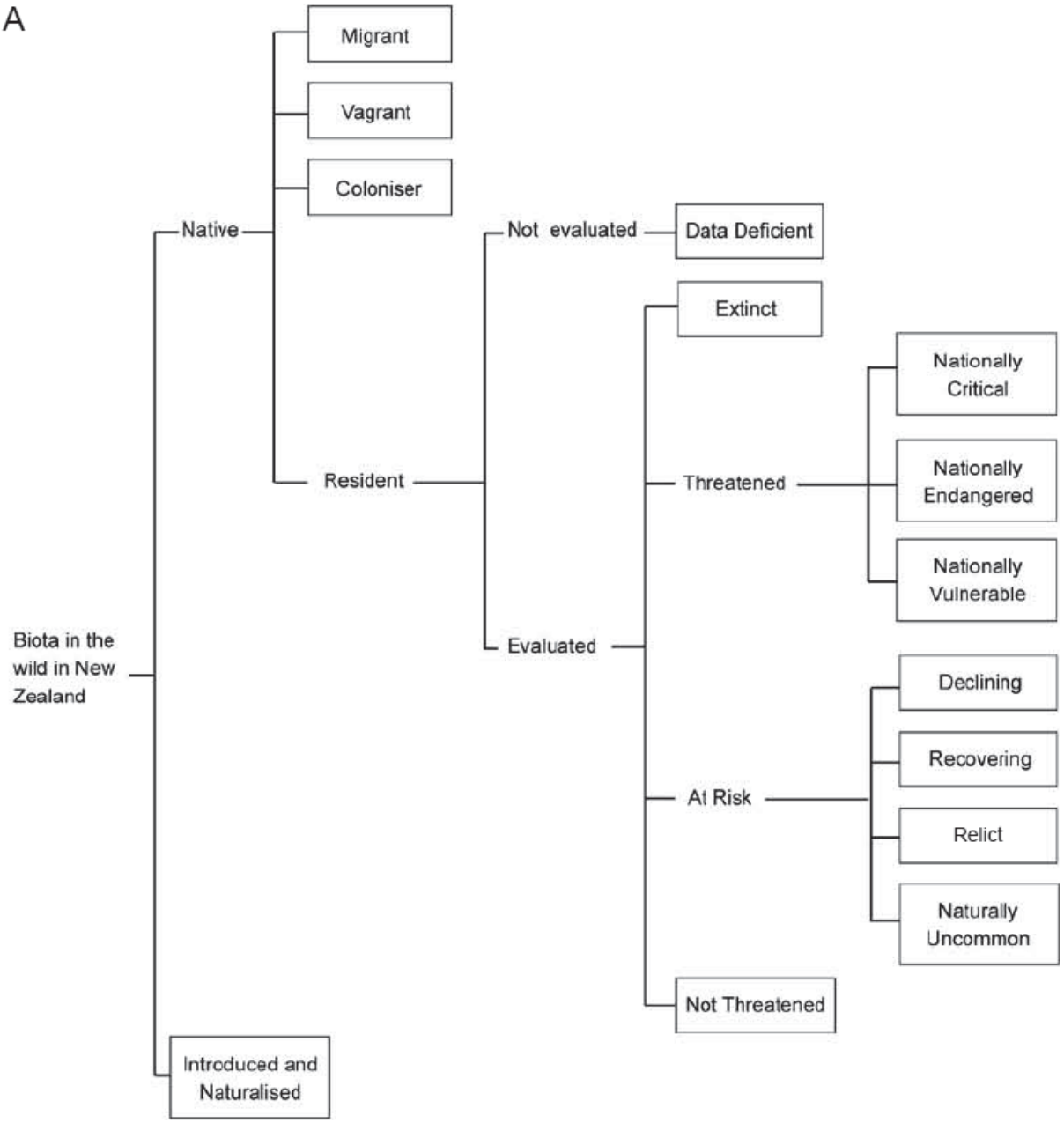
14. APPENDICES

Appendix 11.A: Threat Classification

(From Townsend et.al. 2008)

A



Classification Sub Categories

Criteria for 'Threatened' taxa	**Nationally Critical**	A. Very small population (natural or unnatural)
		B. Small population (natural or unnatural) with a high ongoing or predicted decline
		C. Population with a very high ongoing or predicted decline (> 70%)
	Nationally Endangered	A. Small population that has a low to high ongoing or predicted decline
		B. Small stable population (unnatural)
		C. Moderate population and high ongoing or predicted decline
	Nationally Vulnerable	A. Small, increasing population (unnatural)
		B. Moderate, stable population (unnatural)
		C. Moderate population, with population trend that is declining
		D. Moderate to large population and moderate to high ongoing or predicted decline
		E. Large population and high ongoing or predicted decline
Criteria for 'At Risk' Taxa	**Declining**	A. Moderate to large population and low ongoing or predicted Decline
		B. Large population and low to moderate ongoing or predicted decline
		C. Very large population and low to high ongoing or predicted Decline
	Recovering	A. Moderate population
		B. Moderate to large population
	Relict	
	Naturally Uncommon	
Not Threatened		

Qualifiers used in the classification

Qualifier	Stands for Status	Explanation
CD	Conservation Dependent	The taxon is likely to move to a higher threat category if current management ceases.
DP	Data Poor	Confidence in the listing is low due to there being only poor data available for assessment.
EF	Extreme Fluctuations	The taxon experiences extreme unnatural population fluctuations, or natural fluctuations overlaying human-induced declines, that increase the threat of extinction. When ranking taxa with extreme fluctuations, the lowest number of mature individuals should be used for determining population size, as a precautionary measure.
EW	Extinct in the Wild	The taxon is known only in cultivation or captivity.
OL	One Location	Found at one location (geographically or ecologically distinct area) of less than 1000 km2 (100 000 ha), in which a single event (e.g. a predator irruption) could easily affect all individuals of the taxon, e.g. L'Esperance Rock groundsel (Senecio lautus var. esperensis) and Open Bay Island leech (Hirudobdella antipodum). Taxa with restricted distributions but where it is unlikely that all sub-populations would be threatened by a single event (e.g. because water gaps within an archipelago are larger than known rodent swimming distances) should be qualified as 'Range Restricted' (RR). 'OL' can apply to all 'Threatened' and 'At Risk' taxa, regardless of whether their restricted distribution is natural or human-induced.
RF	Recruitment Failure	The taxon's current population may appear stable but the age structure is such that catastrophic declines are likely in the future.
SO	Secure Overseas	The taxon is secure in other parts of its natural range outside New Zealand.
TO	Threatened Overseas	The taxon is threatened in those parts of its natural range outside New Zealand.

St	Stable	The total population is stable (± 10%), taken over the last 10 years or three generations, whichever is longer.
IE	Island Endemic	A taxon whose natural distribution is restricted to one island archipelago (e.g. Auckland Islands) and is not part of the North or South Islands or Stewart Island/Rakiura.
Inc	Increasing	There is an ongoing or predicted increase of > 10% in the total population, taken over the next 10 years or three generations, whichever is longer. Note that this qualifier is redundant for taxa ranked as 'Recovering'.
PD	Partial Decline	Taxa undergoing decline over the majority of their range, but with one or more secure populations (such as on offshore islands). Partial decline taxa (e.g. North Island kaka Nestor meridionalis septentrionalis and Pacific gecko Hoplodactylus pacificus) are declining towards 'Relict' status rather than towards extinction.
RR	Range Restricted	Taxa confined to specific substrates, habitats or geographic areas of less than 1000 km2 (100 000 ha); this is assessed by taking into account the area of occupied habitat of all sub-populations (and summing the areas of habitat if there is more than one sub-population), e.g. Chatham Island forget-me-not (Myosotidium hortensia) and Auckland Island snipe (Coenocorypha aucklandica aucklandica). This qualifier can apply to all 'Threatened' and 'At Risk' taxa regardless of whether their restricted distribution is natural or human-induced, but is redundant if a taxon is confined to 'One Location' (OL).
Sp	Sparse	Taxa that occur within typically small and widely scattered populations.
De	Designated	A taxon that does not fit within the criteria provided, and which the Expert Panel has designated to the most appropriate listing without full application of the criteria. For example, a commercial fish stock that is being fished down to Biomass Maximum Sustainable Yield (BMSY) may meet criteria for 'Declining'; however, it could be designated as 'Not Threatened' if the Expert Panel believes that this better describes the taxon's risk of extinction.

Appendix 11. B: Early Retirement Sites

Site	Catchment	Riparian Vegetation (ha)	Terrestrial Vegetation (ha)	Stream Length (m)
1	Duck Creek	0.3	1.5	42
2	Duck Creek	0.6	0.7	553
3	Duck Creek	0.2	1.1	505
4	Duck Creek	0.5	1.2	-
5	Pauatahanui Stream	1.3	1.0	362
6	Ration Creek	1.0	2.0	150
7	Ration Creek	1.1	0.5	349
8	Ration Creek	0.3	0.9	-
9	Horokiwi Stream	0.7	3.5	-
10	Horokiwi Stream (enrichment)	0.7	6.9	0
11	Horokiwi Stream (enrichment)	3.7	11.8	0
Sub total		**10.4**	**31.1**	**1,961**
Total		**41.5 ha**		

Appendix 11.C: Project Shaping / Ecology

Item	Location, date, chaingage	Description of the change	Reasons for the change	Effects of the change	Requested by and why
1	James Cook Drive link to TG Interchange 18.12.2010 1,950	Two alternative alignment options have been investigated for the link road. One through Silverwood property (an optimised SAR alignment) and the preferred option through Whitby Coastal Estates, to the west of the SAR route, on an adjacent land parcel.	Wider project team discussions involving further environmental specialist input identified concerns with the SAR alignment due to its proximity to, and impacts on an existing stream. This led to identification and development of an alternative option utilising adjacent land to the west (Whitby Coastal Estates) with avoidance of any earthworks encroachment into the stream. This option was developed with PCC and with the relevant landowners' agreement that this is the preferred option.	Reduced cut volumes Reduced height of cuts in poor quality material - loess (reduced risk) No incursion into the existing stream Improved interface with adjacent development proposals.	NZTA, PCC, Whitby Coastal Estates, Silverwood Forest WS08 Ecology: Reduced or no effect on stream known to have high value. Reduced impact on PCC ecosite (PCC033).
2	Waitangirua Link to TG Interchange 18.12.2010 1,950	Two Options were identified, developed and presented to NZTA and PCC: Eastern Western Option 2 was based around the SAR alignment utilising a 200m bridge crossing of Duck Creek, while Option 1 (an alignment to the west) eliminated the need for a significant bridge & reduced embankment heights. Consultation with affected parties & further assessment identified the eastern option (option 1) as the preferred solution.	Consultation with land owners and PCC raised concerns with the SAR alignment including a need to reduce impacts on properties and allow better development opportunities. Opportunities were explored to reduce proposed fill heights and the need for expensive long bridge structures. Option 1 was developed to reduce the height of the fill embankment over duck Creek. The SAR alignment Option 2 was 30m above the creek which resulted in a significant bridge structure (200m span). The preferred Option 1 has lowered the road level by 20m by achieving a better fitting alignment (a slightly longer road but with reduced lengths of 10% grades). Option 1 removes a 200m long bridge and replaces it with a box culvert at a naturally occurring narrow point in the Creek. This solution was favoured by ecological and stormwater specialists together with PCC and affected land owners.	Alignment altered to achieve best fit / minimise impacts on properties and provide better interface with existing topography. Significant reduction in earthworks fill heights in vicinity of Duck Creek (reduced from 30m in height to approximately 10m). Reduced impact on areas of identified native vegetation. – PCC eco site. Elimination of significant bridge structures and replaced with box culvert.	NZTA Board: Item #06 NZTA, PCC WS08 Ecology: Reduced impact on PCC eco site (PCC190 & PCC155B).
3	Horokiri Stream 31.01.2010 6,500	The main TG alignment has been moved to the west by approximately 10m between sta 6500m and 7500m, and up to 30m to the east between Sta 7500m to 9500m to reduce ecological impacts on the Horokiri Stream.	Identified by a site visit (late January 2010). In the upper part of Horokiri stream the edge of the proposed SAR alignment 1:1 fill slopes encroached into the stream in several locations requiring stream diversions. At Sta 8,500m the SAR alignment earthworks were significantly affecting approx 500m of stream and requiring two stream bridges.	Significantly reduces the effect on the lengths of stream diversion required between Sta 6500 and 7500m. Eliminated physical impacts on the stream over a 500m length at Sta 8,500m and removed 1 bridge/stream crossing. Reduce the number of cross culverts required. Reduced the earthworks cut volumes by 400,000cu.m over this section of the project with no	WS08 Ecology: Reduced effects on high value section of Horokiri stream and on Porirua eco-site PCC199) WS12 Stormwater Viability of stream diversions questioned

				change to the proposed fill volumes.	
7	Riepen Curve 05.02.2010 1,500	The SAR alignment between sta 1,000m and 2,000m has been moved east by approx 30m, away from the Riepen property towards the existing state highway. This alternative ties in better to the newly constructed MacKays Crossing project and provides opportunity for a cycleway and landscape earth bunding to the west of the highway.	The SAR alignment had significant land take impact on the Riepen and Sang Su properties. Consultation feedback and further investigation identified opportunities to improve the balance of needs between the road alignment, ramp configurations, provision for separate cycleway facilities, existing service utilities (Gas and Transpower pylons) impacts, and land take.	Reduced land take effect on the Riepen property. Positioning of relocated O/H pylons can be accommodated within the proposed land take. Opportunity for inclusion of landscape bunding and cycleway. Potentially reduces earthworks effects on the margins of McKays crossing wetland.	NZTA Board: Item #01 WS08 Ecology: Reduced effects on wetland KCDC eco-site K106).
12	Te Puka Culvert 18.03.2010 2,800	The SAR alignment between sta 2,000m and 3,200m has moved east by approx 10m to retain the existing stream at the lower end of Te Puka Stream.	Opportunity identified by ecological and stormwater specialists for a significant reduction in the length of stream culverting and a reduction in the overall length of stream diversion.	Removed the need for a 300m long culvert Significant reduction in the length of stream modification compared to the SAR alignment (SAR option resulted in an extra 500m length of modified stream compared with the preferred option). Increased earthworks cut to the east on the plateau, but more than offset by reduction in stream impacts.	WS08Ecology: significant reduction of stream habitat loss and vegetation loss through reduced culvert length. WS12 Stormwater – reduce culvert length and risk of storm event issues.
14	Wainui Saddle Earthworks 22.03.2010 5,300	SAR alignment moved to the west by 10m to reduce impacts on identified area of ecological value.	Identified by a site visit (January 2010) SAR alignment modified and shifted to the west to reduce the footprint on the eastern side of the saddle. This area was identified as an area of ecological value by the project ecologist, Stephen Fuller.	Increases footprint on the western flanks of the Wainui saddle thereby reducing impact on an area of identified ecological value to the east.	WS08 Ecology – to reduce effect on eastern area of ecological value (native bush) WS07 Landscape & Visual: Reduced footprint and extent of cut batters reduce visual impact at this key location. Also, relocation of road better reflects existing landform. NZTA NZTA Board: Item #02 – reduce footprint at saddle – scale, magnitude of cuts and visual impacts.
19	Te Puka Earthworks 20.05.2010 3,500 to 4,900	Various alternatives considered against the SAR Viaduct structure to address route security concerns. Options included: Retaining Walls (25m ht) Earth embankment (45 deg) Earth embankment (51 deg) Stepped Walls (63 deg)	Route Security The SAR scheme (as well as previous 2004 Costed viaduct option) proposed viaducts alongside steep hillsides and proposed cuttings in the Te Puka Valley. Also vertical walls on steep slopes were proposed. These structures were also in close proximity to the Ohariu Fault. Earthquake induced landslides from these steep slopes had the potential to affect route security, as severe damage to viaducts from such landslides would take a long time to reinstate after an earthquake. A 45° reinforced soil embankment (RSE) alternative was chosen instead of the viaducts and vertical walls	Improved route security Potentially lower costs Greater ecological effects on Te Puka Stream Need larger good quality fill for RSE in the Te Puka area.	WS02 Roading, Geotechnical Engineer. The Preliminary Geotechnical Assessment report identified the risks associated with retaining walls on steep slopes in Te Puka and the vulnerability of bridges directly adjacent to steep slopes due to earthquake induced landslides. WS08 Ecology – Will result in significant loss of stream and require extensive stream restoration and mitigation.

