Impacts of dust from unsealed roads
Context – The Unsealed Environment

Unsealed Roads (km)

- Far North District Council: 641 km
- Wairoa District Council: 550 km
- Marlborough District Council: 853 km
- Hurunui District Council: 1,800 km

Percent of Roads that are Unsealed

- Far North District Council: 59%
- Wairoa District Council: 42%
- Marlborough District Council: 71%
- Hurunui District Council: 66%
Dust from Unsealed Roads?

- What are the RISKS?
- What are the options for MITIGATION?
- What is the BENEFIT/COST of mitigations?
Acknowledgements

- **NZTA:** Funding – Research project TAR14/31.
- **Project Steering Group:** Rob Hannaby (NZTA), Jon Cunliffe (Marlborough District Council), Frances Graham (Ministry for Health), Greg Haldane (NZTA) and Iain McGlinchy (Ministry of Transport).
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- **Dust Control Solutions:** (Anthony Stewart) for advice on dust suppressant type and for supplying the dust suppressant.
- **Equipment hosts:** Kaingahoa Marae (Jane Whiu), Tasha Whiu, Doug Boyd, Colin Pinkney for hosting the monitoring equipment on their Mataraua Road properties.
- **Northland Regional Council:** for assistance with clarifying the activity status of applying the dust suppressant.
An important note for the Audience

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Research objectives

1. **Describe and quantify the impacts of dust** exposure from unsealed roads
2. **Collect new data** to characterise the dust and quantify the impacts of dust
3. Investigate **dust mitigation measures**.
4. Estimate the **costs of the health impacts** and the **benefits of mitigating the dust**
5. Tools to **support decision making** about mitigation options.
Monitoring Site Selection: Phase 1

- Unsealed roads trafficked by reasonably high volumes of vehicles including a significant number of heavy duty vehicles.
- A Territorial Local Authority (TLA) that was prepared to act as a host by assisting with site selection, provision of traffic data, and providing support with the logistics of monitoring.
- Be within a region that allowed the application of dust suppressants on unsealed roads.
Monitoring Site Location: Phase 2

- **Number and type of vehicles** passing the site each day
- Number of **nearby dwellings**
- **Topography and meteorology** (maximum frequency of cross-road winds).
- **Cell phone coverage** (ability to telemeter the data from site).
- **Suitable locations to install equipment** on roadside (requires permission from private land owners).
- **Power supply available** for equipment (solar powered equipment more expensive to install and problematic to run).

- Potential sites in the Far North District
  - Ngapipito Road
  - Pipiwai Road
  - Mataraua Road
  - Piccadilly Road

December 2, 2015
Monitoring Site Location
Site geology, roadway construction and traffic

- Base geological material is **sedimentary rock**
- The **design and construction** is **typical of other unsealed roads** within the Northland Region.
- The **maintenance schedule** is **typical** of other unsealed roads in the FNDC.
- **Metal** used to cover the road bases in Northland **varies from road to road** with metals being supplied from close by sources.
- Logging **truck numbers** are **relatively high**

December 2, 2015
Monitoring equipment - Dust
Dust monitoring was not NES compliant

- NES compliant monitoring
  - BAM
- Campaign monitoring
  - Dust Mote
- Dust mote data is
  - NOT NES compliant
- Converted to BAM equivalent
- Good indicative data
- Fit for the purpose of this project

December 2, 2015
Monitoring site layout and equipment network

- Treated North - 80m
- Treated North - 30m
- Treated North - 5m
- Treated South - 5m

Mataraua Road

Coordinate System: NZGD 2000 New Zealand Transverse Mercator
Map Image: LINZ Land Eagle Technology
Limitation on results presented

- Results presented:
  - Have not fully completed the peer review process
  - Are subject to change
- Results will be finalised when the NZTA report is published.
Meteorology of the site

Wind Speed (m/s)

