Appendix I: Air Quality Assessment

REPORT

Nelson Arterial Study: Assessment of Route Options on the Basis of Air Quality

Prepared for Nelson City Council

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QUALITY ASSURANCE STATEMENT

PROJECT MANAGER	REVIEWED BY
Phil Peet	Phil Peet
PREPARED BY	**APPROVED FOR ISSUE BY**
Paul Heveldt	Phil Peet

CHRISTCHURCH
Hazeldean Business Park, 6 Hazeldean Road, Addington, Christchurch 8024
PO Box 13-249, Armagh, Christchurch 8141
TEL +64 3 366 7449, FAX +64 3 366 7780

REVISION SCHEDULE

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NELSON CITY COUNCIL

Nelson Arterial Study: Assessment of Route Options on the Basis of Air Quality

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1 Introduction

1.1 Background

In order to objectively examine the air quality issues associated with the various options proposed for a Nelson arterial transportation route, it is important to establish the relevant quantitative air quality indicators for the areas of Nelson which the several route options will traverse.

Air quality has consistently been the issue which has been prominent in just about every instance of the Nelson arterial transport route debate and, more specifically, the possible (or even probable) compromising of air quality along the various route options. The focus on air quality as the major environmental issue stems fundamentally from the unique geographical configuration and associated meteorological parameters that are features of Nelson City. Thus, especially in winter months, Nelson is prone to inversion layers and extensive calm periods and, when coupled with the deeply incised residential valleys within the City limits, the outcome is often significantly elevated air pollution episodes which may exceed national guideline levels, sometimes by considerable margins. Air quality is thus an environmental issue which Nelson residents have been deeply aware of historically.

There are also clear associations of air pollution with adverse health outcomes for residents in areas of the City which are prone to these high pollutant concentration episodes. These include an increase in the number of episodes and the severity of symptoms of acute and chronic respiratory effects, and cardiac problems associated with exposure to fine particulate. Any suggestion of a further increase in pollutant levels associated with an arterial transport route carrying enhanced traffic volumes, and possibly also altering the mix of vehicle types passing through a particular locality will be likely to raise significant numbers of objectors.

In the Environment Court decision on the so-called Southern Link option the matter of deleterious air quality effects and the inability to satisfactorily mitigate these effects on a specific area of inner City Nelson (the Victory Square area) was central to the Environment Court's cancelling of the Notice of Requirement to designate land for the purposes of constructing the Southern Link route.

1.2 Focus of this Report

Clearly therefore the options to be considered in the Nelson Arterial Study will undoubtedly be scrutinised in great detail as to their implications for air quality. The question ultimately to be answered will be – which option (or options) has the least impact in local air quality terms. Further, to enable the question to be answered in as quantified a manner as possible, the existing local air quality baseline has first to be established. This was addressed in Stage 1 of this study in which the base case scenario was investigated; a summary of the findings of this previous report is given in section 2 below.

Further sections of this report consider the four route options which were selected in Stage 2 of this study for more in-depth scrutiny. The likely air quality impacts for each route option are reviewed, based on fine particulate monitoring data (PM_{10}) as the best available indicator for air quality, and on projections from traffic modelling of likely changes in vehicle numbers and traffic speeds over time. The importance of finer particulates ($PM_{2.5}$ and below) as vehicle-associated contaminants with significant potential health impacts is noted but the relative dominance of PM_{10} data means that it is most practical to use this extensive information for modelling of the route option comparisons of this study.

To the greatest possible extent the options have been quantitatively compared. This will allow the multi-criteria analysis process, which is to be used for selection of the preferred option, to be utilised to best advantage and to produce a defensible outcome.

2 Summary of Preliminary Assessment of Air Quality Under a Base Case Scenario

2.1 Predictions for Nelson City Air Quality Under the Status Quo

The base case scenario report, entitled “Nelson Arterial Study: Preliminary Assessment to Develop a Base Case Scenario for Air Quality” had the purpose of establishing air quality baseline parameters and of making a qualitative prediction of the implications for Nelson City air quality in succeeding years if the status quo with respect to movement of vehicular traffic through Nelson City was maintained.