			on steep slopes, as these are more durable road forms that are robust to withstand earthquake induced landslides that would run over the RSE and the debris can be cleared quickly to reinstate access. This would provide much improved route security for the TG highway.		
Added in workshop 2010-08-25					
20	Te Puka Bridge/Culvert 20.08.2010 2,800	Refinement of culvert/arch/bridge including steepening retaining up and downstream and avoiding diversions.	'12' is route alignment '20' is fine tuning crossing to reduce diversions and decisions on final crossing design	Eliminates the potential effects of the box culvert on fish passage by maintaining the natural bed of the stream. Eliminates stream habitat loss in a section of high value stream. Reduces loss of indigenous forest (KCDC eco-site K224 & K223) Reduces the potential for culvert blockages Ease of construction in a constrained environment. Reduced erosion potential	WS08 Ecology: further reduce ecological effects on significant stream of this challenging culvert location. WS03 Bridging WS12 Stormwater
21	Te Puka Stream ongoing 3,500 to 4,900	Diversion driven by 19. We have optimised a solution that deals with the issues of construction staging including stream diversion during construction, staging of the construction of the new waterway and, Staging of the earthworks and construction of the MSE wall. Erosion and sediment control, Construction of culvert outlet stepped structures. This solution also had to incorporate best ecological and landscape outcomes.	'19' is route security '21' is stream construction solutions	The final solution managed to; Provide an appropriate grade (close as possible to natural) to the final constructed waterway Retain the vegetation on the eastern bank of the valley by lifting the stream to avoid major cuts Provide a clear construction method that allowed for construction staging Enable the maintenance of stream flows through construction	WS12 Stormwater WS08 Ecology: minimises some effects of unavoidable loss of stream habitat. Ensure design solutions for fish passage and enhancement of diversion to provide some benefit. WS02 Roading / Geotech
22	Horokiri & Te Puka	Alternate Fish Passage Design Use of spat thread for fish passage Still requires detailed design for inlet and outlet for SEMP.	Significant reduce cost and size of culverts and provides fish passage that may not have been possible otherwise without huge cost of retro-fitting and maintenance.	Best solution ecological / hydraulically / economically. Also proposed for stepped culvert outlet structures.	WS08 Ecology: Increases confidence that fish passage can be maintained. WS04 Hydrology / culvert design: Provides flexibility in design of culverts in challenging site.
23	Horokiri Stream / Battle Hill / SH58	Stormwater Treatment Wetlands in some portions of the highway	A better treatment outcome can be achieved in areas where wetlands may be effectively constructed.	Enables us to combine stormwater treatment with natural systems.	WS12 Stormwater: Assists in meeting treatment efficiency targets.

	Interchange 7,750, 11,000, 17,500			Lower long term whole of life costs Improved treatment capacity Greater hydraulic neutrality	WS08 Ecology: Assists in reducing road runoff contaminants entering streams and harbour. Provides some ecological benefit as compensation for loss of small headwater wetlands.
BRIDGES					
2	Bridge over Te Puka Stream July 2010 2,800	Bridge provided in lieu of culvert where TG crosses the Te Puka Stream.	Culvert considered impractical in location as no room exists to temporarily divert steam to enable the culvert to be constructed.	Best possible environmental outcome – no direct effect on local ecology. Extra bridge costs $3.5 million	WS04 Hydrology WS08 Ecology: Eliminate loss of stream habitat and fish passage issues in stream of high value.
9	Duck Creek Bridges April – June 2010 21,500 – 22,800	Bridges BSN 18 & 19 increase in length and Bridge BSN 17 is added	All changes to bridges resulting from environmental requirements. Bridges in these locations result in a much smaller environmental footprint when compared with earth embankments.	Less fill in streams and rivers. Increase in cost of structures = $17.5 million	WS 04, WS08 Ecology: eliminate loss of stream habitat and fish passage issues in regionally significant stream. & 12
11	Kenepuru Hills June 2010 26,010	Add new bridge.	Alternative earth embankment footprint considered excessive.	Reduction in earthworks, New bridge cost $7.8 million.	WS 02 WS 08 Ecology: Eliminates loss of long section of stream. Avoids removal of small forest remnant.
27	Duck Creek	Replace perched culverts (6) in current farm access road to improve fish passage	For ecological mitigation only	Provides significant ecological benefit to offset effects elsewhere in alignment.	WS08 Ecology Required to meet mitigation targets for loss or modification of stream habitat.

Appendix 11.D: Comparisons of Stormwater Treatment and Baseline (2031)

	Comparison between 2031 without road, and 2031 with road but no treatment						Comparison between 2031 without road, and 2031 with road with treatment					
Catchment (taken at mouth)	TSS (g/m³)		Total Zinc (g/m³)		Total Copper (g/m³)		TSS (g/m³)		Total Zinc (g/m³)		Total Copper (g/m³)	
Horokiri	-0.4	-0.25%	0.0012	14.30%	0.0004	21.39%	-0.6	-0.41%	0.0004	4.15%	0.0000	2.64%
Pauatahanui	-0.1	-0.08%	0.0004	3.50%	0.0001	5.05%	-0.2	-0.14%	0.0002	1.55%	0.0000	1.45%
Porirua	-0.1	-0.13%	0.0002	0.28%	0.0001	0.59%	-0.2	-0.25%	-0.0002	-0.31%	-0.0001	-0.91%
Duck	-1.0	-0.57%	0.0039	10.13%	0.0013	35.93%	-1.5	-0.87%	0.0020	5.18%	0.0005	15.49%
Ration	0.0	0.05%	0.0033	72.18%	0.0011	98.83%	-0.5	-0.63%	0.0014	30.14%	0.0003	31.04%
Kenepuru	-0.3	-0.31%	0.0016	1.94%	0.0005	9.45%	-0.5	-0.58%	0.0008	0.95%	0.0002	3.84%
Te Puka	-0.4	-1.04%	0.0005	10.55%	0.0002	19.90%	-0.5	-1.28%	0.0001	1.99%	0.0000	0.86%
Whareroa	0.0	0.00%	0.0000	0.00%	0.0000	0.00%	-0.2	-0.71%	-0.0008	-21.06%	-0.0003	-32.50%

Appendix 11.E: Harbour Modelling of Suspended Sediment

Table 11-72: Effect of suspended sediment (TSS) derived from combined rainfall/wind events during peak construction period.

Rainfall Event /Wind Environment	Net Area exposed to TSS conc (ha) 1 day post event	Net Area exposed to TSS conc (ha) 3 days post event peak	SKM Map Reference (NB: 1 day maps only)	Description of TSS Distribution	Significance of Effect of TSS from Potential Rainfall Event
Combined 10 Yr rainfall event in all catchments modelled					
	50-100 g/m3				
Calm	92.6	0	10Yr-1D-07	1 day post event peak Primarily in the subtidal areas. Small areas at the mouth of the Porirua Stream and the Pauatahanui Stream. 3 days post event peak TSS from event runoff is nil.	Negligible
N-NW	203.6	0	10Yr-1D-08	1 day post event peak Wide-spread throughout both the Pauatahanui Inlet and the Onepoto Inlet. 3 days post event peak TSS from event runoff is nil.	Negligible
S-SE	157.2	0	10Yr-1D-09	1 day post event peak Wide-spread throughout the subtidal area of the Pauatahanui Inlet. Within the Onepoto Inlet, this low concentration of TSS is focussed around the Porirua Stream mouth, the western shore and the central subtidal area. 3 days post event peak TSS from event runoff is nil.	Negligible
	100-300g/m3				
Calm	72.1	0	10Yr-1D-07	1 day post event peak Localised central subtidal areas primarily. Small area at the Porirua Stream mouth. 3 days post event peak TSS from event runoff is nil.	Negligible
N-NW	152.2	0	10Yr-1D-08	1 day post event peak In the Pauatahanui Inlet this concentration of TSS is primarily located around the northern, eastern and southern near shore habitat, extending to the central subtidal basin area from Duck Creek to sampling site P6. The southern part of the Onepoto Inlet is affected around the Porirua Stream mouth and the central subtidal area. 3 days post event peak TSS from event runoff is nil.	Negligible
S-SE	80.2	0	10Yr-1D-09	1 day post event peak The northern near shore area, plus the central subtidal basins are affected in the Pautahanui Inlet, whereas only the Porirua Stream mouth is affected in the Onepoto Inlet. 3 days post event peak TSS from event runoff is nil.	Negligible
	>300 g/m3				
Calm	0	0	10Yr-1D-07	1 day post event peak TSS in this range is nil. 3 days post event peak TSS from event runoff is nil.	Negligible

Rainfall Event /Wind Environment	Net Area exposed to TSS conc (ha) 1 day post event	Net Area exposed to TSS conc (ha) 3 days post event peak	SKM Map Reference (NB: 1 day maps only)	Description of TSS Distribution	Significance of Effect of TSS from Potential Rainfall Event
N-NW	10.7	0	10Yr-1D-08	1 day post event peak Highest concentrations in the eastern near shore habitat of Pauatahanui Inlet and adjacent to Porirua Stream. 3 days post event peak TSS from event runoff is nil.	Negligible
S-SE	39.0	0	10Yr-1D-09	1 day post event peak Suspended sediment accumulates in northern near shore habitat to the west of Ration and Horokiri Stream mouths in the Pauatahanui Stream. Very small area at the mouth of the Porirua Stream. 3 days post event peak TSS from event runoff is nil.	Negligible
2 Yr in all catchments modelled					
	50-100 g/m3				
Calm	5.3	0	2Yr-1D-07	1 day post event peak Very small area adjacent to Horokiri and Pauatahanui Stream mouths. 3 days post event peak TSS from event runoff is nil.	Negligible
N-NW	127.0	2.8	2Yr-1D-08	1 day post event peak Large area from the central subtidal basins to the northern near shore habitat in the Pauatahanui Inlet. Some areas within the central subtidal part of the southern Onepoto Inlet and a small area adjacent to the mouth of Porirua Stream. 3 days post event peak TSS from event runoff is nil.	Negligible
S-SE	10.3	0	2Yr-1D-09	1 day post event peak Suspended sediment located in the central subtidal basins and adjacent to the northern near shore area in the Pauatahanui Inlet. In the Onepoto Inlet there is a small area adjacent to the mouth of Porirua Stream. 3 days post event peak TSS from event runoff is nil.	Negligible
	100-300 g/m3				
Calm	1.8	0	2Yr-1D-07	1 day post event peak Very small area adjacent to Horokiri and Pauatahanui Stream mouths. 3 days post event peak TSS from event runoff is nil.	Negligible
N-NW	81.2	0.01	2Yr-1D-08	1 day post event peak Sediment accumulates adjacent to the northern and western near shore habitat and adjacent to the mouth of Duck Creek within the Pauatahanui Inlet, and adjacent to the mouth of Porirua Stream. 3 days post event peak TSS from event runoff is virtually nil.	Negligible
S-SE	13.0	0	2Yr-1D-09	1 day post event peak Suspended sediment located in the central subtidal basins and adjacent to the northern near shore area in the Pauatahanui Inlet. In the Onepoto Inlet there is a small area adjacent to the mouth of Porirua Stream. 3 days post event peak TSS from event runoff is nil.	Negligible

Rainfall Event /Wind Environment	Net Area exposed to TSS conc (ha) 1 day post event	Net Area exposed to TSS conc (ha) 3 days post event peak	SKM Map Reference (NB: 1 day maps only)	Description of TSS Distribution	Significance of Effect of TSS from Potential Rainfall Event
	>300 g/m3				
Calm	0	0	2Yr-1D-07	1 day post event peak No suspended sediment present. 3 days post event peak TSS from event runoff is nil.	Negligible
N-NW	0	0	2Yr-1D-08	1 day post event peak No suspended sediment present. 3 days post event peak TSS from event runoff is nil.	Negligible
S-SE	0	0	2Yr-1D-09	1 day post event peak No suspended sediment present. 3 days post event peak TSS from event runoff is nil.	Negligible

Appendix 11.F: Harbour Modelling Simulations

The following simulations are attached

10Yr-1D-07: TSS,10 year **combined**, NNW, 1 Day

2Yr-3D-TA02: Deposited Sediment, 5mm threshold analsysis peak - pre construction, 2 year **combined**, Calm, 3 Day,

10Yr-3D-TA04: Deposited Sediment, 5mm threshold analsysis peak - pre construction, 10 year **Duck / Pauatahanui**, Calm, 3 Day,

10Yr-3D-TA15: Deposited Sediment, 5mm threshold analysis peak - pre construction, 10 year **Horokiri,** South, 3 Day,

10Yr-3D-TA22: Deposited Sediment, 5mm threshold analsysis peak - pre construction, 10 year **Kenepuru/Porirua**, North, 3 Day,

10Yr-3D-TA17: Deposited Sediment, 5mm threshold analsysis peak - pre construction, 10 year **Kenepuru/Porirua**, South, 3 Day,

LTS-04: Long Term Deposition Comparison with-without construction. 20yrs.

