Heavy-Duty Diesel Vehicle Emissions in Greater Vancouver

Wayne Edwards,
Levelton Consultants Ltd.
Richmond, British Columbia
wedwards@levelton.com

Ali Ergudenler, Derek Jennejohn
Greater Vancouver Regional District
Ali.Ergudenler@gvrd.bc.ca; Derrek.Jennejohn@gvrd.bc.ca

Objectives

- Overall objective was to evaluate cost-effectiveness and emission reduction potential of options for fleet HDDVs.
- Focus of this paper is the emission analysis that was integral to the broader study:
  - Characterize government and large privately owned fleets.
  - Estimate emission factors for each class of vehicle in the HDDV fleets.
  - Calculate “baseline” emissions of criteria air pollutants, greenhouse gases and air toxics to 2025.
  - Estimate annual average PM2.5 concentrations contributed by HDDVs near major roads and in the region.

Fleet Characterization Data Sources

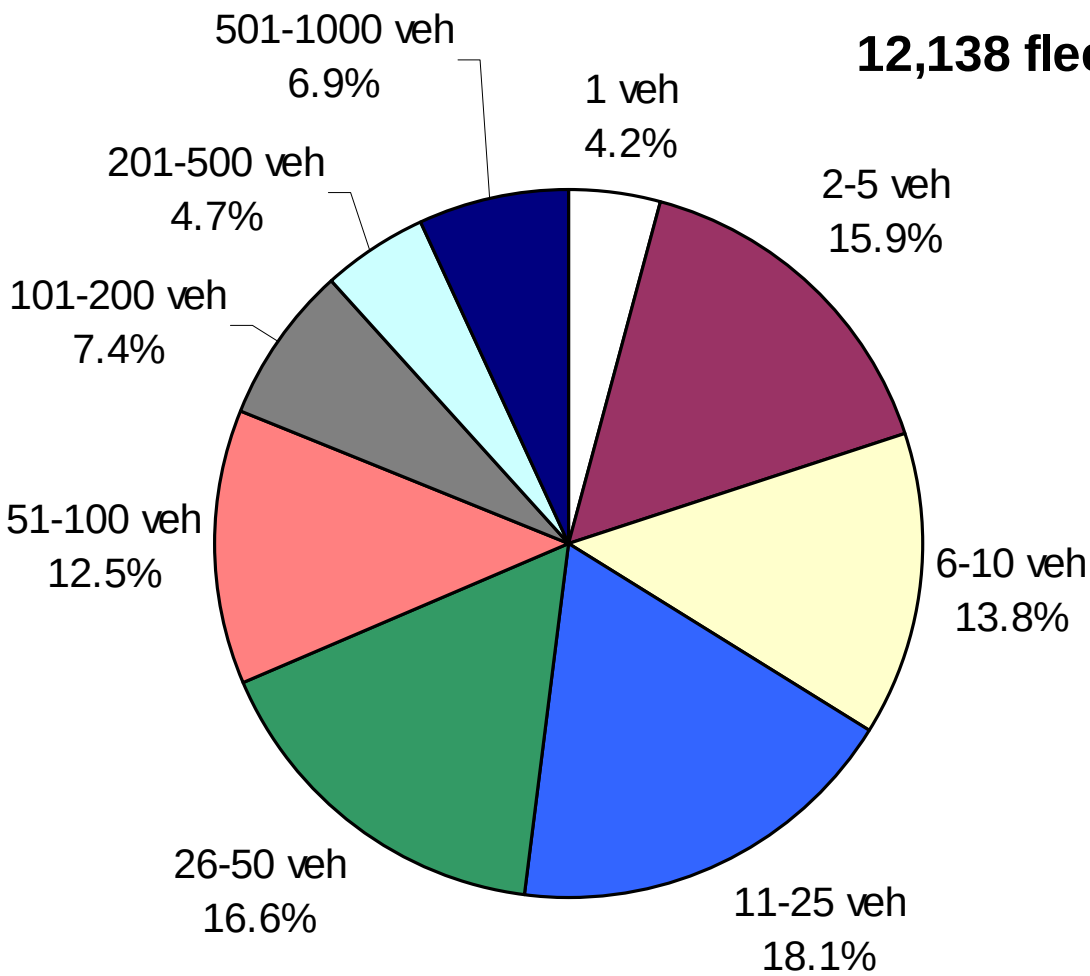
- Vehicle registration data for June 30, 2003.
- Data set included commercial vehicles:
  - With GVW of 8,500 lb or more.
  - Normally operated in Lower Fraser Valley according to owners registration.
  - Vehicle model year, GVW, body style, territory code, fleet code, and other data.
- Survey data from government and some primate fleet managers – fleet code (voluntary), km/yr, Litre fuel/100km, BHP, rebuild year, and other.

