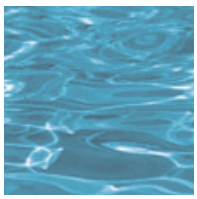
Appendix D

Wildland Consultants' Report



PRELIMINARY ECOLOGICAL ASSESSMENTS OF SIX BULK WATER SUPPLY OPTIONS FOR KAPITI COAST

JULY 2010

Report No. 2381b

Prepared for:

BECA
AORANGI HOUSE,
85 MOLESWORTH STREET
PO BOX 3942,
WELLINGTON 6140

WILDLAND CONSULTANTS LTD, 7B SUNLIGHT GROVE, ELSDON, P.O. BOX 50-539, PORIRUA
Ph 04-237-7341; Fax 04-237-7496

HEAD OFFICE: 99 SALA STREET, P.O. BOX 7137, TE NGAE, ROTORUA
Ph 07-343-9017; Fax 07-343-9018, email ecology@wildlands.co.nz, www.wildlands.co.nz

CONTENTS

PROJECT TEAM

Astrid van Meeuwen-Dijkgraaf - report author.
William Shaw - report review.
Roger Bawden - GIS.
Jenny Long - GIS.

1. INTRODUCTION

This report summarises the technical investigation methods and ecological values of six potential bulk water supply options for Kapiti Coast. Short-listed options are presented in Table 1.

Table 1: Short-listed potential bulk water supply options for Kapiti Coast.

Option No.	Option Name	Type
12	Kapakapanui Dam (IC) *	Dam
13	Ngātiawa Dam (IC)	Dam
18	Lower Maungakotukutuku Dam (IC)	Dam
27	Aquifer Storage & Recovery (IC)	Groundwater
29	Groundwater River Recharge (IC)	Groundwater
23/38	Extend Waikanae Borefield and/or Storage (IC)	Other

* (IC) = in catchment option.

2. ASSESSMENT METHODOLOGY

Each of the potential dam and storage pond sites was visited and vegetation types were mapped onto an aerial photograph of the site. Where it was possible to obtain access to a particular vegetation type, then a vascular plant species list was compiled for that area. Likely habitat was searched to determine if threatened plant species were present. Fauna heard and seen was noted for each site. Site visits occurred on 9 April 2010 (Lower Maungakotukutuku), 12 April 2010 (Kapakapanui, Ngātiawa, Storage ponds), and 10 May 2010 (Lower Maungakotukutuku, Kapakapanui, Ngātiawa). The latter visit, to Maungakotukutuku and Kapakapanui, was in the company of BECA geologists, Ian Cooksley from the Department of Conservation (Maungakotukutuku only), and members of the drilling team; one of the reasons for the visit was to assess the ecological values of the sites proposed for test drilling.

Field records of vegetation types were then mapped onto digital aerial photography using ArcGIS9.3, and the total area of potential inundation and infrastructure calculated for each vegetation type at each site. Note that these areas are not adjusted for topography, and are therefore minimum areas.

3. KAPAKAPANUI DAM

3.1 Protected areas and areas of significance

The current access road to the dam site fords the Mangaone River, and the crossing location falls within the 0.6 ha Department of Conservation-managed Mangaone River Marginal Strip (R26028) (Figure 1). This is a fixed Marginal Strip, under Section 24(3) of the Conservation Act 1987. Upgrading of the access road, or placement of a bridge, will need to be undertaken in consultation with the Department of Conservation, or an alternative access route, outside the reserve, will need to be created.

Riparian vegetation in this area is predominantly a mahoe-kamahi (*Melicytus ramiflorus-Weinmannia racemosa*) canopy with a diverse understorey including rangiora (*Brachyglottis repanda*), indigenous tree fuchsia (*Fuchsia excorticata*), and *Coprosma* and fern species. The riparian margin varies from a few metres to *c*.50 m wide and will assist with protecting water quality, including sediment and temperature control. Whichever option is chosen, a small amount of good quality riparian indigenous vegetation will be affected by upgrading of the access route.

North-east of the proposed dam site there are two private covenants managed by the Department of Conservation: Adlam Covenant (R26071, 10 ha) and the Kaitawa Covenant (R26067, 119.5 ha). These covenants adjoin the 717.6 ha Department of Conservation-managed Kaitawa Scenic Reserve (R26022), a roughly 'J' shaped area of land that also passes to the north of the proposed dam site. To the west lies the Department of Conservation-managed Hemi Matenga Memorial Park Scenic Reserve (R26023, 326.2 ha). It is unlikely that works at the site would affect the ecology of these sites.