Figure 10Yr1D-07	Measurement:	Peak Construction TSS Concentration
	Rainfall Average Return Interval:	10 Year
	Wind Conditions:	Calm
	Time From Peak of Storm:	1 Day

Client: NEW ZEALAND TRANSPORT AGENCY
Project: TRANSMISSION GULLY PROJECT WS12

Drawn	Date	Design Review	Reviewed Project Manager
JPA	10 JAN 2011		

DHI SKM

PLOT DATE:
FILENAME:

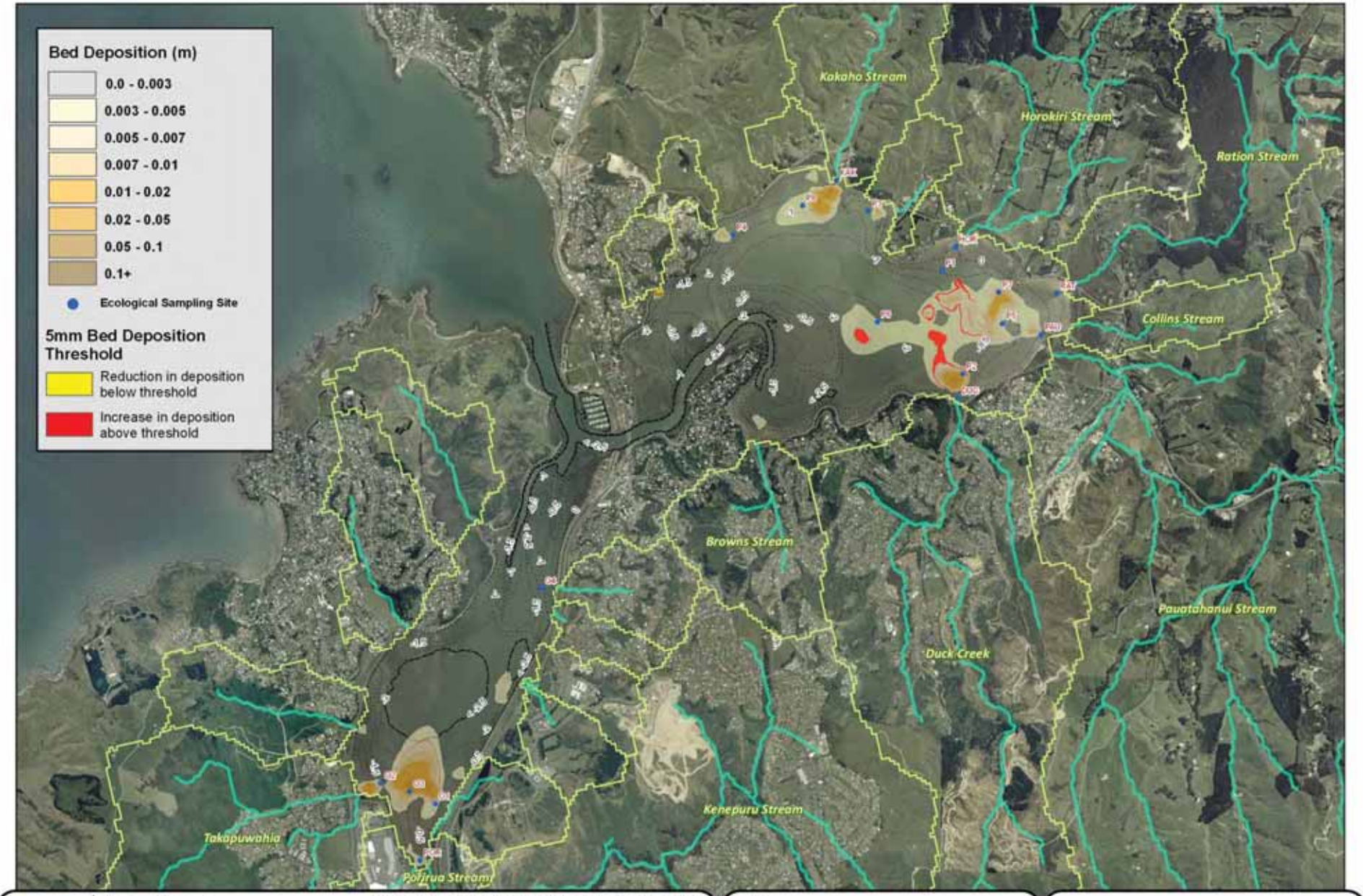


Figure 2Yr 3D-TA 02	Measurement:	5mm Threshold Analysis Peak – Pre Construction
	Rainfall Average Return Interval:	2 Year
	Wind Conditions:	Calm
	Time From Peak of Storm:	3 Day

Client: NEW ZEALAND TRANSPORT AGENCY
Project: TRANSMISSION GULLY PROJECT WS12

Drawn	Date	Design Review	Reviewed Project Manager
NDC	14 Apr 2011		

DHI SKM

PLOT DATE:
FILENAME:

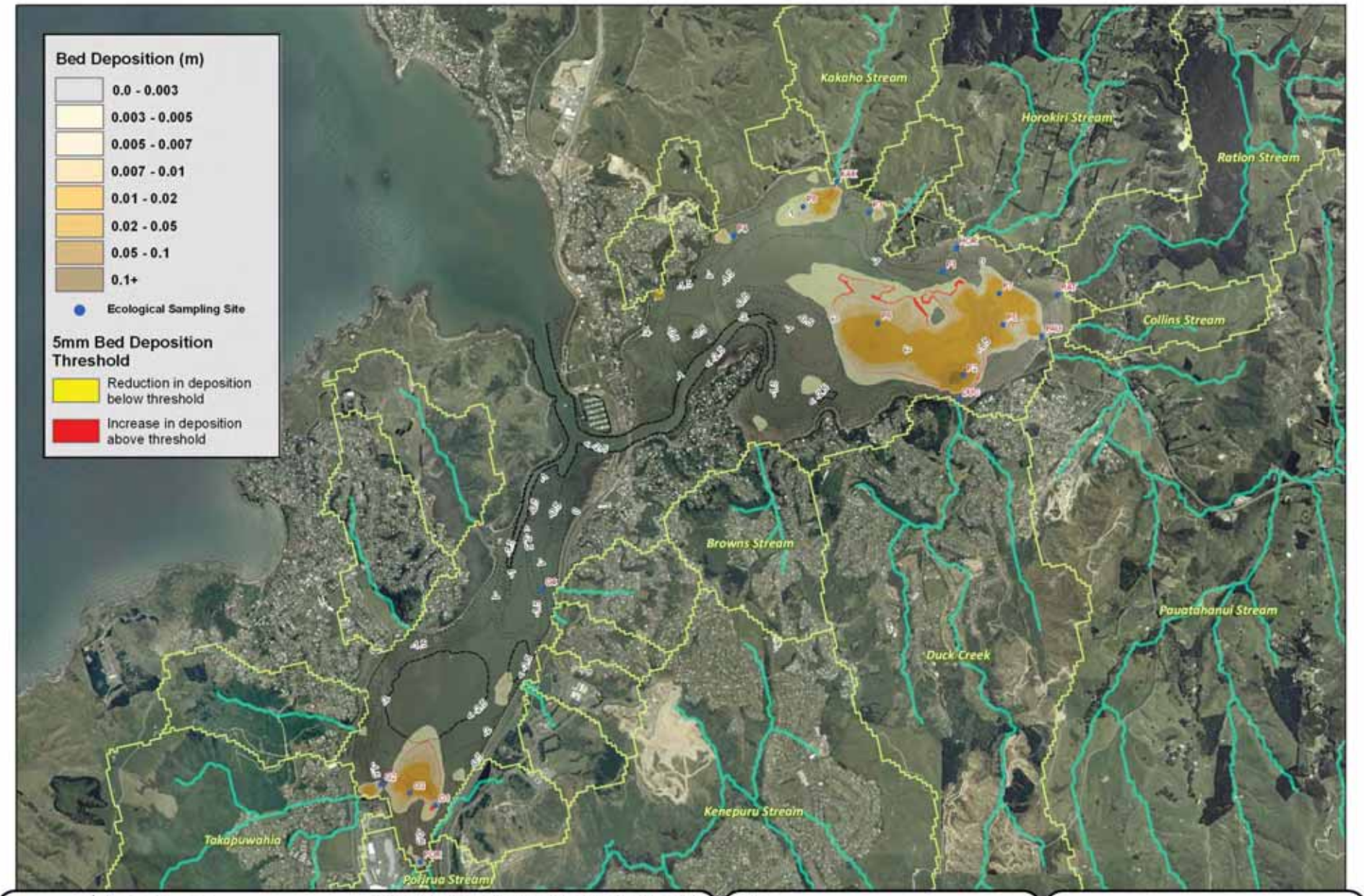


Figure 10Yr-3D-TA 04	Measurement:	5mm Threshold Analysis Peak – Pre Construction
	Rainfall Average Return Interval:	10 Year Duck/Pauatahanui
	Wind Conditions:	Calm
	Time From Peak of Storm:	3 Day

Client	Project			
NEW ZEALAND TRANSPORT AGENCY	TRANSMISSION GULLY PROJECT W512			
Drawn	Date	Design Review	Reviewed Project Manager	
NDC	14 Apr 2011			

DHI SKM

PLOT DATE:

FILENAME:

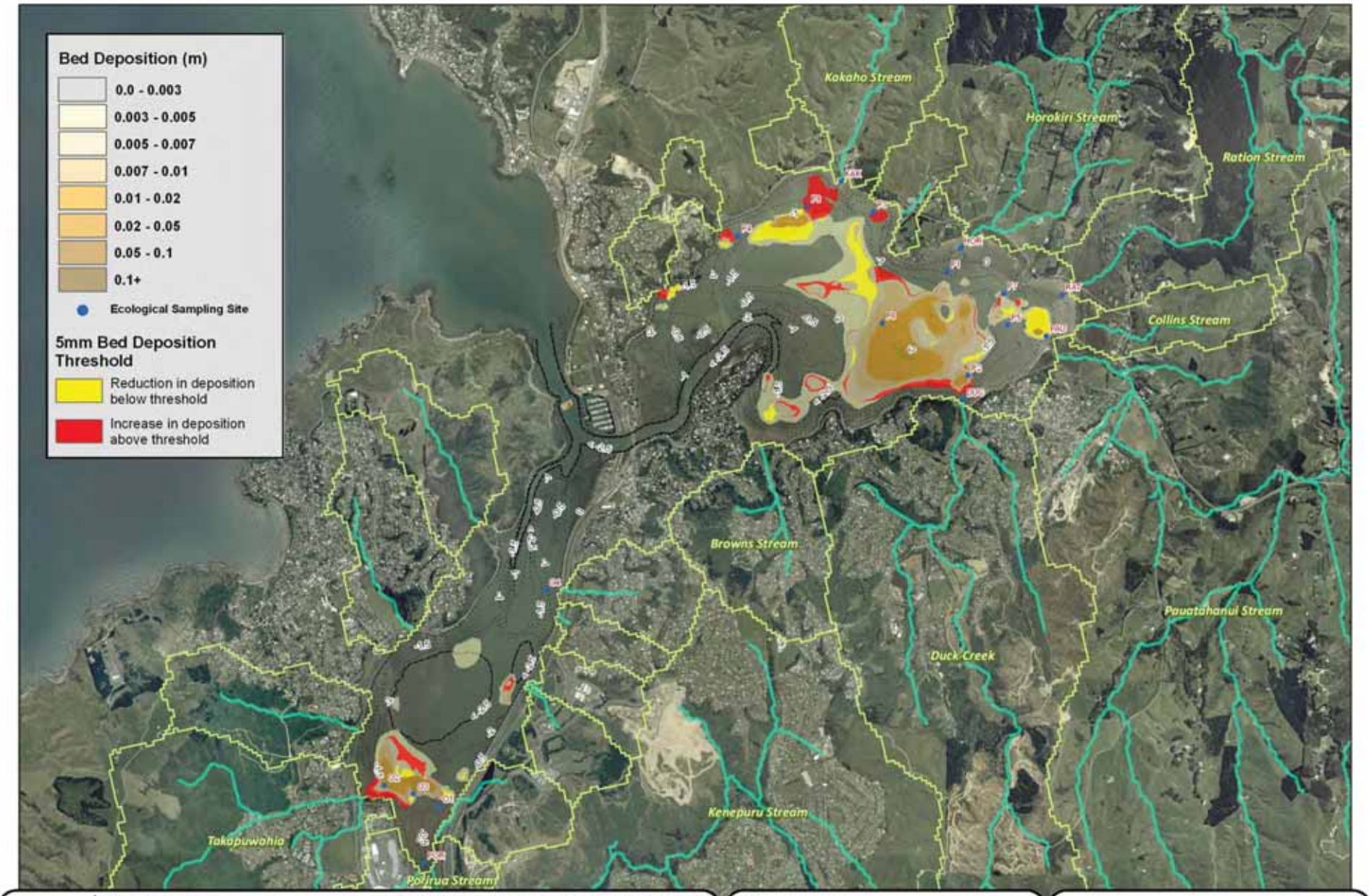


Figure	Measurement:	5mm Threshold Analysis Peak – Pre Construction
10Yr-3D-TA	Rainfall Average Return Interval:	10 Year Horokiri
15	Wind Conditions:	South
	Time From Peak of Storm:	3 Day

Client: NEW ZEALAND TRANSPORT AGENCY

Project: TRANSMISSION GULLY PROJECT WS12

Drawn	Date	Design Review	Reviewed Project Manager
NDC	14 Apr 2011		

DHI SKM

PLOT DATE:

FILENAME:

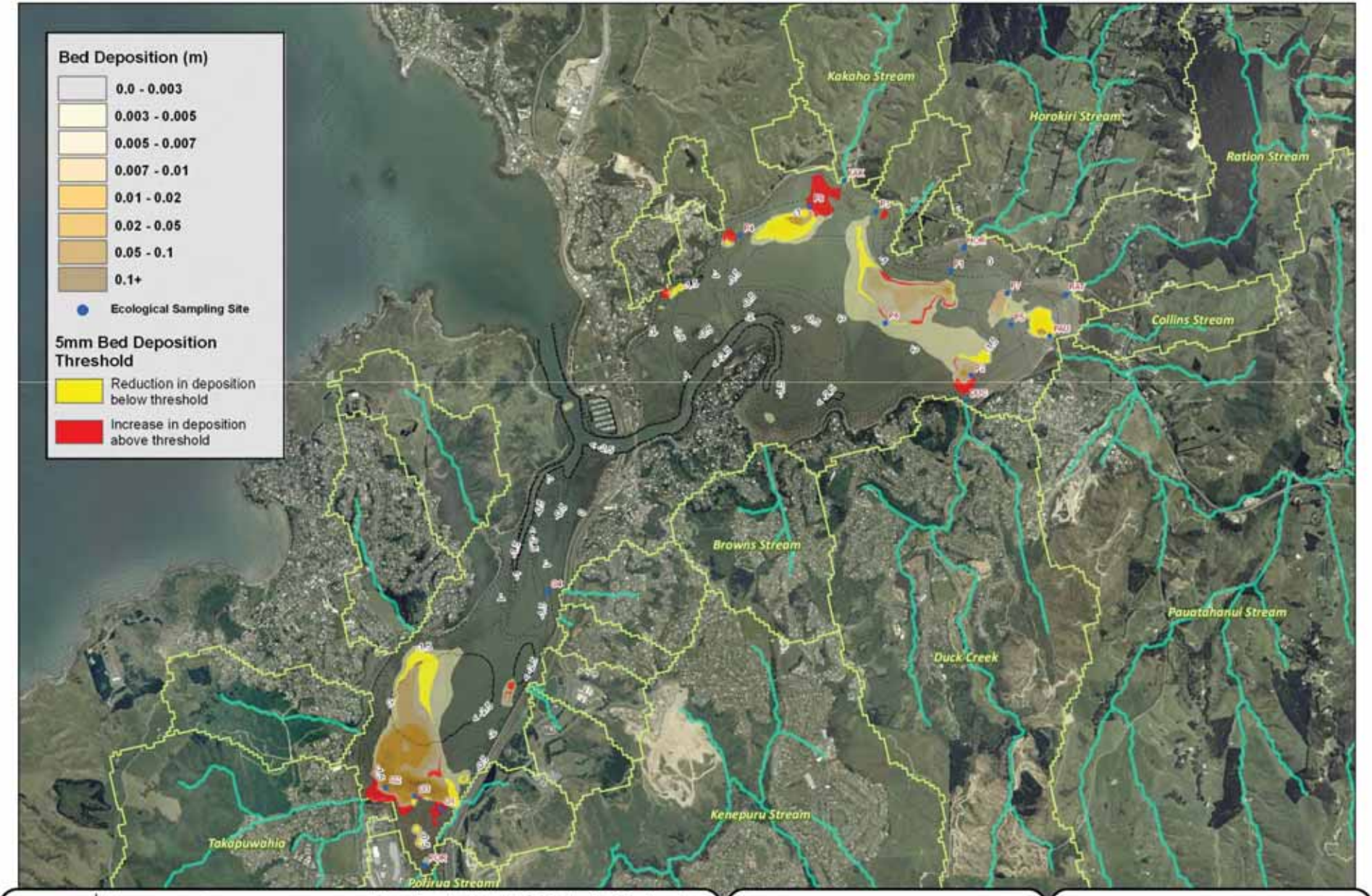


Figure 10Yr-3D-TA 17	Measurement:	5mm Threshold Analysis Peak – Pre Construction
	Rainfall Average Return Interval:	10 Year Kenepuru/Porirua
	Wind Conditions:	South
	Time From Peak of Storm:	3 Day

Client: NEW ZEALAND TRANSPORT AGENCY
Project: TRANSMISSION GULLY PROJECT WS12

Drawn	Date	Design Review	Reviewed Project Manager
NDC	14 Apr 2011		

DHI SKM

PLOT DATE:
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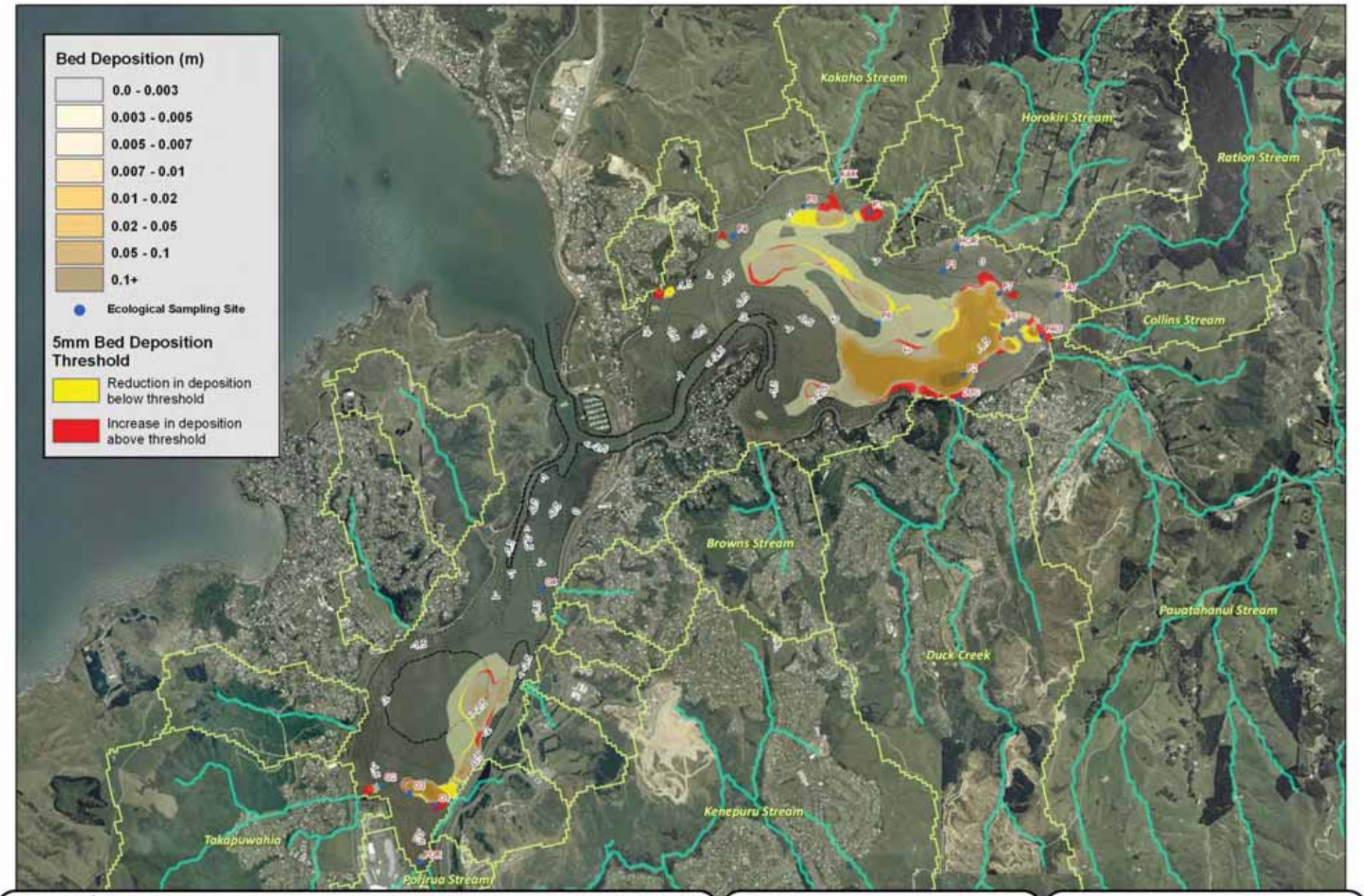


Figure	Measurement:	5mm Threshold Analysis Peak – Pre Construction
10Yr-3D-TA	Rainfall Average Return Interval:	10 Year Duck/Pauatahanui
22	Wind Conditions:	North
	Time From Peak of Storm:	3 Day

Client: NEW ZEALAND TRANSPORT AGENCY

Project: TRANSMISSION GULLY PROJECT WS12

Drawn	Date	Design Review	Reviewed Project Manager
NDC	14 Apr 2011		

DHI SKM

PLOT DATE:

FILENAME:

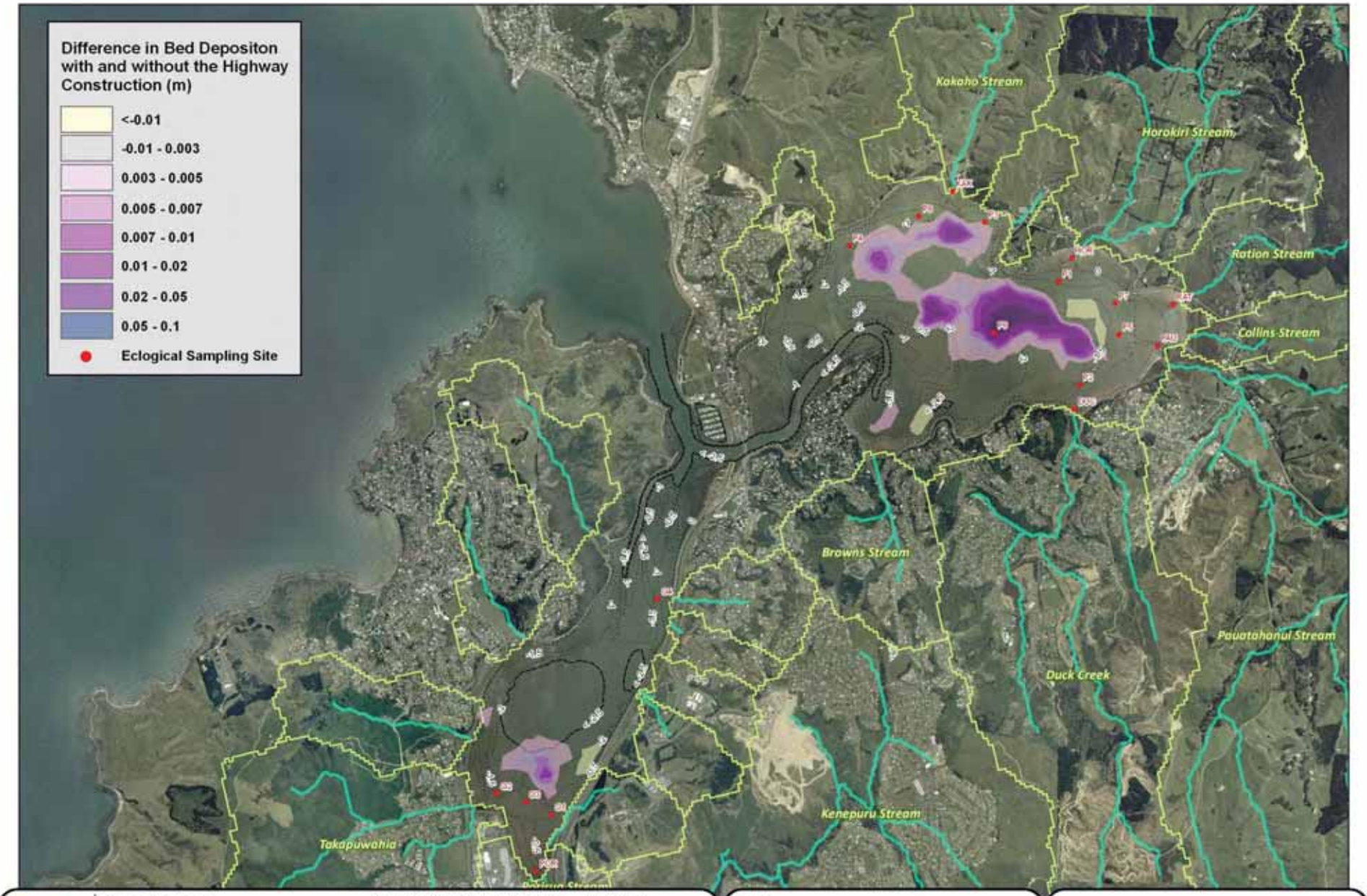


Figure LTS-4	Measurement:	Deposition Comparison: With – Without Construction
	Time From Beginning of Simulation:	20 Years

Client: NEW ZEALAND TRANSPORT AGENCY
Project: TRANSMISSION GULLY PROJECT WS12

Drawn	Date	Design Review	Technical Project Manager
JPA	10 JAN 2011		

DHI SKM

PLOT DATE:
FILENAME:

Appendix 11.G: Selection of Mitigation Areas

Site No.	A	B	C	D	E	F	G	H	I	J
Potential Benefit	**Te Puka - Western Slopes**	**Te Puka Valley Floor**	**Horokiri Western Slopes**	**Horokiri Valley Floor**	**Horokiri Eastern Slopes**	**Lanes Flats**	**Duck Western Slopes**	**Duck Eastern Slopes**	**Cannon's Creek**	**Ranui Pine**
Vegetation/habitat	7		9	8	10				6	
Fauna (terrestrial)	8	9	5	6	10				7	
Fauna (avian)	7	9			10	6			8	
Landscape						10	7	8		9
Treatment				9		10		8	5	6
Flora (rare)				10						
Erosion protection	10		9							
Aquatic		5		10	8	7	6	9		
Score	**32**	**23**	**23**	**43**	**38**	**33**	**13**	**25**	**26**	**15**

