figure 6.8.

6.2.4 Watercourse Enhancement Opportunities

In enhancing freshwater systems there is a need to consider both ecology and hydrology in order to achieve natural and potentially enhanced form and function. This is part and parcel of integrated management. For the proposed WNSP area, the generally poor-quality streams would be subject to riparian planting and bio-engineering techniques that would aim to address issues of sustainability, hydro-modification, aesthetics and biodiversity, both in the aquatic environment and its immediate surrounds. Geotechnical investigations of the land surrounding intermittent watercourses indicate it is unstable and highly prone to erosion. Retention and enhancement of the highest aquatic ecological habitat will be prioritised. Enhancement opportunities include re-contouring the land to stabilise the soil. This approach recognises and aligns with the visions, objectives and policies in the Auckland Unitary Plan Operative in Part and Auckland Council's Indigenous Biodiversity Strategy, and specifically aligns with recommendations in the Draft Strategic Plan for Auckland's Urban Ngahere (forest) for the management and greening of the regions watercourses in urban Auckland.

Some of the enhancement techniques being considered include:

Boulder clusters – large boulders placed in the stream bed. Boulders placed in isolation or in clusters in the stream bed provide cover and velocity shelters for fish and other aquatic organisms (e.g. invertebrates). Strategic use of boulders in a stream bed is an effective and simple way of improving habitat.

Spur dikes, Vanes and other rock deflectors – extend away from the bank into the watercourse and redirect flow. They are usually set to deflect flows away from the bank and they create changes in hydrology and velocity (e.g. eddies and pools) and increases in surface area which enhance instream habitat.

Rock vanes are usually elongated rock prisms with a triangular cross section, which are placed at strategic locations to deflect or redirect impinging flow away from a bank. The vanes are usually orientated in an upstream direction at roughly a 30^{o} angle with the bank. Cross vanes serve a similar purpose but extend from both banks and V upstream; they deflect the current into the centre of the stream. Rock vanes and other deflectors are an environmentally sensitive alternative to bank armouring.

Rock riffles – constructed rock cascades that create habitat and dissipate energy and stop down cutting.

Cobble or rock substrate – Large cobbles, 120-150 mm across, are stable and form numerous crevices and gaps between stones which aquatic insects and native fish use as habitat. Stream beds with cobble or rock provide some of the highest quality aquatic habitat for stream life, provided the siltation is not excessive and fills the crevices. Boulders, greater than 250 mm and small cobbles 60-120 mm also provide good habitat.

Cobble floodways – the use of cobble in flat area adjacent to the channel. Cobble floodways in flat areas that have frequent high-water inundation can provide important breeding habitat for native fish, providing the area is well shaded or has over hanging marginal vegetation from the banks.

Root wads or large woody debris – embedded into the bank at water level. Large woody debris structures or a root ball/ root wad including the lower trunk of a tree provide good aquatic habitat, bank protection and velocity attenuation. Large woody debris structures provide variation in flow direction and create natural structures in the stream. Using existing on-site trees that would otherwise be removed is desirable. The trunk is cut above the base and the root ball and lower section of the trunk is laid or embedded into the channel edge.

Vegetated floodways – confining the floodwaters to a broad vegetated floodway. Developing a bank slope or terraces that would not normally be inundated by floodwater, and can therefore support vegetation, is a useful technique that reduces high floodwater velocity by allowing access to a flood attenuation area, but for most of the year providing habitat and recreational opportunities.

Live siltation – installing a living or non-living bushy system at the water's edge. Live siltation is intended to increase the roughness at the stream edge, encouraging deposition and reducing bank erosion. The roots and branches are imbedded into the bank and not only reinforce the bank but provide habitat for aquatic biota.

Erosion control blankets (ECB) – straw and coconut fibre ECBs placed on the banks. Erosion control blankets made with straw or coconut fibre can be used to protect stream banks above either rock armour, logs or other protection placed at the toe of the bank. ECRs can quickly provide natural looking banks. The use of live staking of suitable stems and insertion of seeds and plants speeds the process of stabilisation and naturalisation of the banks and can quickly provide edge cover and edge shading for stream fauna.

Living walls – Mulch, seeds and plants incorporated into vertical substrate. Mulch and vegetation included in mechanically stabilized earth (MSE) can provide a living wall on the banks of the stream. This is particularly effective to meet the requirement for retaining as well as natural habitat.

Culvert designed to allow fish passage – all culverts should follow the Auckland Council guidelines for effective fish passage (ARC, 2000; Franklin *et al.,* 2018). General guidelines for fish passage recommend culverts should match the natural conditions, maintain natural stream alignment and gradient, if possible should be greater than the natural width of the stream bed (where it intersects with the culvert), maintain a continuous path with water velocities less than 0.3 metres per second and retain natural stream substrate within the culvert. Arch culverts are preferred as they do not result in damage to the existing stream bed during installation.

Inanga spawning – A review of the Auckland Council GeoMaps inanga (*Galaxias maculatus*) spawning overlay indicated that the watercourses within the SP area are unlikely to be important for spawning (neither actual or potential spawning areas), probably due to the distance of the site from the coast (i.e. outside of the freshwater-saltwater influence). However, we recognise that the watercourses (particularly the Mahurangi Tributary) provide important for spawning sites for other galaxid fishes and the protection and planting of riparian margins and wetlands would contribute to spawning habitat creation/ improvement.

6.3 SUMMARY OF THE ECOLOGICAL VALUES AND ASSESSMENT OF EFFECTS

In general, the ecological values across the northern, eastern and southern properties within Warkworth North Structure Plan area are of low to moderate value. The reasoning being that the land use has been intensively farmed and much of the vegetation and habitat is heavily degraded. The vegetation values are restricted to two relatively small patches of native forest on Stubbs Farm (220 Falls Road & 12 Sanderson Road) and a strip of riparian vegetation along the tributary of the Mahurangi River at 223 Falls Road. These do provide ecological value in the context of the wider surrounding landscape as habitat and food resources for native fauna (e.g. birds and lizards) and the two small patches of native forest meet Significant Ecological Area (SEA) criteria under the AUP Op based on our application of the criteria. In general, although these two bush patches support low species diversity, two specimens of kawaka (*Libocedrus plumose*) with a conservation threat status of *At Risk - Naturally Uncommon* (de Lange *et al*. 2013) are present on Stubbs Farm. The remaining vegetation includes young regenerating plantings along riparian margins of the Mahurangi River tributary, which is not legally protected, and isolated exotic (occasional native) trees growing in grazed paddocks. All areas of significant vegetation will be retained as part of the project, either as areas to vest as public land – Auckland Council Parks or Healthy Waters; or the areas will be subject to protective covenants at the time of subdivision.

The avifauna of the site is represented by common native and exotic birds, and no threatened species are likely to utilise the site. Native lizards may be present, but these are likely to exist at low abundance given the land use history (significant habitat fragmentation) and presence of mammalian predators (particularly rodents, hedgehogs, mustelids and possums).

With respect to watercourses, the ecological value of those on site vary considerably, and outside of the channel of the main tributary of the Mahurangi River, all watercourses are heavily influenced by livestock. It is acknowledged that the watercourses have potential value, and all those with high potential value will be avoided, restored and protected.

The project will result in some minor loss of terrestrial vegetation and wildlife habitat (i.e. loss restricted to isolated exotic trees in grazed pasture), the loss (entire or partial) of intermittent watercourses, and conversion of a peri-urban/ rural landscape into a high density urban-scape in accordance with the Future Urban zoning of the land. The loss of some intermittent watercourses cannot be avoided, due to engineering or planning constraints. The assessment of effects identified that the loss of intermittent watercourses results in more than minor effects in the absence of mitigation and/ or compensation. However, where appropriate mitigation and/ or compensation is implemented the effects on intermittent streams would be considered less than minor (aquatic offsetting details are described *Section 7*). Specific measures will be determined at subdivision consent and/ or earthworks consent stages when the most appropriate outcomes will be known and able to be secured by way of resource consent conditions.

The effects, specifically the loss of intermittent watercourses, need to be weighed up when considering the balance between compact urban form and environmental protection, i.e. considering all provisions of the Unitary Plan holistically. This is specifically acknowledged in Chapter E3 Background where the Plan states that *"…there is a balance to be struck between the need to provide for the ongoing growth of urban Auckland, including the requirements of infrastructure, and the protection, maintenance and enhancement of lakes, rivers, streams and wetland. It is important that development occurs in a sustainable manner which should involve, where practicable, the retention and enhancement of lakes, rivers, streams and wetlands*". Under the current proposal, all of the highest value watercourses would be avoided, enhanced and protected, and mitigation provided (e.g. enhancement planting, land covenants, long-term weed and mammalian predator control, enhancement and protection of watercourses, enhancement of hydrological function of watercourses, restoration of natural wetlands and streetscape planting and natural restoration of swales), to reduce ecological impacts as far as practicable.

The project recognises that the ecological features of the site hold value but that in its current state, the values are relatively low. In particular, the watercourse values are significantly below their potential value given livestock access causing bank erosion, nutrification, dechannelising of streams, and reducing the ability of the streams to provide instream habitat for native fish and stream invertebrates. The amenity value of these areas is also low as vegetation has not been able to grow along the riparian margins. In addition, water catchment filtering is reduced and water quality input into the Mahurangi negatively affected. Restoration of watercourses through riparian planting, fencing, and the use of structures like arched culverts to reduce alterations to the streambed, would improve the water quality and instream habitat.

Some loss of lower quality ephemeral and intermittent watercourses will be required to accommodate the objectives and policies relating to urban development in the AUP. Activities undertaken in, on, or within the bed of ephemeral watercourses are permitted under the AUP, where the activities comply with standards E3.6.1.1., which is the case with respect to reclamation of ephemeral watercourses within the site.