Hour of Day

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

1st Quartile to Median  Median to 3rd Quartile  Mean
Vehicle movements

![Graph showing vehicle movements by hour of day, categorized into light duty, heavy duty, and unclassified vehicles.]
Total suspended particulates and PM$_{10}$
Total suspended particulates and PM$_{10}$

DRAFT RESULT - 30 m

- TSP
- PM10

32%
68%
Untreated section of road
PM$_{10}$ concentrations - untreated

DRAFT RESULT

24-hour average PM$_{10}$ conc. (µg/m$^3$) vs. Day / Month

- Untreated North 5m
- Untreated North 30m

December 2, 2015
PM$_{10}$ concentrations - untreated

Table 4-1: Summary statistics for daily average PM$_{10}$ monitoring – untreated section of the road

<table>
<thead>
<tr>
<th>Site</th>
<th>Number of days with data</th>
<th>Number of days with PM$_{10}$ concs. $&gt;$50 $\mu$g$m^{-3}$</th>
<th>Campaign average PM$_{10}$ conc. ($\mu$g$m^{-3}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated north - 5 m</td>
<td>52</td>
<td>25</td>
<td>83</td>
</tr>
<tr>
<td>Untreated north - 30 m</td>
<td>52</td>
<td>15</td>
<td>47</td>
</tr>
<tr>
<td>Untreated south - 5 m</td>
<td>45</td>
<td>19</td>
<td>101</td>
</tr>
</tbody>
</table>

- Non-NES compliant monitoring method
  - Results indicative rather than definitive
- PM$_{10}$ NES exceeded **one day in two** on the non-treated section of the road at the roadside
- PM$_{10}$ NES exceeded on **one day in three** the non-treated section of the road at **typical exposure locations**
Treated section of road
PM$_{10}$ NES Concentrations - treated

DRAFT RESULT

24-hour average PM$_{10}$ conc. (µg/m$^3$)

Day / Month

Treated North 5m  Treated North 30m

December 2, 2015
PM\textsubscript{10} concentrations - treated

<table>
<thead>
<tr>
<th>Site</th>
<th>Number of days with data</th>
<th>Number of days with PM\textsubscript{10} concs. $&gt;50$ $\mu$gm$^2$</th>
<th>Campaign average PM\textsubscript{10} conc. ($\mu$gm$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated north - 5 m</td>
<td>47</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Treated north - 30 m</td>
<td>55</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Treated south - 5 m</td>
<td>47</td>
<td>4</td>
<td>26</td>
</tr>
</tbody>
</table>

- Non-NES compliant monitoring method
  - Results indicative rather than definitive
- **PM\textsubscript{10} NES were exceeded at the roadside** of the treated section of the road infrequently, **one day in 15**
- **PM\textsubscript{10} NES is not exceeded on the non-treated** section of the road at typical exposure locations
Extent of dust plume impact – Background

PM$_{10}$

**DRAFT RESULT**

### 1-hour PM$_{10}$ conc. (µg/m$^3$)

- **30m**
  - Mean: 11.1
  - 1st Quartile to Median: 7.6
  - Median to 3rd Quartile: 6.9

- **80m**
  - Mean: 10.9
  - 1st Quartile to Median: 6.9
  - Median to 3rd Quartile: 6.9

**Note:** Top error bars represent 90th percentile values. Bottom error bars represent minimum values.

**Treated North sites (distance from road)**

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**December 2, 2015**
Extent of dust plume impact - Untreated

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Note: Top error bars represent 90th percentile values. Bottom error bars represent minimum values.
Extent of dust plume impact - treated

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1-hour PM$_{10}$ conc. (µg/m$^3$)

Untreated North sites (distance from road)

0 50 100 150 200 250 300 350

5m 27.4 20.6
30m 14.1 10.6
80m 14.2 10.2

Note: Top error bars represent 90th percentile values. Bottom error bars represent minimum values.
Vehicle speed as a dust mitigation measure

