9 Appendices

APPENDIX 1: CLIMATIC DATA

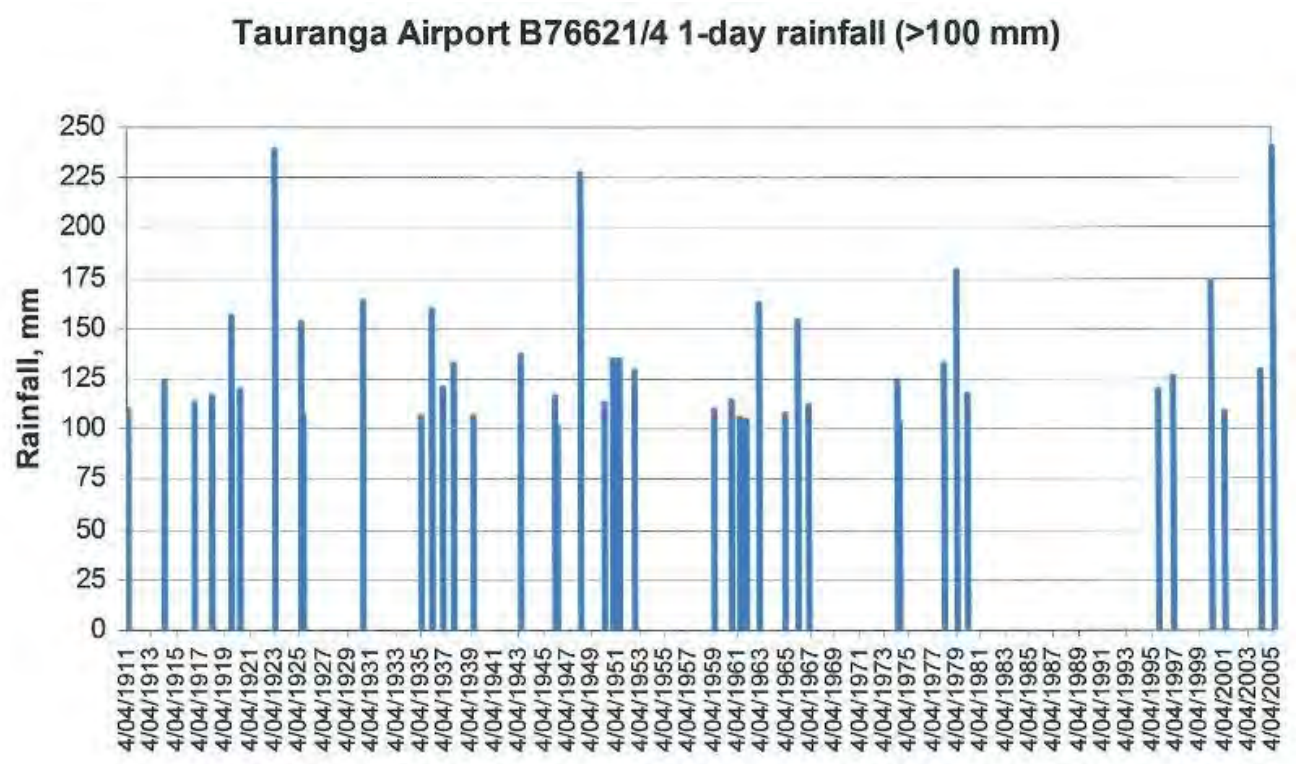
Data supplied by Stuart Burgess of NIWA in June 2005. Note the 24 hour periods are added on a running total over two days to give the 48 hour periods.

Name	Rainfall mm	24 Hour Event	48 Hour Event	Comment
Pikowai Jan 1968	≥ 100	20	47	
	≥ 125	3	21	
	≥ 150	3	10	
	≥ 175		1	
	≥ 200	1	1	
	≥ 250		2	
	≥ 300		1	May 19 2005

Name	Rainfall mm	24 Hour Event	48 Hour Event	Comment
Tauranga Airport 1911	≥ 100	28		
	≥ 125	17	22	
	≥ 150	7	11	
	≥ 175	2	5	
	≥ 200	4	9	
	≥ 250		2	
	≥ 300		1	18 May 2005

Name	Rainfall mm	24 Hour Event	48 Hour Event	Comment
Whakatane Airport Dec 1974	≥ 100	8	16	
	≥ 125	1	8	
	≥ 150		4	
	≥ 175		1	
	≥ 200		1	18 July 2004
	≥ 250			
	≥ 300			

Name	Rainfall mm	24 Hour Event	48 Hour Event	Comment
Rotorua Airport (2) Nov 1963	≥ 100	27	31	
	≥ 125	5	9	
	≥ 150	3	5	
	≥ 175	1	3	
	≥ 200	1	2	2 May 1999
	≥ 250			
	≥ 300			


Tauranga Airport B76621/4 1-day rainfall (>100 mm)
Rainfall, mm
250
225
200
175
150
125
100
75
50
25
0
4/04/1911
4/04/1913
4/04/1915
4/04/1917
4/04/1919
4/04/1921
4/04/1923
4/04/1925
4/04/1927
4/04/1929
4/04/1931
4/04/1933
4/04/1935
4/04/1937
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4/04/1981
4/04/1983
4/04/1985
4/04/1987
4/04/1989
4/04/1991
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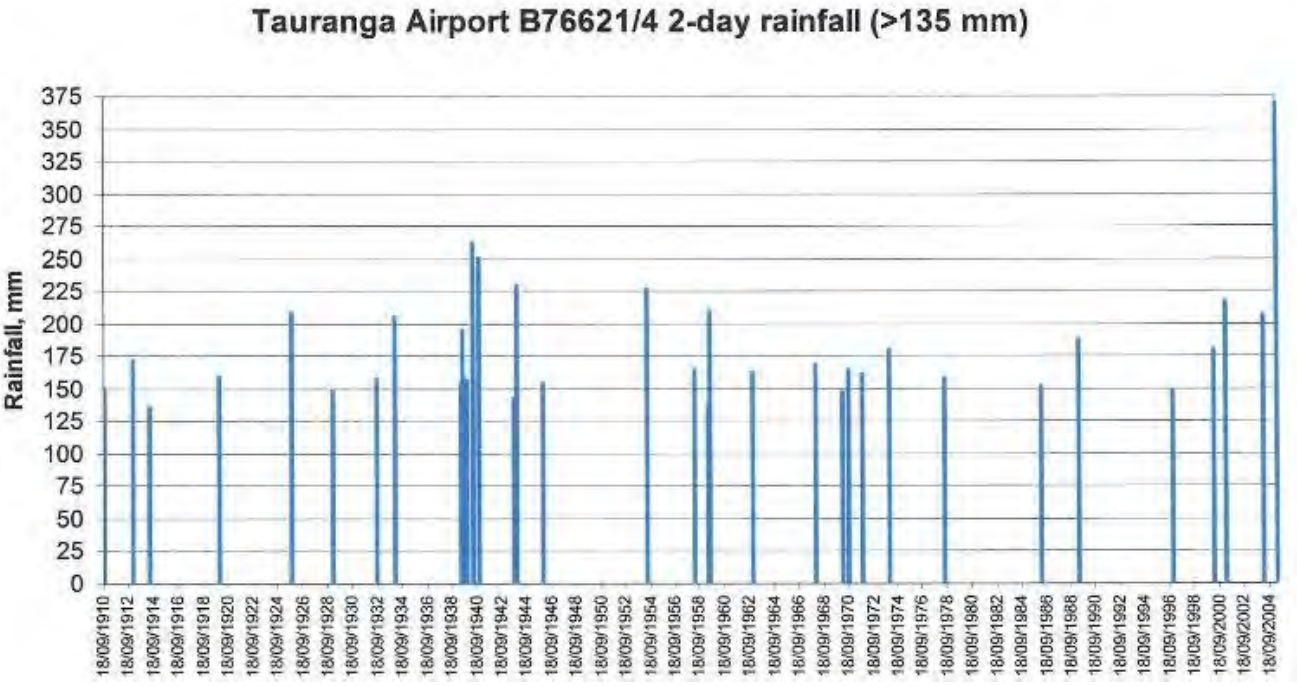
4/04/1995
4/04/1997
4/04/1999
4/04/2001
4/04/2003
4/04/2005