Potential effects on hydrological and water quality aspects can be mitigated and managed through stormwater management practices (e.g. stormwater management area (SMAF) controls) and mechanisms. Stormwater quality treatment is proposed on high-use roads with full treatment proposed in accordance with E9 of the AUP OP. Local roads are proposed to have partial treatment through the provision of tree pits which are used primarily for stormwater retention. Enhancement of the remaining watercourses will also mitigate stormwater effects.

The two largest patches of vegetation will be retained and enhanced through weed management, pest control, fencing, vesting as public land or land covenanting and infill planting, as well as connections through the creation of riparian corridors along the tributaries of the Mahurangi River. The retention and protection of vegetation as part of the structure plan will enhance the ecological value of the site within the wider landscape by providing higher quality habitat and food resources for native wildlife (e.g. birds, lizards and terrestrial invertebrates). The vegetation also provides a buffer for the headwaters of tributaries flowing into the Mahurangi River.

All stream crossings will be engineered to minimise the impact on watercourses (e.g. arch culverts) and allow for fish passage (in accordance with Auckland Council TP131 and NIWA Fish Passage guidelines).

All information to date indicates that the proposed zoning is unlikely to result in more than minor effects, and any minor effects could be mitigated to an acceptable level. In addition, to this conclusion an Ecological Impact Assessment (EcIA) was undertaken as per the guidelines set by the Environment Institute of Australia and New Zealand (EIANZ) and is provided below.

6.4 Ecological Impact Assessment (EcIA)

6.4.1 Assigning Ecological Value

The guidelines indicate that the first stage of the assessment is to identify the value of an ecological feature (habitat or species) (Table 6.2), the magnitude of change to an ecological feature as a result of the Structure Plan Change is then determined for the purpose of assessing actual and potential effects of the Project.

Table 6.2. Assessment of value (significance) against criteria presented in the AUP Op

Criteria	Meets Criteria
Auckland Unitary Plan Operative in Part	
- **Representativeness**	
Is an example of an indigenous ecosystem (including both mature and successional stages) that makes up part of at least 10% of the natural extent of each of Auckland's original ecosystem types in each ecological district of Auckland (starting with the largest, most natural and intact, most geographically spread) and reflecting the environmental gradients of the region. AND Is an example of an indigenous ecosystem (including both mature and successional stages), or habitat of indigenous fauna, that is characteristic or typical of the natural ecosystem diversity of the ecological district and/or Auckland OR is a habitat that is important to indigenous species of Auckland, either seasonally or permanently, including for migratory species and species at different stages of their life cycle (and including refuges from predation, or key habitat for feeding, breeding, spawning, roosting, resting, or haul out areas for marine mammals).	No (Not significant)
- Threat status and rarity	
Is an indigenous habitat, community or ecosystem that occurs naturally in Auckland and has been assessed by the Council (using the IUCN threat classification system) to be threatened based on evidence and expert advice (including Holdaway *et al*. In press. Status assessment of NZ naturally uncommon ecosystems) Is a habitat that supports occurrences of a plant, animal or fungi that has been assessed by the Department of Conservation and determined to have a national threatened conservation status (acutely or chronically) including Critical, Endangered, Vulnerable, Declining, Serious Decline, Gradual Decline and Recovering (see de Lange et al 2009) OR assessed by the Council to have a regional threatened conservation status including Regionally Critical, Endangered and Vulnerable and Serious and Gradual Decline (see Stanley *et al*. 2005) Is indigenous vegetation or habitat of indigenous fauna that occurs in Land Environments New Zealand Category IV where less than 20% remains. Is any indigenous vegetation or habitat of indigenous fauna that occurs within an indigenous wetland or dune ecosystem. Is a habitat that supports an occurrence of a plant, animal or fungi that is locally rare and has been assessed by the Department of Conservation and determined to have a national conservation status of Naturally Uncommon, Range Restricted or Relict.	Yes (Significant)
- Diversity	
Is any indigenous vegetation that extends across at least one environmental gradient resulting in a sequence that supports more than one indigenous habitat, community or ecosystem type e.g., an indigenous estuary to an indigenous freshwater wetland. Supports the expected ecosystem diversity for the habitat(s). Is a habitat type that supports a typical species richness or species assemblage for its type.	No (Not significant)
- Stepping stones, migration pathways and buffers	
Is an example of an indigenous ecosystem, or habitat of indigenous fauna that is used by any native species permanently or intermittently for an essential* part of their life cycle (e.g., known to facilitate the movement of indigenous species across the landscape) and therefore makes an important contribution to the resilience and ecological integrity of surrounding areas.	Yes (Significant)

Is an example of an ecosystem, indigenous vegetation or habitat of indigenous fauna, that is immediately adjacent to, and provides protection for, indigenous biodiversity in an existing protected natural area (established for the purposes of biodiversity protection) or an area identified as significant under the 'threat status and rarity' or 'uniqueness' criteria. This includes areas of vegetation (that may be native or exotic) that buffer a known significant site. It does not include buffers to the buffers Is part of a network of sites that cumulatively provide important habitat for indigenous fauna or when aggregated make an important contribution to the provision of a particular ecosystem in the landscape Is a site which makes an important contribution to the resilience and ecological integrity of surrounding areas	

6.4.2 Assessing magnitude of effects

The magnitude of predicted effects is assessed based on the scale of actual and potential effects and the degree of change that is expected. Based on the assessor's knowledge and experience the magnitude of effects on the Project Area's ecological values was given a score ranging from 'Negligible' to 'Very High' (refer to Table 6.3).

Table 6.3. Criteria for describing the magnitude of effects.

Magnitude	Description
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the "no change" situation; and/or having negligible effect on the known population or range of the element/feature.
Low	Minor shift away from baseline conditions. Change arising from the loss/ alteration will be discernible but underlying character/ composition/ attributes of baseline condition will be similar to predevelopment circumstances/ patterns; and/ or having a minor effect on the known population or range of the element/feature.
Moderate	Loss or alteration to one or more key elements/ features of the baseline conditions such that post development character/ composition/ attributes of baseline will be partially changed; and/or loss of a moderate proportion of the known population or range of the element/feature.
High	Major loss or major alteration to key elements/ features of the baseline (predevelopment) conditions such that post development character/ composition/ attributes will be fundamentally changed; and/ or loss of a high proportion of the known population or range of the element/feature.
Very High	Total loss or very major alteration to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will

	be fundamentally changed and may be lost from the site altogether; and/or loss of a very high proportion of the known population or range of the element/ feature.

Table 6.4 presents a summary of the assessment and a conclusion as to whether an impact in the absence of mitigation would have an impact that could be considered more than minor.

Table 6.4. Assessment of the significance of Project impacts based on calculated ecological value and magnitude of the effect

Ecological Feature	Ecological Value	Magnitude of Effect	Assessment of Impact, without mitigation
Terrestrial vegetation	Significant	Negligible	Less than minor
Avifauna	Not significant	Negligible	Less than minor
Herpetofauna (lizards)	Not significant	Negligible	Less than minor
Freshwater (streams)			
- Ephemeral	Not significant	Low	Less than minor
- Intermittent	Significant	Moderate	More than minor
- Permanent	Significant	High	More than minor
- Wetland	Significant	High	More than minor

6.4.3 Cumulative ecological effects within the wider catchment

Minor loss of terrestrial vegetation and wildlife habitat would occur as a result of the project. In addition, the loss (entire or partial) of intermittent watercourses and ecological effects related to the conversion of a peri-urban/ rural landscape into a high density urban-scape are expected. The assessment of effects identified that the loss of intermittent watercourses and the modification/ enhancement of permanent watercourses and wetlands would result in more than minor effects in the absence of mitigation. However, where mitigation is implemented the effects on permanent streams and wetlands could be considered less than minor. The effects, specifically on the loss of intermittent watercourses, need to be weighed up when considering the balance between compact urban form and environmental protection i.e. considering all provisions of the Unitary Plan holistically. This is specifically acknowledged in Chapter E3 Background where the Plan states that *"…there is a balance to be struck between the need to provide for the ongoing growth of urban Auckland, including the requirements of infrastructure, and the protection, maintenance and enhancement of lakes, rivers, streams and wetland. It is important that development occurs in a sustainable manner which should involve, where practicable, the retention and enhancement of lakes, rivers, streams and wetlands*". Under the current proposal, all the highest value watercourses would be avoided, enhanced and protected, and mitigation provided (e.g. enhancement planting, land covenants, long-term weed and mammalian predator control, enhancement and protection of watercourses, enhancement of hydrological function of watercourses, restoration of natural wetlands and streetscape planting and natural restoration of swales), to reduce ecological impacts as far as practicable.

The project recognises that the ecological features of the site hold value but that in its current state, the values are relatively low. In particular, the watercourse values are significantly below their potential value given livestock access causing bank erosion, nutrification, dechannelising of streams, and reducing the ability of the streams to provide instream habitat for native fish and stream invertebrates. The amenity value of these areas is also low as vegetation has not been able to grow along the riparian margins. In addition, water catchment filtering is reduced and water quality input into the Mahurangi negatively affected. Restoration of watercourses through riparian planting, fencing, and the use of structures like arched culverts to reduce alterations to the streambed, would improve the water quality and instream habitat.

Some loss of lower quality ephemeral and intermittent watercourses will be required to accommodate the objectives and policies relating to urban development in the AUP. Activities undertaken in, on, or within the bed of ephemeral watercourses are permitted under the AUP, where the activities comply with standards E3.6.1.1., which is the case with respect to reclamation of ephemeral watercourses in proposed NWSP area.

Potential effects on hydrological and water quality aspects can be mitigated and managed through stormwater management practices (e.g. stormwater management area (SMAF) controls) and mechanisms. Enhancement of watercourses will also mitigate stormwater effects.

The two largest patches of vegetation would be retained and enhanced through weed management, pest control, fencing, land covenanting and infill planting, as well as connections through the creation of riparian corridors along the tributaries of the Mahurangi River. The retention and protection of vegetation as part of the structure plan will enhance the ecological value of the site within the wider landscape by providing higher quality habitat and food resources for native wildlife (e.g. birds, lizards and terrestrial invertebrates). The vegetation also provides a buffer for the headwaters of tributaries flowing into the Mahurangi River.

