SH1 Edendale Realignment

Assessment of Noise Effects

November 2016

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FINAL 1 23 November 2016
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Contents

1 Introduction

The New Zealand Transport Agency (the Transport Agency) proposes to change the alignment of State Highway 1 through Edendale. The alignment currently passes just to the north of the Edendale Township, between the township and Fonterra's Edendale Dairy Factory. The current alignment suffers delays caused by passing through the Edendale 50 km/h area and from waiting for trains at the existing rail crossing accessing the Fonterra factory. There are also safety concerns with the current alignment directly passing the Edendale Primary School and traffic having to negotiate a tight 45km/h curve. The Transport Agency have also noted elevated noise levels from through traffic (particularly heavy vehicles) on the existing alignment.

The proposed alignment moves State Highway 1 further away from the main bulk of the Edendale Township with the alignment passing through farmland to the north and west of the Fonterra factory. The proposed alignment also includes a roundabout near the southern end, partly to allow access to State Highway 1 for Fonterra traffic. As the proposed new alignment and roundabout pass through land which is currently paddocks, a new designation will be required.

The Resource Management Act, 1991 (RMA) allows for land to be designated for use as network utilities (such as roads and telecommunications facilities) or large public works (such as schools and prisons). The land might be designated without any conditions on the designation or it might be designated subject to conditions, such as conditions on the noise effects.

As part of the application for the designation to allow for the proposed alignment and roundabout, the Requiring Authority will make recommendations as to conditions that should be placed on the designation alterations. This report concludes with recommendations in regard to suitable noise conditions.

A concept design of the alignment and roundabout layout was prepared so that the potential effects could be assessed. This report presents the undertaking of the noise assessment and the results and conclusions of our noise assessment.

Noise effects were considered for operational road-traffic noise from the proposed alignment and roundabout. The report discusses the standards and guidelines applicable to road-traffic noise and the approach taken to assessment of the road-traffic noise effects. The road-traffic noise levels have been assessed and the likely extent of noise mitigation evaluated.

The effects from construction related noise have also been assessed and reported in section 4 along with a discussion on a construction noise mitigation plan.

2 Introduction to the road-traffic noise assessment

2.1 Resource Management Act and "reasonable" noise

The overarching requirement for management of noise is established by the Resource Management Act 1991 (RMA). Section 16(1) states "every occupier of land (including any premises and any coastal marine area), and every person carrying out an activity in, on, or under a water body or the coastal marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level."

The RMA requires that the actual and potential effects of the proposed designation alteration be assessed. It is necessary to identify those effects relative to a "baseline" environment. With regard to noise, the baseline environment is the current noise environment plus noise from any activities that are either permitted or consented to take place. In the area surrounding the proposed realignment there are already several permitted activities contributing to the existing noise environment. These are the Fonterra dairy factory and waste water treatment plant, the railway line running adjacent to the north-south section of State Highway 1 and the existing State Highway 1 alignment. The noise modelling in this assessment only considers road-traffic noise, and while noise from the other sources is not included numerically they are still recognised as being present and should be remembered in any discussion on noise in the immediate area.

The definition of "a reasonable level" for noise is not straightforward. The response of people to noise is broad. For any particular level of noise, a proportion of the population will find it disturbing and a proportion will find that same noise level of little disturbance. As noise levels change, there is a progressive change in these proportions of population that are disturbed and those that are undisturbed, with the proportion disturbed increasing as noise levels increase.

This broad response to noise is explained by various research findings. For example, some research indicates that acceptance of noise is influenced by the extent that the noise is perceived to be necessary or unavoidable. Other research indicates that tolerance of noise depends on the extent that the noise intrudes into the activities that are sought to be undertaken. The effects of noise on amenity are therefore highly variable. Higher noise levels can also impact on health, perhaps indirectly by causing stress or by reducing the quality of sleep. Very high noise levels that may impact on loss of hearing are not usually associated with road-traffic noise sources.

Because the response to noise is broad, noise tends to be managed at the level of community-response rather than individual-response.

In considering whether noise is reasonable, it is useful to have regard to guidelines or standards in which noise limits are recommended. Given the development process for those guidelines and standards, the noise limits they contain represent the view of stakeholders and experts as to the acceptable level of community disturbance. In general, guidelines or standards for noise are targeted at protecting health and reducing the worst of the noise effects on amenity.

2.2 NZS 6806

The New Zealand Standard for Acoustics – Road-traffic noise – New and altered roads, NZS 6806, was published in 2010. NZS 6806 provides tiered categories of noise level targets as reproduced here as Table 1.

Table 1: Reproduction of Table 2 Noise criteria from NZS 6806: 2010 clause 6.1.2

Category	Altered roads dB $L_{Aeq(24h)}$	New roads with a predicted traffic volume >75,000 AADT at the design year dB $L_{Aeq(24h)}$	New roads with a predicted traffic volume of 2,000 to 75,000 AADT at the design year dB $L_{Aeq(24h)}$
A (primary free-field external noise criterion)	64	64	57
B (secondary free-field external noise criterion)	67	67	64
C (internal noise criterion)	40	40	40

The noise criteria are applied to Protected Premises and Facilities (PPFs). These are defined in NZS 6806 as buildings used for noise-sensitive activities such as residential activities, marae, some education activities, and overnight patient medical care. NZS 6806 recognises that propagation of noise is affected by the presence or absence of structures and features that act as obstacles to the spread of noise from the source to the receiver. Therefore, NZS 6806 requires that in an urban area all PPFs within 100 metres of the new or altered road are given assessment; whereas in a rural area, with potentially fewer obstacles affecting noise spread, all PPFs within 200 metres of the new or altered road are given assessment. (Determination of urban area and rural area is based on the classifications as assigned to areas by Statistics NZ but with categorisation as defined in NZS 6806.) The area of proposed works has been assessed as a rural area for this assessment (as defined by Statistics NZ) and all PPFs within 200m of the proposed alignment and roundabout have been considered.

The method of NZS 6806 requires that noise levels are predicted with the new or altered road project in place and operating with the traffic volumes forecast for a future year (the “design year”) between 10 and 20 years after the opening of the project. Initially noise level predictions are made with the “do-minimum” project. NZS 6806 provides a specific meaning of “do-minimum”. The do-minimum project is the project as it would be prior to inclusion of any design features deliberately provided for additional noise mitigation.

In NZS 6806, the do-minimum project is not a design with nothing being done to mitigate noise effects; rather, the do-minimum project separates out design features provided for another main purpose (but which may have also a noise mitigation effect) from those design features further provided which have noise mitigation as their main purpose.

