Before a Board of Inquiry
MacKays to Peka Peka Expressway Proposal

under: the Resource Management Act 1991

in the matter of: Notice of requirement for designation and resource consent applications by the NZ Transport Agency for the MacKays to Peka Peka Expressway Proposal

applicant: **NZ Transport Agency**
Requiring Authority

Supplementary statement of evidence of **Camilla Borger** (Air Quality) for the NZ Transport Agency

Dated: 14 September 2012

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SUPPLEMENTARY STATEMENT OF EVIDENCE OF CAMILLA BORGER FOR THE NZ TRANSPORT AGENCY

QUALIFICATIONS AND EXPERIENCE

1 My full name is Camilla Elizabeth Borger. My qualifications and experience are set out in my Evidence in Chief (*EIC)*, dated 5 September 2012.

2 I repeat the confirmation given in my EIC that I have read, and agree to comply with, the Code of Conduct for Expert Witnesses (Consolidated Practice Note 2011).

3 In response to the section 92 request from the Board of Inquiry (dated 7 August 2012) the NZ Transport Agency commissioned Beca Infrastructure Limited (*Beca)* to carry out a Community Exposure Assessment. This was discussed at paragraphs 112-113 of my EIC.

4 The Community Exposure Assessment (entitled Supplementary Report - Assessment of Air Quality Health Effects) (*the Assessment)* has now been completed and I have attached a copy as **Annexure A** to this supplementary statement of evidence.

5 The Assessment was prepared by members of my team at Beca. I reviewed the Assessment undertaken and support its methodology and conclusions.

6 I confirm that nothing in the Assessment causes me to change the conclusions reached in my EIC.

Camilla Borger
14 September 2012

ANNEXURE A – SUPPLEMENTARY REPORT - ASSESSMENT OF AIR QUALITY HEALTH EFFECTS

Supplementary Report

Assessment of Air Quality Health Effects

Prepared By Beca Infrastructure Limited

14 September 2012

NZ TRANSPORT AGENCY
WAKA KOTAHI

1 MacKays to Peka Peka Expressway

Revision History

Revision N°	Prepared By	Description	Date
A	Charles Kirkby	Draft	11/09/2012
B	Charles Kirkby	Final	14/09/2012

Document Acceptance

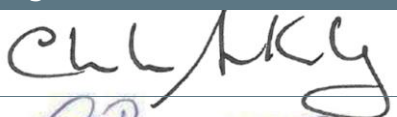
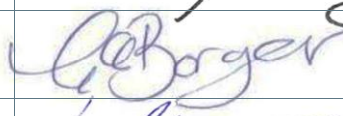
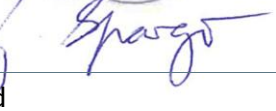
Action	Name	Signed	Date
Prepared by	Charles Kirkby		14/09/2012
Reviewed by	Camilla Borger		14/09/2012
Approved by	Graham Spargo		14/09/2012
on behalf of	Beca Infrastructure Limited		

Table of Contents

List of Tables

Appendices

Executive Summary

The NZ Transport Agency (the NZTA) has commissioned Beca Infrastructure Limited (Beca) to undertake an assessment of impacts on human health arising from air discharges associated with vehicles travelling on the proposed MacKays to Peka Peka Expressway (the Project). This assessment has been provided in response to a section 92 request (dated 7 August 2012) from the Board of Inquiry (BoI) appointed to consider the NZTA's notice of requirement and an application for associated resource consents for the Project, under the Resource Management Act 1991 (RMA).

In undertaking this assessment, Beca has followed the methodology recommended in the Ministry for the Environment's (MfE) Good Practice Guide for Assessing Discharges to Air from Land Transport (MfE, 2008) (MfE Transport GPG). The MfE Transport GPG presents methodologies for undertaking a simple assessment of the health impacts associated with roading projects. In addition, the significance criteria presented in the MfE Transport GPG were used to select a representative part of the Project area for the assessment.

The increases in concentrations of PM_{10} within the assessment areas were estimated from the dispersion modelling carried out for the Project (see Technical Report 13: Assessment of Operational Air Quality Effects (Beca, 2012)) (Technical Report 13).

The health effects study area focussed on the population exposed to exhaust emissions from vehicles on the Expressway between Kāpiti Road and Te Moana Road, which is predicted to be the busiest section of the Expressway. Predicted traffic volumes on the section of the Expressway between Kāpiti Road and Te Moana Road (i.e. most of Sector 2 and Sector 3) are higher than on any other part of the Expressway.

Comparison of the results of atmospheric dispersion modelling indicates that changes in concentration of air pollutants due to the Project do not exceed the MfE significance criteria. Only in the vicinity of the Kāpiti Road interchange (Sector 2) are the increases in maximum concentrations of any air pollutants predicted to approach any of the relevant significance criteria.

Digital mapping software was used to count the number of dwellings within bands less than 50m, 50m-100m, 100m-150m and 150m-200m from the Expressway between Kāpiti Road and Te Moana Road. The population of these dwellings was estimated from the occupancy rate within each 2006 census mesh block.

The results of this assessment provide an 'Estimated Increase in Annual Mortality' of 0.005 within the study area. An increase in annual mortality of 0.005 represents approximately one additional premature mortality in 200 years. It is recognised that people will be exposed to increases in concentrations of air pollutants due to vehicle exhaust emissions in other parts of the Project area (e.g. between Poplar Avenue and Kāpiti Road, and north of Te Moana Road). However, given the lower traffic volumes on other parts of the Expressway and lower population exposed, it can be inferred that the calculated health effects for the whole Expressway would be less than 0.01 (i.e. less than one additional premature mortality in 100 years).

1 Introduction

This report forms a supplementary report to Technical Report 13 and should be read in conjunction with that document.