1 – low benefit
10 – high benefit

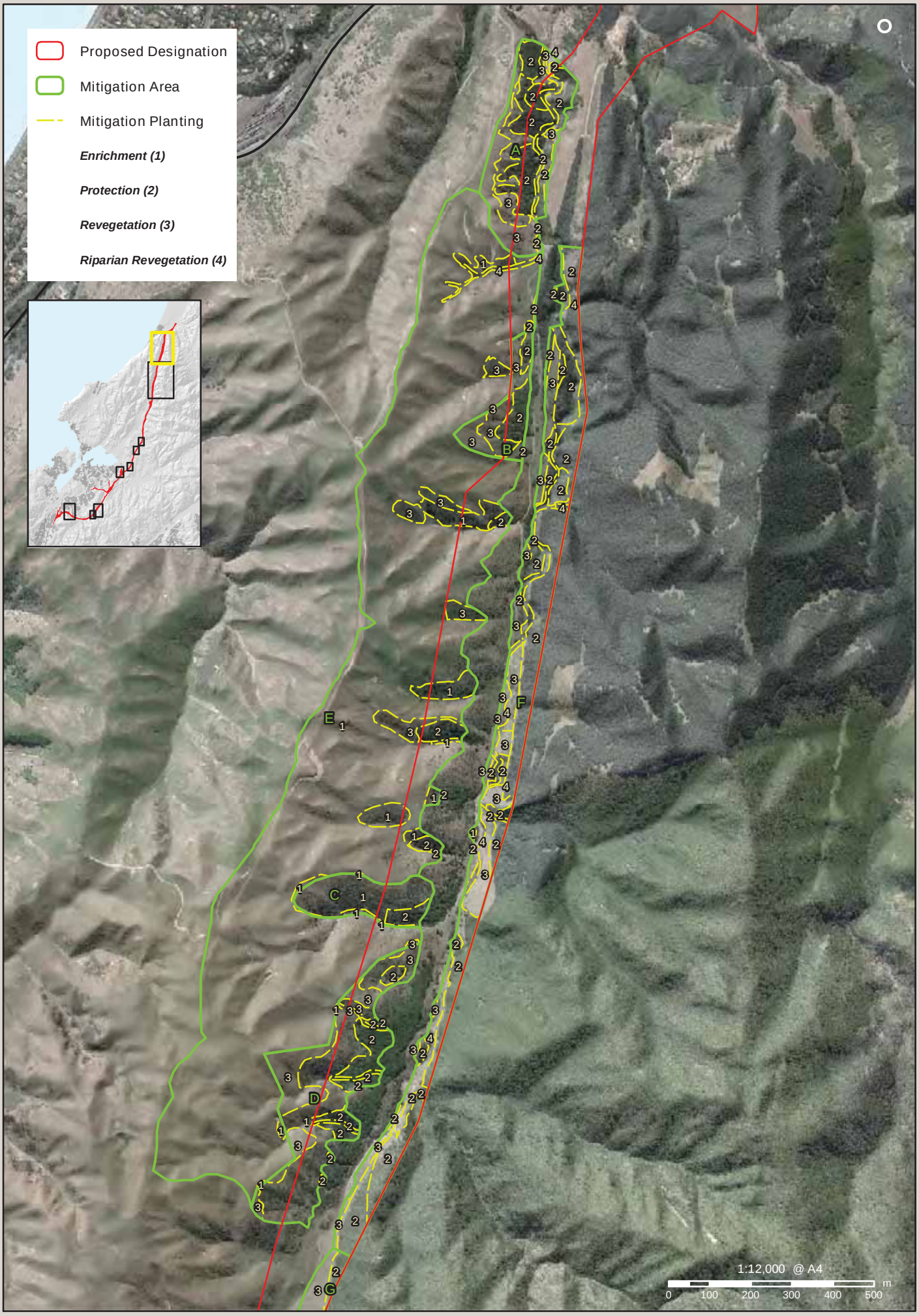
Appendix 11.H: Mitigation Areas – Existing Vegetation

			Designation		Mitigaiton Areas		Potential mitigation areas (ha) excl. fpb50																		
Sort	TYPE	Description	Area (ha)	Area (% of total)	Area (ha)	Area (% of total)	A: Te Puka (Coastal forest remnant)	B: Te Puka (Coastal forest remnant)	C: Te Puka (Coastal forest remnant)	D: Te Puka (Coastal forest remnant)	E: Te Puka (Western Slopes)	F: Te Puka (Valley Floor)	G: Horokiri (Valley Floor)	H: Horokiri (Retirement Area 11)	I: Horokiri (Retirement Area 10)	J: Horokiri (Eastern Slopes)	K: Ration (Retirement Area 9)	L: Ration (Retirement Area 8)	M: Ration (Retirement Area 7)	N: Pauatahanui (Lanes Flats)	O: Duck (Retirement Area 3)	P: Duck (Retirement Area 2)	Q: Duck (Retirement Area 1)	S: Duck (Stream Channel)	R: Porirua (Scenic Reserve Margin)
1	**Grassland, shrublands, rushland and wetlands**																								
2	1.01	Improved pasture	182	37.6%	99	24.6%	2.0	1.0	0.2	2.3	69.1	3.1	10.7	0.1		1.3	1.1	0.8	0.6	0.0	1.2	0.6	1.2	3.5	
3	1.02	Rough pasture and shrublands	30	6.3%	44	11.0%	1.1	0.6		1.0	1.7	0.5	4.1	1.9	0.7	28.0			0.0	4.4				0.1	0.2
4	1.03	Cropland	4	0.9%																					
5	1.04	Stony streambed in pasture (occasion	10	2.1%	5	1.2%	0.1					1.4	1.9			0.1	0.0			0.5		0.2	0.1	0.6	
6	1.05	Streambed in rushland	4	0.8%	1	0.2%	0.0				0.3						0.0	0.0	0.3	0.1	0.2				
7	1.06	Indigenous wetland	2	0.4%	1	0.2%							0.6												
8	**Pioneer shrublands and low scrub**																								
9	2.01	Gorse dominated scrub (closed cano	31	6.5%	91	22.7%	0.0	0.0	0.0	0.0	0.0	0.0	3.3	7.6	3.1	73.7	0.5	0.0	1.5	0.4	0.0	0.0	0.0	0.0	1.4
10	2.02	Tauhinu scrub (closed canopy)	16	3.4%	15	3.6%	0.0	0.0	2.4	4.4	2.8	0.0	1.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
11	2.03	Streambed with low scrub	3	0.7%	2	0.6%	0.0	0.0	0.1	0.0	0.1	0.0	0.7	0.0	0.0	1.0	0.3	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0
12	**Regenerating kanuka scrub & forest**																								
13	3.01	Secondary native forest (kanuka)	10	2.0%	3	0.8%	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.1	0.0	0.0	0.0	0.0	0.0
14	**Regenerating broadleaved scrub & forest**																								
15	4.01	Transmission Gully restoration plant	16	3.3%	10	2.5%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	1.5	1.3	0.0	1.3	1.6	1.5	0.0	0.0
16	4.02	Secondary native forest (broadleaf)	15	3.1%	65	16.2%	0.0	0.0	0.0	0.0	0.0	0.6	0.4	0.0	0.9	61.5	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.2
17	4.03	Streambed with secondary native fore	6	1.3%	11	2.8%	0.0	0.0	0.0	0.0	0.0	1.1	1.6	0.0	0.0	7.9	0.0	0.0	0.2	0.6	0.0	0.0	0.0	0.0	0.0
18	**Remnant indigenous forest**																								
19	5.01	Remnant tawa forest	4	0.8%	2	0.6%	0.0	0.0	0.0	0.0	0.0	1.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
20	5.02	Remnant coastal broadleaved forest	12	2.4%	8	2.1%	1.7	0.9	0.4	1.9	0.9	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0
21	5.03	Sub-montane hardwood forest	1	0.3%	1	0.4%	0.0	0.0	0.0	0.0	0.0	0.9	0.4	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	5.04	Streambed with remnant vegetation	3	0.7%	2	0.6%	0.4	0.0	0.0	0.3	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
23	**Exotic vegetation**																								
24	6.01	Plantation pine	47	9.7%	37	9.3%	0.0	0.0	0.0	0.0	0.0	5.8	0.0	0.0	0.0	30.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	6.02	Plantation pine - harvested	43	8.9%	0	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	6.03	Exotic trees	12	2.5%	1	0.3%	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.8
27	6.04	Streambed with exotic trees – pine	2	0.4%	1	0.2%	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
28	**Undefined**																								
29	7.01	Built-up area	29	5.9%	0	0.1%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
	total		**483**	**100.0%**	**402**	**100.0%**	7.1	2.6	3.1	9.9	74.9	17.5	24.8	9.6	4.7	208.1	5.7	3.0	4.5	7.9	2.8	2.4	3.2	5.4	4.9

Appendix 11.I: Mitigation Areas – Proposed Revegetation Treatment

SITE	CATCHMENT	NAME	OWNERSHIP	Treatment	AREA (ha)	STREAM LENGTH (m)
1	Te Puka	A: Te Puka (Coastal forest remnant)	Within Designation	Marginal Planting - buffer forest	7	758
2	Te Puka	B: Te Puka (Coastal forest remnant)	Within Designation	Marginal Planting - buffer forest	3	52
3	Te Puka	C: Te Puka (Coastal forest remnant)	Within Designation	Marginal Planting - buffer forest	3	253
4	Te Puka	D: Te Puka (Coastal forest remnant)	Within Designation	Marginal Planting - buffer forest	10	259
5	Te Puka	E: Te Puka (Western Slopes)	NZTA Owned	Retirement and enrichment planting (gullies)	75	1,504
6	Te Puka	F: Te Puka (Valley Floor)	Within Designation	Intensive Plant valley floor	18	5,097
7	Horokiri	G: Horokiri (Valley Floor)	Within Designation	Intensive Plant valley floor	25	6,804
8	Horokiri	H: Horokiri (Retirement Area 11)	NZTA Owned	Done	10	0
9	Horokiri	I: Horokiri (Retirement Area 10)	NZTA Owned	Done	5	0
10	Horokiri	J: Horokiri (Eastern Slopes)	NZTA Owned	Retirement and enrichment planting (gullies)	208	9,982
11	Ration	K: Ration (Retirement Area 9)	Within Designation	Extend existing	6	349
12	Ration	L: Ration (Retirement Area 8)	Within Designation	Extend existing	3	150
13	Ration	M: Ration (Retirement Area 7)	Within Designation	Extend existing	5	362
14	Pauatahanui	N: Pauatahanui (Lanes Flats)	NZTA Owned	Riparian Planting	8	2,130
15	Duck	O: Duck (Retirement Area 3)	Within Designation	Extend existing	3	505
16	Duck	P: Duck (Retirement Area 2)	Within Designation	Extend existing	2	553
17	Duck	Q: Duck (Retirement Area 1)	Within Designation	Extend existing	3	42
18	Duck	S: Duck (Stream Channel)	GWRC (Belmont Regional Park)	Riparian Planting	5	1,365
19	Kenepuru	R: Porirua (Scenic Reserve Margin)	Within Designation	Marginal Planting - buffer forest	5	98
20	Duck	T: Duck Creek Culverts (Offset)	GWRC (Belmont Regional Park)	nil	0	8,541
					402	**38,804**

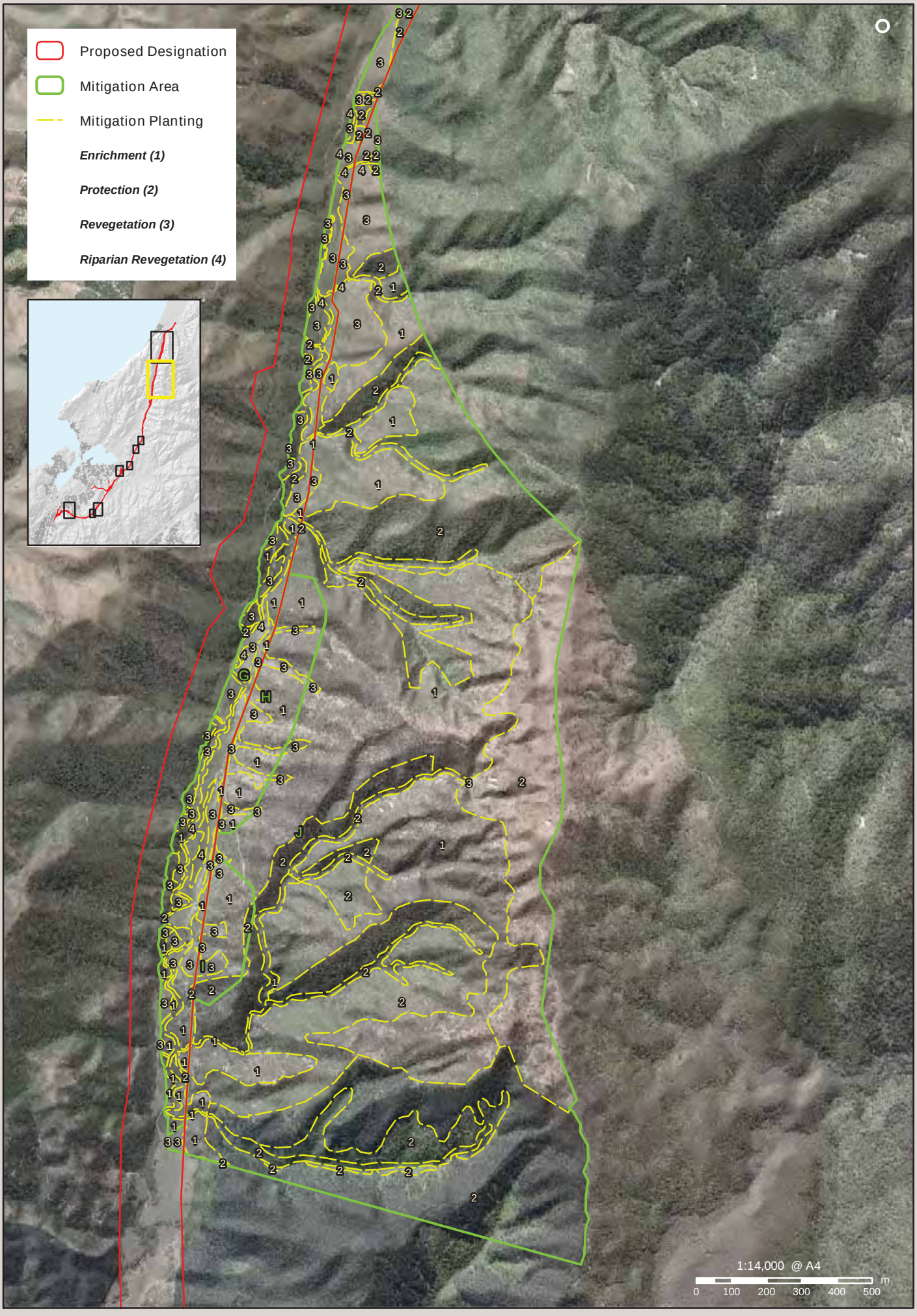
Appendix 11.J: Mitigation Area Detail - Vegetation and Terrestrial Habitat Benefit