Tauranga Airport B76621/4 2-day rainfall (>135 mm)
Rainfall, mm
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
18/09/1910
18/09/1912
18/09/1914
18/09/1916
18/09/1918
18/09/1920
18/09/1922
18/09/1924
18/09/1926
18/09/1928
18/09/1930
18/09/1932
18/09/1934
18/09/1936
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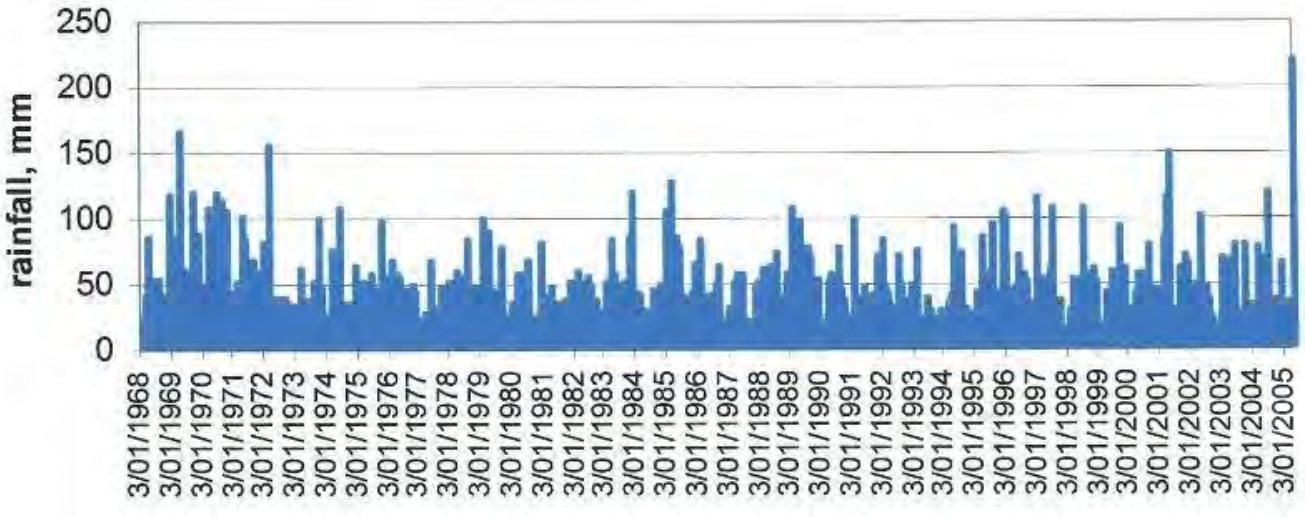
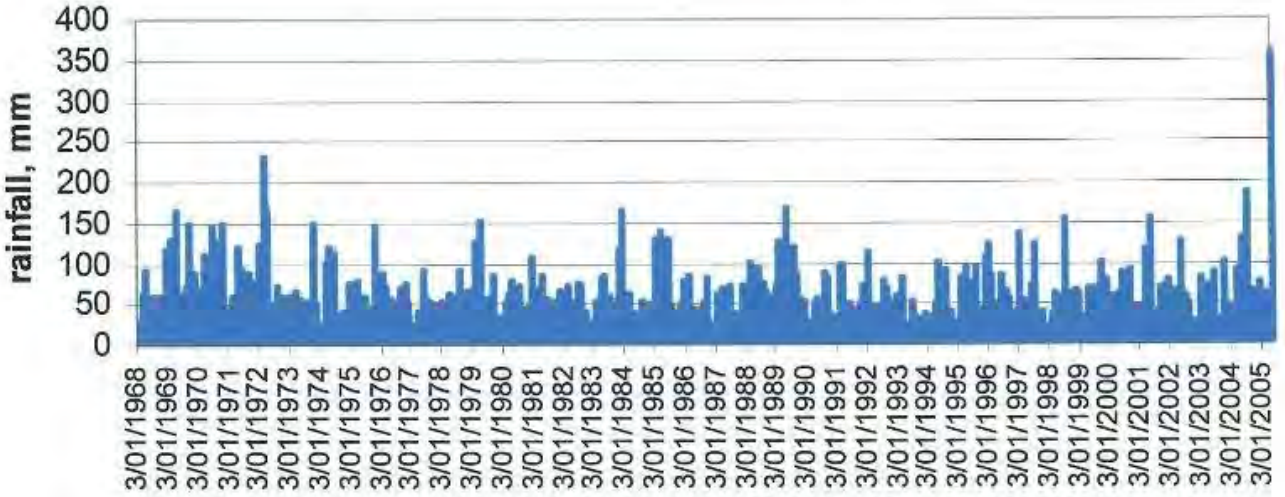
18/09/1968
18/09/1970
18/09/1972
18/09/1974
18/09/1976
18/09/1978
18/09/1980
18/09/1982
18/09/1984
18/09/1986
18/09/1988
18/09/1990
18/09/1992
18/09/1994
18/09/1996
18/09/1998
18/09/2000
18/09/2002
18/09/2004

Pikowai B76861/2 1-day rainfall



Pikowai B76861/2 2-day rainfall



APPENDIX 2: FLORA AND FAUNA ASSOCIATED WITH MATATA WILDLIFE REFUGE RESERVE AND THE EFFECTS OF THE MAY 2005 STORM

Compiled by Keith Owen, Department of Conservation, Rotorua

1.1 Introduction

The Matata Wildlife Refuge Reserve (WRR) (including the Matata Wildlife Refuge (WR)) (collectively called the Reserve) lies in the Te Teko Ecological District and the Whakatane Ecological Region (Irving and Beadel, 1992). These wetlands, lagoons and sand dunes exist in their present state largely as a result of the realignment of the Tarawera River mouth in 1917. Nationally, wetlands are a diminishing resource and few remain unmodified.