The BoI appointed to consider the NZTA's notice of requirement and applications for resource consent for the Project has made a request for further information under section 92 of the RMA (by letter dated 7 August 2012). The section 92 request referred to a community exposure assessment as recommended in the MfE Transport GPG, and sought confirmation if this was intended to be undertaken for the Project. Although it is not strictly necessary to carry out such an assessment on the basis of the recommendations in the MfE Transport GPG[1], the NZTA has commissioned Beca to undertake an assessment of impacts on human health arising from air discharges associated with vehicles travelling on the Project.

Through the Project, the NZTA proposes to construct, operate and maintain a four-lane Expressway that largely follows the existing Western Link Route designation over a length of approximately 16km from just south of Poplar Avenue to Te Kowhai Road, Peka Peka.

For ease of reference, the Expressway alignment has been divided into four geographic sectors. Each of the sectors covers a geographic area that is described in Table 1.1.

Table 1.1 – Sector Description

Sector number	Sector name	Description	Chainage (m)	Length (km)
1	Raumati South	From just south of Poplar Ave to just north of Raumati Road	1900 – 4500	2.6
2	Raumati/Paraparaumu	From just north of Raumati Road to north of Mazengarb Road	4500 – 8300	3.8
3	Otaihanga/Waikanae	From north of Mazengarb Road to north of Te Moana Road	8300 – 12400	4.1
4	Waikanae North	From north of Te Moana Road to Peka Peka	12400 – 18050	5.7

[1] The MfE Transport GPG states: *"In some situations it may be necessary to undertake a more comprehensive air pollution health risk assessment as part of a detailed study. For example when predicted effects exceed ambient air quality criteria..."* As described in Technical Report 13, the Expressway is not predicted to exceed ambient air quality criteria.

2 Assessment of Health Impacts

2.1 Background

The MfE Transport GPG recommends a tiered approach to the assessment of effects of air discharges from land transport. Within the Tier 3 detailed assessment, it is recommended that consideration be given to undertaking a health impact or health risk assessment. However, it also notes that, where concentrations of air pollutants are not predicted to exceed the relevant assessment criteria, a health risk assessment is unlikely to be required.

The results of atmospheric dispersion modelling reported in Technical Report 13 indicate that predicted ground level concentrations of all air pollutants caused by exhaust emissions from vehicles on the Expressway are not expected to exceed either the relevant health based guidelines[2] or the significance criteria recommended in the MfE Transport GPG (refer section 2.3 of this report). However, ground level concentrations of $PM_{2.5}$ are predicted to be only slightly lower than the relevant MfE Transport GPG significance criterion at receptors located with 50m of the alignment between Kāpiti Road and Mazengarb Road (refer Appendix A)[3].

2.2 Approach to Assessment of Health Impacts

Appendix 4 to the MfE Transport GPG presents methodologies for undertaking a simple assessment of health impacts (based on the level of community exposure) associated with roading projects. In addition, the significance criteria presented in section 7.4.2 of the MfE Transport GPG (part of a Tier 2 assessment) were used to select those parts of the Project area for which the assessment of health impacts was considered appropriate.

This assessment has followed the approach presented in Appendix 4.2 of the MfE Transport GPG, making use of the results of the dispersion modelling assessment (presented in Technical Report 13), except that a financial value has not been attributed to any health impacts identified. This assessment compares the difference between predicted ground level concentrations of particulate matter (PM_{10}) for the 'With Project' and 'Do Minimum' scenarios for both 2016 and 2026.

The health risk assessment focussed on the potential health effects of increases in the concentration of PM_{10}, since that is the only parameter for which a health effect factor and a methodology is given in the MfE Transport GPG. This is valid in most cases because the majority of health effects in New Zealand are associated with this pollutant and it is a good indicator of the sources and effects of other air pollutants (Kuschel, et al., 2012)[4].

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[2] Air Quality National Environmental Standards (*AQNES),* NZ Ambient Air Quality Guidelines (*NZAAQG)*, Greater Wellington Regional Council's Ambient Air Quality Guidelines (*GWRC's AAQG*) and the World Health Organisation's (*WHO*) Air Quality Guidelines.

[3] The maximum increase in predicted $PM_{2.5}$ concentrations in 2026 is 1.22 $\mu g/m^3$ (at receptors on a transect within 50m of the alignment), compared to a significance criterion of 1.25 $\mu g/m^3$.

[4] The 2012 update to the Health and Air Pollution in New Zealand study (Kuschel, et al., 2012) notes that health effects associated with vehicle emissions are also linked to other pollutants, in particular nitrogen dioxide. Whether PM_{10}, $PM_{2.5}$, NO_2 or any of the other vehicle related pollutants are the 'cause' of the majority of vehicle emission related health effects in NZ is still to

The health effect was calculated using the following relationship (Equation 2.1), modified from Equation A4-1 in the MfE Transport GPG:

Equation 2.1 Effect = health effect factor x ΔPM_{10} x population exposed x normal death rate

where:

1. *health effect factor* is the percentage increase in daily mortality for a 1 µg/m³ increase in PM_{10} concentration. Based on the 2012 update to the Health and Air Pollution in New Zealand Study (HAPiNZ 2012 update) (Kuschel, et al., 2012), it is currently recommended that a value of 0.7% be used)

2. *ΔPM_{10}* is the change in annual average PM_{10} concentration (µg/m³)

3. *normal death rate* is taken from the published life tables in New Zealand and is currently 3.8 per year per thousand people (www.stats.govt.nz)

2.3 Assessment of Effects

2.3.1 Selection of Study Area

The selection of the study area is based on the significance criteria recommended in section 7.4.2 of the MfE Transport GPG, which are used as screening criteria to assess the significance of any increase in ground level concentrations of air pollutants caused by vehicle exhaust emissions. These significance criteria are summarised in Table 2.1.