Further downstream of the access road the lies the 23.18 ha Mangaone Road Bush (K079), which has been ranked as being of 'Regional Significance' in the Kapiti Coast District Council Plan. This site comprises tawa (*Beilschmiedia tawa*) forest and kamahi forest, is of moderate size, and is a relatively good quality example of tawa forest with small area of riparian kamahi forest. This area is likely to provide habitat for indigenous bird species such as tui (*Prosthemadera novaeseelandiae*) and kereru (*Hemiphaga novaeseelandiae*) (Wildland Consultants 2003). It is unlikely to be affected by the construction or operation of the Kapakapanui Dam, unless sediment control is inadequate.

3.2 Vegetation and habitats

Most (10.42 ha, 71%) of the area that could potentially be inundated comprises habitats with low indigenous ecological values, such as pasture and a constructed farm pond (Figure 2, Table 2). Total inundation area is calculated to be approximately *c.*14.8 ha (not adjusted for topography).

Low-moderate quality vegetation and habitat types (covering *c.*16% of the potential inundation area), are largely dominated by exotic species, or are heavily modified through land use or stock browse. A number of macrocarpa (*Cupressus macrocarpa*) and radiata pine (*Pinus radiata*) shelterbelts and plantations (introduced conifer forest) occur at the site and these tend to have an understorey of mostly indigenous species, including mahoe (*Melicytus ramiflorus*), tauhinu (*Ozothamnus leptophyllus*), karamu (*Coprosma robusta*), kanono (*Coprosma grandifolia*), kawakawa (*Macropiper excelsum*), ongaonga (*Urtica ferox*), and a range of indigenous ferns, but also barberry (*Berberis glaucocarpa*) and blackberry (*R. fruticosus* agg.). The indigenous-exotic shrublands are dominated by mahoe, kamahi (*Weinmannia racemosa*), ongaonga, remnant mamaku (*Cyathea medullaris*), occasional kotukutuku (*Fuchsia excorticata*), barberry, and blackberry, with a range of smaller browse-resistant species in the understorey. Areas of bare earth are also present. Vegetation on gravel substrate was dominated by pasture grasses, fleabane (*Conyza albida*), and ragwort (*Senecio jacobaea*). Wetland areas were also dominated by pasture grasses, with *Juncus gregiflorus*.

Table 2: Vegetation types within potential Kapakapanui inundation area.

Ecological Value	Vegetation Type	Area inundated (ha)	% of Total Inundation Area
High	Kahikatea/mahoe-kamahi forest	0.88	6.0%
	Kamahi-mahoe forest	0.64	4.3%
High Total		**1.52**	**10.3%**
Moderate	Indigenous-exotic forest	0.28	1.9%
	Kahikatea/blackberry scrub	0.19	1.3%
Moderate Total		**0.47**	**3.2%**
Low-moderate	Degraded wetlands and seeps	0.93	6.3%
	Introduced conifer forest	0.83	5.7%
	Gravel banks	0.37	2.5%
	Indigenous-exotic shrubland	0.20	1.3%
Low-moderate Total		**2.34**	**15.9%**
Low	Pasture	10.27	69.6%
	Farm pond	0.15	1.0%
Low Total		**10.42**	**70.7%**
Total Inundation Area		**14.76**	**100.0%**
Total Area High and Moderate Value		**1.99**	**13.49%**

Moderate ecological values (0.47 ha, 3.2% of the potential inundation area) were ascribed to forest that was generally dominated by indigenous species such as mahoe, kamahi, tawa, kawakawa, and tree-ferns, but also includes a significant amount of barberry, blackberry, or other exotic and often weedy species. There were also isolated kahikatea (*Dacrycarpus dacrydioides*) along the stream, often with dense blackberry scrub at their bases.

High ecological value habitats and vegetation types were dominated by indigenous plant species, with generally intact vegetation tiers, although the understorey was moderately affected by stock browse in places. Only 1.52 ha (10.3% of the site likely to be inundated or affected by works) of high value habitat will be affected by the proposed dam development. This is mainly riparian vegetation which, in the lower part of the valley, comprises kahikatea trees (up to 25 m tall with diameters at breast height of up to 75 cm) emergent over 15 m tall mahoe-kamahi forest. In the upper part of the inundation zone, the forest canopy is primarily mahoe-kamahi with occasional emergent pukatea (*Laurelia novae-zelandiae*). Both indigenous forest types have a wide range of understorey species including mahoe, tauhinu, karamu, kanono, kawakawa, ongaonga, *Coprsoma rhamnoides*, pate (*Schefflera digitata*), koromiko (*Hebe stricta*), kaikomako (*Pennantia corymbosa*), wheki (*Dicksonia squarrosa*), mamaku, kotukutuku, heketara (*Olearia rani*), pigeonwood (*Hedycarya arborea*), white rata (*Metrosideros diffusa*), scarlet rata (*Metrosideros fulgens*), akakaikiore (*Parsonsia heterophylla*), bush laywer (*Rubus cissoides*), and a range of fern species.