The method of NZS 6806 requires that noise mitigation options be investigated where the noise level predicted with the do-minimum project in the design year does not achieve the Category A noise criterion for a PPF. To select the best practicable option, the noise mitigation options are subject to an integrated evaluation in which the effects on noise objectives of the project are considered with any positive or negative effects on other project objectives, including monetary cost. As a general approach, NZS 6806 favours the assessment of the practicability of mitigation in terms of its effects on clusters of PPFs where a cluster is three or more PPFs affected by the same segment of road. If provided, mitigation should only be applied if it achieves a worthwhile reduction in noise.

When applying NZS 6806, where consistent with the best practicable option, Category A should be achieved. If achieving Category A is inconsistent with the best practicable option, then Category B should be achieved. If achieving Category A or Category B is inconsistent with the best practicable option then the criteria of Category C should be achieved to the extent that it is practicable.

2.3 Other noise criteria

The Transport Agency has adopted NZS 6806 as applicable to its roading projects unless other noise criteria take precedence.

However, NZS6806 does not specifically address the impacts on the change in noise especially for new roads. Although superseded as the primary guide for assessing noise impacts the Transit New Zealand Noise Guidelines are still relevant and are helpful in addressing the impacts of the change in noise levels caused by the project. These Noise Guidelines generally allow quite large changes in noise of 10- 12 dBA when existing noise levels are low to medium and only small changes such as 3dBA when noise levels are medium to high. In practice the Noise Guidelines and the standard NZS6806, although using different approaches tend to produce similar outcomes (within 3 to 4 dBA) as to the final noise levels achieved.

2.3.1 Southland District Plan

The district plan rules do not directly apply to the designation, but they provide guidance to the specific community's expectations of reasonable noise and can be useful in framing acceptable conditions on the designation. At the time of writing this report there is both an operative and a proposed district plan for the Southland District. The Operative Southland District Plan (2002) doesn't set specific noise limits for particular zones, but rather follows the RMA in that the best practicable option should be taken to ensure noise levels do not exceed a reasonable level.

The Proposed Southland District Plan does set noise limits for particular zones however noise generated from vehicles on public roads is exempt from complying with these limits.[1]

The criteria set in NZS 6806 are considered to be reasonable and take into account adverse health effects associated with noise and the potential benefits of new roads, and when coupled with the Transit Noise Guidelines, address the effects of relative changes in noise levels. Therefore, NZS 6806 is taken as appropriate for application to the proposed designation.

[1] Rule NSE.3 – Section 2.11 : Noise – Proposed Southland District Plan (2012) – (Appeal Version September 2016)

2.4 Summary of approach

The assessment of road-traffic noise effects was undertaken in accordance with NZS 6806.

NZS 6806 uses the $L_{Aeq(24h)}$ descriptor which is a time-average A-weighted sound pressure level. When a noise varies over time, as environmental noise does, the L_{eq} is the equivalent continuous sound which would contain the same sound energy as the time varying sound. The $_{(24h)}$ part of the descriptor indicates averaging over a 24 hour period. The $_{A}$ part of the descriptor indicates the frequencies within the sound have been weighted in accordance with the sensitivities of human hearing. The foreword of NZS 6806 states "the $L_{Aeq(24h)}$ unit is established as the preferred metric for the assessment of road-traffic noise in New Zealand." However, acknowledging that the NZS 6806 method for prediction of noise levels uses a model based on uninterrupted vehicle flows and acknowledging past experiences of public concerns about noise from acceleration/deceleration associated with intersections; this assessment includes extra discussion about the road-traffic noise effects of roundabouts.

3 Road-traffic noise effects

As partly noted within Section 2.2, NZS 6806 uses some terminology used also by other disciplines but defines the terms differently.

With regard to the proposed alignment and roundabout:

- Completion of the proposed alignment and roundabout is expected to be before 2019. Based on this and the availability of traffic modelling forecasts, 2029 has been used as the design year.
- The NZS 6806 do-nothing situation used in traffic modelling would be the road layout as existing with traffic as forecast for a future design year. The do-nothing situation is essentially what would occur at the design year if the proposed alignment and roundabout were not constructed. This is considered as the baseline noise environment.
- The NZS 6806 do-minimum situation is taken as having the proposed alignment and roundabout constructed with traffic volumes for the design year. The do-minimum situation also assumes there is no noise-specific mitigation included (i.e. no barriers or low noise road surfaces for the sole purpose of noise mitigation).

This section gives noise levels calculated for PPFs in the design year (2029) with the State Highway 1 alignment as existing and with the proposed new alignment. The road-traffic noise is modelled in accordance with NZS 6806. Appendix A contains details of the noise modelling software, inputs, and methodology.

In this section, the noise levels and noise level changes are reported to the first decimal place. While it is recognised that this level of precision is higher than what can be reliably measured or perceived, we maintain this level of detail because it avoids some of the anomalies and potential confusion that can arise if the noise levels are rounded to whole numbers only, especially when comparing one modelled situation with another. Using one decimal place, some noise level changes will appear incorrectly calculated (±0.1 dB $L_{Aeq(24h)}$) due to rounding error.

The new alignment and roundabout are proposed to increase the efficiency and safety of the route and the traffic modelling forecasts that future traffic volumes will be unaffected by the proposal, i.e. the do-nothing and the do-minimum situations will have the same traffic volumes.

The designation being sought for the new alignment and roundabout will include an application for resource consent for earthworks associated with new accesses for Fonterra traffic to the diary factory. The new Fonterra accesses are private access ways and will not form part of the designated State Highway. Strictly speaking this would mean that traffic on this access way should not be assessed under NZS6806. However, in reality the location of this roundabout will cause Fonterra traffic to make some contribution to noise levels at some PPFs. In the do-minimum situation a section of the Fonterra access has been included and modelled with 2010 traffic volumes for the site. While the traffic volumes may not be fully representative of 2029 traffic volumes, including them in the model at least gives an indication of the effect this traffic will have on nearby PPFs.

The calculation of the noise levels for the do-nothing situation has been done using the current posted speed limits. For the do-minimum situation the speed limits have been taken as 100 km/h through the main alignment with 50 km/h limits on the roundabout arms leading to the Fonterra access and into Edendale township. The negotiation speed for the roundabout will be significantly lower than the 100 km/h speed limit. However, the traffic on the roundabout has still been modelled at 100 km/h to give a conservative noise level. (Deceleration and acceleration associated with the roundabout's design negotiation speed is considered in Section 3.2.)