Table 2.1 – Significance Criteria

Pollutant	**Averaging period**	**Significance** criteria	**Derivation of** criteria
Nitrogen dioxide	1-hour 24-hour	20 µg/m³ 5 µg/m³	10% of the AQNES 5% of the WRC AAQG
Carbon monoxide	Rolling 8-hour	1 mg/m³	10% of the AQNES
Fine particles (PM_{10})	24-hour	2.5 µg/m³	5% of the AQNES
Fine particles ($PM_{2.5}$)	24-hour	1.25 µg/m³	5% of the AAQG

Notes: mg/m³ – milligrams per cubic metre
µg/m³ – micrograms per cubic metre
AQNES – Resource Management (National Environmental Standards for Air Quality) Regulations 2004
WRC AAQG – Wellington Regional Council Ambient Air Quality Guideline (GWRC, 2000)
AAQG – New Zealand Ambient Air Quality Guideline (MfE MOH, 2002)

be determined. The effects of pollutants other than PM_{10} were not quantified in the HAPiNZ 2012 update due to a lack of appropriate data.

The significance criteria for PM_{10} in Table 2.1 have been applied to the predicted ground level concentrations from the dispersion modelling results to select the locations where differences between the 'With Project' and 'Do Nothing' options approach or exceed the significance criteria.

Appendix A presents a summary of maximum predicted concentrations of NO_x, CO, PM_{10} and $PM_{2.5}$[5] both with and without the Project at the most affected receptors in Sectors 1 and 2[6], along with the difference between maximum predicted concentrations for the 'Do Minimum' and 'With Project' scenarios.

Only in the vicinity of the Kāpiti Road interchange (Sector 2) are the increases in maximum concentrations of any of these air pollutants (i.e. 24-hour average $PM_{2.5}$) between the 'Do Minimum' and 'With Project' scenarios predicted to approach any of the relevant significance criteria. Predicted traffic volumes on the section of the Expressway between Kāpiti Road and Te Moana Road (i.e. most of Sector 2 and Sector 3) are higher than on any other part of the Expressway[7]. Therefore, the study area selected focuses on the population exposed to exhaust emissions from vehicles on the Expressway between Kāpiti Road and Te Moana Road, although it is recognised that vehicle exhaust emission on other parts of the Expressway will also have effects on air quality and human health.

2.3.2 Determining the Population Exposed

The total population living with 200 metres of the Expressway alignment within the study area (i.e. between Kāpiti Road and Te Moana Road) is estimated to be approximately 1,300[8]. This is estimated to be well over half of the total population living within 200 metres of all parts of the Expressway.

Once the study area had been identified, digital mapping software was used to count the number of dwellings within bands less than 50m, 50m-100m, 100m-150m and 150m-200m from the Expressway. Where buildings lay partially within two or more of these bands, these were counted as being within the closest band to the Expressway within which they lay. For the purpose of this assessment, 'dwellings' were defined as buildings with a footprint of more than $20m^2$ located within Residential or Rural zoned areas (i.e. excluding most commercial premises, educational institutions, private garages and sheds). It should also be noted that a small number of dwellings that will be removed as part of the construction program for the Project were counted in this assessment.

Although this method is likely to count a number of non-residential buildings areas as dwellings (e.g. shops, larger private garages and farm buildings), and thus overpredict the

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5 Mass emission rates (and hence ground level concentrations due to vehicle emissions) for $PM_{2.5}$ are assumed to be 60% of the mass emission rates for PM_{10} (refer Technical Report 13).

6 Sector 1 covers the Expressway between Poplar Interchange and Raumati Road, while Sector to covers Raumati Road to Mazengarb Road, including the Kāpiti Interchange (refer Table 1.1).

7 Traffic volumes between Kāpiti Road and Te Moana Road are predicted to be 16,500 (2016) and 20,800 (2026) and between Poplar Ave and Kāpiti Road: 12,100 (2016) and 13,900 (2026). Ref Table 6.1, Assessment of Transport Effects, Technical Report 32.

8 As explained further below, this estimation was informed by census data.

population exposed, it was considered that this approach provided an adequate level of accuracy and conservatism within the scope of this assessment. There are also a small number of buildings close to the alignment, particularly in the vicinity of the Kāpiti Road and Te Moana road interchanges, that will be removed as part of the construction of the Expressway, but have been included in this assessment, also adding to the conservatism. Maps showing all the buildings identified in the study area are attached at Appendix B.

The population of these dwellings was estimated from the occupancy rate within each census mesh block that intersected with the study area – i.e. the total population within each mesh block from the 2006 census divided by the number of dwellings within each mesh block. For this purpose, the number of dwellings in each mesh block was estimated by the same method used to count the number of dwellings within 200m of the Expressway.

2006 census data was also used to estimate the population over 30 years old in the study area. The MfE Transport GPG notes that the method used in this assessment has only been validated for people aged over 30.

Full details of the numbers of dwellings in each mesh block within the study area, occupancy rates and population exposed are presented in Appendix C and summarised below:

4. Total population in mesh blocks = 4,239
5. Total population aged over 30 in mesh blocks = 2,922
6. Total number of dwellings in mesh blocks = 2,856
7. Number of dwellings in study area = 780
8. Population of study area = 1,299
9. Population of study area aged over 30 = 828

2.3.3 Determining the Change in PM_{10} Concentrations

Concentrations of air pollutants arising from vehicle exhaust emissions decrease rapidly with increasing distance from the source. At distances greater than 200m-300m from the kerbside, elevated concentrations of vehicle exhaust emissions become difficult to detect.

The average increase in concentrations of annual average PM_{10} within each band (less than 50m, 50m-100m, 100m-150m and 150m-200m from surface sections of the Expressway) was estimated from the results of dispersion modelling for a transect across the Expressway between Kāpiti Road and Mazengarb Road.