The Reserve in association with other nearby freshwater wetlands (Awaiti Wildlife Management Reserve (WMR), Bregmans WMR, etc) forms the remains of what were once the extensive wetland habitats of the Rangitaiki Plains. On the Rangitaiki Plains only about 1.7% now remains today (Irving and Beadel, 1992). The lagoon and wetland areas of the Reserve have exceptional or high botanical values (Beadel 1995).

It should be noted that the following botanical and wildlife accounts that follow are those in existence prior to the May 2005 storm event.

1.2 Vegetation and Flora

A botanical assessment of the wetland, lagoons and sand dunes was carried out in 1991 to ascertain community types and species composition (Irving & Beadel 1992). This work identified fourteen vegetation types and these were mapped (Figure 6).

The types were:

Wetlands

Juncus- oioi rushland
(Flax)/*Juncus*- oioi-*Baumea* association
Marsh ribbonwood shrubland
Herbfields
Raupo reedland
Carex geminata sedgeland
(Willow)/*Baumea juncea* community
Reed sweet grassland
Open water

Drylands

(African boxthorn)/*Muehlenbeckia* shrub and vineland
Grasslands
Honeysuckle-tall fescue-(pampas) grass and vineland
Road verges and disturbed areas
Gorse-pampas-blackberry

A total of 185 higher plant species have been recorded in the Reserve (see Appendix 3). Two nationally threatened plant species are found in the Reserve. They are the threatened fern *Cyclosorus interuptus,* At Risk-Declining (de Lange *et. al*. 2009) recorded at two sites in the wetland (a total of about 21 plants) and pingao (*Ficinia spiralis*) At Risk-Relict (de Lange *et. al*. 2009), a sand binding plant which is growing in scattered colonies along the top and seaward side of the dunes.

What is so unique and outstanding about the Reserve is the complex dune land-wetland-open water system on the freshwater-saltwater interface. This is not found anywhere else in the Whakatane Ecological Region (the closest to this type would be Thornton Lagoon WMR where water is ponded behind fore dunes at the mouth of the Rangitaiki River).

For the benefit of management the constituent parts of the Reserve can be ranked into categories of relative botanical importance (1. being the most important):
Juncus-oioi rushland.
(Flax)/*Juncus*-oioi-*Baumea* association, herbfields, marsh ribbonwood shrubland.
Raupo reedland, *Carex geminata* sedgeland, open water, (African boxthorn)/*Muehlenbeckia* shrub and vineland.
(Willow)/*Baumea juncea* community, grasslands.
Road verges and disturbed areas, gorse-pampas-blackberry, reed sweet grassland, honeysuckle-tall fescue-(pampas) grass and vineland.

1.3 May 2005 Storm Event Impacts on Vegetation and Flora

The vegetation communities most heavily impacted by the storm event were the raupo reedland, *Carex geminata* sedgeland and honeysuckle-tall fescue-pampas grass and vinelands at the western end of the western lagoon. These were destroyed by huge deposits of silt and debris caused by the over topping of the Awatarariki Stream by flood waters coming from the catchment. The western lagoon was totally in-filled by an enormous amount of silt and debris deposits destroying the open water area and replacing it with a silt pan and a very limited area of shallow water. At the western end of the east lagoon the raupo reedland and honeysuckle-tall fescue-pampas grass and vinelands vegetation was largely destroyed by the flood water and silt coming from the Waitepuru Stream catchment creating a silt fan at the western end.

1.4 Fauna

The Reserve is recognised as a significant wildlife habitat. The former New Zealand Wildlife Service (NZWS) ranked the Reserve as a Site of Special Wildlife Interest (SSWI) of high wildlife habitat value (Rasch, 1989). This ranking was the second highest accorded on a 5 tier ranking system. The Rasch report describes the notable wildlife features as:

Progression of estuarine rush wetland to freshwater raupo-flax wetland, bordered by scrub and dunes. It's relatively unmodified but has invasive willow. Large number of species inhabits the Reserve including banded rail, NZ dabchick, spotless crake, marsh crake, Australasian bittern, white heron, reef heron, and Caspian tern and North Island fernbird."

The Bay of Plenty Branch of the Ornithological Society of NZ has carried out twice yearly counts of all the water bird species in the Reserve between June 1989 and November 2003 (Owen, et al. 2006). Their counts (and those of the former NZWS) show that 43 species of birds mainly water birds (waterfowl, waders, herons, shags, gulls, terns, rails and fernbird) are fully or partially dependant on the wetland for their yearly and/or seasonal habitat requirements (see Appendix 4 for their common and scientific names and their status).

The wetland has many features of good wetland wildlife habitat. There are open water areas in both lagoons for loafing water birds especially waterfowl, shallow margins for wading birds, sheltered areas of vegetation for secretive species such as fernbird, rail and bittern, banks for shags and herons to roost and islands for potential breeding sites.

In addition to these species, grey teal, NZ scaup, grey duck, mallard, paradise shelduck, black swan and Canada geese reside in good numbers at the lagoons especially during the waterfowl hunting season when the Reserve becomes extremely popular as no hunting is permitted. Wading birds such as spur-winged plover, black-fronted dotterel and royal spoonbill also frequent the wetland most often at the western end of the east lagoon.

Daily inhabitants include good numbers of the following waterfowl NZ scaup, Australasian shoveler, paradise shelduck, grey teal, grey duck, NZ dabchick, Australasian coot, mallard, black swan, Canada geese and feral geese. The following wading birds use the shallow or dry margins of the two lagoons, pied stilt, white-faced heron, spur-winged plover, white heron, royal spoonbill, variable oystercatcher and northern NZ dotterel. Other rare migratory visitors recorded there include little egret, black-fronted dotterel, sharp-tailed sandpiper, turnstone, banded dotterel, black-fronted tern, white-winged black tern and Eastern cattle egret.

The open water areas are used regularly by little shag, little black shag, black shag, pied shag, Caspian tern, white-fronted tern, red-billed gull, black-billed gull, and southern black-backed gull. Pukeko, banded rail, North Island fernbird and Australasian bittern inhabit the dense vegetated raupo reed lands and salt marsh margins of both lagoons.

A total of twenty-two threatened bird species (Miskelly, *et. al* 2008) have been recorded at the Reserve. They are NZ dabchick, black shag, pied shag, little black shag, little shag, white heron, reef heron, Australasian bittern, royal spoonbill, grey duck, banded rail, spotless crake, marsh crake, pied stilt, northern NZ dotterel, banded dotterel, red-billed gull, black-billed gull, black-fronted tern, Caspian tern, white-fronted tern and North Island fernbird.