Currently (October 2016), the existing road surfaces on State Highway 1 are a mixture of single and two coat chip seals with some sections of Asphaltic Concrete (AC) near to the 45 km/h curve. For the do-minimum situation the entire new alignment and roundabout has been modelled as a two coat chip seal (grade 2/4). See Appendix A for more details.

No actual noise measurements have been taken in the area of the proposed alignment. Noise measurements can be used to understand the existing noise environment and also to confirm the accuracy of the noise modelling. As no noise measurements were available a second set of calculation software was used (using the same mathematical models) to check the noise levels of the road-traffic sources. These checks showed that the two software programmes agreed and the calculations appeared to give reasonable results.

3.1 Results of Noise Modelling – Design Year 2029

Table 2 shows road-traffic noise levels calculated for the year 2029 for the PPFs in the area of the proposed alignment and roundabout. Appendix B shows the road-traffic noise levels as graphical contours for the area.

Figures 1 and 2, below, shows a plan of the buildings identified in Table 2 showing the locations of the PPFs assessed. It should be noted that the PPF at location E has been purchased by the Transport Agency for the purposes of this project. The PPF at location R is currently owned by Fonterra who intend to demolish it. Rigid application of NZS 6806 would limit assessment to only PPFs within 200 metres of the edge of the proposed road but road-traffic noise levels have been calculated for some buildings further out for more information. The house at 1925 State Highway 1 (The Edendale Homestead Property), was also briefly investigated and found to be approximately 850m from the Project. At this distance noise levels from the Project be well below those permitted by NZS 6806 and will have negligible noise effects on the residents of the house.

NZS 6806 does not give assessment to commercial buildings so these have been excluded from our assessment.

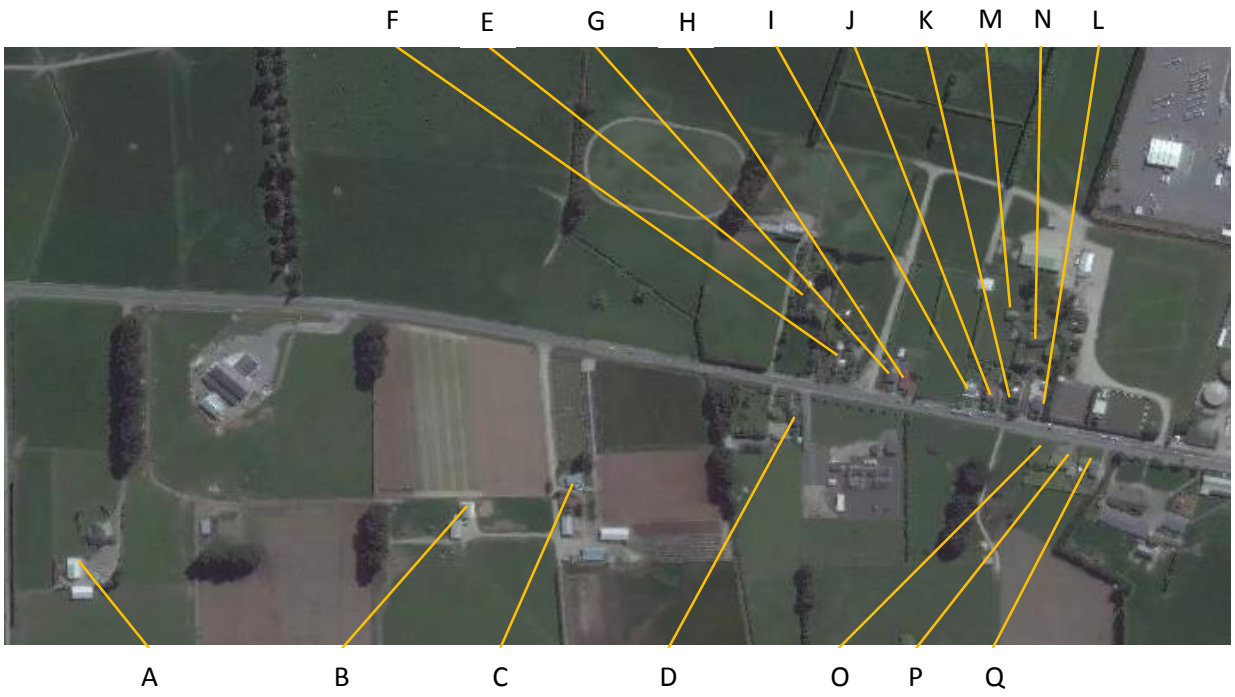


Figure 1: Aerial image of the southern end of the Project area showing the location of the PPFs modelled.

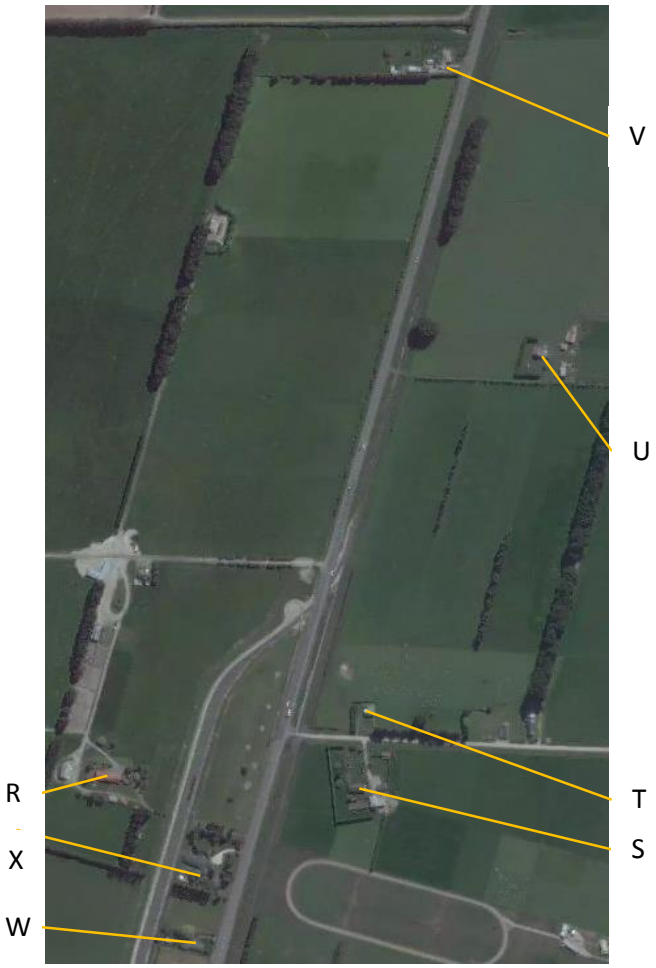


Figure 2: Aerial image of the northern end of the Project area showing the location of the PPFs modelled.