2.3.4 Quantification of PM_{10} Health Impact

Table 2.2 and Table 2.3 summarise the increase in annual mortality within the study area for the years 2016 and 2026 respectively, based on Equation 2.1. The 'Estimated Annual Mortality' in column 8 of these tables is derived from the current national annual mortality rate (3.8 per thousand) and the estimated population over 30 years old in the study area.

The 'Estimated Increase in Annual Mortality' in column 8 of these tables represents the impact of the operation the Project on annual mortality in the study area.

Table 2.2 – Estimated Health Effect of Predicted Increases in Ground Level Concentrations of PM_{10} Caused by Vehicle Exhaust Emissions from the Project (2016)

Distance from motorway (m)	Number of dwellings	Population exposed	Population over 30 exposed	ΔPM_{10} ($\mu g/m^3$)	Health effect factor	Estimated annual mortality *	Estimated increase in annual mortality
0-50	132	230	143	0.56	0.70%	0.54	0.002
50-100	203	343	215	0.29	0.70%	0.82	0.002
100-150	220	362	230	0.15	0.70%	0.87	0.001
150-200	225	364	240	0.09	0.70%	0.91	<0.001
Total	**780**	**1299**	**828**	**0.24**	**0.70%**	**3.14**	**0.005**

Note: * Estimated annual mortality is the statistically expected number of deaths within the population over 30, based on the normal death rate (refer Equation 2.1)

Table 2.3 – Estimated Health Effect of Predicted Increases in Ground Level Concentrations of PM_{10} Caused by Vehicle Exhaust Emissions from the Project (2026)

Distance from motorway (m)	Number of dwellings	Population exposed	Population over 30 exposed	ΔPM_{10} ($\mu g/m^3$)	Health effect factor	Estimated annual mortality*	Estimated increase in annual mortality
0-50	132	230	143	0.59	0.70%	0.54	0.001
50-100	203	343	215	0.31	0.70%	0.82	0.002
100-150	220	362	230	0.15	0.70%	0.87	0.001
150-200	225	364	240	0.10	0.70%	0.91	<0.001
Total	**780**	**1299**	**828**	**0.25**	**0.70%**	**3.14**	**0.006**

Note: * Estimated annual mortality is the statistically expected number of deaths within the population over 30, based on the normal death rate (refer Equation 2.1)

2.4 Discussion of Results

The results of this assessment, represented by the 'Estimated Increase in Annual Mortality' of 0.005 (in 2016) and 0.006 (in 2026), shown in column 8 of Table 2.2 and Table 2.3, predict that exhaust emissions from vehicles travelling on the Expressway will only have a

minor effect on human health within the study area. An increase in annual mortality of 0.005 represents approximately one additional premature mortality in 200 years.

The effects of pollutants other than PM_{10} were not quantified the HAPiNZ 2012 update. The HAPiNZ 2012 update notes that exposure to other air pollutants – in particular $PM_{2.5}$ and NO_2 – also has significant health impacts. However, the limited availability of representative $PM_{2.5}$ and NO_2 monitoring data across New Zealand means that it is not possible at this stage to robustly quantify the effects of that exposure (Kuschel, et al., 2012).

As discussed in section 2.3.1 of this report, the study area, which is between Kāpiti Road and Te Moana Road (Sectors 2 and 3) contains the majority of the population who will live in close proximity to the proposed Expressway, and is also the section of Expressway predicted to have the highest traffic volumes. It is recognised that people will be exposed to increases in concentrations of air pollutants due to vehicle exhaust emissions in other parts of the Project area (e.g. between Poplar Avenue and Kāpiti Road, and north of Te Moana Road). However, given the lower traffic volumes on other parts of the Expressway, and lower population exposed, it can be inferred that the calculated health effects for the whole Expressway (in 2016) would be less than 0.01 (i.e. less than one additional premature mortality in 100 years).[9]

[9] I.e. this is double the health effect for the Study area. More than half of the population living within 200 metres of the Project is located within the Study area.

3 Assumptions

A number of assumptions have been made in this assessment:

1. The most common wind directions in Kāpiti are from the southwest. Therefore, the contribution of vehicle exhaust emissions from the Expressway on annual average concentrations of pollutants is likely to be greater for receptors to the east of the proposed Expressway alignment (downwind) than for those to the west (upwind). To partially account for this, dispersion modelling was based on a full year meteorological dataset, with concentrations predicted for a transect across the Expressway. The maximum predicted concentrations for each band were conservatively assumed to represent concentrations across that band on both sides of the Expressway.

2. Current land use zoning has been assumed. It is possible that this may change between now and 2016 or 2026.

3. Population estimates were based on 2006 census data (the census scheduled for March 2011 was delayed due to the Christchurch earthquakes). No attempt has been made to account for potential changes to occupancy rates or the age distribution of the population by 2016 or 2026. Building footprints were based on aerial surveys by the Kāpiti Coast District Council, supplemented as appropriate by comparison with aerial photography undertaken for the Project in 2010.

4. The occupancy rate of dwellings and age distribution has been assumed to be within each mesh block.

5. All buildings greater than 20m^2 coverage in areas zoned residential or rural have been assumed to be dwellings.

6. Buildings in areas zoned for business activities or within designations have been excluded from the count of dwellings.

7. Where a building lies in more than one distance band, it has been assumed to be wholly within the band closest to the proposed alignment of the Expressway.

8. All buildings within 200m of the alignment in the study area have been included in this assessment, although a few (in the immediate vicinity of the Kāpiti Road and Te Moana Road interchanges, will be removed as part of the construction program for the Expressway.