All stream crossings will be engineered to minimise the impact on watercourses (e.g. arch culverts) and allow for fish passage (in accordance with Auckland Council TP131 and NIWA Fish Passage guidelines).

6.4.4 Summary

In general, the wildlife values across the northern, eastern and southern properties within Warkworth North Structure Plan area are like or of lower value to those described for Stubbs Farm (see *Section 2: Stubbs Farm* of this report). That is, most of the vegetation is of low to moderate botanical value but does provide ecological values in the context of the wider surrounding landscape as habitat and food resources for native fauna (e.g. birds and lizards).

This preliminary assessment indicated that the proposed zoning is unlikely to result in more than minor effects, and any minor effects could be mitigated for to an acceptable level.

With respect to watercourses, any degradation, reclamation or culverting of intermittent or permanent watercourses would be, in the first instance, avoided in accordance with Objectives E3.2. and Policy E3.3 (1) of the AUP Op. Where degradation, reclamation or culverting of intermittent and

permanent watercourse cannot be avoided, due to engineering or planning constraints, the adverse ecological effects would be appropriately mitigated or compensated for through offsetting in accordance with Policy E3.3 (4) of the AUP Op.

Where future development of these properties is proposed, the findings of this desktop review would require corroboration through detailed ecological investigations to categorically highlight ecological effects and mitigation requirements.

6.5 DELIVERY OF ECOLOGICAL ENHANCEMENT AND RESTORATION OUTCOMES

The existing ecological connections within the wider landscape are poor or lacking altogether due to historic land-use activities (e.g. intensive farming). It is noted that without urban development the existing farming activities can continue.

The Mahurangi River and its tributaries provide a potential network of interconnected watercourses, riparian margins and bush clad areas where restoration initiatives are enacted, achieved and maintained. This is proposed for the NWSP area, where ecological corridors will form connections between watercourses and proposed open space zones (e.g. future parks and reserves).

6.5.1 Proposed freshwater enhancement:

- Identification of watercourse values has been undertaken and the most valuable watercourses and those with the greatest potential for enhanced ecological outcomes have been protected and enhanced.
- Protection and enhancement of watercourses are far as practicable, with mitigation implemented to compensate for any habitat loss.
- Removal of fish barriers through removal and/ or retrofitting culverts. Ensure the upstream habitats are restored and protected.
- Protection and enhancement of the most natural wetlands is proposed. Wetland loss is minimised to the greatest extent practicable.
- Riparian buffers (minimum average of 10 m on each bank) on identified/ remaining watercourses to enhance water filtration and prevent erosion.

6.5.2 Proposed terrestrial enhancement:

- Weed and pest mammal control through all protected bush and revegetation areas (e.g. riparian margins)
- Use of indigenous trees and vegetation in street scape plantings and open space zones, and to form ecological connections with riparian margins and watercourse networks.
- Focus on diversity of plant species to encourage more natural habitats rather than monocultures.

- Ensure vigilance and management of pests and diseases, notably kauri dieback and myrtle rust. Mitigation through a detailed management plan that recommends using the optimal mix of species and where possible disease resistant variants of susceptible species in new plantings, and by responding quickly and effectively to new and emerging threats.

6.5.3 Integrated Planning and Ecosystem Enhancement Opportunities

In its existing state the habitat within the proposed NWSP area is managed agricultural land, which is heavily degraded and lacks functional ecological connections both within the site boundaries and within the wider landscape. Under the proposed NWSP change, a large area (c. 10 ha) of 'Open Space' is proposed, of which mature bushland and replanted riparian margins comprises approximately 75% of this total area. The remaining area of open space will represent open parkland for recreational activities. The vegetated areas would be enhanced (planting, weed management, pest-control) and protected in perpetuity (e.g. vested with Council/ protected in public ownership), and would provide ecological linkages between the Mahurangi River tributary and the areas of established native bush (Figures 6.9 – 6.11). On a landscape scale, the bush-clad areas within the proposed NWSP area would provide a noticeable network of ecological corridors and offer stepping stones and migration pathways for local wildlife (Figure 6.11).

In addition, native street scape planting is proposed along most road networks passing through the proposed NWSP area. Approximately, 4.7 km of road is proposed, and street scape trees will contribute further ecological linkages, particularly for birds and flighted invertebrates, throughout the site. Street trees and vegetation, and native planting of swales (details provided elsewhere in the document), will provide direct connections between the two larger protected bush areas and the riparian margins of all retained watercourses.

The project will balance environmental values with urban design by including street scape planting, riparian protection areas, improvements to stream values (water quality, fish habitat and fish passage – details provided elsewhere in the document), and protected bush lots in the design. This approach recognises and aligns with the visions, objectives and policies in the Auckland Unitary Plan Operative in Part, Draft Strategic Plan for Auckland's Urban Ngahere (forest), and Auckland Council's Indigenous Biodiversity Strategy.

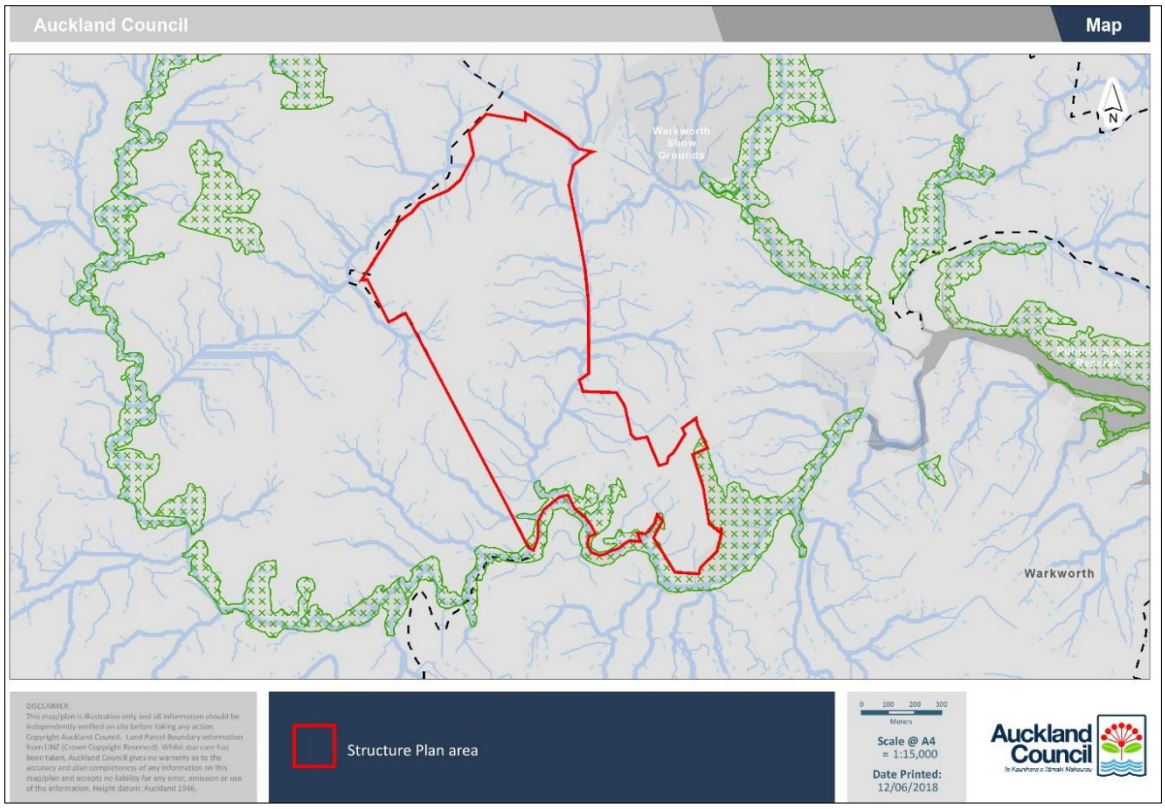

Figure 6.9. Proposed NWSP area and existing Significant Ecological Areas – Existing state

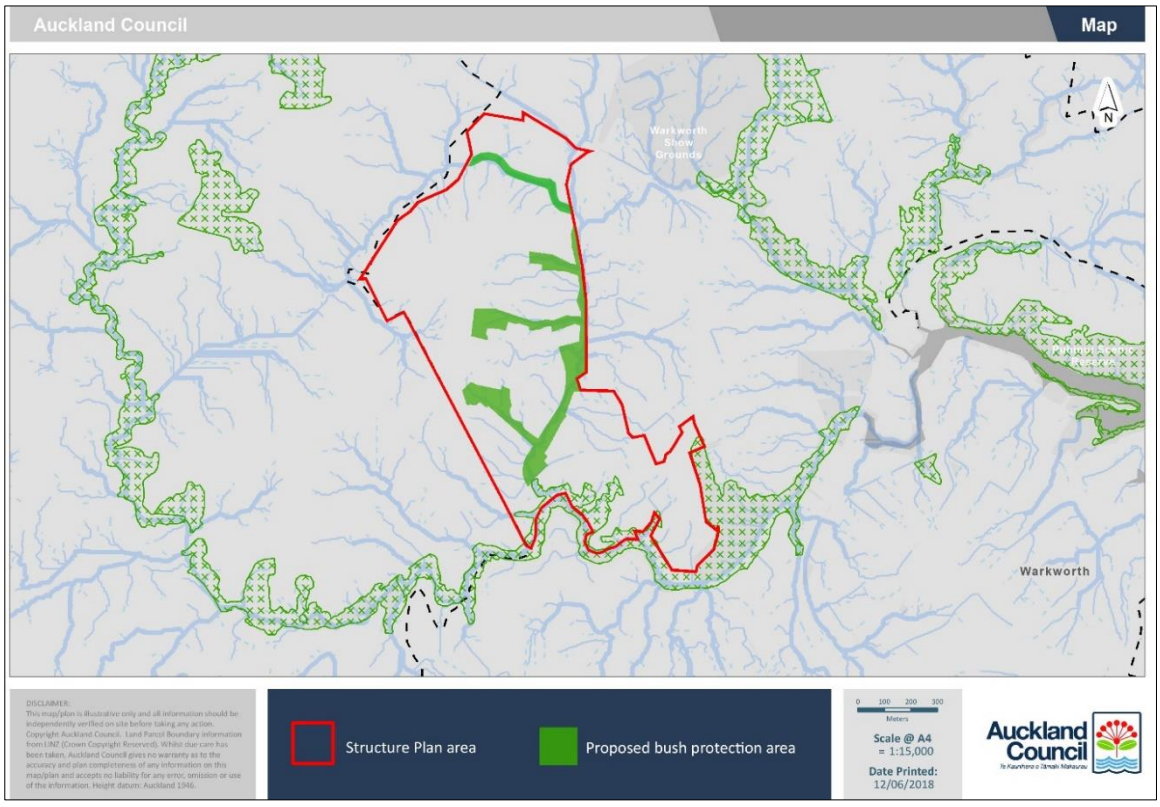

Figure 6.10. Proposed NWSP area, existing Significant Ecological Areas and proposed green corridors (excluding street scape planting).