The Transit Guidelines[2] are a useful reference for interpreting the noise level changes shown in Table 2. The Transit Guidelines show the actual effect that changes in noise level will have on a PPF depend on the ambient noise level. For instance, in the Transit Guidelines, a 10 dB increase in noise level caused by a roading project may be acceptable if the ambient noise environment is 50 dB $L_{Aeq(24h)}$, but not if the ambient noise levels are 60 dB $L_{Aeq(24h)}$.

Table 2 shows the maximum noise level calculated at the exterior surface of the PPFs modelled for both the do-nothing and the do-minimum situations. The change in noise level has been calculated as the do-minimum noise level minus the do-nothing noise level and any increases identified have been highlighted in yellow.

Table 2: Free field noise levels (dB $L_{Aeq(24h)}$) calculated for the design year (2029)

Identifier	Modelled Noise Levels		
	Do-noth.	Do-min.	Change
E	50.5	58.6	8.1
M	46.4	49.2	2.8
R	48.9	51	2.1
N	47.5	49.2	1.7
U	50.2	51.2	1
A	46.6	47.5	0.9
B	48.5	49.2	0.7
C	49.6	49.9	0.3
V	64.5	64.5	0
D	56.6	53.3	-3.3
T	54.4	50.8	-3.6
S	53.2	49.5	-3.7
F	57.7	53.1	-4.6
G	58.2	53.2	-5
P	55.7	50.6	-5.1
I	57.2	51.9	-5.3
X	57.8	52.5	-5.3
O	57.2	51.8	-5.4
Q	57.4	52	-5.4
K	57	51.5	-5.5
J	56.7	51	-5.7
L	59.1	53.2	-5.9
H	59.9	53.8	-6.1
W	63.5	57.4	-6.1

NZS 6806 applies to two types of roading projects, these are defined as ‘new roads’ and ‘altered roads’. New roads are defined as any road to be constructed where no previously formed legal road existed. The new road criteria are included in NZS 6806 to be used in the situation where the road-traffic noise from a new road is being introduced into an area which previously had little road-traffic noise. Although the proposed alignment and roundabout are technically ‘new roads’, the fact that all of the PPFs are currently

[2] Transit New Zealand’s Guidelines for the Management of Road Traffic Noise, Appendix 6 to the 1999 Planning Policy Manual.

close to the existing State Highway 1 alignment, and that their existing noise environment is already largely made up of road-traffic noise means that the criteria for altered roads are more appropriate.

For PPFs to be assessed against the altered road criteria in NZS 6806, the do-minimum noise levels must be greater than 64 dB $L_{Aeq(24)}$ and the increase over the do-nothing situation must be greater than 3 db $L_{Aeq(24h)}$. There are no PPFs which meet the required noise levels to be assessed against the altered roads criteria in NZS 6806. As such, no noise mitigation has been investigated for any PPFs.

The PPF at location V is the only PPF with sufficient noise levels in the do-minimum situation to meet the altered road criteria in NZS 6806. This PPF is very close to the existing State Highway 1 alignment which will remain unchanged at this location. However, the difference in noise levels between the do-minimum and do-nothing situations is smaller than the 3 dB required to trigger NZS6806 for altered roads.

The PPF at location E sees the largest increase in noise levels. This property not only sees a change in the absolute noise level but it also sees a change in the direction that the noise is coming from. The majority of PPFs will also see a change in the direction of noise, but as noise levels are generally dropping will be less affected by it. The property at location E has already been purchased by the NZTA to assist with development of the new alignment.

Other than the PPF at location E which is owned by the Transport Agency, and the PPF at location R which is to be demolished, the PPFs at locations M and N see the largest increases in noise level in the do-minimum situation, although it should be noted these increases are small, particularly at the ambient noise environment involved. The noise levels at the PPFs at locations M and N in the do-minimum situation are well within the Category A noise criteria of NZS6806 and there is no need for further assessment under NZS 6806.

The final column in Table 2 shows noise level changes between the do-minimum noise level and the do-nothing noise level at that same position. It can be seen that in general there are reductions in noise levels at PPFs when the proposed alignment and roundabout are modelled. The major influence on this reduction in traffic noise is simply that the traffic is being moved further away from the PPFs. The majority of PPFs are situated in close proximity to the existing State Highway 1 alignment and with the majority of the traffic being moved from the existing alignment to the new proposed alignment the amount of traffic passing closely to PPFs will be reduced. Generally speaking the closer a PPF is to the existing State Highway 1 alignment, the larger the drop in noise level caused by moving a large proportion of existing traffic to the proposed alignment.

3.2 Characteristics of roundabout road-traffic noise

The previous section has assessed road-traffic noise in accordance with NZS 6806 and that assessment assumes uninterrupted traffic flows. This is accepted practice. However, this section is added to recognise characteristics of road-traffic noise associated with interrupted traffic flows that occur at intersections, including roundabouts. Our understanding of road-traffic noise characteristics near intersections comes from both noise measurements we have conducted and literature.

The first consideration is the overall speeds of vehicles. The dominant source of road-traffic noise for cars travelling at steady speeds greater than 30 to 40 km/h is from road/tyre interaction. Even for trucks, at steady speeds from 50 km/h and above, road/tyre noise is the dominant noise source. So generally, the primary noise source is road/tyre noise.

Engine-related noise becomes more pronounced as vehicles decelerate, such as when approaching intersections including roundabouts, or as vehicles accelerate when leaving the intersection. However the

associated noise level change per vehicle has been found to be small, say 1 dB or 2 dB in extreme cases, but may be tonally more obvious. A frequently expressed concern is that of "engine braking noise" but only a small proportion of the current heavy vehicle fleet have noisy engine brakes and this proportion will decrease further over time as new heavy vehicles with quieter braking systems enter the fleet.[3]

Overall, noise from interrupted traffic flows may often be of almost the same order of the noise level from equivalent traffic flowing uninterrupted, but the different noise sources/events are tonally different and that is the characteristic that may be readily noticed.