Boffa Miskell

NZ TRANSPORT AGENCY
WAKA KOTAHI

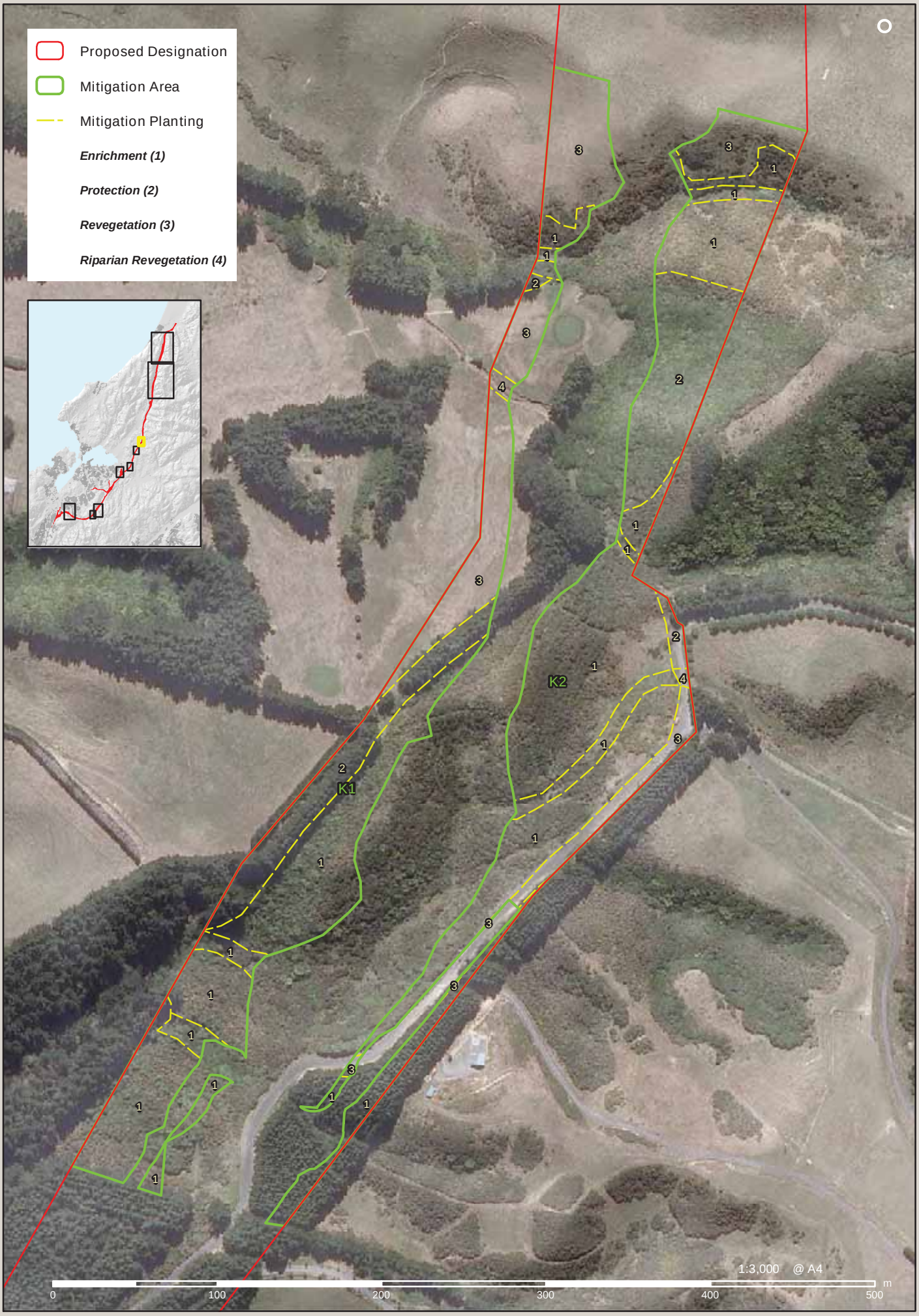
TRANSMISSION GULLY
MITIGATION AREAS 11.11a
TE PUKA STREAM



Boffa Miskell

NZ TRANSPORT AGENCY WAKA KOTAHI

TRANSMISSION GULLY
MITIGATION AREAS 11.11b
HOROKIRI STREAM



July 29, 2011 W09034A_EIA_Mitigation_A4mb.mxd

Boffa Miskell

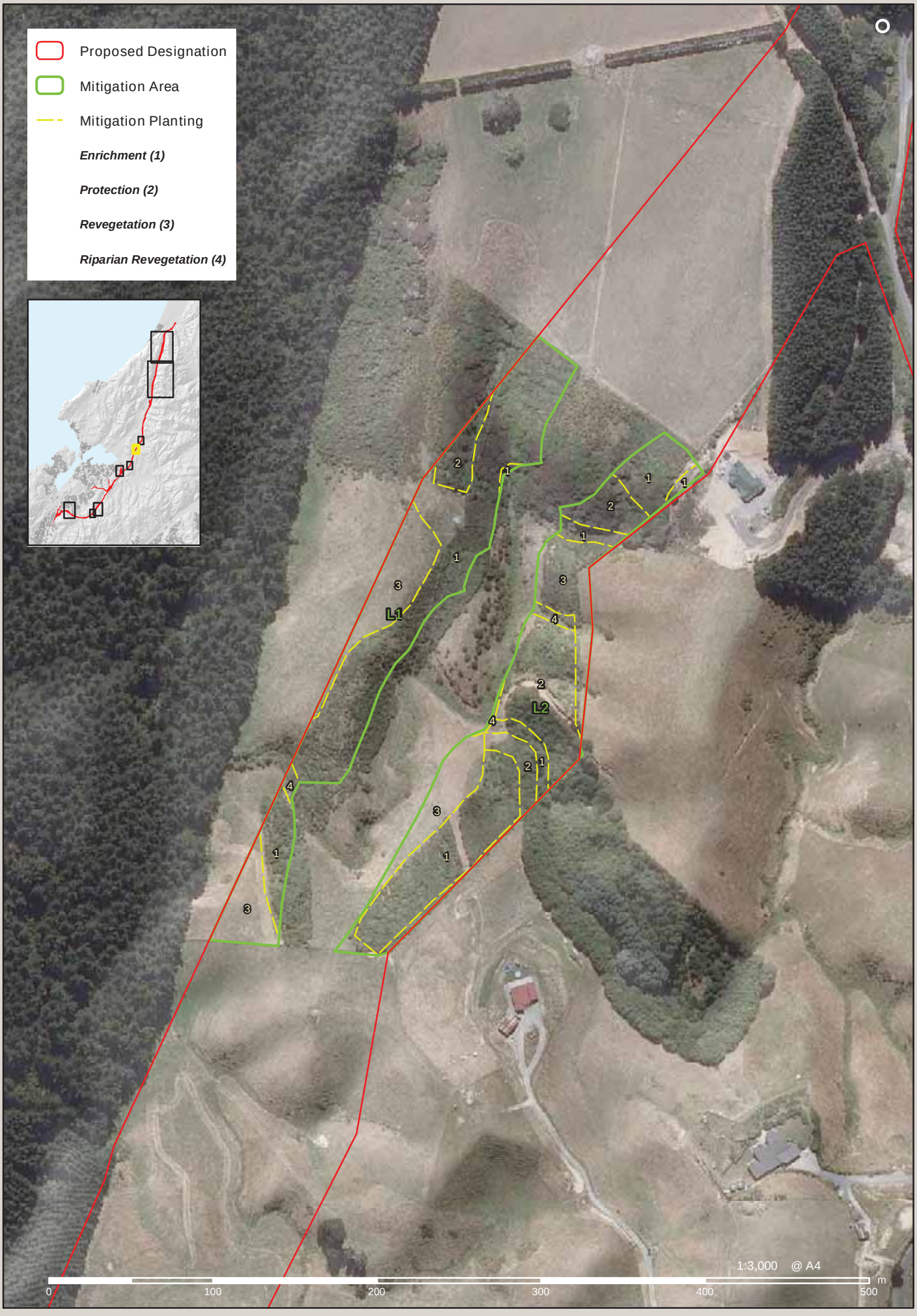
NZ TRANSPORT AGENCY WAKA KOTAHI

TRANSMISSION GULLY

MITIGATION AREAS

RATION CREEK (ER7)

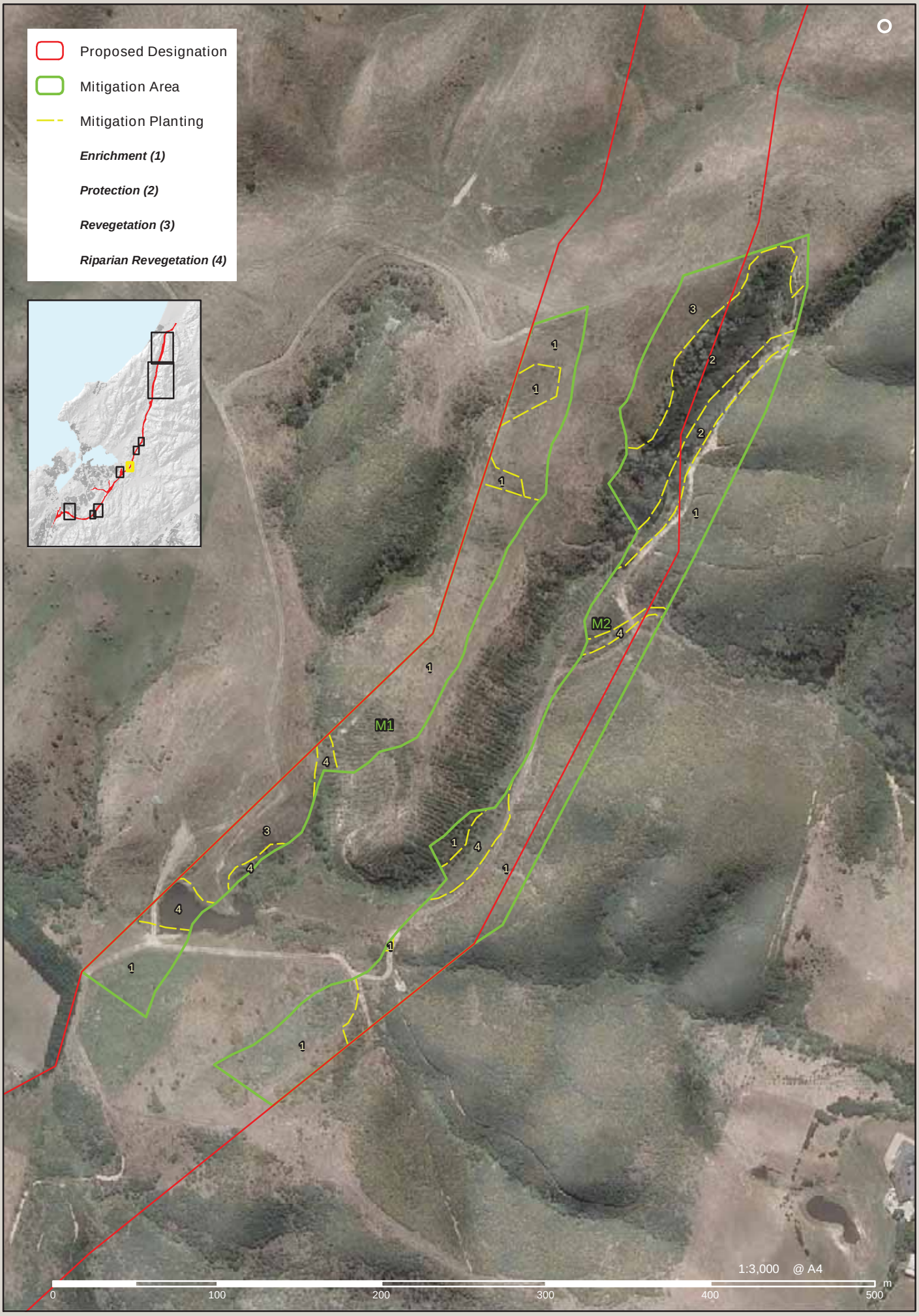
11.11c



Boffa Miskell

NZ TRANSPORT AGENCY
WAKA KOTAHI

TRANSMISSION GULLY
MITIGATION AREAS 11.11d
RATION CREEK (ER6)



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Boffa Miskell

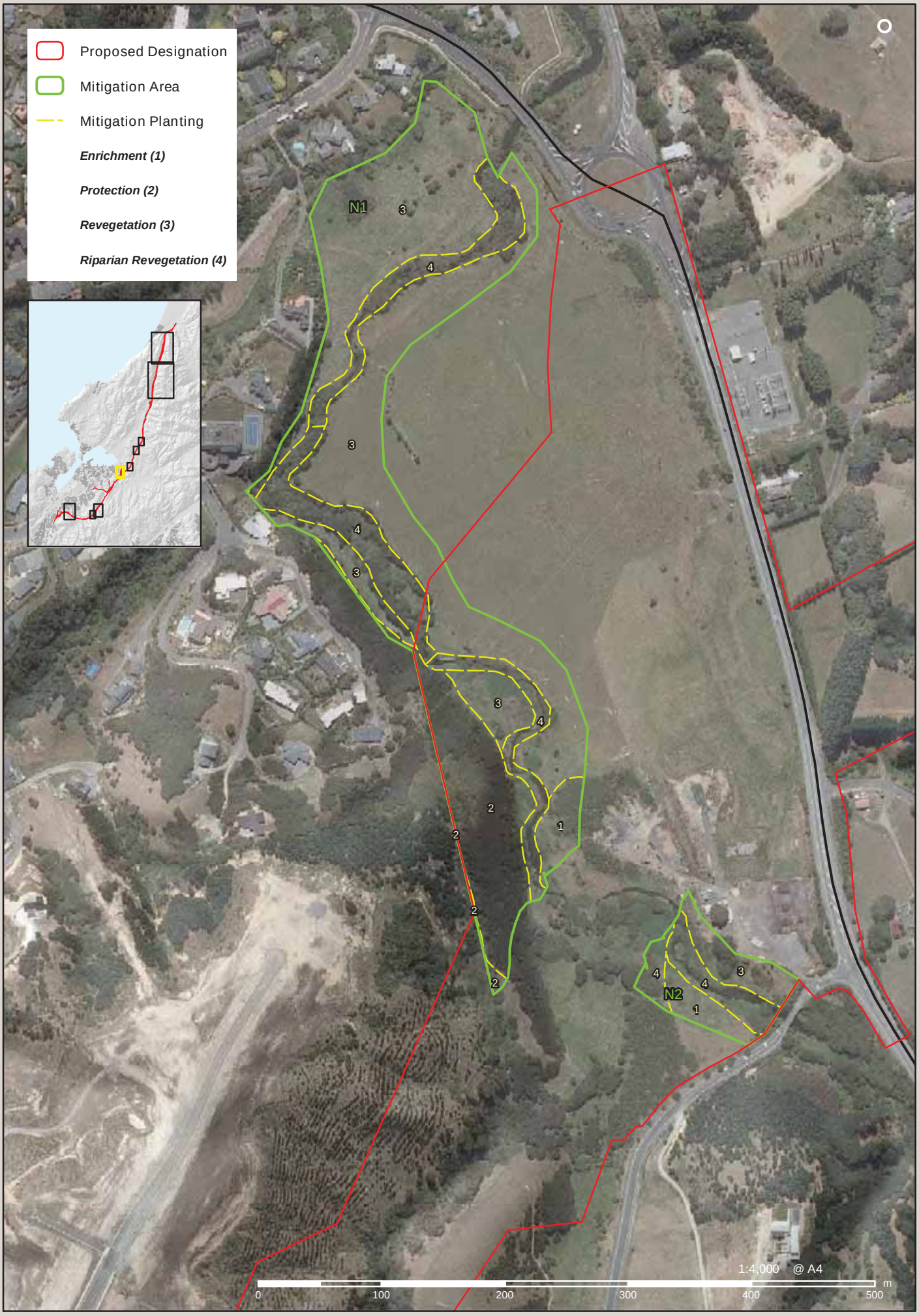
NZ TRANSPORT AGENCY WAKA KOTAHI

TRANSMISSION GULLY

MITIGATION AREAS

PAUATAHANUI STREAM (ER5)