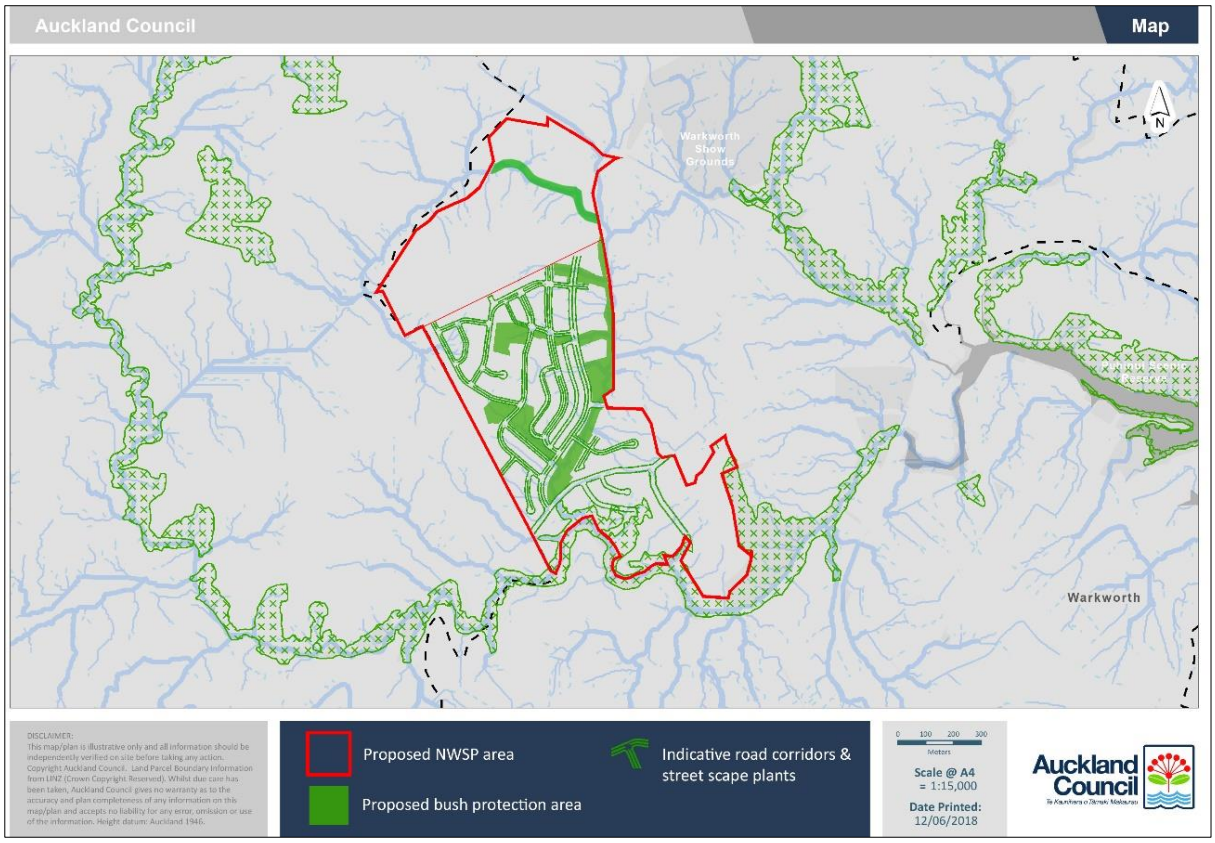

Figure 6.11. Concept plan of the proposed NWSP area, Significant Ecological Areas (SEAs) and indicative road network within the Stubbs Farm/Falls Road development with associated street scape vegetation and swale plantings.

Ecological restoration and green corridor connections within proposed urban growth and development areas is an initiative consistent with the vision expressed for future Auckland within the principles of the Auckland Unitary Plan Operative in part, Auckland Council's Indigenous Biodiversity Strategy and the Strategic Plan for Auckland's Urban Ngahere (forest). Areas of green open space, riparian margins of streams, protected forest, street trees (street scape planting), residential gardens, and storm water devices (rain gardens, ponds) all contribute the green network, and these features would be integrated into the urban design within the proposed NWSP area. Open space, protected parkland and street scape plants are expected to cover approximately > 10% of the land area within the NWSP area under the current proposal. The extent of this 'green space', with the addition of appropriate pest mammal and weed management regimes, would considerably improve the ecological state of the land (intensively managed and degraded farmland). A green network of corridors along roadsides would connect the more significant 'fingers' of bushland that extend into the site from the Mahurangi River tributary on the eastern boundary, providing fauna and flora dispersal pathways throughout the landscape.

Figures 6.12 shows the current state of the protected areas (Significant Ecological Areas, habitat protection areas [covenants]) present in the North Warkworth landscape and the location of the proposed NWSP area, and Figure 6.13 provides a visual concept of the green network within the proposed NWSP area and its position relative to other local SEAs.

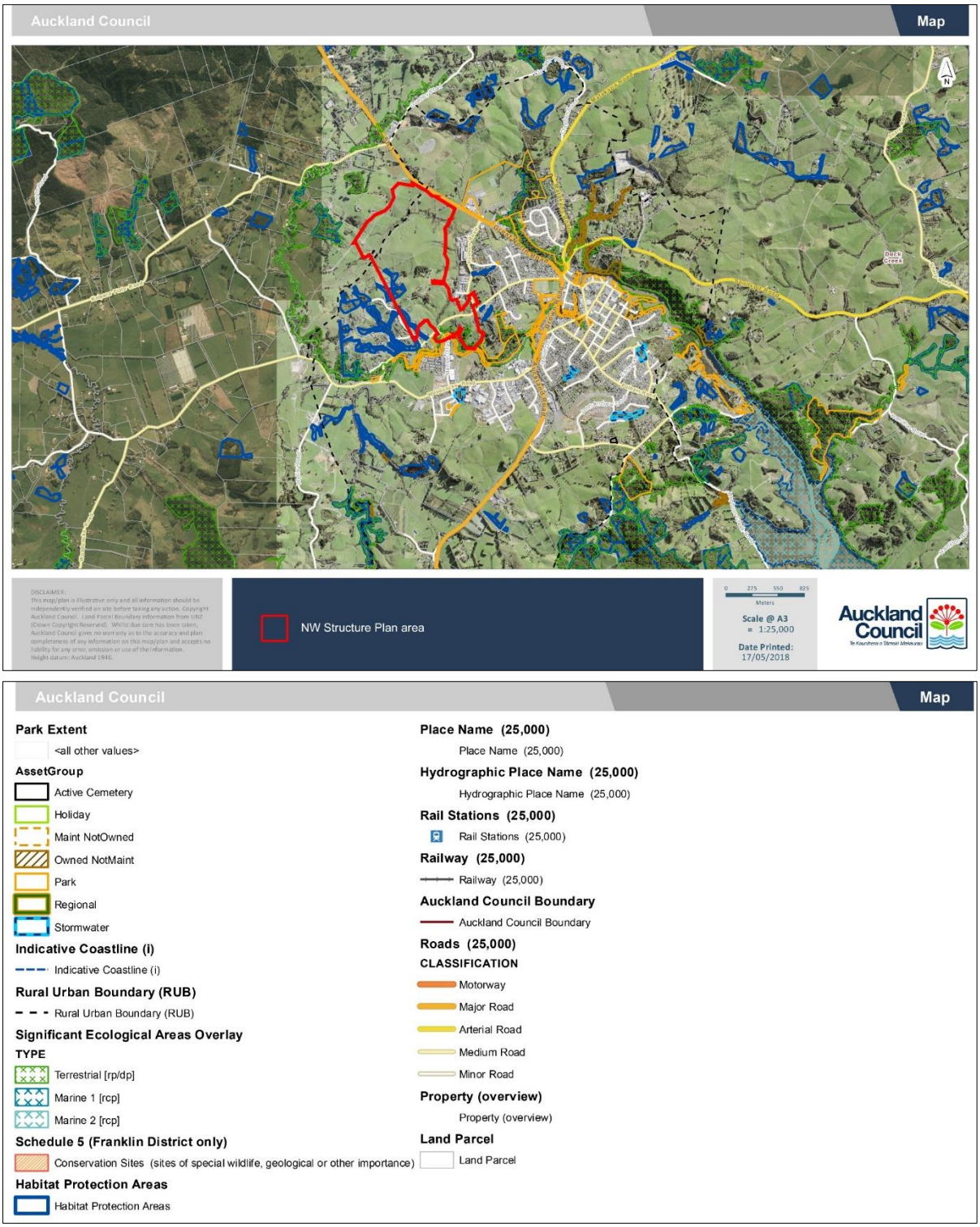

Figure 6.12. Habitat Protection Areas (covenants) of North Warkworth (map provided by AC)