For the existing State Highway 1 layout there is no intersection in the area of the proposed roundabout however there is an existing speed limit change from 100 km/h to 50 km/h. This speed limit change will create some acceleration/deceleration noise. With the proposed roundabout, traffic approaching the roundabout should decelerate to be prepared to yield to circulating traffic. Some traffic would slow significantly and some will stop completely, with concomitant deceleration/acceleration noise generated. The necessity to slow should be anticipated such that abrupt/heavy deceleration should be avoided. Fonterra heavy vehicle traffic entering and leaving the factory will also generate acceleration/deceleration related noise while negotiating the roundabout. As traffic on the roundabout will be dominated by through traffic on State Highway 1, heavy vehicles using the Fonterra access (particularly exiting) may need to slow or stop more often to give way to circulating traffic. This may give slightly elevated noise levels as heavy vehicles accelerate onto the roundabout from low speeds (or from a stop).

Queuing, delays, and flow characteristics from operation of an intersection, signalised or non-signalised, are dependent on multiple factors considered and modelled by traffic engineers. These characteristics affect noise also, therefore it is difficult to make generalised comment on noise effects of different intersection controls. However, it is typically expected that traffic signals have a greater effect on "interrupting" traffic flows compared to roundabouts or other priority-controlled intersection layouts. Thus, if the proposal was to construct a signalised intersection, changes to the characteristics of the road-traffic noise would likely be slightly different, possibly greater, than expected with the proposed roundabout. The use of a roundabout through enabling traffic flows can therefore reduce potential noise effects.

It should also be noted that there will be a northbound passing lane on the proposed alignment. This passing lane may lead to some increased acceleration as vehicles pass in this area however the actual increase in noise created by these accelerating vehicles is expected to be small, particularly as the majority of passing vehicles will be cars rather than heavy vehicles.

3.3 Summary

An assessment of the operational noise effects of a proposed new SH1 alignment and roundabout around the Edendale Township has been undertaken. This assessment was performed using the New Zealand standard for road-traffic noise for new and altered roads NZS 6806:2010. The bulk of the assessment involved comparing the noise levels at nearby Protected Premises and Facilities (PPFs) as modelled for the existing alignment against the noise levels modelled for the proposed alignment and roundabout using traffic volumes for the design year of 2029.

Noise levels were calculated for PPFs located within 200m of the proposed alignment. The road-traffic noise effects of the proposed alignment and roundabout are 'reasonable' without additional noise mitigation for all PPFs. For the above statement 'reasonable' has been taken as meaning either that noise levels do not qualify for assessment or are below the noise criteria in NZS 6806. The criteria in NZS 6806 are

[3] Refer to nzta.govt.nz/commercial/assistance/enginebrakingtrail.html

considered reasonable and take into account the health effects of noise on people and communities, the effects of changes in noise levels and the potential benefits of new roads.

The proposed realignment leads to a mixture of increases and decreases in noise level at the PPFs modelled. Increases are generally caused by the new alignment coming closer to the PPFs than the existing alignment. The majority of PPFs, for which noise levels decreased with the Project, are closely built to the existing State Highway 1 alignment. These PPFs have seen a decrease in noise level as the new alignment moves the majority of the traffic further away from them to the proposed alignment.

The proposed SH1 alignment and roundabout will not give rise to any significant noise effects and projected noise levels from the new State Highway alignment are considered reasonable when assessed under the relevant New Zealand standard.

4 Assessment of construction noise effects

Noise effects due to construction of the proposed State Highway 1 realignment and roundabout are also required to be reasonable and conditions on the designation should ensure this. With regard to construction, “reasonable noise” needs to allow construction to occur in an efficient manner and protect the adjacent community from high levels of noise, especially when activities such as sleep are expected. The foreword to the New Zealand Standard for construction noise, NZS 6803: 1999, establishes its relationship with the RMA, requiring the best practicable option for mitigation to ensure that noise levels are reasonable. The Operational Southland District Plan states that construction noise needs to be measured and assessed to the older version of the standard NZS 6803: 1984, whereas the Proposed Southland District Plan quotes the newer version of the standard NZS 6803:1999 in rule NSE.12. For this assessment the newer version of the standard has been used as this is more current and is accepted and best practice. . The newer version is also more explicit that the noise limits set should have regard to the existing noise environment.

Noise during construction of the proposed alignment and roundabout is different from the road-traffic noise once the road is operational. Established practice is that people will accept construction noise, even 25 to 30 dB above normal District Plan noise levels, so long as the higher noise levels are for a finite period and good noise management practices are being followed. A further proviso on construction noise acceptability relates to the timing at which the construction noise occurs. Usually high levels of construction noise are acceptable only during daytime and only on weekdays, although construction noise on Saturdays can also be acceptable. Acceptance of construction noise during the night is particularly dependent on (public perception of) its necessity and appropriate notification of its occurrence.

NZS 6803 was developed based on these principles. It is a guideline for setting construction noise limits that are specific to the project being undertaken and the situation in which that project is located. The current ambient noise levels existing prior to construction starting are an important factor in setting the construction noise limits. The practicality of achieving the construction work within particular limits is another important factor.

NZS 6803 contains two tables of recommended construction noise limits; Table 2 for application in residential and rural areas, and Table 3 to apply to commercial areas. However, NZS 6803 expects that these sample tables will be modified according to the project’s specifics and the tables are provided to assist in formulating project-specific construction noise upper limits. Table 2 from NZS 6803 is reproduced here as Table 3.

Table 3: Reproduction of NZS 6803 Table 2 – Recommended upper limits for construction noise received in residential zones and dwellings in rural areas.

Time of week	Time period	Duration of work					
		Typical (dBA)		Short-term (dBA)		Long-term (dBA)	
		L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
Weekdays	0630-0730	60	75	65	75	55	75
	0730-1800	75	90	80	95	70	85
	1800-2000	70	85	75	90	65	80
	2000-0630	45	75	45	75	45	75
Saturdays	0630-0730	45	75	45	75	45	75
	0730-1800	75	90	80	95	70	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75
Sundays and public holidays	0630-0730	45	75	45	75	45	75
	0730-1800	55	85	55	85	55	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75

In NZS 6803:

- Short-term duration means construction work at any one location for up to 14 calendar days;
- Typical duration means construction work at any one location for more than 14 calendar days but less than 20 weeks; and
- Long-term duration means construction work at any one location with a duration exceeding 20 weeks.