2.1.1 Note on Nelson Airsheds

In line with the requirements of the National Environmental Standard for Air Quality, the Nelson Air Quality Plan divides discrete areas of Nelson City and its environs into a total of three “Airsheds” for the purposes of air quality assessment.

A (gazetted) airshed is defined as:

A specific area identified by a council where air quality standards are (or may be) breached.

The designated Airsheds in Nelson City are described in a series of maps; these are reproduced in an Appendix to the “Preliminary Assessment to Develop a Base Case Scenario for Air Quality” report referred to in section 2.1 above. Airshed A covers much of the Waimea Road area, while Rocks Rd is generally in Airshed B. Airshed C covers northern areas of Nelson City most of which (except Wakefield Quay and the northern part of Rocks Rd) are outside the general ambit of the arterial route options being considered.

2.1.2 Changes in Air Quality Along Existing Nelson City Route Options

While the total pollutant emissions from vehicular traffic will gradually decrease over time, as the population increases in the Nelson City area over forthcoming years there will (all other things being equal) be an associated increase in vehicle numbers on the City’s roads. If the status quo is maintained and a Nelson Arterial Route is not constructed, the existing through-routes along SH6 (Rocks Road and Tahunanui) in Airshed B, and along Waimea Road in Airshed A, will be subjected generally to increased traffic congestion, reduced vehicle speeds, and associated increased total vehicle exhaust emissions.

Thus, while emissions from the vehicle fleet itself will trend downwards when assessed on a per-vehicle basis, the other effects associated with increased total vehicle numbers, overall congestion of through-routes or, more particularly, feeder roads, and decreased traffic speeds with greater emitted pollutant concentrations as a result, will have a nett effect of increasing emissions of (particularly) PM_{10} (and finer) particulate in Airsheds A and B through which the two existing routes pass.

2.2 Relevance of Base Case Scenario to Route Options Considerations

The selection, construction and implementation of an arterial route for vehicular traffic movement through the City, which is the subject of this study, will have impacts on the air quality baseline. Traffic flows will undoubtedly increase along the corridor of the selected route option and vehicle numbers will be higher, although total emissions per vehicle will be lower (and will continue to decrease further over time).

Other relevant factors will be the extent of deceleration and acceleration imposed by route constraints on vehicles using the selected route, the extent to which gradients may increase vehicle emissions, the degree to which the selected route option will modulate the variability of vehicle speeds, and a range of other matters.

Thus the base case scenario will be added to by contributions derived from traffic flow and vehicle numbers data under the various feasible route options. Using the spreadsheet model discussed in section 4.1 below, these additional contaminant (PM_{10}) contributions to the base case scenario have been calculated. In this way a quantified comparison of the effects on air quality of the options has been derived.

It should be noted that, while the base case scenario was dependent on consideration of Airshed-related data, the assessment of route options takes traffic data derived from modelling of each option and applies the base case PM_{10} data as one further input factor to thus produce contaminant concentrations, as outputs, along the property boundaries immediately adjacent to the road edges of each route. In this way the route options assessment includes the spatial layout of the routes and has no direct relationship to or reliance on the Airshed(s) through which the routes pass.

Quantitative and comparative data on air quality along the route options will provide decision makers with just one of the selection parameters against which a decision on a preferred Nelson Arterial Route will be made. It will not by any means be the only parameter but, based on the importance of air quality considerations in previous deliberations, it will certainly be of major significance.

2.3 Monitoring Data Available on Baseline Air Quality Parameters

2.3.1 General PM_{10} Concentration Trends in Nelson City

The continuing trend in PM_{10} concentrations, as the widely accepted yardstick for urban air quality in Nelson City, has been and continues to be for a gradual reduction. The chief contributors to effecting this improvement have been changes to the resource management rules contained in the Nelson Air Quality Plan concerning domestic fires, upgrades of industrial discharges (especially coal-fired boilers being replaced by diesel-fired alternatives) and a ban on open burning.