3.3 Fauna

The farm is stocked primarily with red deer (*Cervus elaphus scoticus*) and sheep (*Ovis aries*), with pheasants (*Phasianus colchicus*) common. In pasture areas, New Zealand pipit (*Anthus novaeseelandiae*), paradise shelduck (*Tadorna variegata*), spur-winged plover (*Vanellus miles*), pukeko (*Porphyrio porphyrio melanotus*), Australasian harrier (*Circus approximans*), and introduced Australian magpie (*Gymnorhina tibicen*), goldfinch (*Carduelis carduelis*), and greenfinch (*Carduelis chloris*) were noted. Indigenous species in the forested area included grey warbler (*Gerygone igata*), silvereye (*Zosterops lateralis*), fantail (*Rhipidura fuliginosa*), and possibly rifleman (*Acanthisitta chloris*, At risk - Declining), as well as the introduced eastern rosella (*Platycercus eximius*). Goat sign (*Capra hircus*) and brushtail possum damage (*Trichosurus vulpecula*) were also seen.

3.4 Proposed test drilling

Proposed test drilling at this site was located on pasture or within a pine plantation. Provided that sediment controls are sufficient, there will be little ecological impact.

3.5 Potential adverse ecological effects

- Clearance of riparian vegetation and potential deterioration of in-stream ecological values, including along the new or realigned access route.
- Vegetation clearance may cause surrounding vegetation to dry out, as a result of removal of buffering vegetation.
- Potential introduction of unwanted species (e.g. weeds).
- Soil compaction.
- Changes to the water table, which could cause previously unaffected vegetation to die or deteriorate through root rot.
- Loss of habitat for indigenous terrestrial fauna.

3.6 Opportunities for mitigation

- Fence other indigenous forest areas within the property to exclude stock and undertake pest control within these areas.
- Consider legal protection, e.g. covenant, for other indigenous forest areas within the property.
- Check for weeds on construction sites every three months for the first two years, and yearly thereafter, for up to five years, and undertake weed control as required.
- Establish temporary fences or high visibility tape around trees and parts of the sites to be avoided during construction.

- Employ silt-retention devices around the perimeter of the working area.
- Consider establishing an indigenous riparian margin (at least 20 m wide) using suitably eco-sourced plant species, along non-forested sections of the final lake shoreline.

4. NGATIAWA DAM

4.1 Protected areas

The Ngatiawa River Marginal Strip (R26039, *c*.1.4 ha) is a Department of Conservation-managed reserve within the proposed dam inundation area (Figure 3). This is a fixed marginal strip, under Section 24(3) of the Conservation Act 1987. Near the bridge to Kents Road, there is a small conservation area: Kents Road Conservation Area (R26030, *c*.0.1 ha), a Stewardship Area under Section 25 of the Conservation Act 1987. Most of the forest in this area is identified in the Kapiti Coast District Council Heritage Register as Site K080 Ngatiawa Road Bush (8.69 ha), which is of 'District Significance'.

4.2 Vegetation and habitats

Vegetation in this area is a mosaic of indigenous and introduced vegetation types (Figure 4). Downstream of the proposed dam site, on the true left (looking downstream) the canopy appears to be dominated by barberry and tree lucerne (*Chamaecytisus palmensis*). The true right bank and near to the proposed dam location, the canopy principally comprised kamahi-mahoe-kaikomako forest with emergent rewarewa (*Knightia excelsa*). Upstream of the dam, on the true right, is a large area of mature tawa canopy with occasional mature emergent kahikatea and rimu (*Dacrydium cupressinum*). The tawa forest continues along the scarp of the uppermost terrace, on the true right of the river.

Table 3: Vegetation types within potential Ngatiawa inundation area.