Emission Estimation Method

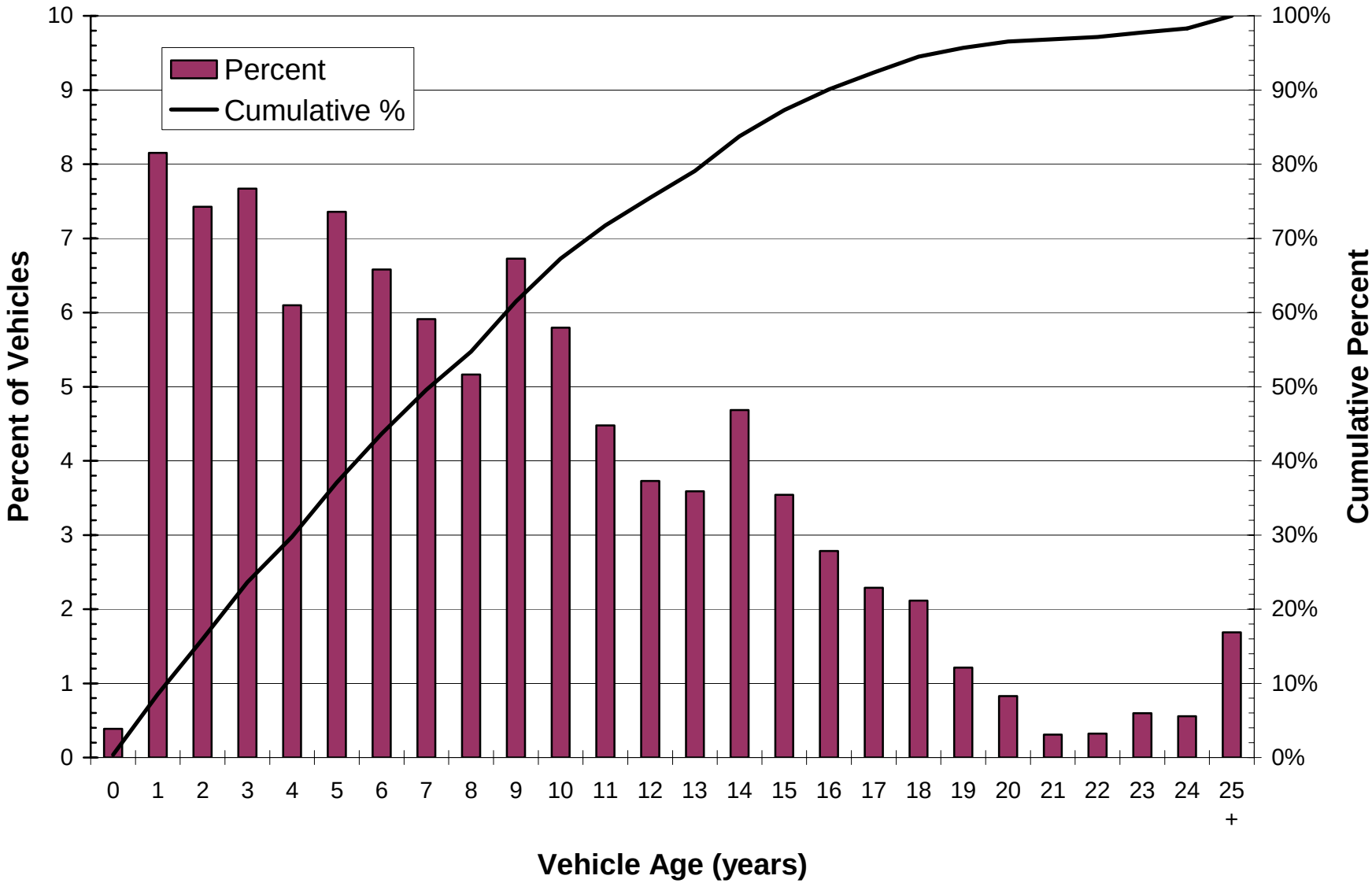
No. of vehicles by age in each vehicle classification x **Annual VkmT** x **Emission factor for each pollutant** = **Annual emission**

