Bus fleet emissions monitoring on Wellington's Golden Mile

Presentation to TEKH August 2021, Tamsin Mitchell, Senior Environmental Scientist, GWRC



Overview

Talk outline

- Context the Golden Mile and public bus fleet
- Looking back: Impacts of bus fleet transformation (2017-2019) using NO2 tube data
- Looking forward: 2020 pilot study using black carbon to track impacts of future bus fleet decarbonisation
- Conclusions



Context: The Golden Mile

The Golden Mile 2.3 km from Courtney Place to Wellington train station



Context: The Golden Mile

Golden Mile is "heart of Wellington city"

- Up to 70,000 people per day
- 50% spilt between on foot and on bus
- Buses ~600 per weekday and 17 bus stops
- 17 traffic lights and 6 signalised pedestrian crossings





Context: The Golden Mile

Golden mile has poor air quality

• Frequent stop/start conditions lead to high diesel bus emissions which are trapped by 'street canyon' effect.



Source: City of Helsinki Environment Centre, 2017

Looking back: Impacts of bus fleet transformation on GM

Public Transport Operating Model (PTOM)

- New operating model with changed routes and new bus companies (tender process)
- Replacement of electric trolley buses with diesel buses September 2017

③ 3 minutes to read

• New fleet configuration and routes rolled out in July 2018

Protesters 'kayak' through Wellington city, call to save trolley buses

21 Nov. 2017 8:01an

GO DIESEL FREE WELLINGROW

Looking back: NO2 tube monitoring

Wellington CBD NO2 tube monitoring installed in late 2016



Golden Mile sites

- Courtney Place
- Manners Street
- Lambton Quay

Contrast sites

- Wakefield Street
- Wellington central air monitoring site

Looking back: NO2 tube monitoring



Looking back: bus emissions model

Bus fleet emissions prediction model (regional cohort)

Bus activity data (speed, km's travelled, passenger and tare weight) x COPERT emission factors (g/km) New fleet



Source: Hamish Clark, GWRC

Looking back: NO2 tube monitoring

Manners Street NO2 tube monitoring (Jan to Jun)



Looking back: NO2 tube monitoring

Nitrogen dioxide (NO₂) smoothed de-seasonalised trend 2017 to 2019



Looking forward: More bus fleet improvements on the way



Metlink Public Bus targets

- ~100 new electric bus to replace diesels by Dec 2023 (22% EV fleet)
- Decarbonisation of bus fleet by 2030
- Contribute to 40% increased mode share for public transport and active modes

Wellington Regional Public Transport Plan 2021-2031

Looking forward: changes to the Golden Mile

Let's Get Wellington Moving – Golden Mile Transformation (starting late 2022)



https://lgwm.nz/our-plan/our-projects/golden-mile/

Support and encourage more walking, cycling and public transport use which will help reduce our carbon emissions.

Black carbon as indicator of diesel particulate

- Light absorbing component of particulate matter (fine soot particles)
- Specific (most of diesel particulate is black carbon)
- Inert (no chemistry compared to NO2)
- Suitable compact continuous monitoring technology exists
- No health guidelines for black carbon but reducing BC levels means reduced health impacts from PM2.5 (World Health Organization)
- Also wood smoke indicator





- New Manners Street monitoring site at bus stop to get bus movements and 'worst-case' emissions
- Bus only lane during the day
- Street canyon confinement of emissions



Black carbon monitoring pilot study report (21/11/2019 to 3/2/2020)

Manners Street bus stop 5006



Introducing the MA350 (5 wavelength mini aethalometer)



Battery for 2-3 days otherwise requires mains power connection (campaign monitor)

Currently manual data download (30 sec to 5 min averages)

Good correlation with AE33 black carbon monitor at reference station (Wellington central)

Estimating emissions emitted on Manners Street

Each bus has unique ID matched to engine type and can be geo-located by on-board GPS



Excludes brake, tyre and road wear

- Bus tracking system based on actual GPS locations called Real Time Information (RTI)
- Using COPERT emissions factors (matched GWRC bus types) can estimate NOx and PM emissions for all buses travelling down Manners Street at hourly resolution



Pilot data: monitored black carbon concentrations match modelled bus PM emissions



Caveat: long term averages match – but still significant day to day variation due to weather





Conditional Probability Function for 75th percentile



Source: adapted from Wiesner (et al. 2021)



Bus strike on Friday 23rd April 2021

During bus strike Manners Street BC lower than Wellington central for first time (no EURO III in service)

BC typically up to 4x higher at Manners Street than Wellington central site

Conclusion: Black carbon indicator

Black carbon indicator useful for:



- Tracking positive impacts of bus fleet decarbonisation and of replacing older EUROs on air quality along the Golden Mile
- Potentially show any impacts of changes to Golden Mile to reduce congestion (bus priority) LGWM
- Evidence to support network design decision fully electric fleet through Golden Mile?
- Next steps working on the reporting format of the indicator and how to best account for inter-annual meteorological variation
- Differences in differences approach? trend relative to Wellington central monitoring site where black carbon concentrations are largely unaffected by buses

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