This downward trend is readily apparent in contaminant monitoring data (particularly PM_{10} but also other parameters) for the Victory Airshed where PM_{10} concentrations are decreasing by around 6% per year on average. The importance of this consistent reduction in contaminant concentrations over time to the health profile of residents has not been specifically quantified but can be inferred as particularly positive, given the known adverse health implications of exposure to airborne contaminants (see section 1.1) in terms of respiratory and cardiac effects.

2.3.2 Nelson City Monitoring Stations

Within each of the three Nelson Airsheds the Nelson City Council (NCC) has a fixed air quality monitoring station. Each station measures PM_{10} particulate concentrations (PM_{10} = particles smaller than 10 microns in aerodynamic diameter) and the St Vincent St monitoring station in Airshed A has, on occasions, measured carbon monoxide.

There are ten years of PM_{10} monitoring data for the St Vincent St monitoring station in Airshed A and seven years PM_{10} data for the three composite monitoring sites of Airshed B. Particulate monitoring has concentrated over the past decade on PM_{10}; however, almost two years of $PM_{2.5}$ data from the St Vincent St monitoring site have also been collected.

The Airshed C monitoring site in Brook St has only been active for the past two years. This very limited data set, together with the fact that the Brook St site is a considerable distance away from the northern sections of the probable route options, in combination mean that the data from Brook St is not useful for the development of overall baseline air quality data for further use in the Nelson Arterial Options Study.

The preponderance of PM_{10} monitoring data (and the lack of data on other parameters) is not a limitation to the assessment of air quality in this study. In fact, even if other data were more generally available, it is considered that particulate monitoring data is the best generic indicator of air quality impacts associated with vehicular traffic and thus its use as an air quality baseline parameter and for subsequent options comparisons is fully justified.

It should be noted that only summary data are presented in the following sections of this report; however complete and highly detailed data sets of monthly PM_{10} concentrations have been used to develop the baseline data for the study.

3 Summary of Preferred Arterial Route Options

MWH's Stage 2 Report "Selection of Best Arterial Route Options" presents a short list of four options (five, if the "Do Minimum" option is also included) derived from a considerably longer list identified in earlier studies and from public consultation inputs.

To reduce the long list of options down to the final short list, a "Fatal Flaw" analysis was undertaken. This analysis involved a broad assessment of cost (those options considered unduly expensive were rejected) and whether each option could meet the objectives of the study and assist "arterial traffic" in the future.

The remaining options were then reviewed based on both the Fatal Flaw analysis and on a draft "broad brush" multi-criteria analysis. The result identified the following four options; the Stage 2 report provides a more in-depth summary of each of these.

Option A: Part-Time Clearways

Option B: Southern Arterial Route

Option H: Rocks Road Four Laning

Option I: Waimea Road Four Laning

These (as well as the "Do Minimum" Stage 1 baseline) are the four options for which the air quality modelling assessment has been undertaken, as now described.

4 Air Assessment Modelling

4.1 Model Used

The spreadsheet model used in this assessment is that published by the UK Highways Agency, taken from the Design Manual for Roads and Bridges (DMRB) and entitled "DMRB Screening Method V1.03c (2007)". The model provides a relatively simple and straightforward means of predicting pollutant concentrations associated with road traffic emissions. The method is not intended to provide accurate predictions of air quality but it is a suitable approach in circumstances where the predicted environmental concentrations lie sufficiently below the applicable air quality standards (taken to be <90% of the standard) and where there are no complex or unusual features of the routes being compared (eg. tunnels, steep hills, deeply incised cuttings or "road canyons").

The model is thus suitable for use in the context of the Nelson Arterial Traffic Study in that the NES air quality standard for PM_{10} particulate is set at 50 µg/m^3 (24-hr average) and the most conservative numerical values for PM_{10} in the current modelling assessment are around 40 µg/m^3, as an average maximum.

The model has been calibrated against actual monitoring data from schemes assessed using it and thus a good level of confidence can be held in the results, certainly in terms of its use (as in this case) for comparing various route options on air quality grounds.

4.2 Assumptions and Comments on Modelling Input Data

The following paragraphs summarise a series of assumptions and comments about the model, in terms of its use in this route selection exercise for the Nelson Arterial Route Study.