- MOBILE6.2C (adapted by Environment Canada)
- Emission factors for criteria and toxic pollutants.
- Local data for input assumptions – fuel quality, climate, etc.
- Default EPA data for VkmT.
- GHG factors for vehicle and life-cycle determined using GHGenius model.

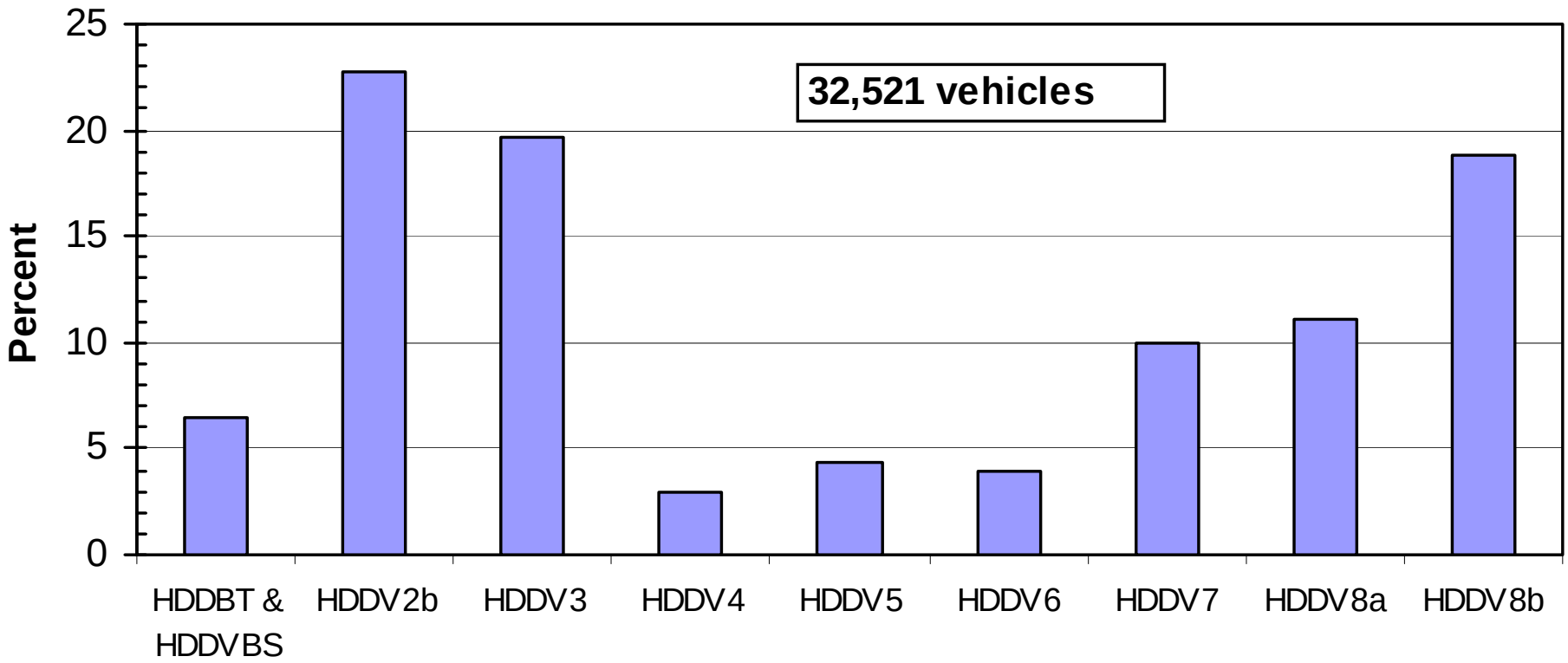
Distribution of Fleet Size