Most road construction activity readily complies with the recommended construction noise upper limits where there is more than 40 to 60 metres separation between the main construction activity and the receiver. Though there may be a number of items of plant or machinery operating throughout the project area, at any time a single PPF is likely only in close proximity to typically three to four (but occasionally more) items of plant or machinery. Where there are several items of plant or machinery working together, they are usually spread over the immediate work area. This dispersal tends to reduce the noise level of the combination of plant or machinery compared to if they were all working clustered closely together.

For the proposed alignment and roundabout, construction activities are expected to predominantly match typical resurfacing and realignment activities, with limited periods of noisier road construction activities. There are no piling operations expected to be required during the construction of the proposed alignment.

NZS 6803:1999 provides a table of L_{Aeq} noise levels generated by different construction equipment, and the method for calculating ambient noise levels for sets of equipment and machinery at different distances from the source. Table 4 shows noise levels for construction equipment likely to be employed for this project. The noise levels in the table are applicable for equipment and machines assumed to be operating on a construction sites at one spot and at the same distance from the receptor site. For real conditions, when equipment and machines are spread through the site and moving, noise levels in the table should be reduced by 2 dB.

Table 4: Likely construction noise levels at the different distances from the source

Combination of equipment or machine in operation	Nominal noise at 10 m distance	Closest approach in metres				
		20 m	30 m	40 m	50 m	60 m
Bulldozer, excavator and dump truck	88	81	77	75	73	71

Two trucks, roller or compactor or paving machine	84	78	74	71	69	67

Only a few buildings are within 40 to 60 metres of where works for the proposed alignment would be undertaken. The buildings closest to the proposed works are (more details on buildings given in Appendix A):

- Building F – approximately 55m from the proposed works
- Building E – approximately 30m from the proposed works (owned by the Transport Agency and is part of the construction site).
- Building V – approximately 15m from the proposed works

Any Construction Noise Management Plan should include special consideration of these buildings, particularly at location V where the ambient noise levels are already reasonably high due to its proximity to State Highway 1. Overall, setting of the noise limits for construction of the proposed alignment and roundabout should take account of the noise environment existing prior to construction commencing.

4.1 Construction Noise Management Plan

NZS 6803 provides extensive guidance on good practice to manage construction noise and its effects. Much of this guidance is typically captured in a Construction Noise Management Plan which is prepared in association with each specific construction project. The Transport Agency also offers guidance on management of construction noise[4]. Expectations from these sources of the minimum requirements for a Construction Noise Management Plan include:

- Description of the works, anticipated equipment processes/durations;
- Identification of the noise-sensitive receivers likely most affected by construction noise of specific construction activities;
- "Construction noise upper limits" determined with regard to the receiving noise environment and including daily/weekly scheduling considerations, and with regard to any specific consent/designation requirements, and this may also take into account where particular noise-sensitive receivers are recently subject to other construction noise sources;
- Assessment of likely construction noise levels and scheduling, with appropriate noise mitigation measures to be implemented;
- Establishing a monitoring regime which targets both the more noisy activities and their potential occurrences near noise-sensitive locations;
- Staff training/awareness programme;
- Procedures for maintaining contact with stakeholders, including informing them when noisy activities may occur and providing summary reports of monitoring and investigations of any noise complaints;
- Process for managing noise complaints; and
- Contact telephone numbers for key construction staff, staff responsible for noise assessment and Council offices, plus a single point of contact for immediate advice of concerns about noisy activities.

[4] State highway construction and maintenance noise and vibration guide, published August 2013 http://www.nzta.govt.nz/resources/sh-construction-maintenance-noise/

It is recommended that a Construction Noise Management Plan is drafted for the project and this could be required as a condition of the NOR. The Construction Noise Management Plan will outline management practices to accompany construction activities with noise levels within the “construction noise upper limits”. While the constructor is expected to make practicable efforts to comply with the construction noise upper limits recommended for a project, NZS 6803 recognises there may still be occasions where, even with application of the best practicable options for noise avoidance or mitigation, the construction activity does not comply with the recommended construction noise upper limits (which as mentioned above may be acceptable provided the higher noise levels are for a finite time and good noise management practices are being followed). Therefore, the Construction Noise Management Plan will also outline more intense and/or additional management practices that will be used for those activities which are expected to exceed the construction noise limits.

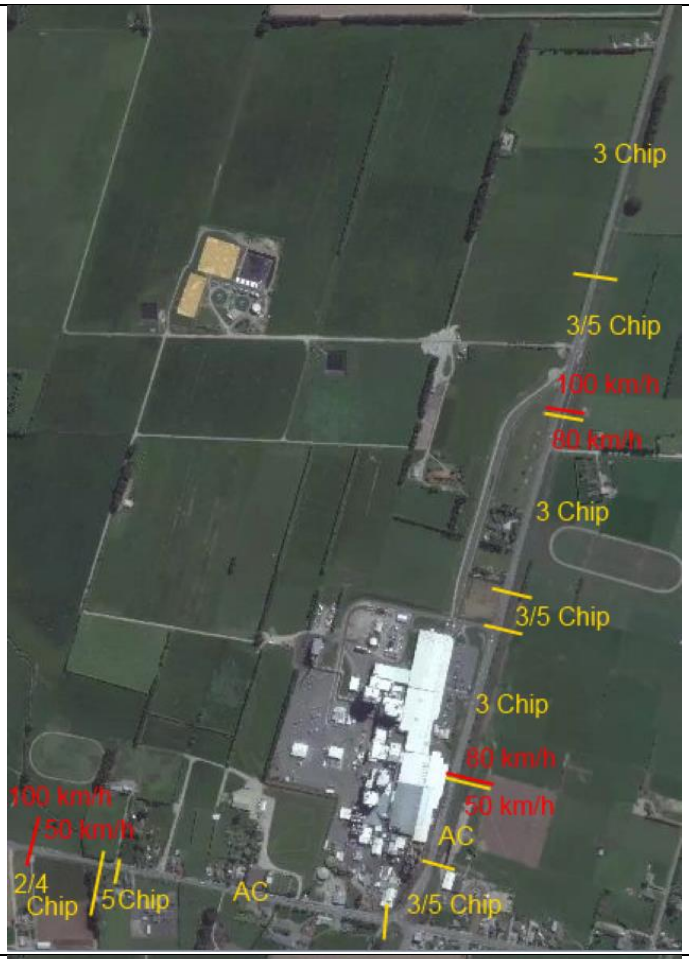
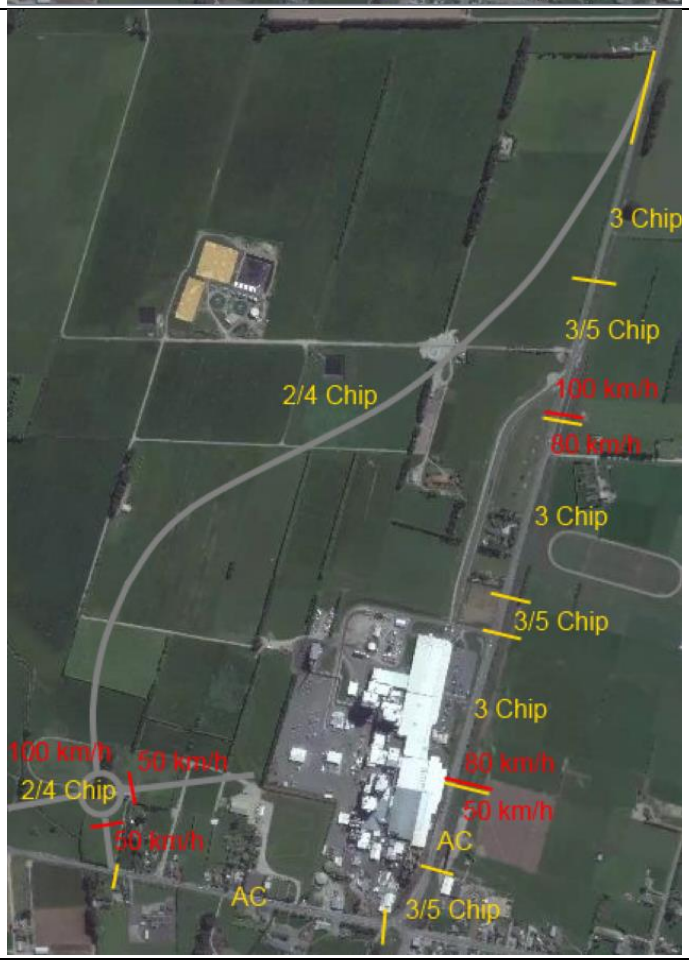
We recommend that a Construction Noise Management Plan is required as a condition of the NOR.