- PM_{10} is the air quality parameter for which the most comprehensive data set is available for Nelson City. From time to time other parameters have been monitored (eg. CO), and $PM_{2.5}$ is monitored at the St Vincent St monitoring station. However PM_{10} is the air quality parameter which is most suitable as a yardstick against which to compare the various options, simply because a more comprehensive monitoring dataset is available for this parameter. This is not to downplay the relevance of $PM_{2.5}$ as a vehicle-associated contaminant with significant potential effects on health but PM_{10} is simply the most pragmatic selection of a contaminant to use for option comparison purposes

- PM_{10} background concentrations will vary widely over the various route configurations of the four options being assessed. Thus, Rocks Road air quality will be heavily influenced by the proximity of the sea on the immediate western side, resulting in consistent air movement and ventilation of emissions. Waimea Road, because of its configuration and associated katabatic drainage, shows significantly lower contaminant concentrations than, for example, St Vincent St. The Annesbrook Drive component of the options involving Rocks Road is a further case where contaminant concentrations vary from those experienced in other parts of the arterial route options. Taking all of these factors into account, and utilising data provided by David Jackson of NCC with respect to a recent NIWA report on mobile monitoring in Nelson City, and also evidence presented to the Environment Court at the Southern Link Hearings by Jenny Simpson, it is considered that Annesbrook Drive PM_{10} concentrations are satisfactorily represented by data from the Blackwood St monitoring station in Airshed B, St Vincent St monitoring data are suitable for the inner city street components of the various options, and that both Waimea Road and Rocks Road can be fairly represented in the modelling exercise by taking 40% of the St Vincent St data (this could be an overestimate for Rocks Road, in fact). The NIWA mobile monitoring data supports this as a realistic approach, and Jenny Simpson's data is similarly in accord.

- To align with the traffic modelling data (which covers, respectively, 2006, 2016 and 2036) it was decided to use 2006 representative PM_{10} data for baseline concentrations. Data for the month of July 2006 were thus used.

- As noted earlier, the trend in PM_{10} concentrations in Nelson City is gradually (and relatively consistently) downward, as a result of recently instituted controls on domestic fires and the ban on open burning. For modelling purposes this trend is taken conservatively to be 5% per decade and the 2006 PM_{10} concentrations used as baselines have been adjusted accordingly for 2016 and 2036 respectively.

- The distance from the road option centre line to the nearest receptor has been derived from the cross-sectional areas for each of the four options, as follows:

  Option A = 9m
  Option B = 10m
  Option H = 15m
  Option I = 15m

  [Note: In this context, a "receptor" is taken to be the nearest boundary of residential or commercial premises closest to each route option.]

- AADTs (combined vehicles / day) have been taken from supplied traffic modelling data.

- Annual average speeds for all options have been taken from traffic modelling data.

- The traffic composition used in the model (on the basis of the number of vehicles in each category) is that which has been used and published in previous reports in this arterial routes options study. Thus we have used:

  For Rocks Road
  92% passenger cars and light goods vehicles <3.5t
  8% heavy goods vehicles >3.5t

  For Waimea Road
  98% passenger cars and light goods vehicles <3.5t
  2% heavy goods vehicles >3.5t

  For the "Southern Arterial" (Option B)
  96% passenger cars and light goods vehicles <3.5t
  4% heavy goods vehicles >3.5t

It should be noted that traffic modelling predicts little change in these ratios of passenger cars to heavy goods vehicles in 2016 and 2036.

4.3 Model Results and Discussion

4.3.1 Model Set-Up

The traffic modelling data (total vehicle numbers along the various sections of the four route options per day, and the average speed expected) provide fundamentally important inputs into the spreadsheet model. The model requires the selection of a "road type" with, in this context, all of the options attracting an "A" road type rating which is equivalent to the UK's "A road" classification (four-laned road, or three-laned with a passing lane).

The baseline PM_{10} concentrations and their derivation have been discussed in section 4.2 above.