Ecological Value	Vegetation Type	Area inundated (ha)	% of Total Inundation Area
High	(Podocarp)/tawa forest	3.41	17.2%
	(Rewarewa)/mahoe-kamahi-kaikomako forest	2.88	14.5%
	(Kahikatea)/mahoe-kamahi forest	0.84	4.3%
High Total		**7.14**	**36.0%**
Moderate-high	Exotic conifers/indigenous forest	2.05	10.3%
	Mahoe-mixed indigenous-exotic forest	0.15	0.8%
Moderate-high Total		**2.20**	**11.1%**
Moderate	Indigenous-exotic forest	1.06	5.4%
	Riparian indigenous-exotic scrub	0.79	4.0%
Moderate Total		**1.85**	**9.3%**
Low-moderate	Gravel banks	1.66	8.4%
Low-moderate Total		**1.66**	**8.4%**

Ecological Value	Vegetation Type	Area inundated (ha)	% of Total Inundation Area
Low	Pasture	4.41	22.2%
Low	Mixed introduced species	1.74	8.8%
Low	Introduced conifer shelterbelts and forest	0.48	2.4%
Low	Introduced conifer and barberry forest	0.34	1.7%
Low Total		**6.97**	**35.2%**
Total Inundation Area		**19.82**	**100.0%**
Total Area High and Moderate Value		**11.19**	**56.5%**

Vegetation on the true left side comprises areas of mahoe-dominated forest, with a range of indigenous species, including karamu, kanono, kawakawa, ongaonga, *Coprsoma rhamnoides*, koromiko, kaikomako, wheki, mamaku, kotukutuku, heketara, and pigeonwood, with occasional barberry and blackberry. These forest areas are interspersed with large mature macrocarpa and radiata pine trees with a similar understorey to the mahoe-dominated forest.

On the gravel flats near the river, buddleia (*Buddleja davidii*), barberry, wheki and toetoe (*Cortaderia fulvida*) were prominent. On less frequently flooded gravel flats, vegetation composition becomes more indigenous in character, with wheki, puka (*Muehlenbeckia australis*), tutu (*Coriaria arborea*), and mahoe being more prominent than weedy species. Willow (possibly grey willow, *Salix cinerea*) occurs on some of the river banks. Near Kent Road, there were mature sycamore (*Acer pseudoplatanus*) trees, with wildings scattered along the river margins.

More than half of the vegetation and habitat types that could potentially be inundated comprise high (tawa forest and mahoe-kamahi forest) or moderate ecological value vegetation (riparian forest).

4.3 Fauna

Indigenous species recorded at the site were pukeko, paradise shelduck, Australasian harrier, grey warbler, silvereye, fantail, tui, and kereru. Introduced species recorded were Australian magpie, goldfinch, blackbird (*Turdus merula*), and starling (*Sturnus vulgaris*).

4.4 Test drilling

No test drilling is proposed for this site.

4.5 Potential ecological effects

- Clearance of vegetation that includes mature rimu and kahikatea, and tawa forest. Indigenous vegetation clearance may be greater than indicated above, as this figure was based solely on potential inundation area and did not include the work platform or access or maintenance routes.

- Vegetation clearance may cause surrounding vegetation to dry out by removal of buffering vegetation. Such edge effects are more pronounced in taller vegetation.
- Soil slumping, especially on river terraces, causing additional loss of vegetation.
- May cause damage to roots of large trees adjacent to clearance areas, with subsequent deterioration in health.
- Potential introduction of unwanted species (e.g. weeds).
- Soil compaction.
- Changes to the water table, which could cause previously unaffected vegetation to die or deteriorate through root rot.
- Loss of habitat for indigenous terrestrial fauna.
- Loss of riparian vegetation and potential deterioration of in-stream ecological values.

4.6 Opportunities for mitigation

- It will not be possible to mitigate for the loss of the relatively large area of mature indigenous forest at the site. This may mean that mitigation, such as pest control, should be undertaken at nearby sites to offset loss of indigenous vegetation.
- Replanting forest edges with suitable eco-sourced plant species to assist with more rapid edge re-establishment.
- Check for weeds on construction sites every three months for the first two years, and yearly thereafter for up to five years or until an indigenous canopy is re-established, and undertake weed control as required.
- Establish temporary fences or high visibility tape around trees and parts of the sites that need to be avoided during construction works.
- Employ silt retention devices around the perimeter of the cleared and working sites.
- Establish indigenous riparian margin (at least 20 m wide) using suitably eco-sourced plant species, along non-forested sections of the final lake shoreline.

5. LOWER MAUNGAKOTUKUTUKU

5.1 Protected areas

About 18 ha of land, in Lot 2 Deposited Plan 360865, has been covenanted by previous landowners under the Reserves Act 1977, to protect ecological values (Figure 5). This area is part of the 41,353 ha Heritage Site E17 in the District Plan, which is the largest example of indigenous bush/wilderness area on the Kapiti Coast, and is considered to be of 'Regional Significance'. Approximately 4.41 ha of this

covenant would be inundated or affected by construction works. However adverse effects on the forest could extend beyond this area as waterlogged soils may kill some species or rot roots, and vegetation clearance increases edge effects, such as drying out of the interior of the forest margin due to increased exposure to wind and sunlight.