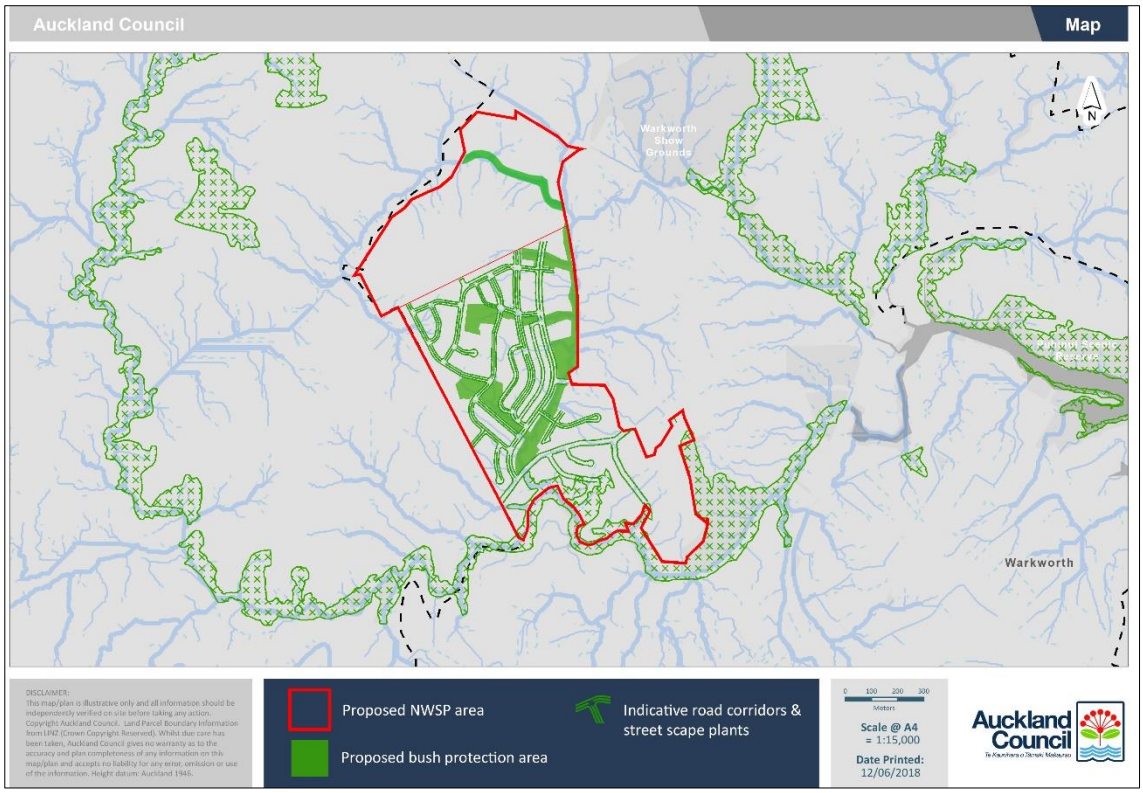

Figure 6.13. Concept plan of the Proposed NWSP area, Significant Ecological Areas (SEAs) and indicative road network with associated street scape vegetation.

6.6 REFERENCES

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7 STUBBS FARM AQUATIC HABITAT OFFSETTING

The highest ecological valued aquatic habitat will be retained and enhanced, namely all identified permanent watercourses (Figure 7.1), i.e. the main tributary of the Mahurangi River, Watercourse 1, Watercourse 2, Watercourse 6 and additionally Wetland 8 (Figure & 7.2).

Due to engineering or planning constraints (e.g. the Western Collector Road), the proposed development requires five stream crossings (Figure 7.2). As stated previously all culverts will be arch culverts to mitigate adverse ecological effects. It should also be noted that six redundant culverts will be removed and the associated streams daylighted, in particular the crossing over the main tributary of the Mahurangi River (Figure 7.2).

Additionally, due to engineering or planning constraints a number of intermittent watercourses are proposed to be reclaimed, namely Watercourses 3, 7 and 9 (Figure 7.1 & 7.2). The intermittent watercourses that are proposed to be reclaimed all have very low ecological value and are considered to have low ecological potential. This is due to the following: the location of the impacted reach at the very top of the watercourse/ catchment (no upstream connectivity); limited base water flow; and the lack of potential native fish habitat.

Where significant residual adverse effects on aquatic habitat within the Stubbs Farm site cannot be avoided or mitigated, appropriate offsetting will occur in accordance with E3.3.(4) of the AUP Op.

One of the guiding principles of biodiversity offsetting is no net loss: *A biodiversity offset should be designed and implemented to achieve in situ, measurable conservation outcomes than can be reasonably expected to result in no net loss and, preferably, a net gain of biodiversity.* (Guidance on Good Practice Biodiversity Offsetting in New Zealand (GGPBO), 2014).

To achieve 'no net loss' it is recommended that offsetting actions are located as close as possible to the subject site and exchange sites be 'like for like' as reasonably possible. Often where both objectives cannot be met fully a balance or trade-off between the two objectives needs to be considered.

To achieve the first objective, that offsetting actions are located as close as possible to the subject site, it is proposed that onsite offsetting is undertaken. This would entail that the 'like for like' objective is not adhered to in the strictest sense, i.e. the loss of intermittent aquatic habitat would be offset with the enhancement and protection of permanent aquatic habitat.

Although intermittent aquatic habitat and permanent aquatic habitat are not strictly 'like for like', within the Auckland Region these habitats are very similar as they both typically are 'soft bottomed' streams with little or no cobble/ boulder habitat. Additionally, both stream types provide habitat for the same or very similar fauna. This is the case for the Stubbs Farm and Falls Road streams where the two stream types are similar in form and function, and the biodiversity gains and losses are as comparable as possible both in ecological terms and from a conservation-priority perspective.

The GGPBO states as a minimum, it is *good practice* when demonstrating that a biodiversity offset is like for like that no high-value indigenous components or indigenous types should be substituted for other components or types. Again, within the Stubbs Farm and Falls Road, no high-value indigenous components or indigenous types are being substituted.

One of the main concerns with 'like for unlike' or 'out of kind' exchanges is the potential for 'trading down'. With the Stubbs Farm and Falls Road site, intermittent aquatic habitat would be offset with the enhancement and protection of permanent aquatic habitat, which is neither 'trading down' nor 'out of kind'. If the Stubbs Farm and Falls Road offsetting is considered not 'like for like', then at a minimum this offsetting should be considered 'trading up' as the habitats type are similar with the additionality that the permanent streams have a higher habitat richness and permanence of aquatic habitat. Therefore, this proposed offset is in fact a higher value of mitigation being provided in relation to the extent of adverse effect being created thus resulting in 'no net loss'. The GGPBO further states that an overall net gain could be deemed to have been achieved if the biodiversity being lost is of low value and the biodiversity being gained is clearly of a higher value and the amount gained is reasonably of the same or greater magnitude. Consequently, it is considered that in this instance within the Stubbs Farm site the loss of intermittent aquatic habitat can be appropriately offset with the enhancement and protection of permanent aquatic habitat and that potentially there would be a net ecological gain.

To calculate the appropriate amount of offsetting required the SEV/ECR methodology was utilised as in accordance with E3.3.(4) of the AUP OP. It is currently not recommended that intermittent and permanent SEVs are used interchangeably in ECR calculations. However, this is only a recommendation and mainly is in context to the principle of 'like for like'. The 'like for like' concept has been addressed previously and consequently, it is considered that the SEV approach is the most appropriate, as both SEV/ECR models (intermittent and permanent) use the same currency and deal with the same ecological attributes and components.

The following section outlines the offsetting calculations used to demonstrate a not net biodiversity loss using onsite offsetting. Note that a more detailed onsite offsetting plan will be provided to support the resource consent application, once more details regarding road widths and riparian margin widths have been provided.