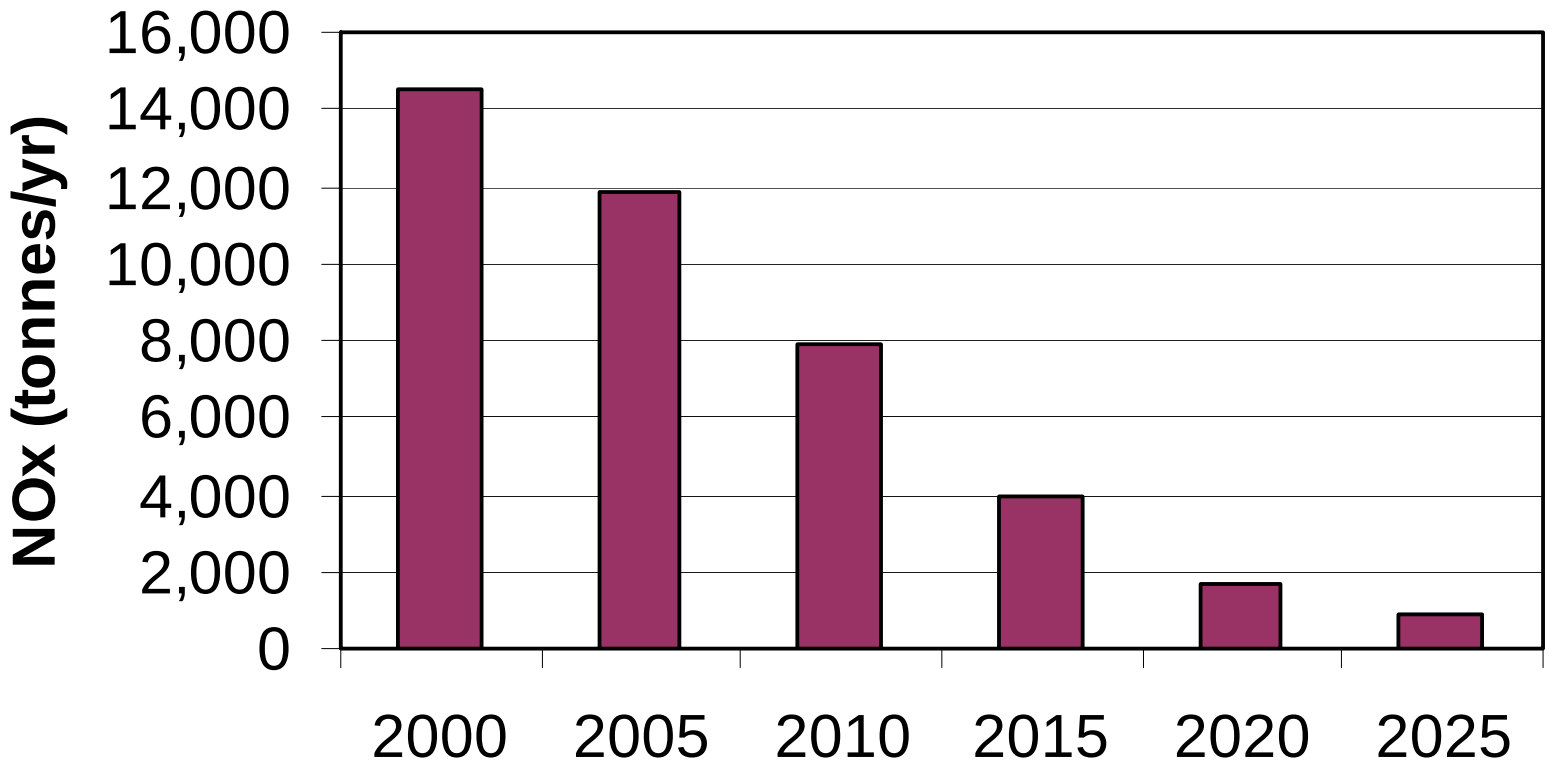
Vehicle Age Distribution - all Onroad



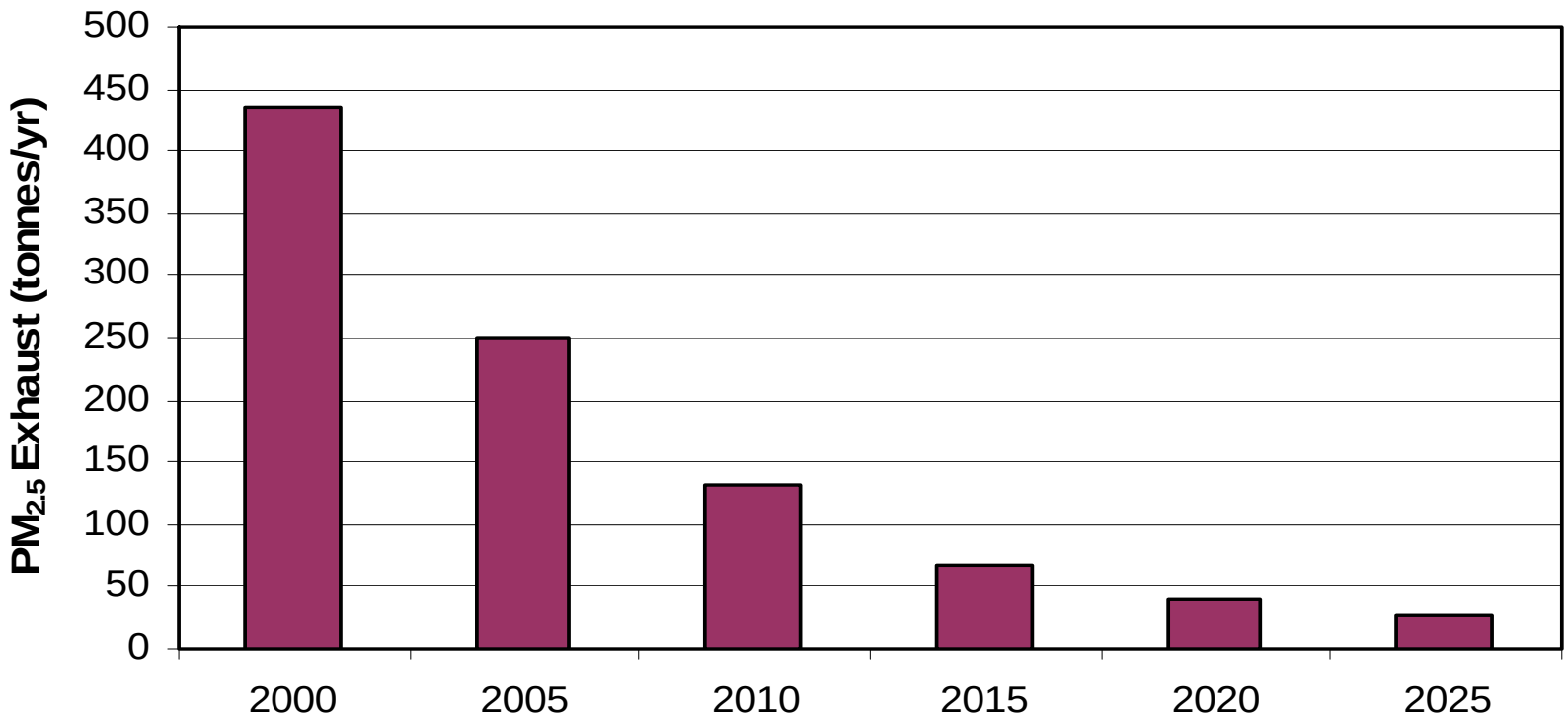
Vehicle Class Distribution – All Onroad