1.5 May 2005 Storm Event Impacts on Fauna

The May 2005 storm event effectively destroyed (by infilling) the very important open water areas of the western lagoon and the eastern portion of the east lagoon and heavily silted and discoloured the remaining open water areas found in the east lagoon. These were heavily utilised by good numbers of waterfowl, shag, heron, wader, and tern and gull species. Most of these species have been forced to vacate the wetland to other wetland habitats in the region and are most were unlikely to return until such time as the lagoons are restored back to open water habitats suitable to these species for their daily and/or seasonal feeding, breeding and roosting requirements.

The loss of raupo reed lands and *Carex geminata* sedge land areas will have the greatest impacted on species such as spotless crake, banded rail, marsh crake, North Island fernbird and Australasian bittern that inhabit these areas. All these secretive species rely heavily on dense wetland vegetation and their margins for their habitat, feeding and breeding requirements. Waterfowl also use these areas extensively for loafingl, resting, breeding and as cover from predators. Unfortunately large areas of this vegetation type have been lost from the wetland. It's hard to quantify the loss as we have a very poor understanding of the distribution of these species at the wetland before the storm event but it’s likely to be substantial.

The loss of honeysuckle-tall fescue-pampas grass and vine land areas will on the other hand have limited impact on most species of wetland bird and is of minor concern.

APPENDIX 3: VASCULAR PLANT SPECIES LIST, MATATA WILDIFE REFUGE RESERVE

Compiled by Robyn M. Irving & Sarah M. Beadel, April 1992.

(* = Introduced, p = Planted)

BOTANICAL NAME	COMMON NAME	
TREES AND SHRUBS		
Coprosma propinqua		
C. repens	taupata	
C. robusta	karamu	
C. tenuicaulis	swamp coprosma	
C. propinqua x *C. robusta*		
Cordyline australis	cabbage tree	
Coriaria arborea	tutu	
Geniostoma ligustrifolium var. *ligustrifolium*	hangehange	
Hebe stricta	koromiko	
Kunzea ericoides	kanuka	
Leptospermum scoparium	manuka	
*Ligustrum sinense**	chinese privet	
*Lupinus arboreus**	tree lupin	
*Lycium ferocissimum**	African boxthorn	
*Metrosideros kermadecensis**	Kermadec pohutukawa	p
*Myoporum insulare**	Australian ngaio	p
*Paraserianthes lophantha **	brush wattle	
Plagianthus divaricatus	marsh ribbonwood	
*Ricinus communis**	castor oil plant	
*Salix cinerea **	grey willow	
*S. fragilis**	crack willow	
*Tecomaria capensis**	tecomaria	
DICOTYLEDONS: HERBS AND LIANES		
*Achillea millefolium**	yarrow	
*Amaranthus viridis**	green amaranth	
*Anagallis arvensis**	scarlet pimpernel	
*Arctotheca calendula **	cape weed	
Apium prostratum	native celery	
*Aster subulatus**	sea aster	
*Atriplex prostrata**	hastate orachne	
*Bellis perennis**	daisy	
*C. stagnalis**	starwort	
Calystegia sepium var. *roseata*	convolvulus	

C. soldanella	shore convulvulus
Cardamine debilis	cress
*Carduus tenuiflorus**	thistle
Centella uniflora	
Ceratophyllum demersum *	hornwort
*Cirsium vulgare**	Scotch thistle
*Chenopodium album**	fathen
*C. ambrosioides**	Mexican tea
*Conyza sumatrensis**	fleabane
Cotula coronopifolia	bachelor's button
*Crepis capillaris**	hawksbeard
Daucus carota *	wild carrot
*Dipsacus sylvestris**	teasel
*Echium vulgare**	viper's bugloss
Elatine gratioloides	
Epilobium pallidiflorum	
*Euphorbia peplus**	milkweed
*Foeniculum vulgare**	fennel
*Fumaria muralis**	scrambling fumitory
*Galium aparine**	cleavers
*G. palustre**	marsh bedstraw
*Geranium molle**	dove's foot cranesbill
*G.robertianum**	herb robert
Haloragis erecta	shrubby haloragis
Hydrocotyle pterocarpa	
Hypochaeris radicata *	catsear
*Leontodon taraxacoides**	hawkbit
*Lepidium bonariense**	Argentine cress
*Leucanthemum vulgare**	ox-eye daisy
*Lepidium didymium**	twin cress
Lilaeopsis novae-zelandiae	
Lobelia anceps	New Zealand lobelia
*Lotus pedunculatus**	lotus major
Lonicera japonica *	Japanese honeysuckle
*Ludwigia palustris**	water purslane
*L. peploides subsp. montevidensis**	water primrose
*Lythrum hyssopifolia**	purple loosestrife
*Melilotus indicus**	melilot
*Mentha pulegium**	pennyroyal
M. x *piperita* var. *citrata**	
Muehlenbeckia australis	pohuehue
M. complexa	pohuehue

*Myosotis arvensis**	forget-me-not
Myriophyllum propinquum	water milfoil
*Physalis peruviana**	cape gooseberry
*Phytolacca octandra**	inkweed
*Plantago australis**	plantain
*P. coronopus**	plantain
*P. lanceolata **	plantain
*P. major**	plantain
Persicaria decipiens	swamp willow weed
*Persicaria hydropiper**	water pepper
*Prunella vulgaris**	selfheal
*Ranunculus flammula**	spearwort
*Ranunculus repens**	creeping buttercup
*R. scleratus**	celery leaved buttercup
*Rosa rubiginosa **	sweet briar
*Rubus fruticosus agg. **	blackberry
*R. phoenicolasius**	Japanese wineberry
*Rumex acetosella **	sheep sorrel
*R. conglomeratus**	dock
Samolus repens	sea primrose
Selliera radicans	remuremu
*Senecio bipinnatisectus**	fireweed
*S. elegans**	purple groundsel
*S. skirrhodon **	gravel groundsel
*Sisymbrium officinale**	hedge mustard
Solanum nodiflorum	nightshade
*Sonchus oleraceus**	sow thistle
*Stellaria media**	chickweed
Suaeda novae-zelandiae	
*Taraxacum officinale**	
*Tropaeolum majus**	garden nasturtium
*Trifolium pratense**	red clover
*T. repens**	white clover
*Ulex europaeus**	gorse
*Verbena bonariensis **	vervain
*Vicia sativa **	vetch

MONOCOTYLEDONS (SEDGES, RUSHES, GRASSES, POND WEEDS ETC.)