4 Conclusion

The effects of the change in PM_{10} concentrations in the vicinity of the MacKays to Peka Peka Expressway have been quantified using the MfE Transport GPG method for quantification of health impacts. The results of this assessment indicated that vehicle exhaust emissions from vehicles travelling on the Expressway will have minor effects on human health within the study area.

5 References

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Appendix A

Maximum Predicted Ground Level Concentrations of Air Pollutants

Maximum Predicted Ground Level Concentrations of Air Pollutants

In these tables, DM and WP refer to Do Minimum (i.e. without the Expressway) and With Project respectively.

Highest 8-hour average CO (mg/m³)	2016		2026		Increase	
	DM	WP	DM	WP	2016	2026
	Poplar interchange to Raumati Rd					
Highest residential	0.05	0.07	0.01	0.03	0.02	0.02
Transect within 50m	0.01	0.09	0.00	0.03	0.08	0.03
	Kāpiti Rd interchange					
Highest residential - along Kāpiti Rd	0.25	0.40	0.17	0.18	0.15	0.01
Highest residential - along Expressway	0.06	0.18	0.03	0.09	0.12	0.06
Highest commercial	0.29	0.37	0.13	0.17	0.08	0.04
Transect within 50m		0.14		0.06	0.14	0.06
Significance criterion					**1.0**	

Highest 99.9th percentile 1-hour average NO_2 (µg/m³)	2016		2026		Increase	
	DM	WP	DM	WP	2016	2026
	Poplar interchange to Raumati Rd					
Highest residential	3.28	5.21	2.66	3.99	1.93	1.33
Transect within 50m	1.01	5.78	0.77	4.43	4.77	3.66
	Kāpiti Rd interchange					
Highest residential - along Kāpiti Rd	9.51	9.99	8.24	7.47	0.49	-0.77
Highest residential - along Expressway	2.34	5.65	1.85	4.99	3.31	3.14
Highest commercial	14.88	16.59	11.75	13.33	1.71	1.58
Transect within 50m		6.28		5.05	6.28	5.05
Significance criterion					**20**	

Highest 24-hour average NO_2 (µg/m³)	2016		2026		Increase	
	DM	WP	DM	WP	2016	2026
	Poplar interchange to Raumati Rd					
Highest residential	0.76	1.25	0.63	0.95	0.49	0.32
Transect within 50m	0.15	1.60	0.11	1.23	1.45	1.12
	Kāpiti Rd interchange					
Highest residential - along Kāpiti Rd	3.01	3.49	2.27	2.64	0.48	0.37
Highest residential - along Expressway	0.71	1.61	0.53	1.35	0.90	0.82
Highest commercial	3.92	4.58	2.97	3.59	0.66	0.62
Transect within 50m		1.98		1.58	1.98	1.58
Significance criterion					**5.0**	

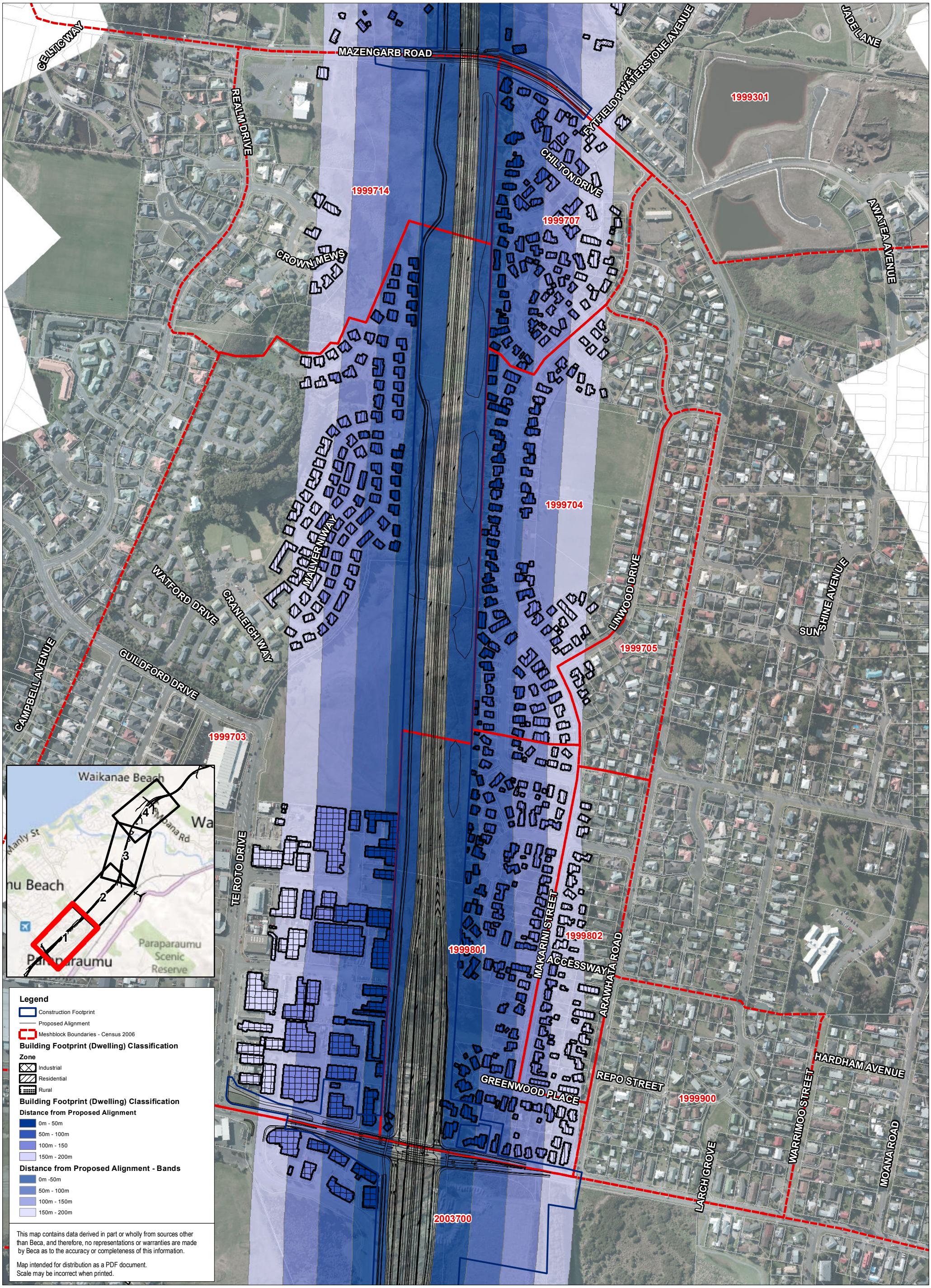
Highest 24-hour average PM_{10} (µg/m³)	2016		2026		Increase	
	DM	WP	DM	WP	2016	2026
	Poplar interchange to Raumati Rd					
Highest residential	0.70	1.17	0.66	1.13	0.47	0.47
Transect within 50m	0.13	1.49	0.12	1.46	1.36	1.34
	Kāpiti Rd interchange					
Highest residential - along Kāpiti Rd	2.84	3.42	2.51	2.90	0.58	0.39
Highest residential - along Expressway	0.67	1.56	0.58	1.41	0.58	0.39
Highest commercial	3.69	4.33	3.28	3.85	0.64	0.57
Transect within 50m	0.00	1.92	0.00	2.04	1.92	2.04
Significance criterion					**2.5**	