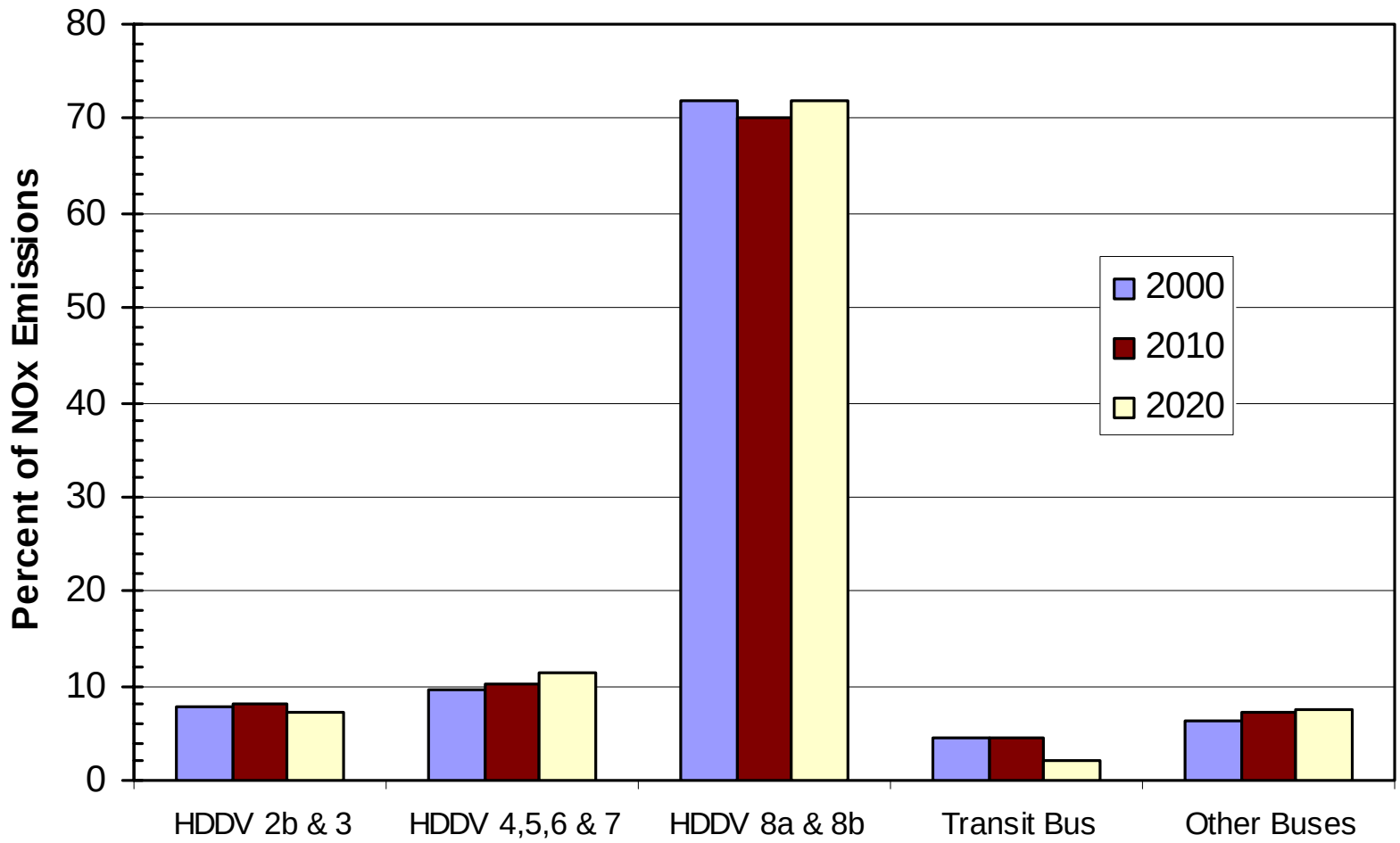
NOx Emission Forecast



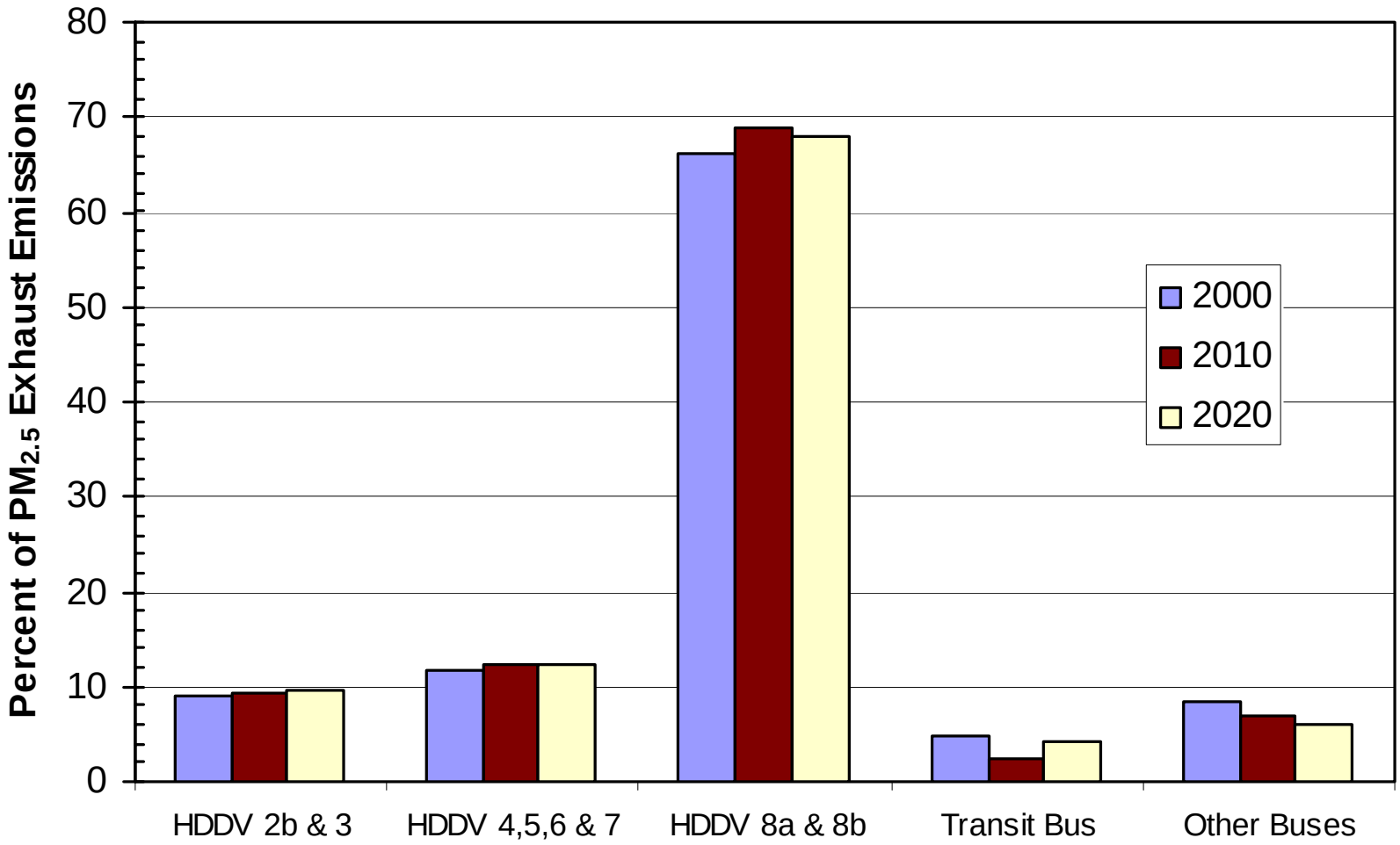
Exhaust PM2.5 Emission Forecast



NOx Emissions by Vehicle Class



PM2.5 Emissions by Vehicle Class



Estimation of Avg PM2.5 Near Roads

C_Z (Link L) $= E_i / L \times F_D$

C_Z = Zone annual average PM2.5 concentration ($\mu g/m^3$)