*Agrostis capillaris**	brown top
*A. stolonifera **	creeping bent
*Alisma plantago - aquatica**	water plantain
*Alopecurus geniculatus**	kneed foxtail
*Ammophila arenaria **	marram
*Anthoxanthum odoratum**	sweet vernal
Apodasmia similis	oioi
*Asparagus officinalis **	asparagus
Baumea articulata	
B. juncea	
B. rubiginosa	
Bolboschoenus fluviatilis	purua grass
*Bromus hordeaceus**	soft brome
*Canna indica **	canna lily
Carex geminata	
C. maorica	
C. pumila	sand sedge
C. secta var. *secta*	pukio
C. virgata	
*Cortaderia selloana **	pampas
C. toetoe	toetoe
*Cyperus congestus **	
*C. eragrostis**	
*C. sp. (papyrus?)**	
C. ustulatus	coastal cutty grass
*Dactylis glomerata **	cocksfoot
Eleocharis acuta	spike sedge
Ficinia nodosa	knobby sedge
Ficinia spiralis	pingao
*Glyceria maxima**	reed sweetgrass
*Holcus lanatus**	Yorkshire fog
Isachne globosa	swamp millet
Isolepis cernua	
*Juncus acuminatus**	rush
*J. bufonius**	rush
J. edgariae	rush
*J. effusus**	rush
J. krausii var. australiensis	sea rush
J. pallidus	
J. planifolius	

J. sarophorus	
*J. tenuis**	
Lachnagrostis billardieri	sand wind grass
*Lagurus ovatus**	harestail
Lemna minor	
*Lolium perenne**	perennial ryegrass
*Paspalum dilatatum **	paspalum
*P. distichum **	Mercer grass
*Pennisetum clandestinum**	kikuyu grass'
Phormium tenax	New Zealand flax
*Poa annua **	annual poa
Ruppia sp.	
*Schoedonorus arundinaceus**	tall fescue
Schoenoplectus pungens	three square
S. tabermontani	
Spinifex sericeus	spinifex
*Sporobolus africanus**	ratstail grass
Triglochin striata	arrow grass
Typha orientalis	raupo
*Zantedeschia aethiopica **	arum lily

FERNS

Asplenium flaccidum subsp. *flaccidum*	spleenwort
A. oblongifolium	shining spleenwort
A. polyodon	sickle spleenwort
*Azolla pinnata **	floating water fern
Blechnum filiforme	thread fern
B. minus	swamp kiokio
Cyclosorus interruptus	
Cyathea dealbata	ponga
C. medullaris	mamaku
Deparia petersenii	
Dicksonia squarrosa	wheki
Histiopteris incisa	water fern
Hypolepis ambigua	
Microsorum pustulatum	hound's tongue
Paesia scaberula	ring fern, pig fern
Pteridium esculentum	bracken
Pteris macilenta	sweet fern
Pteris tremula	
Pyrrosia eleagnifolia	leather fern

APPENDIX 4: WETLAND BIRD LIST, MATATA WILDLIFE REFUGE RESERVE

Complied by Keith Owen, Department of Conservation, Rotorua

Status: E – Endemic, I – Introduced, M – Migrant, N – Native
* Indicates that these species are listed as threatened species (Miskelly *et al*. 2008).

Scientific name	Common name	Status
Poliocephalus rufopectus	New Zealand dabchick *	E
Phalacrocorax carbo novaehollandiae	Black shag *	N
Phalacrocorax varius varius	Pied shag *	N
Phalacrocorax sulcirostris	Little black shag *	N
Phalacrocorax melanoleucos brevirostris	Little shag*	N
Egretta novahollandiae novahollandiae	White-faced heron	N
Ardea modesta	White heron *	N
Egretta garzetta immaculata	Little egret	N
Egretta sacra sacra	Reef heron *	N
Ardea ibis coromanda	Eastern cattle egret	M
Botaurus poiciloptilus	Australasian bittern *	N
Platalea regia	Royal spoonbill*	N
Cygnus atratus	Black swan	I
Branta canadensis maxima	Canada goose	I
Anser anser	Greylag goose	I
Tardona variegata	Paradise shelduck	E
Anas platyrhynchos platyrhynchos	Mallard	I
Anas superciliosa	Grey duck *	N
Anas gracilis	Grey teal	N
Anas rhynchotis	Australasian shoveler	N
Aythya novaeseelandiae	New Zealand scaup	E
Circus approximans	Swamp harrier	N
Gallirallus philippensis assimilis	Banded rail *	N
Porzana tabuensis tabuensis	Spotless crake *	N
Porzana pusilla affinis	Marsh crake *	N
Porphyrio melanotus melanotus	Pukeko	N
Fulica atra australis	Australian coot	N
Haemotopus unicolor	Variable oystercatcher	E
Himantopus himantopus leucocephalus	Pied stilt *	N
Charadrius obscurus aquilonius	Northern New Zealand dotterel *	E
Charadrius bicinctus bicinctus	Banded dotterel *	E
Elseyornis melanops	Black-fronted dotterel	N
Vanellus miles novaehollandiae	Spur-winged plover	N
Arenaria interpres	Ruddy turnstone	M
Calidris acuminata	Sharp-tailed sandpiper	M

Larus dominicanus dominicanus	Southern black-backed gull	N
Larus novaehollandiae scopulinus	Red-billed gull*	N
Larus bulleri	Black-billed gull *	E
Chlidonias leucopterus	White-winged black tern	M
Chlidonias albostriata	Black-fronted tern *	E
Hydroprogne caspia	Caspian tern *	N
Sterna striata	White-fronted tern *	E
Bowdleria punctata vealeae	North Island fernbird *	E

APPENDIX 5: EVALUATION OF RESTORATION OPTIONS: MATATA WILDLIFE REFUGE RESERVE RECOVERY

A spectrum of options were considered ranging from minimal intervention – leaving the western lagoon in-filled and attempting to restore conservation values – to the complete restoration of the Reserve to its state prior to the debris flow. Different scenarios were developed between these two extremes to provide a range of realistic restoration options that could restore the ecological significance of the Reserve.

The options for long term rehabilitation assessed of both western and east lagoons were;

Option A: Create a Terrestrial Dry Ecosystem.

This option would have involved leaving the sediment where it was in the western lagoon and planting either coastal forest or shrubland to create an indigenous terrestrial ecosystem. The Awatarariki Stream and any incoming drains would have been channelled with riparian vegetation along the banks. Wetland ponds could have been established in low-lying or floodable areas.

This option required no major earthmoving, but would have required landscaping, planting, weed and pest control, assessment of the ability of the Reserve to withstand and affect flooding and future debris flows. However this option was not consistent with the current wildlife reserve status.

This option would have created a different ecosystem from that existing before the debris flow and would result in a change in the flora and fauna present. While coastal forest/shrubland is rare in the Te Teko Ecological District, the significant wetland values that existed prior to the debris flow would have been lost, along with the faunal habitat it provided. Management activities such as weed control, recreational opportunities and plantings would have had to increase from the previous management requirements. The main loss of habitat would have been for wading bird species and fish, although the stream could have provided a suitable passage for some fish species.