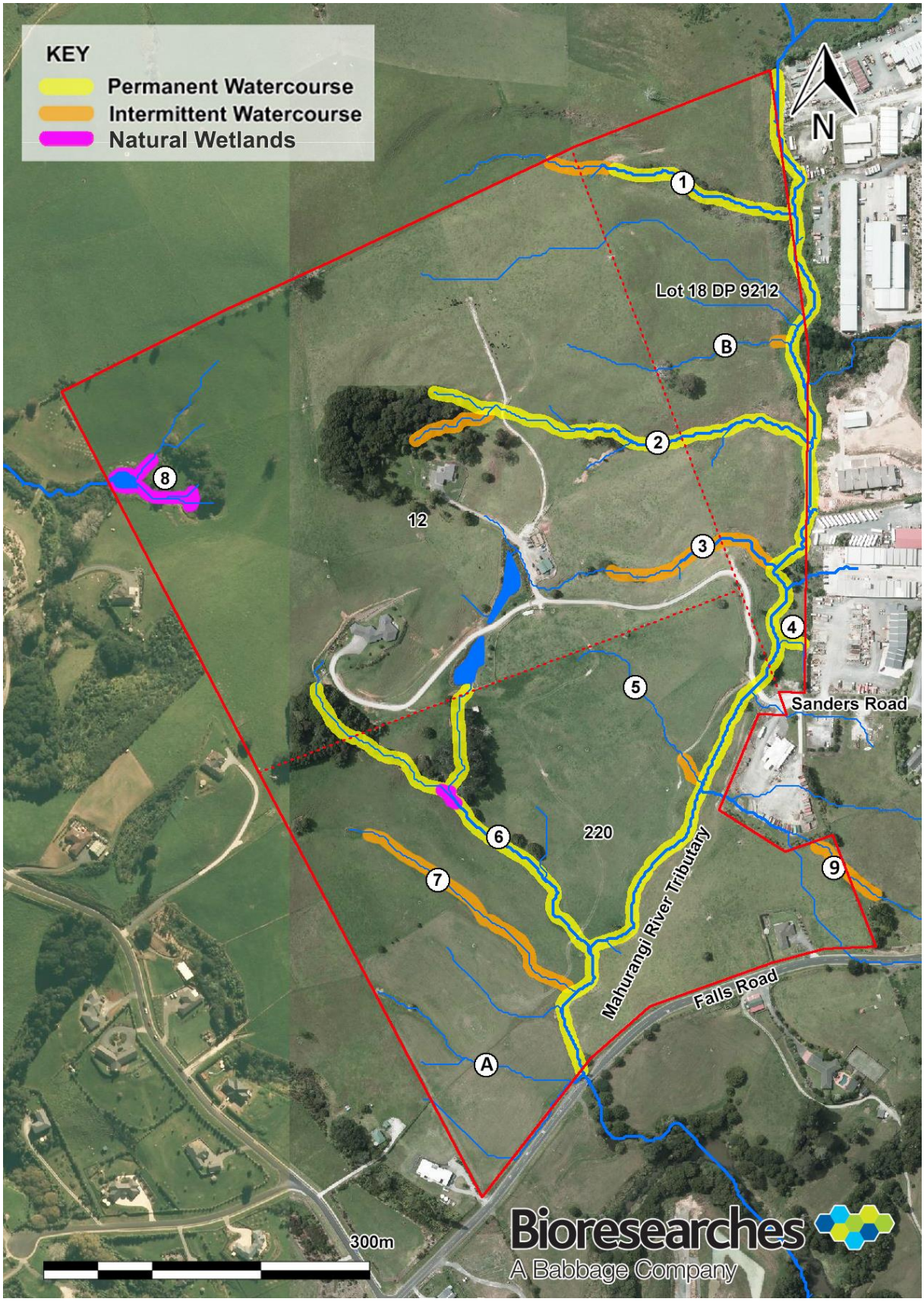

Figure 7.1. Overview map showing watercourse classifications and locations of main wetlands.

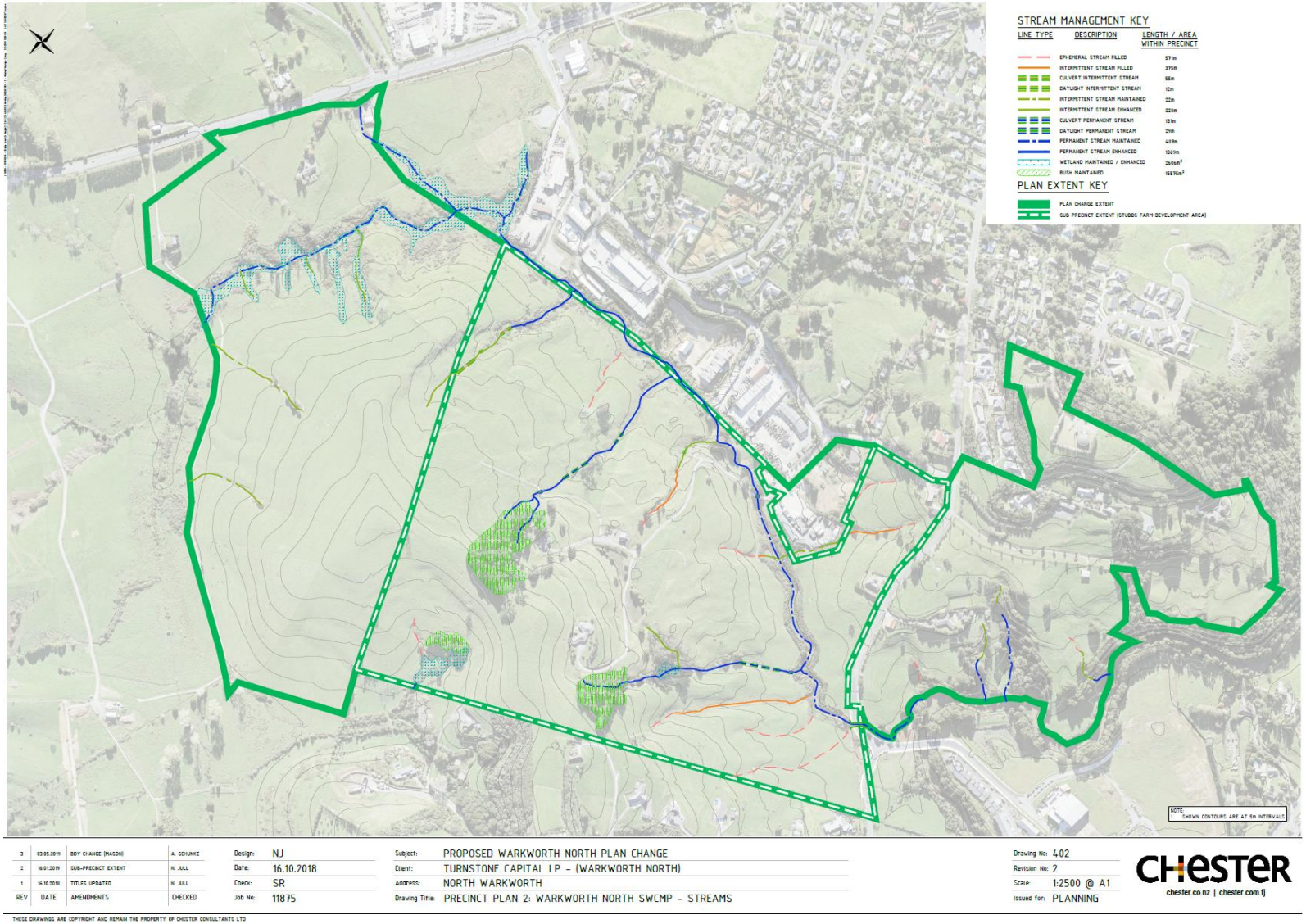

Figure 7.2. Stream Management Plan, produced by Chester.

7.1 OFFSETTING CALCULATIONS

SEVs were undertaken within representative reaches of the main Mahurangi Tributary, Watercourse 2, Watercourse 3 and the upper reach of Watercourse 6 on 15 May 2017.

Watercourses 3, 5, 7 and 9 were of very similar nature and as such the SEV from Watercourse 3 was used as a representative for Watercourses 5, 7 and 9.

Watercourses 1, 2 and the lower reach of Watercourse 6 were of very similar nature and as such the SEV from Watercourse 2 was used as a representative for Watercourse 1 and the lower reach of Watercourse 6.

Stream potentials were calculated on the 'best practice' assumption of 10 m riparian planting and stock exclusion, with the exception of the Main Mahurangi Tributary where the potential riparian planting was reduced on the eastern bank due to the industrial infrastructure currently present. Potential instream habitat enhancement was not included.

Summary SEVs scores, watercourse characteristics (obtained during SEVs), ECR assumptions and additional detailed ECR calculations are presented in the Appendices.

Watercourse 3 will have an approximate stream habitat loss of 42.5 m^2 (85 m length x 0.5 m average width). Watercourse 5 will have an approximate stream habitat loss of 2 m^2 (10 m length x 0.2 m average width). Watercourse 7 will have an approximate stream habitat loss of 70.5 m^2 (235 m length x 0.3 m average width). Watercourse 9 will have an approximate stream habitat loss of 17.2 m^2 (86 m length x 0.2 m average width). Accordingly, the ECR calculations are based on a combined stream habitat loss of 133 m^2 (416 m x 0.318 m) (Impact Site).

Available restoration lengths of Watercourses 1, 2, the lower section of Watercourse 3 and Watercourse 6 do not include sections of proposed crossing or existing wetlands.

Table 7.1 details the ECR calculations.

Table 7.1. ECR calculations for the aquatic habitat loss of Watercourses 3, 5, 7 and 9 within the Stubbs Farm site.

Proposed Activity	Impact Reach					Restoration Reach						
	Length (m)	Average Width (m)	Area (m^2)	ECR	ECR x Area Impacted (m^2)	Restoration Site	Length Available (m)	Average Width (m)	Area Available (m2)	Restoration Length Required to be restored (m)	Length to Restore (m)	Deficit (m)
Reclamation of Watercourses 3, 5,7 & 9	416	0.32	133.12	4.53	603.03	Watercourse 1	118	0.54	63.72	416	118	372.0
	372*	0.32	119.05	4.53	539.31	Watercourse 2	247	0.4	98.8	372.0	247	303.9
	303.9*	0.32	97.24	5.06	492.05	Watercourse 3 (Lower)	83	0.32	26.56	303.9	83	287.5
	287.5*	0.32	91.99	4.53	416.74	Watercourse 6 (Lower)	118	0.4	47.2	287.5	118	254.9
	254.9*	0.32	81.58	13.14	1071.90	Watercourse 6 (Upper)	115	0.4	46	254.9	115	244.0
	244*	0.32	78.07	8.89	694.08	Mahurangi Main Tributary	605	1.5	907.5	244.0	462.7	0.0

* Outstanding amount of stream length not offset for and carried over from deficit cell

From the calculations detailed in Table 7.1, the restoration of 975 m^2 of aquatic habitat from Watercourses 1, 2, the lower section of Watercourse 3, Watercourse 6 and the Main Mahurangi Tributary within the Stubbs Farm site would adequately compensate for the permanent loss of 133m^2 of aquatic habitat from Watercourses 3, 5, 7 and 9.

In regard to length, a total of 416 m is proposed to be reclaimed and 1,144 m is proposed to be restored.

Furthermore, an additional 213.5 m^2 (142.3 m) of the Main Mahurangi Tributary is proposed to be restored.

In regard to the information provided within this report, as a result of the proposed development within the Stubbs Farm site, the overall freshwater system and values within the site will be enhanced and restored. There will be an aquatic biodiversity increase, an enhancement of water quality entering the Mahurangi River and adverse effects on the freshwater ecological values within the site will be appropriately mitigated and / or compensated for.

7.2 REFERENCES

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7.3 APPENDICES

Appendix I: Stream classification under the AUP OP

STREAM DEFINITIONS

Stream or River

A continually or intermittently flowing body of fresh water, excluding ephemeral streams, and includes a stream or modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal except where it is a modified element of a natural drainage system).