Highest 24-hour average $PM_{2.5}$ (µg/m³)	2016		2026		Increase	
	DM	WP	DM	WP	2016	2026
	Poplar interchange to Raumati Rd					
Highest residential	0.42	0.70	0.40	0.68	0.28	0.28
Transect within 50m	0.08	0.89	0.07	0.88	0.81	0.81
	Kāpiti Rd interchange					
Highest residential - along Kāpiti Rd	1.70	2.05	1.51	1.74	0.35	0.23
Highest residential - along Expressway	0.40	0.94	0.35	0.85	0.54	0.50
Highest commercial	2.21	2.60	1.97	2.31	0.39	0.34
Transect within 50m	-	1.15	-	1.22	1.15	1.22
Significance criterion					**1.25**	

Appendix B

Building Footprint Classification

GIS@beca.com



Legend

- Construction Footprint
- Proposed Alignment
- Meshblock Boundaries - Census 2006

Building Footprint (Dwelling) Classification

Zone

- Industrial
- Residential
- Rural

Building Footprint (Dwelling) Classification

Distance from Proposed Alignment

- 0m - 50m
- 50m - 100m
- 100m - 150
- 150m - 200m

Distance from Proposed Alignment - Bands

- 0m -50m
- 50m - 100m
- 100m - 150m
- 150m - 200m

File: P:\318\318-AKL\3320901\TGI\55_Workspaces\01_mxd\GIS-3320901-85-AirQuality_Dwelling.mxd Author: Date: 10/09/2012

Map Scale @ A3: 1:5,000

0 30 60 120 180

Meters

Revision	Author	Verified	Approved	Date
0.1	AYF	CAK	AH4	10/09/12

Title:

Mackays to Peka Peka

Air Quality/Dwelling

Map No: 1

Client: NZTA

Project: Mackays to Peka Peka

Discipline: GIS

Drawing No: GIS-3320901-85

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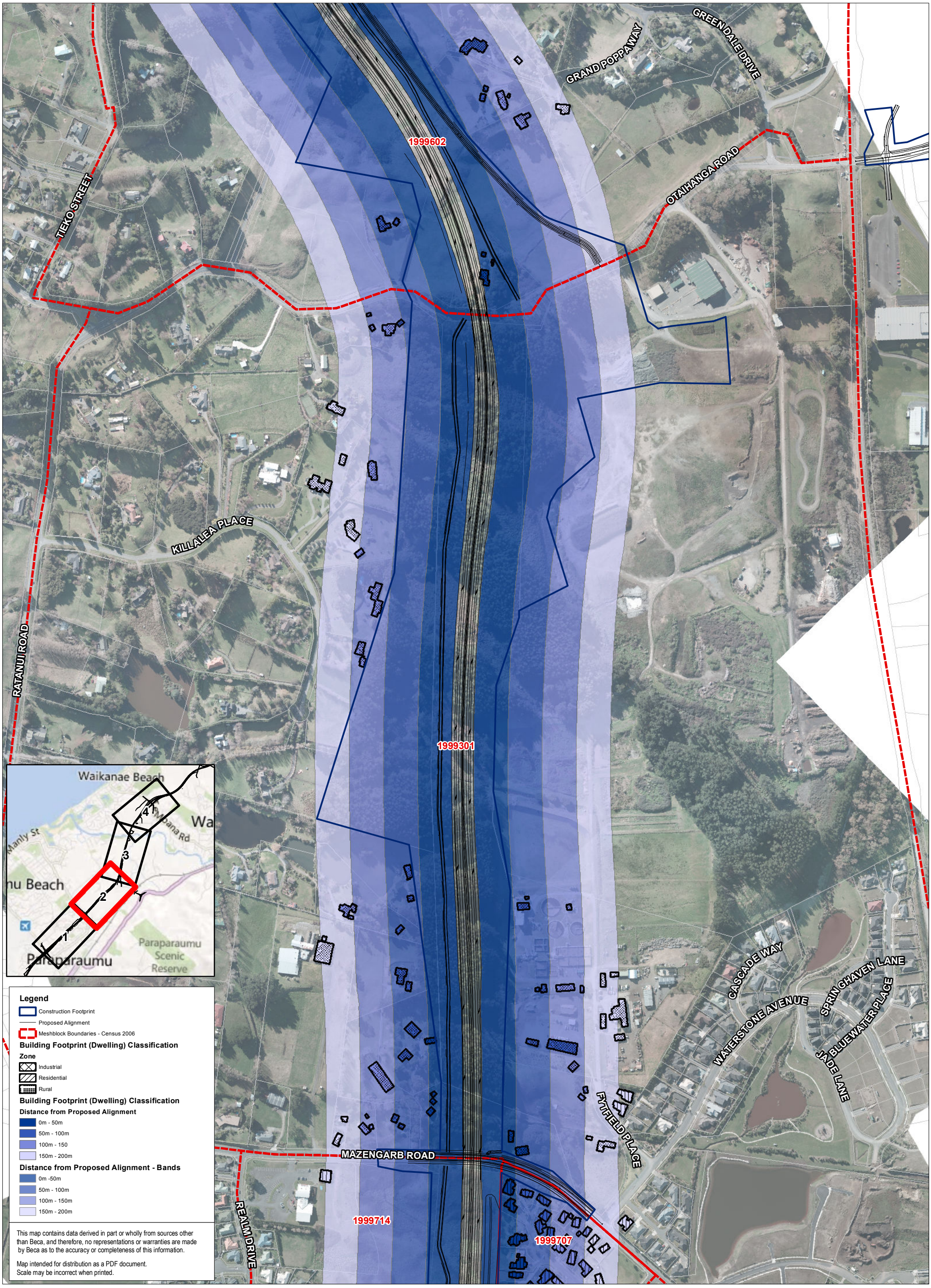