Option B: Create a Lagoon with Bird Roosting Islands

This option involved excavating sediment from the western lagoon to create a shallow water body with a number of small low ‘islands’ formed from the sediment and possibly buttressed by tree stumps and trunks in the lagoon. The shallow water body could have, depending on water flows and levels, be managed as a shallow lagoon or a wetland. A shallow lagoon could have provided more open water areas for wader feeding. This might have required raising the water level of the lagoon slightly after earthworks to provide sufficient water depth. The islands would have been managed to provide wader (stilts, dotterels, plover, etc) roosting/nesting sites and be kept largely free of vegetation with a covering of sand, shell or pebbles.

There would have needed to be some shifting of sediments. This would have necessitated further studies of the hydrological behaviour of the system, and determining appropriate designs for habitat creation and maintenance, landscaping and planting. The past management issues with siltation would have continued, although silt traps or raupo reed land areas could be established to manage this. The main advantage is that it would have recreated a wetland and wildlife refuge values that existed before, and provided enhanced wader habitat but limited that for waterfowl species.

Option C: Create a Wetland Environment

This option would have involved excavating sediment from the western lagoon to form a shallow water body mostly covered by freshwater wetland vegetation. This would have created suitable wetland habitat for secretive wetland bird species and uncommon wetland botanical communities.

This would have required a lot of landscaping, management of water flows and levels and the planting of wetland vegetation, as well as plant pest control requirements.

While providing conservation values, it would differ from those existing prior to the debris flow, and birds that prefer open water would not return. There would also be a loss of local aesthetic values due to the loss of an open water area.

Option D: Restore a Smaller Area of Open Lagoon Water

This option proposed moving most of the sediment deposited in the previously open lagoon to the western end of the western lagoon, creating an open lagoon smaller than that existing previously and a building up a terrestrial area at the western end where the sediment would be deposited. The relative sizes of the lagoon and dry part will be dependant on the amount of sediment moved. There was potential for several different uses of this western ‘reclaimed’ area, including plantings, the development of a channelled stream with riparian vegetation and possible recreational/interpretation uses.

The creation of an area of open lagoon water would provide open water habitat for water birds, and associated ecological and cultural benefits, although the open water habitat value would be reduced due to the reduction in lagoon size. There would continue to be an issue with the gradual infilling of the lagoon with silt and sediment, the effect of which would be more serious due to the reduced size of the lagoon. The amount of sediment to be moved was much greater than any of the previous options and care would be required to avoid exposing the layer of contaminated organic wood fibre underlying the sediment.

Option E: Restore the Wildlife Reserve as it was before the May 2005 flood.

This would be an attempt to restore the Reserve, including both lagoons, to their previous state. Given the changes to the area and the amount of damage done, this complete restoration option would prove difficult or near impossible to achieve. Although an even incomplete restoration could provide some of the original western lagoon open water habitat, there were many issues to consider. These included regaining suitable water flows and establishing water levels; the vast amount of sediment to be moved and disposed of; and the possibility of raising local expectations to a point that was not achievable.

This option would involve excavating the silt and debris out of the in-filled lagoon area and moving it to either the western end of the Reserve or disposal off-site. An assessment of the amount of sediment to be moved and the disposal options, had to be considered before work could begin. This option would require the largest amount of sediment to be moved of all the options and therefore the most expensive to do.

Another issue was that the lagoon, as it was before the debris flow, was not a natural environment, but one artificially managed to provide wildlife habitat. It was under ongoing threat from gradual infilling from stream sediment, coastal dune blowouts and invasive weeds. Even complete restoration of the Reserve along the lines of this option would result in these pressures continuing.

Options assessed against key criteria

Each of the 5 options were given an assessment score for each criteria ranging from 0 (definitely does not meet criteria) to 3 (expected to exceed criteria). Scores between these reflect potential effectiveness and likelihood of achieving this work. Each criterion ‘set’ has 5 values and therefore biological, physical processes and social /community values associated with each criterion were accorded equal weight. The wildlife reserve status and long term sustainability were essential criteria and so are given extra weightings.

Evaluation Matrix: Options assessed against key criteria

Criteria	Option A	Option B	Option C	Option D	Option E
Biological Values					
Plant Communities	2	3	3	2	2
Avian Fauna	1	3	2	3	3
Fish	1	2	2	2	3
Wetlands	0	2	3	2	3
Weeds	2	1	1	1	1
Physical Constraints					
Resilience to future debris flow events	2	1	1	1	0
Sedimentation	3	2	2	1	1
Disturbance of contaminated organic sediments	3	2	2	1	1
Amount of sediment to be moved	3	2	1	1	0
Supply and Management of Water quantity and levels	2	2	1	1	1
Social and Community Values					
Natural Character and Aesthetic Values	1	3	2	2	3
Opportunities for Recreation	2	1	1	1	1
Opportunities for Interpretation	1	3	3	3	3
Community Involvement	3	3	3	3	2
Recognition of Cultural and Historical Values	1	2	2	3	3
Misc.					
Meets Wildlife Reserve Status Criteria	1	3	3	3	3
Long Term Sustainability	3	2	2	1	0
Totals	**31**	**37**	**34**	**32**	**31**

The criteria used are defined as follows;

Biological Values

Plant Communities – there was scope for a natural indigenous vegetation community capable of supporting rare or uncommon species or associations.

Avian Fauna – the establishment of suitable habitat would be provided for a range of common, threatened or rare bird species, including feeding, roosting and nesting habitats.

Fish – the establishment of suitable habitat for fish species, including whitebait spawning.

Wetlands – wetlands are rare in this ecological district and enhancing or creating them is consist with CMS Management Option 3.5.6.2; Assess opportunities that arise for creating new wetlands.

Weeds - includes the potential threat posed by weed invasion and the likely effort required to control them.

Physical Constraints

Resilience to future debris flow events

– as this restoration effort has been necessitated due to the effects of a debris flow, and it is certain that debris flows will continue to occur, it is important that the effects of these on the functioning of the option are assessed.

Sedimentation – the control and minimisation of sediment infilling the lagoon has been a major management issue of the past lagoon. An opportunity to avoid or control this issue is important in assessing the options

Disturbance of contaminated organic sediments

– there is a layer of wood fibre discharged by the Tasman Pulp and Paper Mill lying some 50 cm (pre debris flow) under the sediments of the lagoon. Although they may not be highly contaminated, their uncovering would adversely affect the amenity and biological functioning of the area. This value measures the ability to avoid disturbing the layer.

Amount of sediment to be moved

–the more sediment moved, the higher the cost of the restoration and the more issues with possible disposal requirements.

Supply and Management of Water Quantity and Levels

- to recreate a wetland or lagoon environment, management of incoming water and water levels was required, as it was prior to the debris flow. This assesses the ease of attaining desired water flows.