Ephemeral reaches

Stream reaches with a bed above the water table at all times, with water only flowing during and shortly after rain events.

A river reach is ephemeral where it meets at least three of the following criteria:

- it lacks a well-defined channel, so that there is little or no ability to distinguish between the bed and banks
- it contains no surface water, if no rain has occurred in the previous 48 hours
- it contains terrestrial vegetation
- there is clearly visible organic debris on its floodplain from flood flows
- there is no evidence of substrate sorting through flow processes

Intermittent Stream

Stream reaches that cease to flow for some periods of the year.
Includes:

- reaches with stable natural pools having a depth at their deepest point of not less than 150mm and a total pool surface area that is 10m² or more per 100m of river or stream bed length and
- reaches without stable pools

Permanent River or Stream

The continually flowing reaches of any river or stream.

Appendix II: SEV Score Summarries

Ecological Function	Variable	Watercourse 3 Impact			Watercourse 2		Upper Watercourse 6		Main Trib	
		SEV Values								
		Current i-C	Potential i-P	Impact i-I	Current m-C	Potential m-P	Current m-C	Potential m-P	Current m-C	Potential m-P
Hydraulic										
Natural Flow Regime	Vchann	0.77	0.77	0.00	0.77	0.77	0.65	0.65	0.62	0.62
	Vlining	0.80	0.90	0.00	0.80	0.90	0.94	0.95	0.86	0.94
	Vpipe	1.00	1.00	0.00	1.00	1.00	1.00	1.00	0.30	0.30
	=	**0.78**	**0.81**	**0.00**	**0.78**	**0.81**	**0.75**	**0.75**	**0.21**	**0.22**
Floodplain Effectiveness	Vbank	0.76	0.76	0.00	1.00	1.00	0.60	0.60	0.20	0.20
	Vrough	0.20	0.55	0.00	0.20	0.50	0.24	0.50	0.24	0.50
	=	**0.15**	**0.42**	**0.00**	**0.20**	**0.50**	**0.14**	**0.30**	**0.05**	**0.10**
Connectivity for Natural Species Migration	Vbarr	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
	=	**1.00**	**1.00**	**0.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Natural Connectivity to Groundwater	Vchanshape	0.42	0.42	0.00	0.42	0.42	0.72	0.72	0.52	0.52
	Vlining	0.80	0.90	0.00	0.80	0.90	0.94	0.95	0.86	0.94
	=	**0.67**	**0.74**	**0.00**	**0.67**	**0.74**	**0.87**	**0.87**	**0.75**	**0.80**
Hydraulic function mean score		**0.65**	**0.74**	**0.00**	**0.66**	**0.76**	**0.69**	**0.73**	**0.50**	**0.53**
Biogeochemical										
Water Temperature Control	Vshade	0.26	0.60	0.00	0.38	0.60	1.00	1.00	0.56	0.70
	=	**0.26**	**0.60**	**0.00**	**0.38**	**0.60**	**1.00**	**1.00**	**0.56**	**0.70**
Dissolved Oxygen Levels	Vdod	1.00	1.00	0.00	0.68	1.00	1.00	1.00	1.00	1.00
	=	**1.00**	**1.00**	**0.00**	**0.68**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Organic Matter Input	Vripar	0.00	0.50	0.00	0.01	0.50	0.10	0.50	0.05	0.75
	Vdecid	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
	=	**0.00**	**0.50**	**0.00**	**0.01**	**0.50**	**0.10**	**0.50**	**0.05**	**0.75**
In-Stream Particle Retention	Vmacro	0.13	0.56	0.00	0.12	0.56	0.94	1.00	0.98	0.99
	Vretain	0.62	0.62	0.00	0.62	0.62	0.86	0.86	0.72	0.72
	=	**0.13**	**0.56**	**0.00**	**0.12**	**0.56**	**0.86**	**0.86**	**0.72**	**0.72**
Decontamination of Pollutants	Vsurf	0.81	0.61	0.00	0.74	0.56	0.55	0.63	0.27	0.32
	Vripfilt	0.40	0.50	0.00	0.40	0.50	0.30	0.50	0.44	0.47
	=	**0.61**	**0.55**	**0.00**	**0.57**	**0.53**	**0.43**	**0.56**	**0.35**	**0.40**
Biogeochemical function mean score		**0.40**	**0.64**	**0.00**	**0.35**	**0.64**	**0.68**	**0.78**	**0.54**	**0.71**
Habitat Provision										
Fish Spawning Habitat	Vgalspwn	0.28	0.28	0.00	0.85	0.85	0.00	0.00	0.00	0.00
	Vgalqual	0.00	0.25	0.00	0.00	0.25	0.00	0.25	0.00	0.25
	Vgobspwn	0.10	0.10	0.00	0.10	0.10	0.10	0.10	0.10	0.10
	=	**0.05**	**0.09**	**0.00**	**0.05**	**0.16**	**0.05**	**0.05**	**0.05**	**0.05**
Habitat for Aquatic Fauna	Vphyshab	0.20	0.44	0.00	0.13	0.40	0.62	0.74	0.49	0.69
	Vwatqual	0.18	0.55	0.00	0.20	0.55	1.00	1.00	0.38	0.60
	Vimperv	0.70	0.70	0.00	0.70	0.70	0.70	0.70	0.70	0.70
	=	**0.32**	**0.53**	**0.00**	**0.29**	**0.51**	**0.74**	**0.80**	**0.52**	**0.67**
Habitat provision function mean score		**0.18**	**0.31**	**0.00**	**0.17**	**0.33**	**0.39**	**0.42**	**0.28**	**0.36**
Biodiversity										
Fish Fauna Intactness	Vfish	0.00	0.00	0.00	0.00	0.00	0.23	0.23	0.50	0.50
	=	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.23**	**0.23**	**0.50**	**0.50**
Invertebrate Fauna Intactness	Vmci	0.57	0.57	0.00	0.46	0.46	0.75	0.75	0.36	0.36
	Vept	0.23	0.23	0.00	0.00	0.00	0.67	0.67	0.33	0.33
	Vinvert	0.61	0.61	0.00	0.23	0.23	0.58	0.58	0.12	0.12
	=	**0.47**	**0.47**	**0.00**	**0.23**	**0.23**	**0.67**	**0.67**	**0.27**	**0.27**
Riparian Vegetation Intactness	Vripcond	0.10	0.40	0.00	0.10	0.33	0.12	0.33	0.12	0.31
	Vripconn	1.00	1.00	0.00	1.00	1.00	0.30	0.30	0.33	0.33
	=	**0.10**	**0.40**	**0.00**	**0.10**	**0.33**	**0.04**	**0.10**	**0.04**	**0.10**
Biodiversity function mean score		**0.19**	**0.29**	**0.00**	**0.11**	**0.19**	**0.31**	**0.33**	**0.27**	**0.29**
Overall mean SEV score		**0.396**	**0.548**	**0.000**	**0.363**	**0.533**	**0.562**	**0.621**	**0.433**	**0.520**

Appendix III: SEV Watercourse Charachteristics

Location	Mahurangi Tributary	Watercourse 2	Watercourse 3	Watercourse 6
SEV Start (NZTM)	E 1747816 N 5971047	E 1747667 N 5970801	E 1747752 N 5970703	E 1747476 N 5970488
SEV End (NZTM)	E 1747804 N 5971133	E 1747623 N 5970807	E 1747714 N 5970680	E 1747424 N 5970516
Average width (m)	1.5	0.4	0.3	0.4
Average depth (m)	0.3	0.1	0.1	0.1
Max depth (m)	0.9	0.2	0.2	0.2
Dominant Substrate Types	Mud/Silt	Mud/Silt	Mud/Silt	Mud/Silt
Aquatic Plants	Water Pepper & Watercress	Nil	Watercress & Forget-me-not	Nil
Water Quality				
Time of Sampling (NZST hours)	0920	1300	1400	0940
Temperature (°C)	13.4	15.8	16	14.9
Oxygen saturation (%)	65.7	79.4	62.5	82.7
Dissolved oxygen (mg/L)	6.9	7.85	6.15	8.0
Conductivity (µS/cm)	46.6	47.5	46.3	46
Macroinvertebrates and Biota				
No. of taxa	14	11	17	20
Dominant taxon	*Austrosimulium australense* & *Xanthocnemis zealandica*	Freshwater snails (*Potamopyrgus antipodarum*)	Ostracods (*Herpetocypris pascheri*)	Chironomids (*Tanytarsini sp.*) & Coleoptera (*Scirtidae sp.)*
No. of EPT taxa	2	0	1	4
% EPT	0.74	0	0.50	17.54
MCI – soft bottom	66 'Poor'	73 'Poor'	82 'Fair'	104 'Good'
Total fish recorded	26	0	0	2
Species recorded:	3	Nil	Nil	1
Fish IBI	30 - 'Fair'	0 - 'No Natives'	0 - 'No Natives'	14 'Very Poor'
Stream Ecological Valuation				
SEV score	0.43	0.36	0.40	0.56

Appendix IV: ECR Assumptions

		Potential i-P
Function Category	Variable	Assumption
Hydraulic	Vchann	No change expected
	Vlining	Redcuton in fine sediments
	Vpipe	No change expected
	Vbank	No change expected
	Vrough	Riparian planting along both banks
	Vbarr	No change expected
	Vchanshape	No data entry required – populated from other variables
Biogeochemical	Vshade	Increase in shading from riparian planting
	Vdod	Increase to opitmal where relevant
	Vveloc	No significant change expected
	Vdepth	No significant change expected
	Vripar	Riparian planting along both banks
	Vdecid	No change expected
	Vmacro	Reduction due to increase in shading
	Vretain	No data entry required – populated from other variables
	Vsurf	No change expected with substrate, increase in leaf litter, reduciton in macrophytes
	Vripfilt	Increase due to increase in riparain vegetation
Habitat provision	Vgalspwn	No change expected
	Vgalqual	Increase due to increase in shading
	Vgobspawn	No data entry required – populated from other variables. Changed with increase in wood from Vsurf
	Vphyshab	Increase in ' channel shade and riparain integrity'
	Vwatqual	Increase in upstream shading
	Vimperv	No change assumed
Biodiversity	Vfish	No change expected
	Vmci	No change assumed
	Vept	No data entry required – populated from other variables
	Vripcond	No data entry required – populated from other variables Changed to reflect change in riparian margins.
	Vinvert	No change expected
	Vripconn	No change expected