The covenant includes the following provisions:

(a) To protect and enhance the natural character of the Land with particular regard to the indigenous flora and fauna;

(b) To protect the landscape amenity of the Land;

(c) To protect the landscape amenity of the indigenous vegetation, and to preserve the land as a representative sample of the class of natural ecosystem which in the aggregate originally gave the Tararua Ecological District its own recognisable character;

(d) To allow and encourage the natural regeneration of indigenous species;

(e) To preserve freshwater life and habitat of the land;

(f) To preserve the historical, archaeological and educational values of the land.

Ecological values of this covenant include the primarily indigenous riparian vegetation along the Maungakotukutuku Stream, an extensive area of kohekohe (*Dysoxylum spectabile*) forest on the slopes above the stream, and mature (for lowland parts of Tararua Ecological District) podocarp hardwood forest along the lower reaches of the stream within the land parcel (Figure 6).

5.2 Vegetation and habitats

Most of the area proposed to be flooded is primarily pasture or exotic plantation forest, with a range of indigenous species in the understorey of the pine plantation (Figure 6). The riparian margin of the stream, including that within plantation forest, comprises primarily indigenous species.

The quality of the indigenous riparian vegetation improves along a downstream gradient. Vegetation at the southern end of the property has been more modified by introduced conifers and stock. Vegetation along the stream progressively improves towards the northern half of the property, to become (rimu-pukatea)/tawa-mahoe forest at the northern end, especially on the true right of the stream. Downstream, on the true left, vegetation appeared to be predominantly kohekohe and mahoe, with mamaku and occasional rewarewa, rimu and matai (*Prumnopitys taxifolia*). A small toetoe-bracken (*Pteridium esculentum*) wetland is present where the degraded pastoral wetland drains down through the riparian forest to the Maungakotukutuku Stream.

Table 4: Vegetation types within potential the Lower Maungakotukutuku inundation area.

Ecological Value	Vegetation Type	Area inundated (ha)	% of Total Inundation Area
High	Riparian forest	2.67	9.5%
	Mixed hardwood podocarp forest	1.68	6.0%
	Kohekohe forest	0.85	3.0%
	Wetland	0.03	0.1%
High Total		**5.23**	**18.6%**
Moderate	Introduced conifer/riparian forest	0.71	2.5%
Moderate Total		**0.71**	**2.5%**
Low-moderate	Plantation forest	5.94	21.1%
	Degraded wetland	2.88	10.3%
	Clearing	0.47	1.7%
	Indigenous-exotic shrubland	0.16	0.6%
Low-moderate Total		**9.00**	**33.6%**
Low	Pasture	12.69	45.2%
Low total		**12.69**	**45.2%**
Total inundation area		**27.63**	**100.0%**
Total Area High and Moderate Value		**5.94**	**21.2%**

The entire true right face adjacent to the stream, above the strip of riparian vegetation, comprises kohekohe forest or (rewarewa)/kokekohe forest. Part of this area would also be flooded. The good condition of the kohekohe forest indicates that possums are being controlled to relatively low levels. The canopy is generally completely closed, with the exception of some clearings *c*.100 m upstream of the potential dam site.

Fencing along a section of the southern part of the covenant is in poor repair, with stock gaining access and grazing the understorey. At the northern end, the fence was in better condition, but stock may still move along the stream and gain access to this area.

In the vicinity of the proposed drilling location, at the northern end of the inundation area, the vegetation includes a range of species in the canopy, including tawa, rewarewa, pukatea, and kohekohe with stem diameters greater than 30 cm, and impressive, old multi-stemmed mahoe with a combined stem diameter greater than one metre. A matai with a diameter at breast height (dbh) of *c*.1.7 m and *c*.30 m tall is present near proposed drilling site LM5. Other canopy species include heketara, pigeonwood, pate, nikau (*Rhopalostylis sapida*), and mamaku.

Understorey vegetation, including that present at the proposed drilling sites, was reasonably dense, reflecting stock exclusion and possum control. Understorey vegetation comprised seedlings and small trees of kohekohe, heketara, rewarewa, kawakwawa (*Macropiper excelsum*), mahoe, tawa, and pate. A range of shrub and small tree species was present, including kanono, karamu, *Coprosma rotundifolia*, hangehange (*Geniostoma ligustrifolium*), pigeonwood, ramarama (*Lophomyrtus bullata*), nikau, supplejack vines (*Ripogonum scandens*), silver fern (*Cyathea dealbata*), mamaku, wheki, and kiekie (*Freycinetia banksii*). In most places, a carpet

of ferns clothes the ground, including hen and chicken fern (*Asplenium bulbiferum*), kiokio (*Blechnum novae-zelandiae*), and a variety of filmy ferns (Plate 1).