Social and Community Values

Natural Character and Aesthetic Values

- The re-establishment of the natural character of the area and aesthetic components such as open water and bird species.

Opportunities for Recreation

- Assesses the opportunity for recreational developments on the Reserve. Most options are limited to passive recreation due to the Reserve status.

Opportunities for Interpretation

- Management Option 3.5.2.6 of the CMS states that the Department will undertake public awareness programmes to increase understanding of coastal processes and ecosystems.

Community Involvement

-Community support and involvement in the restoration is considered essential for its success.

Recognition of Cultural and Historical Values

- The option

Other

Meets Wildlife Reserve Status Criteria

- As the underlying status and the purpose for which the land is held is Wildlife Refuge Reserve, an option that provides habitat for wildlife is supported.

Long Term Sustainability

- This criterion assesses the collective sustainability of the option and the ecosystem to be established, which is regarded as an important aspect.

So what changes are there in the physical environment, what effects would these have on the conservation values, which ones are unsavoury and what (if anything) can be done to avoid, remedy or mitigate them?

Analysis of Options

Option A: Leave sediment there in the western lagoon, place drains through the wetland (channelling Awatarariki Stream and incoming drains) and plant with dominantly terrestrial vegetation – need for planting of riparian vegetation along stream banks, possibly wetlands in low lying or floodable areas.

Vegetation would be either low-lying scrub or higher coastal forest.

Strengths

- Indigenous coastal terrestrial vegetation is rare in the Te Teko Ecological District, as most has been cleared.
- Recreational opportunities – walking tracks, etc
- Easy to maintain – access to weeds, etc
- Least disturbance to site
- Attract different group of birdlife to area e.g. forest birds.
- Filtration by plants before water seeps through to river channel?
- Can finally forget about the issues with siltation!

Weaknesses

- Loses current significant wetland values
- Reduces ability to cope with future flooding events and storm water drainage
- May not satisfy community who have a concern for their wildlife and fisheries, although if managed as a freshwater stream, it may have some fishery values.
- Also community concerns about wildlife loss
- Creating a 'new ecosystem'
- Tall vegetation may not please residents who lose their scenic views.

Threats

- Rubbish, disturbance of wildlife by people
- Not being accepted by community
- May be well suited to weed establishment (pampas, willows, blackberry, etc.)
- Pest animals impact on forest birds (unless controlled)

Opportunities

- Possibility of creating complete succession from coastal dunes to nearby Matata SR (except for the road, etc)

Issues

Although there may be some advantages undertaking this option, the change in conservation values and the loss of coastal amenity would be unacceptable to the local community. It would also require a change in the ranking in the Regional Coastal Environment Plan.

Option B: This option, defined as a shallow water body with a number of small islands (exact design to be determined) would be created by excavating some sediment to form islands and hollows in the western lagoon. This would operate as a functioning shallow lake/wetland with the islands being bird habitat/roosting sites. This is dependant on the ability to design, retain and manage water flows.

Raising the level of the lagoon had previously been considered and there were a number of issues associated with this proposal that still remain. The lagoon water level was last raised in 1985; this was made possible by the upgrading and raising of the tennis courts. A further rising of the courts and the placement of bunds was considered by the former Ministry of Works a few years later, but the natural porosity of the sediments and the potential effect of this on flood levels in the town led to this proposal being rejected. Placement of a drain from around the court area directly to the lower lagoon would have overcome this objection and allow the tennis court to be retained at its present level.

Strengths

- Retains wildlife Reserve values
- Recreates notable lagoon/wetland habitat for wading birds
- No removal of silt/debris off site
- Re-introducing water into the lagoon
- Provides habitat for some uncommon bird species as well as for some water fowl species
- Community still have water views
- Potential for birdwatchers, tourists, etc to visit wetland

Weaknesses

- Requires design, reshaping and planting – includes hydrological and engineering input regarding earthworks and water management.
- There could be issues with retaining suitable water levels for the wetland without flooding or drying it out?
- There would still be siltation and infilling issues, although silt traps, raupo reed lands, etc could be incorporated into the design (this could be considered as part of the natural process of wetland evolution over time)
- Need to be certain of regular freshwater inflows to maintain the aquatic values

Threats

- Resilience to future floods/debris flows?
- Weed issues slightly harder to address than in Option 1.
- Had to take care not to expose black organic layer estimated at approx. 50 cm depth before flooding. Highly unlikely given the depth of new sediment.

Opportunities

- Could work well with recreational plans
- Education/interpretation opportunities
- Community involvement in planting
- Potential for community input into design of system, allowing visual amenity issues to be addressed

Issues

This option would need to be done well, and may be slightly more costly than envisaged by residents or councils, but it had the potential to produce a lot of conservation/habitat values.

Option C: Create a largely vegetated wetland in the western lagoon, with the opportunity to route a recreational boardwalk and walkway through or around part of it.

This option consists of managing the lagoon to produce a shallow water wetland; contouring and flattening off sediment, undertaking some landscaping and a lot of wetland planting, with associated weed control in the short-medium term.

Strengths

- Restores wetland habitat for secretive wetland bird species and uncommon botanical communities
- Limits sediment removal/shifting
- Provides a natural area as a scenic view from the township

Weaknesses

- There could be issues with retaining suitable water levels for the wetland without flooding or drying it out, or having a steady flow of water?
- Exclusion of bird species that prefer open water. Not as good for some bird species that previously used the lagoon but good for more secretive species.
- Effectively raises water level above previous level; may cause flooding

Threats

- Weeds (willow, raupo, etc, could invade).
- Not resilient to either flooding or debris flows
- Could involve raising water levels (see comments in option above)

Opportunities

- Could work in with community aspirations for a walkway, although most of the options have this ability as well

Issues

Perception of loss of open water to community
Would create a wetland without open water areas

Option D: Shift sediment from the previously open lagoon area to the western end of the western lagoon, creating a smaller open lagoon and a terrestrial/wetland area at the western end, depending on contouring levels. This would involve shifting a lot more sediment than any of the previous options, but would allow the restoration of a much reduced area of open water.

Strengths

- Restoring an area of open lagoon water, providing both conservation and social benefits
- Providing habitat for a variety of water bird species
- Coastal sequence vegetation possible?

Weaknesses

- Involves moving a lot more sediment than any of the options above
- Would still be long term issues with infilling of lagoon with a protruding sediment delta or raupo community at stream outlets
- Effectively, would end up with half a lagoon and some dry land, which suggests a net loss of conservation values
- Community concern about digging up sediment/toxins

Threats

- Must take care not to expose black organic layer estimated at approx. 50 cm depth before flooding

Opportunities

- Potential for community support to restore lagoon

Issues

Depending on the habitat requirements of water bird species that have used the lagoon in the past, further thought must be given to the use of the 'reclaimed' western end of the lagoon. Possibly excavating a large silt trap and the rest could be planted into coastal forest; part would be required for wetland plant communities.