Appendix V: ECR Calculations

Watercourse 3 and Watercourse 1 ECR

	Impact Current i-C	Mitigation Current m-C	Mitigation Potential m-P	Impact Potential i-P	Impact Impacted i-I
NFR	0.78	0.78	0.81	0.81	0.00
FLE	0.15	0.20	0.50	0.42	0.00
CSM	1.00	1.00	1.00	1.00	0.00
CGW	0.67	0.67	0.74	0.74	0.00
WTC	0.26	0.38	0.60	0.60	0.00
DOM	1.00	0.68	1.00	1.00	0.00
OMI	0.00	0.01	0.50	0.50	0.00
IPR	0.13	0.12	0.56	0.56	0.00
DOP	0.61	0.57	0.53	0.55	0.00
FSH	0.05	0.05	0.16	0.09	0.00
HAF	0.32	0.29	0.51	0.53	0.00
RVI	0.10	0.10	0.33	0.40	0.00
Mean	**0.42**	**0.40**	**0.60**	**0.60**	**0.00**

ECR = [(SEVi-P – SEVi-I)/(SEVm-P – SEVm-C)] x 1.5

ECR = [(0.6-0)/(0.6-0.4)] x 1.5

ECR	4.53

***ECR less than 1 defaults to 1**

			416 Remaining Impact
	width (m)	**length (m)**	**area (m2)**
Impact stream	0.32	43.8	14.1

	actual area (m2)	**ECR***	**ECR area (m2)**
ECR	14.1	4.53	63.7

	ECR area (m2)	**width (m)**	**Mitigation length (m)**	
Mitigation stream	63.7	0.54	117.9	
			118	Offset Available

Watercourse 3 and Watercourse 2 ECR

	Impact Current i-C	Mitigation Current m-C	Mitigation Potential m-P	Impact Potential i-P	Impact Impacted i-I
NFR	0.78	0.78	0.81	0.81	0.00
FLE	0.15	0.20	0.50	0.42	0.00
CSM	1.00	1.00	1.00	1.00	0.00
CGW	0.67	0.67	0.74	0.74	0.00
WTC	0.26	0.38	0.60	0.60	0.00
DOM	1.00	0.68	1.00	1.00	0.00
OMI	0.00	0.01	0.50	0.50	0.00
IPR	0.13	0.12	0.56	0.56	0.00
DOP	0.61	0.57	0.53	0.55	0.00
FSH	0.05	0.05	0.16	0.09	0.00
HAF	0.32	0.29	0.51	0.53	0.00
RVI	0.10	0.10	0.33	0.40	0.00
Mean	**0.42**	**0.40**	**0.60**	**0.60**	**0.00**

ECR = [(SEVi-P – SEVi-I)/(SEVm-P – SEVm-C)] x 1.5

ECR = [(0.6-0)/(0.6-0.4)] x 1.5

ECR	4.53

***ECR less than 1 defaults to 1**

372.2	Remaining Impact

	width (m)	length (m)	area (m2)
Impact stream	0.32	68.2	21.8

	actual area (m2)	ECR*	ECR area (m2)
ECR	21.8	4.53	98.8

	ECR area (m2)	width (m)	Mitigation length (m)
Mitigation stream	98.8	0.40	247.0

247	Offset Available

Watercourse 3 and Watercourse 3 lower ECR

	Impact Current i-C	Mitigation Current m-C	Mitigation Potential m-P	Impact Potential i-P	Impact Impacted i-I
NFR	0.78	0.78	0.81	0.81	0.00
FLE	0.15	0.15	0.42	0.42	0.00
CSM	1.00	1.00	1.00	1.00	0.00
CGW	0.67	0.67	0.74	0.74	0.00
WTC	0.26	0.26	0.60	0.60	0.00
DOM	1.00	1.00	1.00	1.00	0.00
OMI	0.00	0.00	0.50	0.50	0.00
IPR	0.13	0.13	0.56	0.56	0.00
DOP	0.61	0.61	0.55	0.55	0.00
FSH	0.05	0.05	0.09	0.09	0.00
HAF	0.32	0.32	0.53	0.53	0.00
RVI	0.10	0.10	0.40	0.40	0.00
Mean	**0.42**	**0.42**	**0.60**	**0.60**	**0.00**

ECR = [(SEVi-P – SEVi-I)/(SEVm-P – SEVm-C)] x 1.5

ECR = [(0.6-0)/(0.6-0.42)] x 1.5

ECR	5.06

***ECR less than 1 defaults to 1**

304.0	Remaining Impact

	width (m)	length (m)	area (m2)
Impact stream	0.32	16.3	5.2

	actual area (m2)	ECR*	ECR area (m2)
ECR	5.2	5.06	26.4

	ECR area (m2)	width (m)	Mitigation length (m)
Mitigation stream	26.4	0.32	82.5

83	Offset Available

Watercourse 3 and Watercourse 6 Lower ECR

	Impact Current i-C	Mitigation Current m-C	Mitigation Potential m-P	Impact Potential i-P	Impact Impacted i-I
NFR	0.78	0.78	0.81	0.81	0.00
FLE	0.15	0.20	0.50	0.42	0.00
CSM	1.00	1.00	1.00	1.00	0.00
CGW	0.67	0.67	0.74	0.74	0.00
WTC	0.26	0.38	0.60	0.60	0.00
DOM	1.00	0.68	1.00	1.00	0.00
OMI	0.00	0.01	0.50	0.50	0.00
IPR	0.13	0.12	0.56	0.56	0.00
DOP	0.61	0.57	0.53	0.55	0.00
FSH	0.05	0.05	0.16	0.09	0.00
HAF	0.32	0.29	0.51	0.53	0.00
RVI	0.10	0.10	0.33	0.40	0.00
Mean	**0.42**	**0.40**	**0.60**	**0.60**	**0.00**

ECR = [(SEVi-P – SEVi-I)/(SEVm-P – SEVm-C)] x 1.5

ECR = [(0.6-0)/(0.6-0.4)] x 1.5

ECR	4.53

***ECR less than 1 defaults to 1**

		287.7 Remaining Impact

	width (m)	length (m)	area (m2)
Impact stream	0.32	32.5	10.4

	actual area (m2)	ECR*	ECR area (m2)
ECR	10.4	4.53	47.1

	ECR area (m2)	width (m)	Mitigation length (m)
Mitigation stream	47.1	0.40	117.7

118	Offset Available

Watercourse 3 and Watercourse 6 upper ECR

	Impact Current i-C	Mitigation Current m-C	Mitigation Potential m-P	Impact Potential i-P	Impact Impacted i-I
NFR	0.78	0.75	0.75	0.81	0.00
FLE	0.15	0.14	0.30	0.42	0.00
CSM	1.00	1.00	1.00	1.00	0.00
CGW	0.67	0.87	0.87	0.74	0.00
WTC	0.26	1.00	1.00	0.60	0.00
DOM	1.00	1.00	1.00	1.00	0.00
OMI	0.00	0.10	0.50	0.50	0.00
IPR	0.13	0.86	0.86	0.56	0.00
DOP	0.61	0.43	0.56	0.55	0.00
FSH	0.05	0.05	0.05	0.09	0.00
HAF	0.32	0.74	0.80	0.53	0.00
RVI	0.10	0.04	0.10	0.40	0.00
Mean	**0.42**	**0.58**	**0.65**	**0.60**	**0.00**

ECR = [(SEVi-P – SEVi-I)/(SEVm-P – SEVm-C)] x 1.5

ECR = [(0.6-0)/(0.65-0.58)] x 1.5

ECR	13.14

***ECR less than 1 defaults to 1**

255.2	Remaining Impact

	width (m)	length (m)	area (m2)
Impact stream	0.32	10.9	3.5

	actual area (m2)	ECR*	ECR area (m2)
ECR	3.5	13.14	45.8

	ECR area (m2)	width (m)	Mitigation length (m)
Mitigation stream	45.8	0.40	114.6

115	Offset Available

Watercourse 3 and Main Trib ECR

	Impact Current i-C	Mitigation Current m-C	Mitigation Potential m-P	Impact Potential i-P	Impact Impacted i-I
NFR	0.78	0.21	0.22	0.81	0.00
FLE	0.15	0.05	0.10	0.42	0.00
CSM	1.00	1.00	1.00	1.00	0.00
CGW	0.67	0.75	0.80	0.74	0.00
WTC	0.26	0.56	0.70	0.60	0.00
DOM	1.00	1.00	1.00	1.00	0.00
OMI	0.00	0.05	0.75	0.50	0.00
IPR	0.13	0.72	0.72	0.56	0.00
DOP	0.61	0.35	0.40	0.55	0.00
FSH	0.05	0.05	0.05	0.09	0.00
HAF	0.32	0.52	0.67	0.53	0.00
RVI	0.10	0.04	0.10	0.40	0.00
Mean	**0.42**	**0.44**	**0.54**	**0.60**	**0.00**

ECR = [(SEVi-P – SEVi-I)/(SEVm-P – SEVm-C)] x 1.5

ECR = [(0.6-0)/(0.54-0.44)] x 1.5

ECR	8.89

***ECR less than 1 defaults to 1**

244.3	Remaining Impact

	width (m)	length (m)	area (m2)
Impact stream	0.32	244.3	78.2

	actual area (m2)	ECR*	ECR area (m2)
ECR	78.2	8.89	695.1

	ECR area (m2)	width (m)	Mitigation length (m)
Mitigation stream	695.1	1.50	463.4

605	Offset Available

141.6	Remaining Offset