Plate 1: Dense understorey vegetation near proposed test drilling site LM3/LM4.

No threatened plant species were seen during the brief field surveys. The podocarp-hardwood forest and the kohekohe forest, are not classified as regionally-threatened plant communities in the Wellington Region (Sawyer 2004). Kohekohe forest is under threat from possum browse, but possums are controlled to low levels at this site by the Department of Conservation (three-monthly refilling of bait stations with Feratox).

5.3 Fauna

Tui were abundant, and a black shag (*Phalacrocorax carbo novaehollandiae*, Naturally Uncommon) was seen to fly into the northern riparian margin, indicating a possible roost or fishing site. Warblers, silvereyes, fantails, and pukeko were common. Kereru, Australasian harrier and paradise shelduck were regularly seen. A range of introduced species use the site, such as eastern rosella, greenfinch, goldfinch, blackbird, and starling. Sheep and cattle (*Bos taurus*) graze the paddocks and a goat carcass was seen within the pine forest.

5.4 Proposed test drilling

It is proposed to drill at five locations, with access to all locations to be via helicopter (drilling rig) and foot tracks. At each site, a maximum of up to 10×10 m of vegetation will be felled and cleared, possibly with some limited benching to provide

a working area. Any cut earth will be used as fill, where possible. Overlying gravel and boulders at each drilling location will need to be cleared to provide a stable platform for the drilling rigs.

The drilling sites have been selected in consultation with the Department of Conservation, to minimise the impact on indigenous vegetation. At all locations, tree ferns and small trees (with stem diameters up to 20 cm and heights of 6-8 m) will need to be removed, as well as a variety of understorey species including ferns, shrubs, and supplejack vines. However, trees larger than 20 cm dbh will be avoided, and drilling locations have also been located to avoid large overhanging tree limbs.

It is not possible to meet the Kapiti Coast District Plan Rules and Standards (Part D) for disturbance, removal, damage, or destruction ("modification") of naturally-occurring indigenous vegetation (Appendix 1), as some of the trees exceed 4 metres in height. Each drill site will be less than 100 m^2, but the combined area exceeds this. At least one of the proposed drill locations, and hence vegetation clearance, occurs within 20 m of the stream. Furthermore, the site has been identified as part of a heritage site.

5.5 Possible ecological effects

- Clearance of vegetation. Indigenous vegetation clearance may be greater than indicated above, as this figure was based solely on potential inundation area and did not include work platform of access or maintenance routes.
- A forest edge in excess of 700 m long would be created. Vegetation clearance may cause surrounding vegetation to dry out by removal of buffering vegetation. Such edge effects are likely to be more pronounced in taller vegetation.
- Construction and clearance works may cause damage to roots of large trees adjacent to clearance areas, with subsequent deterioration in health.
- Potential introduction of unwanted species (e.g. weeds).
- Soil compaction.
- Changes to the water table, which could cause previously unaffected vegetation to die or deteriorate through root rot.
- Loss of habitat for indigenous terrestrial fauna.
- Loss of riparian vegetation and potential deterioration of in-stream ecological values.
- Soil slumping causing additional loss of vegetation.

5.6 Opportunities for mitigation

- Replanting forest edges with suitable eco-sourced indigenous plant species to assist with rapid edge reestablishment.
- Check for weeds on construction and works sites every three months for the first two years, and yearly thereafter for up to five years, or until an indigenous canopy is re-established, and undertake weed control as required.
- Establish temporary fences or high visibility tape around trees and parts of the site that need to be avoided during construction.
- Employ silt retention devices around the perimeter of the cleared site and construction areas.
- Undertake or fund pest control within remaining area of forest.
- Establish indigenous riparian margin (at least 20 m wide) using suitably eco-sourced plant species, along non-forested portions of the final lake.

6. AQUIFER STORAGE AND RECOVERY

Few, if any, adverse terrestrial ecology effects are expected with this option. Preliminary test pumping of the Waimea aquifer indicates that some vertical leakage occurs from the shallow unconfined aquifer that overlies the Waimea aquifer when pumping from the Waimea takes place (Michaelsen *et al.* 2010). There therefore may be some potential that using the aquifer to store and recover river water may increase the water table of the overlying shallower aquifers. This could result in the reappearance of local springs, and possibly increased water levels in wetlands and wetland forest in the area. These changes could potentially be beneficial to wetlands, provided that the changes occur over several years, rather than abruptly, to allow vegetation to adjust to the altered water table.