Option E: Restore the western lagoon as it was before the May 2005 flood. This option would involve excavating silt/debris out of 'old lagoon area' and placing this debris in a previously drier area at the western end of Reserve (this would then need to be re-vegetated or placed adjacent to the dune systems).

Strengths

- Restores original lagoon habitat
- Ability to re-create open water lagoon area as it was
- Water area easily managed compared to replanting whole area

Weaknesses

- Issues with retaining suitable water levels for the wetland without flooding or drying out, and having a steady flow of water. i.e. May not gain water level exactly as before
- Large amounts of sediment will need to be excavated and dumped at western end of lagoon or elsewhere
- Still have issue of future siltation
- May prove difficult to re-distribute such a large amount of spoil over a limited area and will require planting to cover area
- Is it worth recreating something that was 'artificial' to begin with?

Threats

- Must take care not to expose black organic layer estimated at approx. 50 cm depth before flooding
- Raising community expectations to something that may be unachievable?

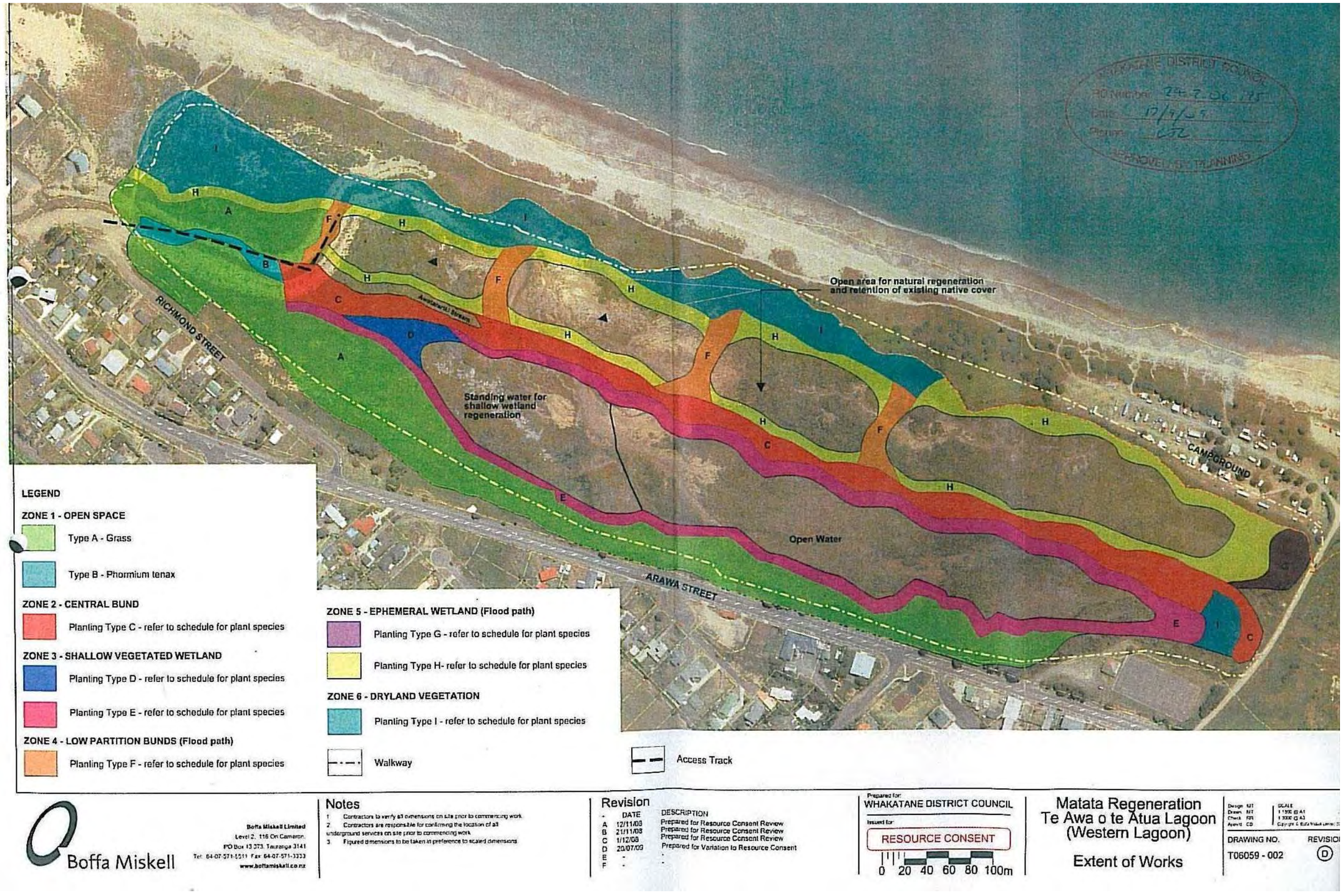
Opportunities

- Potential for community support to restore lagoon to resemble what was once there

Issues

This option may be the hardest one to balance environmental, physical, social and financial issues.

APPENDIX 6: EXTENT OF THE PROPOSED RESTORATION WORKS AND PLANTINGS, AS PREPARED FOR THE RESOURCE CONSENT



APPENDIX 7: COMPARISON PHOTOS TAKEN BETWEEN 2005, 2006 AND 2010

Photos of the western lagoon from the central causeway road at the Reserve. Immediate post-flood May 2005 (above) and post-rehabilitation works July 2010 (below).

Photos looking back south towards Matata from the sand dunes above the Matata Domain Campground. Immediate post-flood May 2005 (above) and post-rehabilitation works July 2010 (below). The area of graded bare dirt in the foreground of the photo below is part of the re-development to enlarge the Matata Campground.

Photos looking back over the Matata lagoon from the western end of the western lagoon. Immediate post-flood May 2005 (above) and post-rehabilitation works July 2010 (below).

Photos showing the west end of the western lagoon, with fresh slip on hill in background and damaged house. Immediate post-flood May 2005 (above). Note: the large house in foreground of photo above was removed along with several others, due to structural damage caused by flooding. Note: how well the site had re-vegetated naturally by July 2010 (below).

Photos of the western end of the western lagoon showing damaged houses immediate post-flood May 2005 (above) and showing naturally regenerated vegetation of the foreground area by July 2010 (below).

View looking west from causeway road, of the western lagoon. Immediate post-flood May 2005 (top photo),

Naturally regenerated vegetation August 2006 prior to rehabilitation works proceeding (middle),

Post completion of rehabilitation works July 2010 (bottom).

View looking west from Matata campground entrance, of the western lagoon. Immediate post-flood May 2005 (top photo),

Western lagoon with naturally regenerating vegetation August 2006 prior to rehabilitation works proceeding (bottom).

View looking north from near Matata campground entrance, of the western lagoon. Post completion of rehabilitation works July 2010.