The traffic modelling outputs have been presented for the years 2006, 2016 and 2036. Options A, B, H and I are of course currently hypothetical and thus model outputs, based on the traffic modelling data, have only been derived for the 2016 and 2036 representative years.

The model outputs include (as reported below) the "road-associated component" of the contaminant being considered. The model also calculates various other parameters, including the mass load per day (or per year) of a particular contaminant being discharged. This type of parameter is not especially relevant for a comparison of route options and has not been reported in the Tables which follow.

4.3.2 "Do Minimum" Option; i.e. the Status Quo

The spreadsheet calculations, as reported in Table 4-1 below, show that the approach of doing nothing has negative consequences in terms of vehicle-associated contaminant concentrations. These contribute between 1 and 8 % of the total PM_{10} emissions, for example, in particular parts of urban Nelson city, based on model outputs.

Table 4-1 : "Do Minimum" Status Quo Option: PM_{10} 24–hr Average Concentrations (µg/m^3)

	2006	**2016**	**2036**
Rocks Road	23.48	20.16	19.18
Road-Associated Component	*3.88*	*1.56*	*1.58*

Annesbrook Drive	42.98	38.66	36.68
Road-Associated Component	*3.88*	*1.56*	*1.58*
Waimea Road	22.2	20.09	19.17
Road-Associated Component	*2.6*	*1.49*	*1.57*
Wakefield Quay	50.26	47.25	44.91
Road-Associated Component	*1.36*	*0.85*	*1.01*
St Vincent St	50.25	47.4	44.7
Road-Associated Component	*1.35*	*0.64*	*0.80*
Vanguard St	49.41	46.76	44.27
Road-Associated Component	*0.51*	*0.36*	*0.37*
Rutherford St	49.98	46.97	44.57
Road-Associated Component	*1.08*	*0.57*	*0.67*

4.3.3 Option A: Part-Time Clearways

The output PM_{10} contaminant concentrations presented in Table 4-2 show elevated concentrations for each of Rocks Road, Annesbrook Drive and Waimea Road, representing contributions of around 4 to 5% respectively of the total PM_{10} concentration. Other parts of the Option A route also show elevated PM_{10} concentrations associated with traffic flows and speeds, in particular Wakefield Quay and St Vincent St.

Table 4-2 : Option A Part-Time Clearways: PM_{10} 24–hr Average Concentrations (µg/m^3)

	2016	**2036**
Rocks Road	20.18	19.19
Road-Associated Component	*1.58*	*1.59*
Annesbrook Drive	38.68	36.69

Road-Associated Component	*1.58*	*1.59*
Waimea Road	20.12	19.19
Road-Associated Component	*1.52*	*1.59*
Wakefield Quay	47.2	44.85
Road-Associated Component	*0.80*	*0.95*
St Vincent St	47.08	44.73
Road-Associated Component	*0.68*	*0.83*
Vanguard St	46.79	44.27
Road-Associated Component	*0.39*	*0.37*
Rutherford St	46.98	44.59
Road-Associated Component	*0.58*	*0.69*

4.3.4 Option B: Southern Arterial Route

For this route option the model outputs shown in Table 4-3 below suggest a somewhat lessened impact from PM_{10} on Waimea Road, Annesbrook Drive and Rocks Road but an enhanced traffic-related PM_{10} concentration along, particularly, St Vincent St, as compared to the Option A outputs. It should be noted that the Option B scenario model did not include any consideration of the possible effects of a sub-option whereby trucks are required to use the Southern Arterial, rather than the waterfront route along Rocks Road.