6.1 Potential ecological effects

- Changes in hydrology that affect the shallow aquifer and vegetation and habitats dependant on the aquifer. May even be a positive net effect.

6.2 Opportunities for mitigation

- Unknown.

7. RIVER RECHARGE WITH GROUNDWATER

Topping up the additional water-take from the river with water sourced from the deep-aquifer is unlikely to have adverse effects on terrestrial ecology in the short-term. Extended use of the aquifer may, however, cause a lowering of the water-table in the shallow aquifers (through percolation of water through the soil

between aquifers as per Michaelsen *et al.* 2010) and this could result in adverse effects on wetlands and indigenous wet forest.

7.1 Potential ecological effects

- Changes in hydrology that affect the shallow aquifer and vegetation and habitats dependant on the aquifer.

7.2 Opportunities for mitigation

- Unknown.

8. EXTEND WAIKANAE BOREFIELD AND/OR STORAGE

Placement of additional bores and pipelines can be micro-sited to avoid areas of significant indigenous vegetation or habitats. Increased use of the aquifer or extending the area over which the aquifer is sourced may, however, cause a lowering of the water-table in the shallow aquifers (through percolation of water through the soil between aquifers as per Michaelsen *et al.* 2010) and this could result in adverse effects on wetlands and indigenous wet forests areas. It is also not entirely sure if additional bores, other than currently installed bores, will tap into the same aquifer or an adjacent aquifer. If it is a different aquifer, then little will be known about the relationship of the new aquifer to the currently used aquifer or the shallower overlying aquifers.

The mixing of stored river water and aquifer water is to ensure that the taste is acceptable to Kapiti Coast residents. The precise mix to achieve this has not yet been finalised. If a greater ratio of stored water is required, then the ponding areas have the potential to be quite large. Within the potential ponding area there is small, 1.37 ha example of kohekohe-karaka-tawa-titoki forest (Wildland Consultants 2007) (Figure 7). In the latest configuration of the storage pond, up to 0.2 ha (14.8%) of this forest could be inundated (Figure 8) but, potentially, the entire area could be inundated. This forest is an under-represented habitat type within the Foxton Ecological District, located on an 'Acutely Threatened' land environment. It will also provide occasional habitat for kereru and other indigenous bird species, and management of plant and animal pests is being carried out. The site is very small and vulnerable to wind/edge effects but has a compact shape and good regeneration occurring within it. The site was ranked as being of 'District Significance'.

8.1 Fauna

None noted during short visit.

8.2 Test drilling

Not required at this stage.

8.3 Potential ecological effects

Possible effects of storage pond construction include:

- Clearance and inundation of vegetation;
- Vegetation clearance may cause surrounding vegetation to dry out by removal of buffer vegetation. Such edge effects are more pronounced in taller vegetation;
- May cause damage to roots of large trees adjacent to clearance areas, with subsequent deterioration in health;
- Potential introduction of unwanted species (e.g. weeds);
- The soil compaction;
- Changes to the water table.
- Changes in hydrology that affect the shallow aquifer and vegetation and habitat dependant on the aquifer.

8.4 Opportunities for mitigation

- Replanting forest edges with suitable eco-sourced indigenous plant species to assist with rapid edge re-establishment.
- Check for weeds on site every three months for the first two years, and yearly thereafter for up to five years or until an indigenous canopy is re-established, and undertake weed control as required.
- Establish temporary fences or high visibility tape around trees and parts of the sites that need to be avoided during construction.
- Employ silt retention devices around the perimeter of the cleared site.
- Undertake or fund pest control within remaining forest areas.

9. DISCUSSION OF EFFECTS

The magnitude of potential ecological effects depends on the quality of the indigenous habitat and the amount of indigenous habitat affected (Table 5). Dams, reservoirs, and associated works at two locations - Ngatiawa and Maungakotukutuku - will adversely affect good quality primary indigenous forest or good quality secondary lowland forest, require clearance of riparian vegetation, and adversely affect habitat that is legally protected (Department of Conservation or private covenant) and has been identified as a Kapiti Coast District Council Ecological Heritage Site. The area affected may be larger than the physical works and inundation footprints due to opening up of the forest (removal of protective vegetation edges), potential weed invasion, likely changes in water-table levels (causing plant death or root rot), and the

potential for soil slumping (additional vegetation loss). Loss of vegetation will also have a moderate impact on habitat available for indigenous fauna, more so at the Ngatiawa site as nearly the entire area of mature tawa forest will be inundated. Due to the amount of vegetation and habitat lost, and the substantial nature of the effects, it seems likely that the effects can only be partially mitigated, or will require an extremely comprehensive and relatively costly mitigation package.