Legend

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Building Footprint (Dwelling) Classification

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- 100m - 150
- 150m - 200m

Distance from Proposed Alignment - Bands

- 0m -50m
- 50m - 100m
- 100m - 150m
- 150m - 200m

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Map Scale @ A3: 1:5,000

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Meters

Revision	Author	Verified	Approved	Date
0.1	AYF	CAK	AH4	10/09/12

Title:

Mackays to Peka Peka

Air Quality/Dwelling

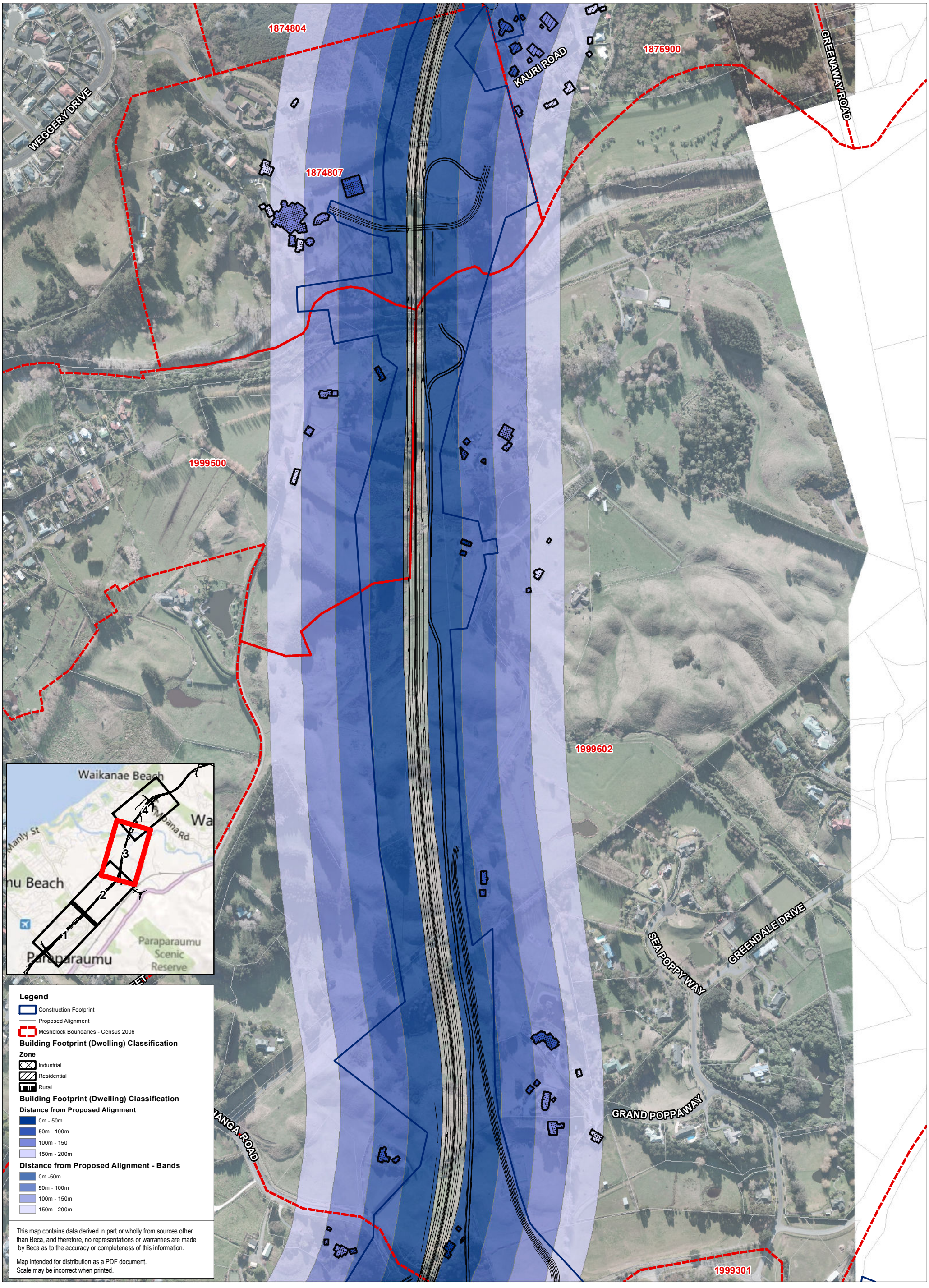
Map No: 2

Client: NZTA

Project: Mackays to Peka Peka

Discipline: GIS

Drawing No: GIS-3320901-85



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Map Scale @ A3: 1:5,000

0 30 60 120 180

Meters

Revision	Author	Verified	Approved	Date
0.1	AYF	CAK	AH4	10/09/12

Title:

Mackays to Peka Peka

Air Quality/Dwelling

Map No: 3

Client: NZTA

Project: Mackays to Peka Peka

Discipline: GIS

Drawing No: GIS-3320901-85

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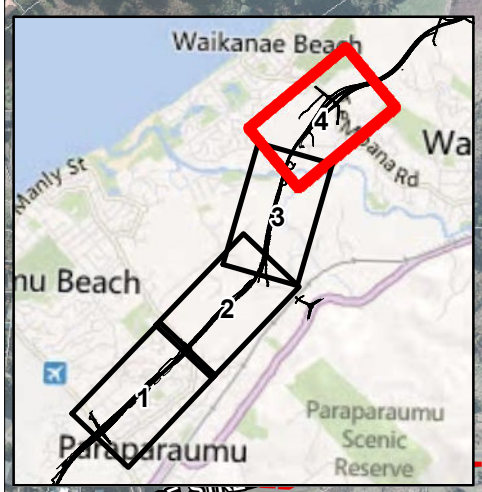
1883803
1876600
1874204
1874900
1874805
1876900
1999602
1874807
1999500

ALEXANDER STREET
LAVINIA GROVE
FAIRWAY OAKS DRIVE
PARK AVENUE
TE MOANA ROAD
OAK BAY
GREENAWAY ROAD
PURIRI ROAD
KAURI ROAD



Legend

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- 50m - 100m
- 100m - 150m
- 150m - 200m

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Map Scale @ A3: 1:5,000

0 30 60 120 180

Meters

Revision	Author	Verified	Approved	Date
0.1	AYF	CAK	AH4	10/09/12

Title:

Mackays to Peka Peka

Air Quality/Dwelling

Map No: 4

Client: NZTA

Project: Mackays to Peka Peka

Discipline: GIS

Drawing No: GIS-3320901-85

Appendix C

Occupancy Rate Calculations

	Entire Mesh blocks					Study Area													
Mesh block ID	Dwelling count	Population		Popn. density		Properties by distance				Affected population - total					Affected population - age >30yrs				
		Total	Age >30yrs	Total	Age >30yrs	200m	150m	100m	50m	200m	150m	100m	50m	Total	200m	150m	100m	50m	Total
1874204	172	165	114	1.0	0.7	2	-	-	-	1.9	-	-	-	2	1.3	-	-	-	1
1874804	86	93	78	1.1	0.9	1	1	-	-	1.1	1.1	-	-	2	0.9	0.9	-	-	2
1874805	94	111	75	1.2	0.8	17	13	16	12	20.1	15.4	18.9	14.2	68	13.6	10.4	12.8	9.6	46
1874807	29	42	9	1.4	0.3	4	3	1	-	5.8	4.3	1.4	-	12	1.2	0.9	0.3	-	2
1874900	117	168	123	1.4	1.1	12	8	6	1	17.2	11.5	8.6	1.4	39	12.6	8.4	6.3	1.1	28
1876600	18	21	0	1.2	0.0	-	1	-	-	-	1.2	-	-	1	-	-	-	-	-
1876900	52	81	51	1.6	1.0	10	5	5	-	15.6	7.8	7.8	-	31	9.8	4.9	4.9	-	20
1883803	13	24	0	1.8	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1883804	144	270	261	1.9	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999301	245	279	177	1.1	0.7	18	20	16	6	20.5	22.8	18.2	6.8	68	13.0	14.4	11.6	4.3	43
1999500	212	294	198	1.4	0.9	1	3	-	1	1.4	4.2	-	1.4	7	0.9	2.8	-	0.9	5
1999602	135	198	135	1.5	1.0	4	6	10	5	5.9	8.8	14.7	7.3	37	4.0	6.0	10.0	5.0	25
1999703	335	354	348	1.1	1.0	48	45	36	24	50.7	47.6	38.0	25.4	162	49.9	46.7	37.4	24.9	159
1999704	151	351	189	2.3	1.3	26	25	32	25	60.4	58.1	74.4	58.1	251	32.5	31.3	40.1	31.3	135
1999705	105	183	90	1.7	0.9	4	-	-	-	7.0	-	-	-	7	3.4	-	-	-	3
1999707	103	213	120	2.1	1.2	18	35	29	18	37.2	72.4	60.0	37.2	207	21.0	40.8	33.8	21.0	117
1999714	45	93	81	2.1	1.8	10	-	-	-	20.7	-	-	-	21	18.0	-	-	-	18
1999801	137	273	153	2.0	1.1	13	39	47	38	25.9	77.7	93.7	75.7	273	14.5	43.6	52.5	42.4	153
1999802	87	171	102	2.0	1.2	37	12	-	-	72.7	23.6	-	-	96	43.4	14.1	-	-	57
1999900	158	276	156	1.7	1.0	-	-	-		-	-	-	-	-	-	-	-	-	-
2003700	418	579	462	1.4	1.1	-	4	5	2	-	5.5	6.9	2.8	15	-	4.4	5.5	2.2	12
Total	**2856**	**4239**	**2922**	-	-	**225**	**220**	**203**	**132**	**364**	**362**	**343**	**230**	**1299**	**240**	**230**	**215**	**143**	**828**