Table 4-3 : Option B Southern Arterial Route: PM_{10} 24–hr Average Concentrations (µg/m^3)

	2016	**2036**
Rocks Road	19.76	18.9
Road-Associated Component	*1.16*	*1.30*
Annesbrook Drive	38.26	36.4
Road-Associated	*1.16*	*1.30*

Component		
Waimea Road	19.75	18.86
Road-Associated Component	*1.15*	*1.26*
Southern Arterial	38.4	36.4
Road-Associated Component	*1.30*	*1.30*
Wakefield Quay	46.96	44.63
Road-Associated Component	*0.56*	*0.73*
St Vincent St	47.24	44.91
Road-Associated Component	*0.84*	*1.01*
Vanguard St	46.92	44.38
Road-Associated Component	*0.52*	*0.48*
Rutherford St	46.69	44.34
Road-Associated Component	*0.29*	*0.44*

4.3.5 Option H: Rocks Road Four-Laning

For this route option there are moderate elevations of PM_{10} expected on Rocks Road, Annesbrook Drive and Waimea Road but the model outputs of PM_{10} concentrations for the other roads associated with this option (Wakefield Quay, St Vincent St, Vanguard St and Rutherford St) are generally reduced from those for either Option A or Option B.

This is shown in the model output data in Table 4-4.

Table 4-4 : Option H Rocks Road Four Laning: PM_{10} 24–hr Average Concentrations (µg/m^3)

	2016	**2036**
Rocks Road	19.96	18.98
Road-Associated Component	*1.36*	*1.38*

Annesbrook Drive	38.46	36.48
Road-Associated Component	*1.36*	*1.38*
Waimea Road	19.91	18.96
Road-Associated Component	*1.31*	*1.36*
Wakefield Quay	47.07	44.72
Road-Associated Component	*0.67*	*0.82*
St Vincent St	46.95	44.59
Road-Associated Component	*0.55*	*0.69*
Vanguard St	46.71	44.22
Road-Associated Component	*0.31*	*0.32*
Rutherford St	46.91	44.49
Road-Associated Component	*0.51*	*0.59*

4.3.6 Option I: Waimea Road Four-Laning

The model outputs of PM_{10} contributions from this option are relatively similar to those for Option H. the PM_{10} road-associated components for Rocks Road, Annesbrook Drive and Waimea Road are, again, moderately elevated but the PM_{10} contributions on the four subsidiary roads are reduced, as compared to Options A and B in particular. Table 4-5 presents this data.

Table 4-5 : Option I Waimea Road Four Laning: PM_{10} 24–hr Average Concentrations (µg/m^3)

	2016	**2036**
Rocks Road	19.91	18.91
Road-Associated Component	*1.31*	*1.31*

Annesbrook Drive	38.41	36.41
Road-Associated Component	*1.31*	*1.31*
Waimea Road	19.83	18.88
Road-Associated Component	*1.23*	*1.28*
Wakefield Quay	47.07	44.68
Road-Associated Component	*0.67*	*0.78*
St Vincent St	46.89	44.51
Road-Associated Component	*0.49*	*0.61*
Vanguard St	46.71	44.22
Road-Associated Component	*0.31*	*0.32*
Rutherford St	46.88	44.46
Road-Associated Component	*0.48*	*0.56*

4.3.7 Consolidated Tables Comparing Road-Associated PM_{10} Contributions from the Model Outputs

Tables 4-6 and 4-7 present, respectively, the model outputs for the road-associated contributions to total PM_{10} contaminant concentrations along the components of each of the four preferred arterial route options for Nelson City, in the years 2016 and 2036.

The tables are reasonably similar in comparative terms and show that Option A will make increased contributions of PM_{10} as a road-associated component to total Airshed PM_{10} concentrations. For Rocks Road, Annesbrook Drive and Waimea Road in particular these PM_{10} contributions in Option A are higher than for the other three options.

The Option B model outputs indicate a moderate reduction in PM_{10} contributions for Rocks Road and Waimea Road but an increased PM_{10} contribution in Wakefield Quay and St Vincent St, in particular, and a small increase also in PM_{10} for Vanguard St and Rutherford St.

In comparison with Options A and B, it can be deduced from the model results that Options H and I (the four-laning options) are generally favoured in terms of the lessened extent to which they will contribute a road-associated PM_{10} component to the total PM_{10} concentrations along various sections of these route options. It is not possible, however, given modelling uncertainties to make a choice on air quality grounds between Option H and Option I.

Overall, the modelled PM_{10} concentrations are quite similar, although trends can be legitimately deduced. The similarity of the various modelling outputs for the options reflects that traffic loads and speeds, which are not greatly different between the four options, are the primary factors in influencing the model outputs.