Appendix A: Modelling details and traffic volumes

General	
Modelling and assessment	Iain McIver, October 2016
Design year	2029
Noise model	NZS 6806: 2010 gives good guidance on the process and particulars expected of road-traffic noise assessments and noise modelling, more explicit and detailed than contained in the Noise Guidelines. All road-traffic noise modelling for this assessment has been in line with NZS 6806: 2010. The modelling techniques used are well established in New Zealand. The model used is based on the Calculation of Road Traffic Noise (CRTN) model. The CRTN model was developed in the United Kingdom more than thirty years ago. Research in New Zealand has validated the model as appropriate in New Zealand so long as some New Zealand-specific adjustments are applied. Adjustments to suit New Zealand conditions are made in accordance with Dravitzki, V. and Kvatch, I. (2007). Road surface effects of traffic noise: Stage 3 selected bituminous mixes. *Land Transport NZ Research Report No. 326.* As recommended in Barnes, J., Ensor, M., Beca Carter Hollings and Ferner Ltd and Hegley Acoustic Consultants Ltd (1994). Traffic noise from uninterrupted traffic flows. *Transit New Zealand Research Report No. 28*, a road surface correction of -2 was used as the base correction for asphaltic concrete. Calibration and validation have extensively established the reliability of noise modelling for assessing changes in noise levels, including New Zealand-specific calibration and validation, as reported in Barnes, J., Ensor, M., Beca Carter Hollings and Ferner Ltd and Hegley Acoustic Consultants Ltd (1994). Traffic noise from uninterrupted traffic flows. *Transit New Zealand Research Report No. 28;* and Dravitzki, V. and Wood, C. (1999). Validation of L_{eq} models for road noise assessment in New Zealand. *Transfund Research Report No. 121.*
Noise modelling software	The noise modelling software used is SoundPLAN version 7.4 with current updates. SoundPLAN fully takes into account the effects of terrain and buildings in the propagation of noise from the road-traffic into the surrounding environment. SoundPLAN calculates the noise level over the entire calculation area that may contribute noise to a particular calculation point. SoundPLAN calculates noise at spaced points over a defined grid so as to produce noise contours, as included in this report. While these noise contours interpolate noise levels between the grid points, using finer spacing reduces any approximations. In addition, SoundPLAN calculates noise at specifically selected points. This is useful, for example, to identify the most exposed part of a façade on a building of interest and the noise level at that position.
Traffic and layout	
In the modelling of the project, the NZS 6806: 2010 definition of the do-minimum design is used. This is "the project implemented including safety barriers and other structures (which may have an incidental noise mitigating effect)" but without "any measures undertaken for the sole purpose of reducing noise." The do-minimum project design is the project without any noise-specific mitigation.	
Road gradient	Road gradient was calculated by the SoundPLAN software based on the imported vertical road alignment. For this area the topography is very flat and as such the area has been taken as being flat in the modelling.
Road layout, horizontal and vertical alignment	Provided 1/11/16 via pdf files of the horizontal alignment. The PDF files were imported directly into SoundPLAN and used to generate the road-traffic noise sources.
Terrain data	Topography for the area of the proposed alignment and roundabout was modelled as being completely flat.