The potential magnitude of effects at the Kapakapanui Dam site are smaller due to a smaller amount of indigenous forest being affected. However, this forest provides riparian protection and contains mature kahikatea. Most of the forest patches affected are discrete, thus the likely additional area affected (e.g. through edge effects, soil compaction) will be smaller than for the previous two dam sites. There are other indigenous forest areas within the subject property that would benefit from fencing and pest control, and this could offset the loss of a relatively small amount of indigenous habitat. There may be issues with upgrading of the access road to the site, as it currently traverses an area of Department of Conservation-managed land, or may require the removal of additional areas of riparian vegetation.

The ecological effects for the 'Extend Waikanae Borefield and/or Storage' option cannot be entirely quantified at this stage as the exact configuration and size of the storage pond has not yet been finalised. The greatest potential ecological effect would be the complete removal of the 1.37 ha indigenous forest remnant. Clearance of a smaller area of forest could result in additional ecological impacts, including edge effects, soil compaction, weed invasion, and, potentially, a change in soil water-table levels due to percolation from the pond.

Table 5: Summary and magnitude of potential ecological effects, and likelihood of offsetting potential adverse effects through mitigation.

	Kapakapanui Dam	Ngātiawa Dam	Lower Maungakotukutuku Dam	Aquifer Storage and Recovery	River Recharge with Ground-water	Extend Waikanae Borefield and/or Storage
Total inundation area (ha)	14.76	19.82	28.07	-	-	Undetermined
Total High and Moderate value area inundated (ha)	1.99	11.19	5.94	-	-	0.20*
% High and Moderate value area inundated	13.49%	56.5%	21.2%	-	-	-
DOC managed land (ha)	Access	1.4	4.41	Unlikely	Unlikely	-
KCDC heritage site (ha)	0	6.51	2.36	Unlikely	Unlikely	1.37
Effect on indigenous vegetation	Moderate	Large	Large	Low	Low	Moderate
Effect on indigenous fauna	Low	Moderate-High	Moderate	Low	Low	Low
Ecological effects	Low-Moderate	High	High	Low	Low	Low-Moderate
Mitigation possible	Yes	Partially	Partially	Unknown	Unknown	Yes

* May 2010 configuration, may yet change and require clearance of entire 1.37 ha indigenous forest area.

All three borefield options have a potential to change shallow aquifer and groundwater levels, mainly through percolation. The 'Aquifer Storage and Recovery' option potentially may re-initiate some local springs that have dried up and increase water levels in wetlands in the vicinity of the aquifer, due to water 'backing up' as percolation into the deep aquifer slows. This is a potential ecological benefit, as it would likely increase the extent, viability, and quality of wetlands. Extraction from aquifers, on the other hand, may lower the shallow aquifer and associated groundwater levels and this could further reduce the size and quality of wetland in the area. It is not clear what mitigation options could be used to offset any changes in groundwater levels.

For all water supply options, weeds introduced by machinery, equipment, or materials, may have adverse ecological impacts on existing indigenous vegetation. This is especially true of weedy vine species, as they could spread to cover extensive areas of the forest canopy or indigenous habitat. Clearance of vegetation and excavation work have the potential to increase sediment run-off, which could affect a wider area than just the work site.

10. CONCLUSIONS

The various bulk-water supply options have a range of potential terrestrial ecological impacts. Adverse effects are likely to be greatest for the Ngatiawa Dam and Lower Maungakotukutuku Dam options, as relatively large areas of good quality lowland forest would be affected. Both sites are also partly legally protected. The Kapakapanui Dam and storage ponds options are likely to have moderate to low ecological impacts, and the bore-field options are likely to have low ecological impacts (depending on how these options affect shallow groundwater hydrology). Adequate mitigation could be undertaken for the Kapakapanui Dam and storage pond options, but could be more difficult and/or expensive for the other two dam options. It is not clear what mitigation could be undertaken should the aquifer options affect shallow groundwater.

REFERENCES

Michaelsen J., Williams A., Pollock G. 2010: Technical Memorandum # 6: Groundwater Model. BECA, Wellington. 6 pp.

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

Wildland Consultants 2003: Kapiti Coast District Council 2002-2003 Ecological Sites survey. *Wildland Consultants Ltd Contract Report No. 662*. Prepared for Kapiti Coast District Council, Rotorua. 60 pp.

Wildland Consultants 2007: Kapiti Coast District Council potential Ecological Sites survey 2007. *Wildland Consultants Ltd Contract Report No. 1684*. Prepared for Kapiti Coast District Council, Rotorua. 30 pp.