<table>
<thead>
<tr>
<th>Vehicle Speed categories (km/hr)</th>
<th>Percentage of Vehicles in each category</th>
<th>Percentage of Vehicles in each category</th>
<th>Percentage increase (+) or decrease (-) in last 2 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average first 6 weeks</td>
<td>Average last 2 weeks</td>
<td></td>
</tr>
<tr>
<td>0-30</td>
<td>16.9%</td>
<td>17.2%</td>
<td>0.37%</td>
</tr>
<tr>
<td>31-40</td>
<td>15.6%</td>
<td>15.0%</td>
<td>-0.60%</td>
</tr>
<tr>
<td>41-50</td>
<td>29.9%</td>
<td>28.4%</td>
<td>-1.44%</td>
</tr>
<tr>
<td>51-60</td>
<td>26.4%</td>
<td>26.9%</td>
<td>0.49%</td>
</tr>
<tr>
<td>61-65</td>
<td>5.7%</td>
<td>6.9%</td>
<td>1.15%</td>
</tr>
</tbody>
</table>
Dust deposition

- Deposited dust adjacent to the untreated section of the road was much higher than the MfE trigger level of 4 g/m²/30 days.

- A large variation was observed in the two results from the untreated section of the road (12 to 48 g/m²/month).

- The deposited dust adjacent to the treated section of the road was no greater than background levels and consistent over both measurement periods.
Respirable silica

- Potentially hazardous components of road dust
- Sampling undertaken at untreated, north 5 m site
- Simple pump and filter set up

- Mass of respirable silica were below the detection limit
- Preliminary conclusion - residents of Mataraua Road are unlikely to be exposed to annual average concentrations of greater than 5 $\mu g/m^3$.
- To confirm this conclusion, a more detailed monitoring programme of longer duration would be required.
Dust mitigation 1: Effectiveness of dust mitigation

DRAFT RESULT

Note: Top error bars represent 90th percentile values. Bottom error bars represent minimum values.
No sign of reduced effectiveness of suppressant over the life of the monitoring programme.

- Qualitative assessment (multivariate statistics could be employed)
Method to Assess health impacts of changes in PM$_{10}$ concentrations

- Assess annual PM$_{10}$ exposure (Mataraua Road data)
  - Untreated road (Baseline)
  - Treated road
  - Sealed road

- Calculate the health cost of dust exposure (HAPINZ)
  - Untreated road (Baseline)
  - Treated road
  - Sealed road

- Calculate the health benefits of mitigation
  - Baseline cost - Treated road cost
  - Baseline cost - Sealed Road cost
Calculating the costs of mitigation

- Baseline (untreated an unsealed road)
  - Maintenance (grading and metal)
- Treated road
  - Chemical suppressant
  - Maintenance (grading and metal)
- Sealed road
  - Sealing
  - Maintenance
## Benefit to cost to ratio of dust mitigation

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Annual average PM$_{10}$ conc. (µg/m$^3$)</th>
<th>Total annual health cost of PM$_{10}$</th>
<th>Annual health benefit of PM$_{10}$ mitigation</th>
<th>Annual cost of mitigation</th>
<th>Annual benefit to cost to ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road treated with chemical suppressant</td>
<td></td>
<td></td>
<td></td>
<td>TBC</td>
<td></td>
</tr>
<tr>
<td>Sealed road surface (40 year life)</td>
<td></td>
<td></td>
<td></td>
<td>TBC</td>
<td></td>
</tr>
<tr>
<td>Sealed road surface (10 year life)</td>
<td></td>
<td></td>
<td></td>
<td>TBC</td>
<td></td>
</tr>
</tbody>
</table>
Dust mitigation - decision making process

Figure 7-1 Dust mitigation – decision making process

Is there a need to mitigate road dust?

Calculate a site dust risk score.

Medium risk. There may be some benefit from mitigation. Return to and repeat Decision Matrix 1 with refined site specific information.

High risk. There is likely to be a benefit from mitigation. Complete assessment of suitable mitigation options.

Low Risk. Little or no benefit from mitigation. End of decision making process.

Assess which mitigation options are suitable?