11.11e



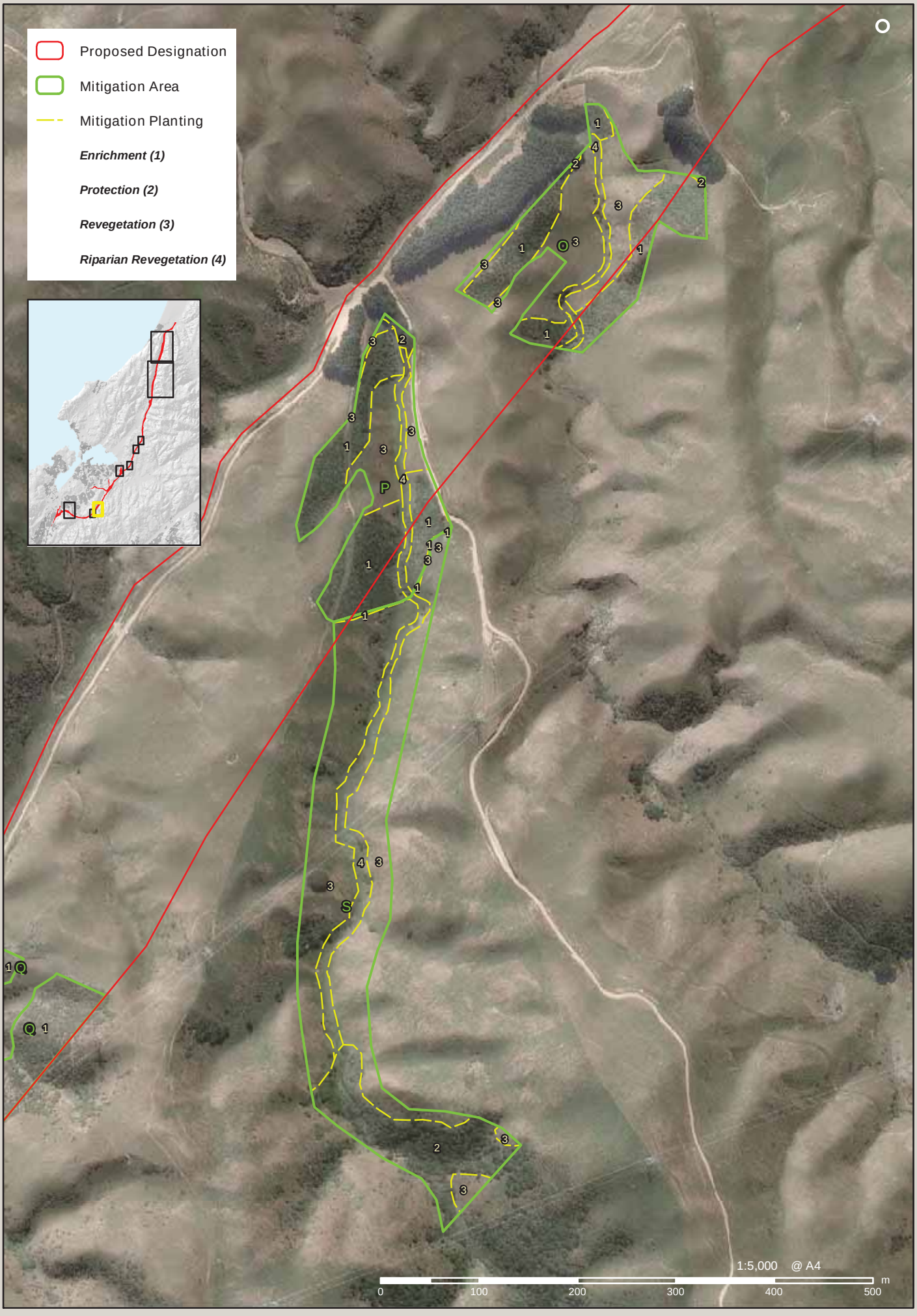
July 29, 2011 W09034A_EIA_Mitigation_A4mb.mxd

Boffa Miskell

NZ TRANSPORT AGENCY
WAKA KOTAHI

TRANSMISSION GULLY
MITIGATION AREAS
PAUATAHANUI STREAM (LANES)

11.11f



July 29, 2011 W09034A_EIA_Mitigation_A4mb.mxd

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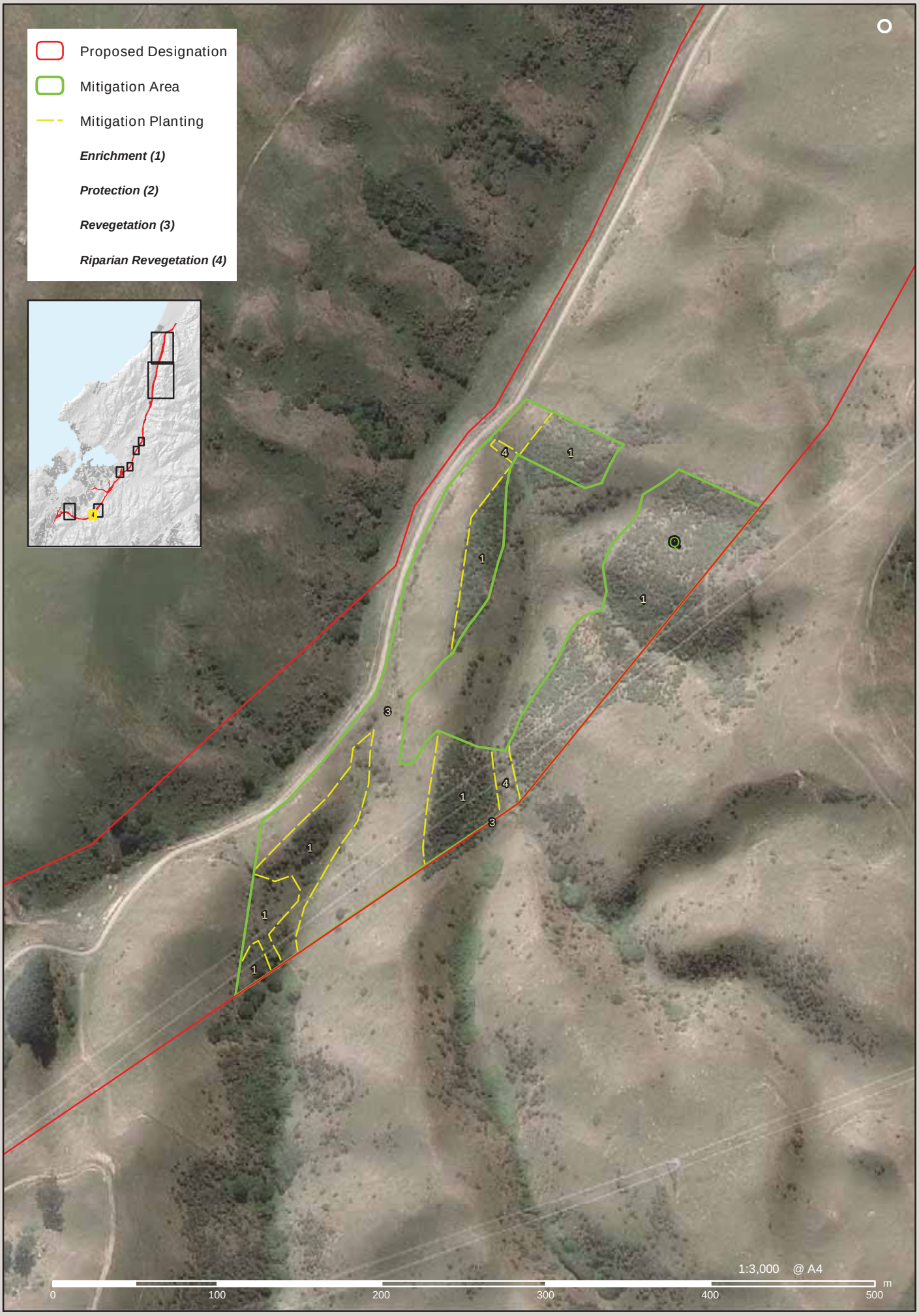
NZ TRANSPORT AGENCY WAKA KOTAHI

TRANSMISSION GULLY
MITIGATION AREAS
DUCK CREEK (ER2 & 3)

11.11g



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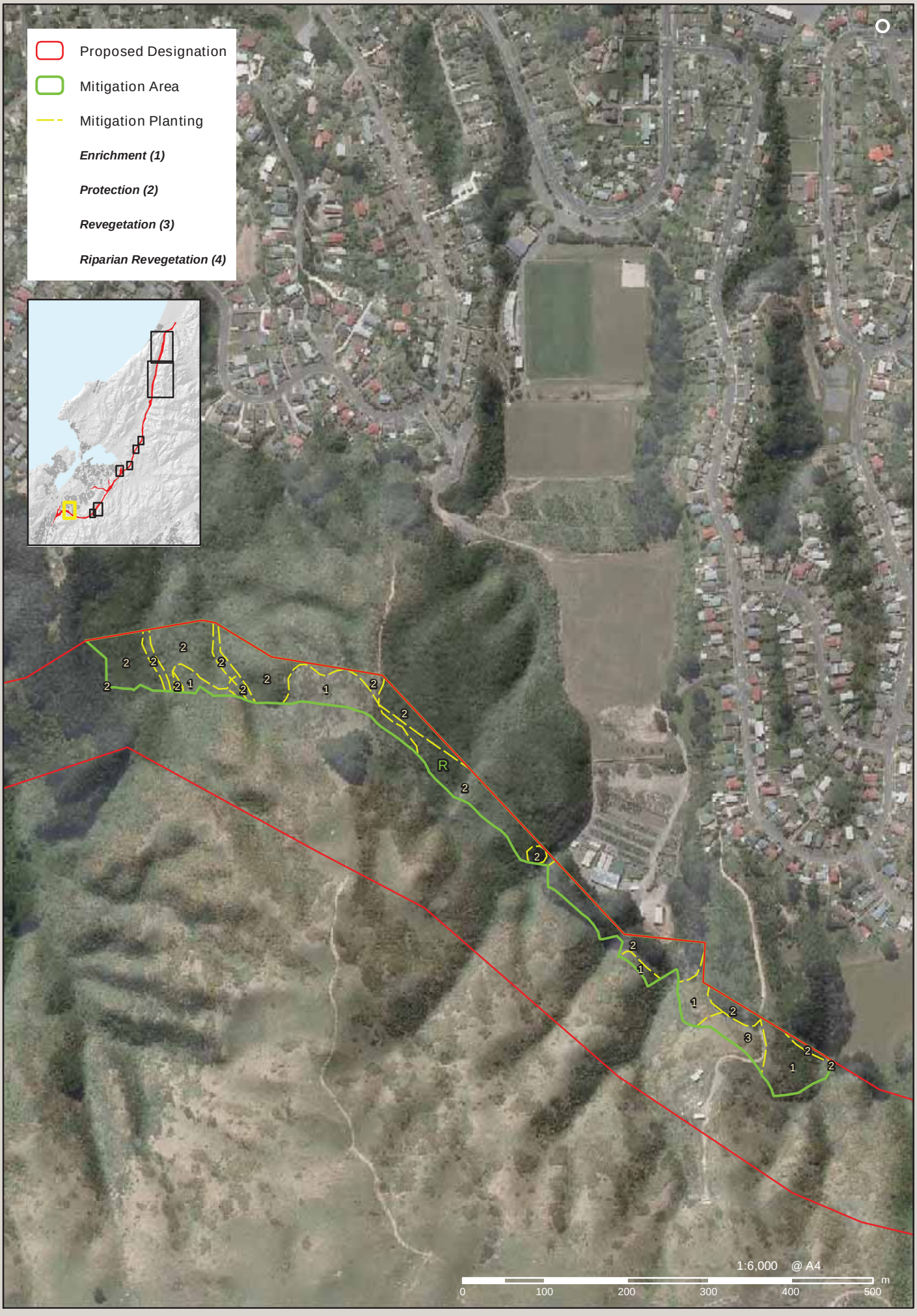
NZ TRANSPORT AGENCY
WAKA KOTAHI

TRANSMISSION GULLY
MITIGATION AREAS
DUCK DREEK (ER1)

11.11h



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Boffa Miskell

NZ TRANSPORT AGENCY
WAKA KOTAHI

TRANSMISSION GULLY
MITIGATION AREAS
PORIRUA STREAM

11.11i

Appendix 11.K: Mitigation Area Detail - Freshwater Habitat Benefit

	Footprint		Potential Retirement		Potential Retirement Streams (m)																		
Decription	Length (m)	Length (% of total)	Combined length (m)	Length (% of total)	A: Te Puka (Coastal forest remnant)	B: Te Puka (Coastal forest remnant)	C: Te Puka (Coastal forest remnant)	D: Te Puka (Coastal forest remnant)	E: Te Puka (Western Slopes)	F: Te Puka (Valley Floor)	G: Horokiri (Valley Floor)	H: Horokiri (Retirement Area 11)	I: Horokiri (Retirement Area 10)	J: Horokiri (Eastern Slopes)	K: Ration (Retirement Area 9)	L: Ration (Retirement Area 8)	M: Ration (Retirement Area 7)	N: Pauatahanui (Lanes Flats)	O: Duck (Retirement Area 3)	P: Duck (Retirement Area 2)	Q: Duck (Retirement Area 1)	S: Duck (Stream Channel)	R: Porirua (Scenic Reserve Margin)	DUCK CREEK CULVERTS OFFSET
0 (LINZ - Ephemerel / Intermittent)	4,628	59%	19,922	66%	393	52	253	259	1,504	2,777	3,651			8,117	211	72	244	1,084	241	274		691	98	2,667
1 (REC)	1,864	24%	4,094	14%						29	576			1,864	70		118	179	264	279	42	674		5,874
2 (REC)	1,081	14%	5,380	18%	365					2,291	2,577				68	78								
3 (REC)	94	1%																						
4 (REC)	123	2%	867	3%														867						
total (LINZ)	**7,790**	**100.0%**	**30,263**	**100.0%**	758	52	253	259	1,504	5,097	6,804			9,982	349	150	362	2,130	505	553	42	1,365	98	8,541

Appendix 11.L: 'Advance' Ecological Mitigation

BACKGROUND

During the designation process for Transmission Gully novel approaches to the management of effects on Pauatahanui Inlet were explored by the consenting team in consultation with the Department of Conservation, Regional Council, and conservation NGO's. A proposal was developed for the advanced retirement and revegetation of key sites along the alignment.