Table 4-6 : Air Quality Impacts of Route Options – Road-Associated PM_{10} Contributions for 2016 ($\mu g/m^3$)

	Option A	Option B	Option H	Option I
Rocks Road	1.58	1.16	1.36	1.31
Annesbrook Drive	1.58	1.16	1.36	1.31
Waimea Road	1.52	1.15	1.31	1.23
Southern Arterial	-	1.30	-	-
Wakefield Quay	0.80	0.56	0.67	0.67
St Vincent St	0.68	0.84	0.55	0.49
Vanguard St	0.39	0.52	0.31	0.31
Rutherford St	0.58	0.29	0.51	0.48

Table 4-7 : Air Quality Impacts of Route Options – Road-Associated PM_{10} Contributions for 2036 ($\mu g/m^3$)

	Option A	Option B	Option H	Option I
Rocks Road	1.59	1.30	1.38	1.31
Annesbrook Drive	1.59	1.30	1.38	1.31
Waimea Road	1.59	1.26	1.36	1.28
Southern Arterial	-	1.30	-	-
Wakefield Quay	0.95	0.73	0.82	0.78
St Vincent St	0.83	1.01	0.69	0.61
Vanguard St	0.37	0.48	0.32	0.32
Rutherford St	0.69	0.44	0.59	0.56

4.3.8 Local Context to Model Results

The assumptions inherent in the spreadsheet model (see section 4.2 above) result in a degree of inflexibility in the outputs. It is important therefore to provide some local context to the results by an at least qualitative consideration of the ways in which various constraints of locality, contaminant dispersion and population densities should be factored in to the way in which the model results should be viewed. The following tabulation illustrates these factors and their applicability.

Table 4-8 : Local Context Factors for Route Options

[redacted]

	Option A	Option B	Option H	Option I
Background Existing PM_{10} Concentrations (in general)	Low / Moderate	High (but reducing)	Low / Moderate	Moderate
Road-Associated PM_{10} Contributions to Local Airshed (µg/m^3;from model outputs)	1.59	1.30	1.38	1.28
Dispersion Characteristics Along Route (in general)	Good / Moderate	Poor	Good / Moderate	Moderate
Human Exposure to Contaminants in Ambient Air	Moderate	Moderate-High	Moderate	Moderate-High

The following specific points are also relevant to the above Table:

- The Northern end of SH1 (Rocks Road) along the coast has low PM_{10} background concentrations, good contaminant dispersion characteristics and moderate human exposure potential as this section of road is only populated on one side of the route.

- The Southern end of SH1 (in the Tahunanui and Annesbrook areas) has moderate background PM_{10} concentrations, moderate contaminant dispersion characteristics and moderate human exposure potential.

- The Southern Arterial route (Option B) has high current PM_{10} background concentrations, poor contaminant dispersion characteristics as the route lies in a valley, and moderate-high human exposure potential due to the density of residential housing along the route.

- The Waimea Road / Rutherford Street area has moderate PM10 background concentrations, moderate contaminant dispersion characteristics, and moderate-high human exposure potential due to population densities, albeit exposed to lower concentrations than along Option B.

5 Conclusions

A calibrated spreadsheet model has been used to predict PM_{10} concentrations, as a suitable representative contaminant associated with road traffic, for a selection of preferred arterial route options for Nelson City.

Based on the outputs of the model, and taking into account the various assumptions made and the uncertainties in the model itself, it can be concluded that Option A Part-Time Clearways and Option B Southern Arterial Route appear to be the least favoured of the four investigated options on air quality grounds, although the differences are small.

In order to incorporate the complexity of topography and local micro-climatic conditions inherent within the options an atmospheric dispersion modelling exercise would be required. The results of such an exercise would be likely to confirm a choice on air quality grounds between the options but, at this stage of the study, the spreadsheet modelling approach undertaken has indicated a preference for either Option H Rocks Road Four-Laning or Option I Waimea Road Four-Laning.

It is not however possible to differentiate between these two options in terms of air quality benefits.