Assess cost/benefit of available mitigation options

Dust Risk assessment matrix
<table>
<thead>
<tr>
<th>Risk Factor/Score</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Waikakaho Valley</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 day AADT of HDVs</td>
<td>Less than 5</td>
<td>05-Oct</td>
<td>Oct-25</td>
<td>25-50</td>
<td>More than 50</td>
<td>60</td>
</tr>
<tr>
<td>Longevity of logging route use</td>
<td>Not a logging route</td>
<td>1 year or less</td>
<td>2 years or less</td>
<td>3 years or less</td>
<td>Longer than 3 years</td>
<td>1</td>
</tr>
<tr>
<td>Speed of HDVs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20 km/hr limit</td>
</tr>
<tr>
<td>Number of dwellings within 80 m of roadway (houses/km)</td>
<td>none</td>
<td>1</td>
<td>02-Apr</td>
<td>05-Aug</td>
<td>More than 8</td>
<td>15</td>
</tr>
<tr>
<td>AADT of LDVs</td>
<td>Less than 50</td>
<td>50-100</td>
<td>100-200</td>
<td>200-400</td>
<td>More than 400</td>
<td>60</td>
</tr>
<tr>
<td>Speed of LDVs</td>
<td>Less than 50 km/hr</td>
<td>50-70 km/hr</td>
<td>Greater than 70 km/hr</td>
<td></td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Location of roadway</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Open plains or costal area</td>
</tr>
<tr>
<td>Frequency of rain days (&gt;5 mm)</td>
<td>More than 3 per week</td>
<td>More than 2 per week</td>
<td>Less than 1 per week</td>
<td>Less than once per week</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Other locations where people are likely to be exposed. (e.g. schools, marae, or hospitals)</td>
<td>None</td>
<td>1 location</td>
<td>2 locations</td>
<td>3 or more locations</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ecologically sensitive areas such as rare species habitats or wetlands</td>
<td>None</td>
<td>1 sensitive areas</td>
<td>2 sensitive areas</td>
<td>3 or more sensitive areas</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Nuisance effects for residents</td>
<td>No</td>
<td>1 – 2 complaints total</td>
<td>More than 2 complaints per year</td>
<td>More than 6 complaints per year</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Horticultural sensitive areas such as fruit orchards</td>
<td>No</td>
<td>1 sensitive areas</td>
<td>2 sensitive areas</td>
<td>3 or more sensitive areas</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>26</strong></td>
</tr>
</tbody>
</table>
Waikakaho Valley Example - Result

Matrix Score of 26 -> High Risk from Dust

=> Benefit likely from mitigations. Assess suitable options
Recent Dust Mitigations in the Waikakaho

- 2014 - carried out prior to this research project
- 2.5 km of road treated
- In response to public concerns
- First water: – 90 days @$1000/day; $36,000 per km
- Then Otta Seal: (2.5km) @ $270,000; $68,000 per km
- [Suppressant at Mataraua Road: (MgCl2): $20,000 per km (pa)]
Recommendations for future investigations

- **Enhancing future monitoring programmes**
  - Time of year
  - Greater use of BAMs to validate dust mote data
  - Effect of speed
  - Other sites
    - Road type
    - Road Construction
    - Vehicle fleet and numbers
    - Meteorology
  - Respirable particulate

- **Additional data analyses**
  - Refine plume extent
  - Investigate the effect of vehicle type (HDV vs LDV), on dust concentrations
  - Investigate the effect of meteorology (high and low wind speeds) on dust concentrations
  - Effect of rainfall on dust concentrations
  - Dust emission factors
  - Dust exposure model
  - Analysis of video
Where to from here?

- Complete the peer review process (end of November)
- Workshops
  - NZ Transport Agency / NZIHT Conference (Paihia 2 Nov)
  - Far North District Stakeholders (Kaikohe 4 Nov)
- Finalise report (before Christmas)
- NZTA publish report – new year
Questions?

It's QUESTION TIME!!