At the time a fifteen year timeframe before construction was assumed. On this basis it was reasonable to expect that early retirement of key sites could be achieved to provide a range of ecological benefits. In particular it was agreed that successful establishment of a continuous cover of native broadleaf species adjacent to important streams would support the mechanical methods of sediment and erosion control used during construction. The vegetation would both prevent direct impact of rain on the ground and trap sediments in a litter layer (FULLER, 1995).

Eleven early retirement sites were identified. Nine were where sizeable streams (catchment areas between 40 ha & 285 ha) were crossed. They include 4 tributaries of Duck Creek, 3 tributaries of Ration stream and 1 tributary of Horokiri stream. Two other sites in the upper Horokiri Stream were identified for early retirement in relation to erosion control above large cuttings.

Advanced ecological mitigation was contained within conditions 7 to 14, and in Schedule 2 (Ecological Measures) of the commissioner's recommendations. (Notice of Requirement for the Designation of the Inland Motorway Route (Transmisison Gully) Commissioners Report and Recommendations., 1997).

The key conditions were:

> *Condition 7 "Transit shall carry out ecological and landscape planting in advance of construction of the Proposed Works in accordance with Conditions 10 and 17 of this designation."*
>
> *Condition 10 "Transit shall not commence construction of the proposed work until the areas numbered 1 to 11 on attached plans A, B and C have been fenced off and retired from all agricultural other productive use or activity at least 8 years prior to the commencement of construction. Transit shall ensure that each of these areas is kept free from such uses or activities during the construction and operation of the Proposed Work."*
>
> *Condition 11 "The objectives of advance ecological mitigation described in condition 10 shall be to avoid, remedy or mitigate erosion, damage to streambeds and the discharge of sediments into waterways."*

PRACTICAL CONSIDERATIONS

The use of vegetation as a means of sediment control is only a secondary measure which supports but does not replace a wide range of mechanical mechanisms. These mechanical means will trap and hold the great majority of sediment.

It was determined that a minimum of eight years was required for the process of revegetation of these early retirement sites to be carried out. A shorter timeframe would not provide the woody native species with sufficient time to establish an effective cover. This timeframe was set in conditions attached to the designation.

EARLY RETIREMENT SITES

The following eleven sites were selected. They have a combined area of 57 ha. 16 ha of this area is taken up with the proposed project footprint leaving 41 ha of planting, 10 ha of riparian revegetation (up and downstream of the footprint) and 31 ha of terrestrial vegetation on slopes to either side fo the footprint.

Table 11-73: General Characteristics of Early Retirement Sites

Site	Catchment	Predominant Existing Vegetation	Topography	Area of Planting	
				Riparian area (ha)	Vegetation area (ha)
1	Duck Creek	Pasture with some tauhinu-manuka scrub on ridges	Rolling hill country with ephemeral stream in valley bottom	0.3	1.5
2	Duck Creek	Pasture with some tauhinu-manuka scrub and shelter belts	Rolling hill country with ephemeral stream in valley bottom	0.6	0.7
3	Duck Creek	Pasture and some tauhinu-manuka scrub and some exotics (c. 5% area) at the edges	Rolling hill country with stream in valley bottom	0.2	1.1
4	Duck Creek	Pasture and residual native scrub along streams if exotic forest has been milled	Valley junction in rolling hill country	0.5	1.2
5	Pauatahanui Stream	Pasture (50%) on stream flats; 50% of area of both stream valley and hills covered with native vegetation	Stream with stream terraces and low rolling hills	1.3	1.0
6	Ration Creek	Pasture (80%); remnant of native scrub (20%) at one end; valley bottom in native sedges and rushes	Stream bottom with low ridges and rolling hills	1.0	2.0
7	Ration Creek	50% of area is in pasture that has 30% cover of scrub; 50% covered with native scrub	Valley with stream flats and some low ridges	1.1	0.5
8	Ration Creek	Pasture (50%); shaded valley side covered in young scrub/coarse pasture	Valley with meandering stream and moderately steep valley sides	0.3	0.9
9	Horokiwi Stream	95% native scrub with some taller vegetation in valleys; except for 5% pasture on rounded ridges - borders onto pine forest	Steep sided valley	0.7	3.5
10	Horokiwi Stream	Rough pasture/light native scrub	Valley side in rolling hill country that extends to edge of stream flats	0.7	6.9
11	Horokiwi Stream	Native scrub/coarse pasture with taller native scrub/low forest in valleys	A series of parallel ridges and valleys	3.7	11.8
			Sub total	**10**	**31**
			Total		**41 ha**

GENERAL APPROACH AND REVEGETATION PRINCIPLES

In 2000 agreement was reached with GWRC and DoC on the general approach to advance ecological mitigation which was then developed into a Retirement and Revegetation Management Plan (Beca Carter Hollings & Ferner Ltd, 2001). Individual plans were prepared for each of the eleven sites as they came available.

The general approach identified a set of revegetation principles (from Section 3 of the Retirement and Revegetation Management Plan) and planting plans were designed around these:

1. Sediment Discharge Control Principles

Vegetative ground cover provides an effective means of filtering sediment from overland runoff. The initial emphasis with retirement planting for the purpose of sediment control is, therefore to increase the vigour and bulk of the existing grass cover by seeding with readily obtained exotic grasses. Subsequent planting includes native grasses, sedges and flax (harakeke) and woody species for the purpose of enhancing the early stages of forest succession. The timing of subsequent planting is critical to ensure that dense ground cover is not killed by shading. Subsequent planting should not occur until construction works are completed.

The type of vegetation suitable for controlling sediment is influenced by location characteristics such as aspect, moisture and substrate type. The planting methodology outlined in Section 5.2 has taken this into consideration.

2. Runoff Rate Control Principles

Vegetation intercepts precipitation and delays overland runoff. Enhancing the existing vegetative cover of designated areas above earthwork sites will further increase precipitation interception and delay runoff. Planting for this purpose should take into account the size and land-use of the up-slope catchment.

Planting for this purpose may also, in effect, compensate for any increased runoff occurring from construction areas and completed paved areas along the route.

Appropriate plant species and plant arrangements are dependent on the orientation, moisture availability and soil type. The planting methodology outlined in Section 5.3 has taken this into consideration.

3. Ecosystem Enhancement Principles

In addition to sediment and erosion control, the ecological mitigation planting will enhance the existing stream ecosystems by:

- *Providing stream margin shade planting upstream of earthworks; and*
- *Providing other general ecological habitat enhancement planting (Clause 9 and 11, Schedule 2 - Commissioners Recommendations).*

The purpose of Objective 3.4(b) is essentially to mitigate for the loss of native vegetation that may occur as a result of construction activities, and may include the planting of native species in appropriate positions to connect isolated stands of existing native vegetation (Schedule 2, Clause 9 – Commissioners Recommendations).

Item (b) also allows for the planting of parts of properties that are severed as a result of the construction o f the route (such properties may include parts of properties marked 14, 23B and 24 as shown in figure 4.2 of the AEE) as required in Clause 11, Schedule 2 of the Commissioners Recommendations.

The general planting arrangements outlined in Section 5.4 are suitable for stream shading, fauna and flora corridors and for minimising the effects of severed properties.

4. Other Planting (Slope Stability)

The exposure of slopes as a result of cut and fill activities can increase the risk of erosion and associated sedimentation. To minimise this risk and to control the rate of runoff from significant cut and fill slopes will be planted, where appropriate, using the general plant arrangements described in Section 5.2-5.4.

A different planting approach was developed for each of these categories.

Note that for sites 10 and 11 the form of planting carried out was 'enrichment planting'. Enrichment Planting (EP): involves inter-planting of climax or sub-climax native tree species in areas that already support early successional native vegetation (eg grey scrub in Horokiri and Te Puka). A limited range of locally sourced tree species are inter-planted in selected sites within the scrub at a reduced density of around 1xPB5 grade plant at 7.5m2 spacing (approx. 180 stems per ha.).

This differs from revegetation which plants 1xPB2 grade plant/m², 1xPB5 plant/7m2 (enrichment planting in year 3).

PLANTING STATUS UPDATE

Planting commenced in 2002 and was carried out progressively as sites were purchased. Planting was completed in 2009.

Status as at November 2009 was that all planting, with the exception of Area 8, was complete. Some minor work relating to pest eradication and weed matting was still being carried out but was due for completion by the end of 2009.

Ongoing inspections, weed and pest control management and plant maintenance of all completed areas. Maintenance programme is due for completion November 2012.

Table 11-74: Planting Areas Status Update (As at November 2009)

Status	Planting Areas	Property Status	Comment
Completed 2003	1	Leased	Plant growing well. Three year maintenance period now complete.
Completed 2003	2	Leased	Plant growing well. Three year maintenance period now complete.
Completed 2003	3	Leased	Plant growing well. Three year maintenance period now complete.
Completed 2007	4	Lease secured	Planting growing well. Three year maintenance period now complete.
Completed 2009	5	Lease secured	Ongoing maintenance underway.
Completed 2002	6	Owned by the crown	Plants growing well. Three year maintenance period now complete.
Completed 2005	7	Owned by the crown	Plants growing well. Three year maintenance period now complete.
Not to be planted	8 North	No action on retirement area proposed	Planting not to be completed. Designation is likely to change as a result preferred alignment and would almost certainly affect any planting that was undertaken.
Completed 2005	8 South	Owned by the crown	Plants growing well. Three year maintenance period now complete.
Fencing only required	9	Lease secured	Fencing completed June 2009
Completed 2009	10	Owned by the crown	Ongoing maintenance underway.
Completed 2009	11	Owned by the crown	Ongoing maintenance underway.

RECOMMENDATIONS

- Planting associated with advanced ecological mitigation has been completed and monitoring of the sites suggests that the general planting approach has been sound, with good strike rates of the majority of species used suggesting appropriate plant selection for each site.
- We recommend that the design of ongoing revegetation continue to follow this model.
- The planting plan for Early Retirement Site 6 is appended to the draft Ecological Management Plan as an example of this approach.

Appendix 11.M: Calculation of Probabilities of Coincident Rain and Wind Events in the Porirua Basin

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Calculation of Probabilities of Coincident Rain and Wind Events in the Porirua Basin

TRANSMISSION GULLY PROJECT

Prepared by

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For

Boffa Miskell Ltd

August, 2011

This analysis has been based on data provided in Technical Report 15 prepared by Sinclair Knight Mertz (SKM)

The specific question of interest is: What is the probability of an event which includes

1. ARI 10 year rainfall, at Porirua;
2. Wind (either SSE (170°) or NNW (340°)) at least 5 m/s; and
3. Over several time frames relevant to the construction period

The SKM report (Table 15.38) gives the observed number of events over approximately 50 years data, when there was:

1. Wind with speed of at least 5 m/s at Wellington Aero, in Northerly or Southerly directions; AND
2. An ARI 10 year rain event at Porirua.

From these data, we calculated the event probabilities using the following assumptions:

1. The wind direction and speed recorded at Wellington Aero can be used to describe wind direction and speed at Porirua;
2. The event can be modeled using a Binomial distribution and 95% confidence intervals can be calculated using that distribution; and
3. The probability of at least 1 event is given by the formula,

   $$P_t = 1 - \left(1 - P_f\right)^n$$

   where:

   P_t = probability of at least one event occurring over a period of n years;

   P_f = probability of occurrence in any one year;

   n = duration of exposure in years.

4. Based on both the ARI2 and ARI 10 data, when either of these major rain events occurred with coincident wind, 50% of the events included a northerly wind, 30% of the events included a southerly wind, and the remainder of these events there was either no wind (calm) or the wind came from neither of these directions. We therefore assumed that for major rain events accompanied by wind in the Porirua Basin, 50% of these would be Northerly, and 30% Southerly.

5. To calculate the probabilities below we:
   a) first, calculated the probability of an ARI 10 rain event, based on the observations compiled by SKM.
   b) then we calculated the exact 95% confidence interval using a Binomial probability distribution.
   c) the probabilities for an event with Northerly or Southerly wind were calculated by multiplying these probabilities by 0.5 and 0.3 respectively.

Probabilities (and 95% confidence intervals) of an ARI 10 rain event at Porirua (all events), accompanied by a northerly wind > 5 m/s, or a southerly wind > 5m/s, based on Wellington wind data.

year	All events	northerly	southerly
1	0.1200 (0.0453, 0.2431)	0.0600 (0.0227,0.1216)	0.0360 (0.0136, 0.0729)
2	0.2256 (0.0885, 0.4271)	0.1164 (0.0449, 0.2284)	0.0707 (0.0270, 0.1405)
3	0.3185 (0.1298, 0.5664)	0.1694 (0.0666, 0.3222)	0.1042 (0.0402, 0.2031)
4	0.4003 (0.1693, 0.6718)	0.2193 (0.0878, 0.4047)	0.1364 (0.0533, 0.2612)
5	0.4723 (0.2069, 0.7516)	0.2661 (0.1085, 0.4770)	0.1675 (0.0662, 0.3151)
6	0.5356 (0.2428, 0.8120)	0.3101 (0.1287, 0.5406)	0.1975 (0.0789, 0.3650)
7	0.5913 (0.2771, 0.8577)	0.3515 (0.1485, 0.5965)	0.2264 (0.0914, 0.4113)
8	0.6404 (0.3099, 0.8923)	0.3904 (0.1678, 0.6456)	0.2542 (0.1038, 0.4542)

Probabilities (and 95% confidence intervals) expressed as percentages, rounded to the nearest integer, of an ARI 10 rain event at Porirua (all events), accompanied by a northerly wind > 5 m/s, or a southerly wind > 5m/s, based on Wellington wind data.

year	All events	northerly	southerly
1	12% (5%, 24%)	6% (2%, 12%)	4% (1%, 7%)
2	23% (9%, 43%)	12% (4%, 23%)	7% (3%, 14%)
3	32% (13%, 57%)	17% (7%, 32%)	10% (4%, 20%)
4	40% (17%, 67%)	22% (9%, 40%)	14% (5%, 26%)
5	47% (21%, 75%)	27% (11%, 48%)	17% (7%, 32%)
6	54% (24%, 81%)	31% (13%, 54%)	20% (8%, 37%)
7	59% (28%, 86%)	35% (15%, 60%)	23% (9%, 41%)
8	64% (31%, 89%)	39% (17%, 65%)	25% (10%, 45%)