<table>
<tr><td>Buildings</td><td>Buildings were identified from LINZ aerial photographs which were cross referenced with the latest Google Earth images and input into the SoundPLAN software.
Where possible a mixture of single and double storey building were modelled as identified using Google Streetview.
<table>
<tr><th>Label</th><th>Address</th><th>Assumed usage / Comment</th></tr>
<tr><td>A</td><td>1924 Edendale-Woodlands Hwy</td><td>House</td></tr>
<tr><td>B</td><td>1966B Edendale-Woodlands Hwy</td><td>House</td></tr>
<tr><td>C</td><td>1966A Edendale-Woodlands Hwy</td><td>House</td></tr>
<tr><td>D</td><td>82 Salford Street</td><td>House</td></tr>
<tr><td>E</td><td>85 Salford Street</td><td>House / Owned by NZTA</td></tr>
<tr><td>F</td><td>83 Salford Street</td><td>House</td></tr>
<tr><td>G</td><td>77 Salford Street</td><td>House</td></tr>
<tr><td>H</td><td>73 Salford Street</td><td>House</td></tr>
<tr><td>I</td><td>61 Salford Street</td><td>House</td></tr>
<tr><td>J</td><td>57 Salford Street</td><td>House</td></tr>
<tr><td>K</td><td>53 Salford Street</td><td>House</td></tr>
<tr><td>L</td><td>49 Salford Street</td><td>House</td></tr>
<tr><td>M</td><td>51B Salford Street</td><td>House</td></tr>
<tr><td>N</td><td>51 Salford Street</td><td>House</td></tr>
<tr><td>O</td><td>42 Salford Street</td><td>House</td></tr>
<tr><td>P</td><td>38 Salford Street</td><td>House</td></tr>
<tr><td>Q</td><td>34 Salford Street</td><td>House</td></tr>
<tr><td>R</td><td>92 North Road</td><td>House / Owned by Fonterra, to be demolished.</td></tr>
<tr><td>S</td><td>10 Crescent Road</td><td>House</td></tr>
<tr><td>T</td><td>11 Crescent Road</td><td>House</td></tr>
<tr><td>U</td><td>1203 Pioneer Hwy</td><td>House</td></tr>
<tr><td>V</td><td>1162 Pioneer Hwy</td><td>House</td></tr>
<tr><td>W</td><td>80 North Road</td><td>House</td></tr>
<tr><td>X</td><td>90 North Road</td><td>House</td></tr>
</table></td></tr>
<tr><td>Assessment positions</td><td>NZS 6806 1.7.2 states the assessment position should be 1.2 to 1.5 metres above each floor level of interest in the building of the Protected Premise or Facility. The noise contours shown in Appendix B are shown for a height 2.0 metres above ground height. Here, 2.0 metres is conservative compared to 1.2 or 1.5 metres and allows for building floor height to be constructed above ground height. For the noise levels shown in the tables, receivers have been modelled in a grid over the full faces of building walls, to a height up to about 3.5 metres above ground level for one storey buildings and 6 to 7 metres above ground level for two storey buildings.</td></tr>
</table>

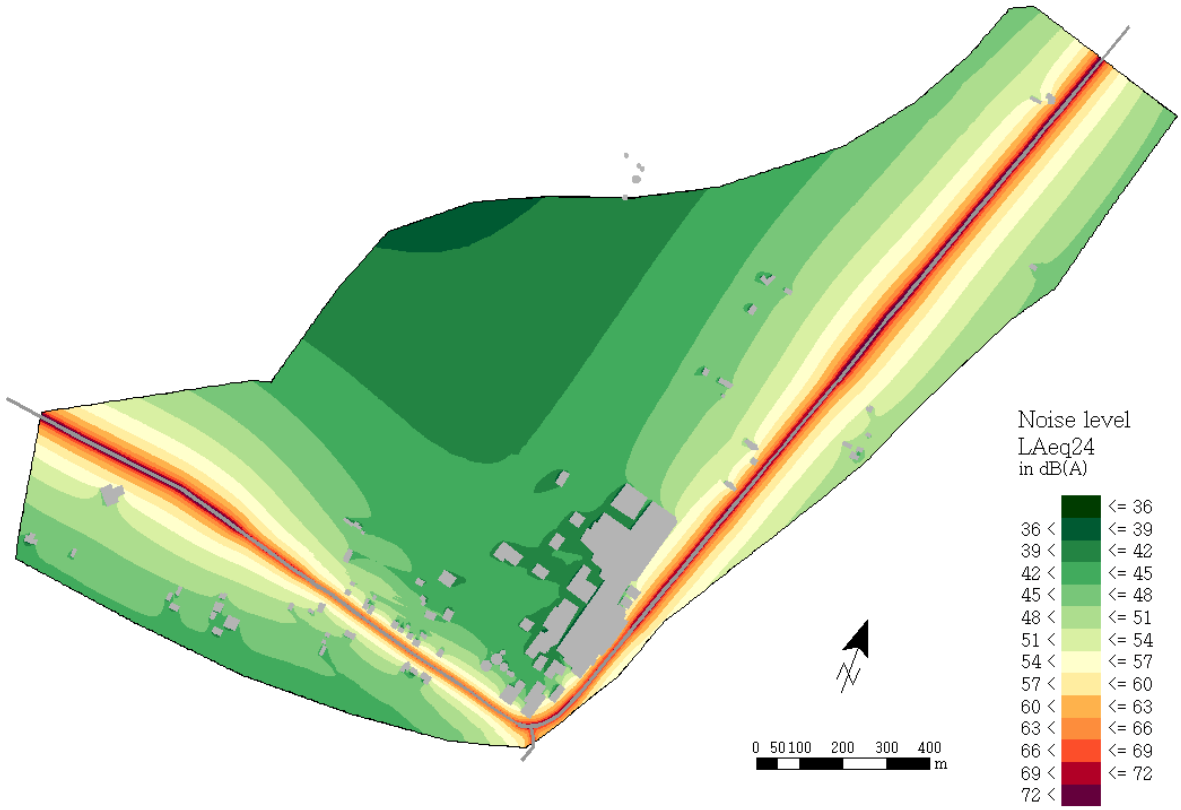
Traffic volumes	Traffic volumes for 2029 were provided by Sreenath Venkataraman (Opus International Consultants). Do-nothing situation: • SH1 west of Edendale – 5,350 vpd (15% heavy vehicles) • SH1 north of Edendale – 5,350 vpd (26% heavy vehicles) • Ferry Road – 3,400 vpd (9% heavy vehicles) Do-minimum situation: • SH1 new alignment west of Roundabout – 5,350 (15% heavy vehicles) • SH1 new alignment north of Roundabout – 5,350 (26% heavy vehicles) • Ferry Road – 3,400 vpd (9% heavy vehicles) • Existing SH1 alignment – 1,700 vpd (9% heavy vehicles) • Fonterra factory access – 1,589 vpd (55% heavy vehicles)
Road surfaces	For the do-nothing situation, generally road surfaces have been assumed as current, with sections of single and two coat chip seal and Asphaltic Concrete (AC). For the do minimum situation the new alignment and roundabout was taken as a two coat chipseal (grade 2/4). The image below gives more information on the surfaces modelled.
Traffic speeds	For the do-nothing situation the existing speed limits have been used. For the do minimum situation the new alignment has been modelled with a 100 km/h speed limit.

Do Nothing – Surfaces and Speed	
Do Minimum- Surfaces and Speed	

Appendix B: Noise environments

(For the following figures, design year is 2029 and noise levels are free-field 2 metres above ground level)

Do-nothing noise environment (current layout with 2029 traffic volumes).



Do-minimum noise environment (proposed alignment with 2029 traffic volumes).