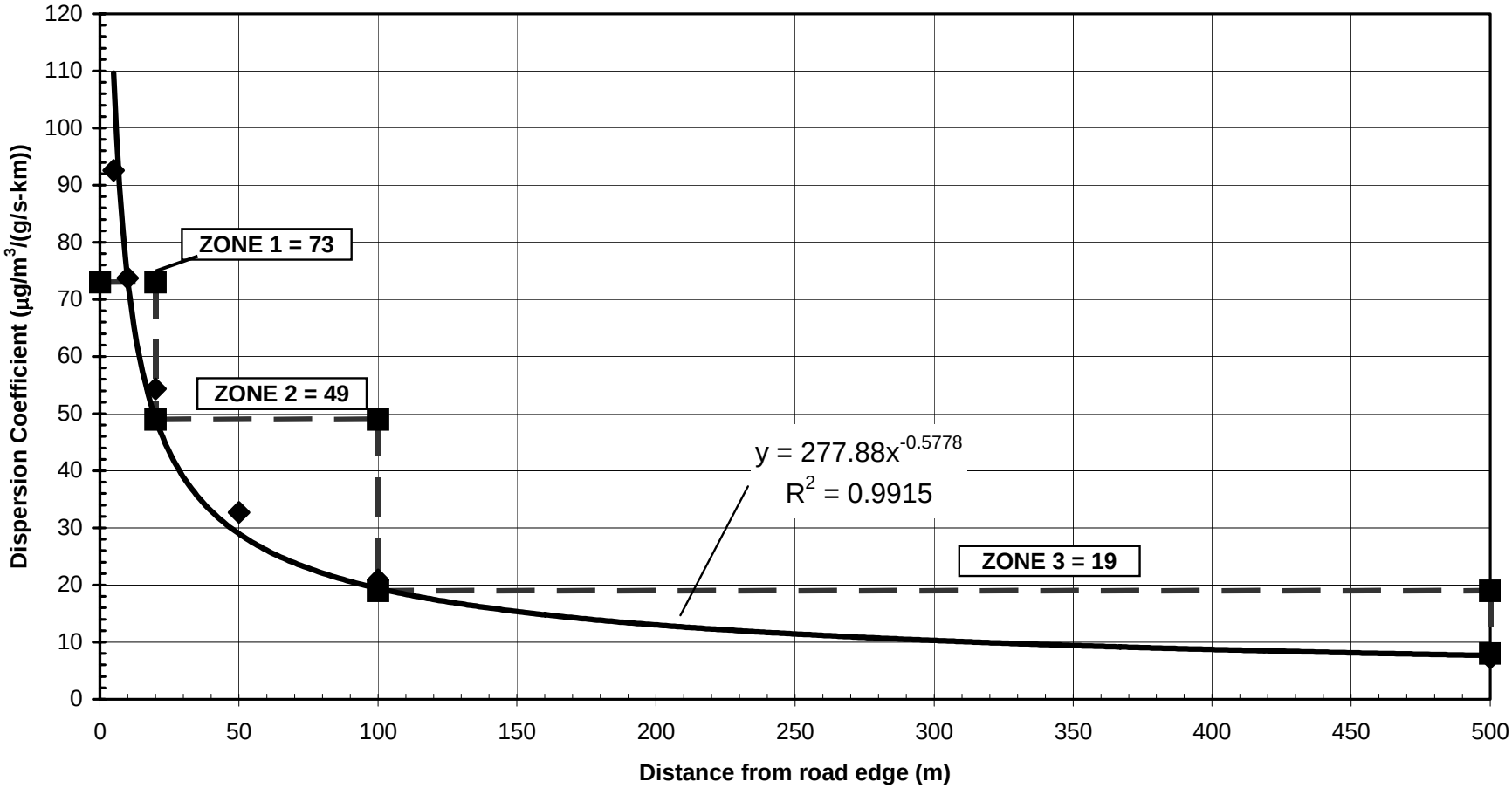
E_i = Annual average emission rate on link L (g/s)

F_D = Dispersion Factor for zone Z ($\mu g/m^3$)/(g/s-km)

L = Link Length (km)

Zones: 5-20 m; 20-100 m; 100-500 m; and >500 m

Dispersion Correlation from CALINE3



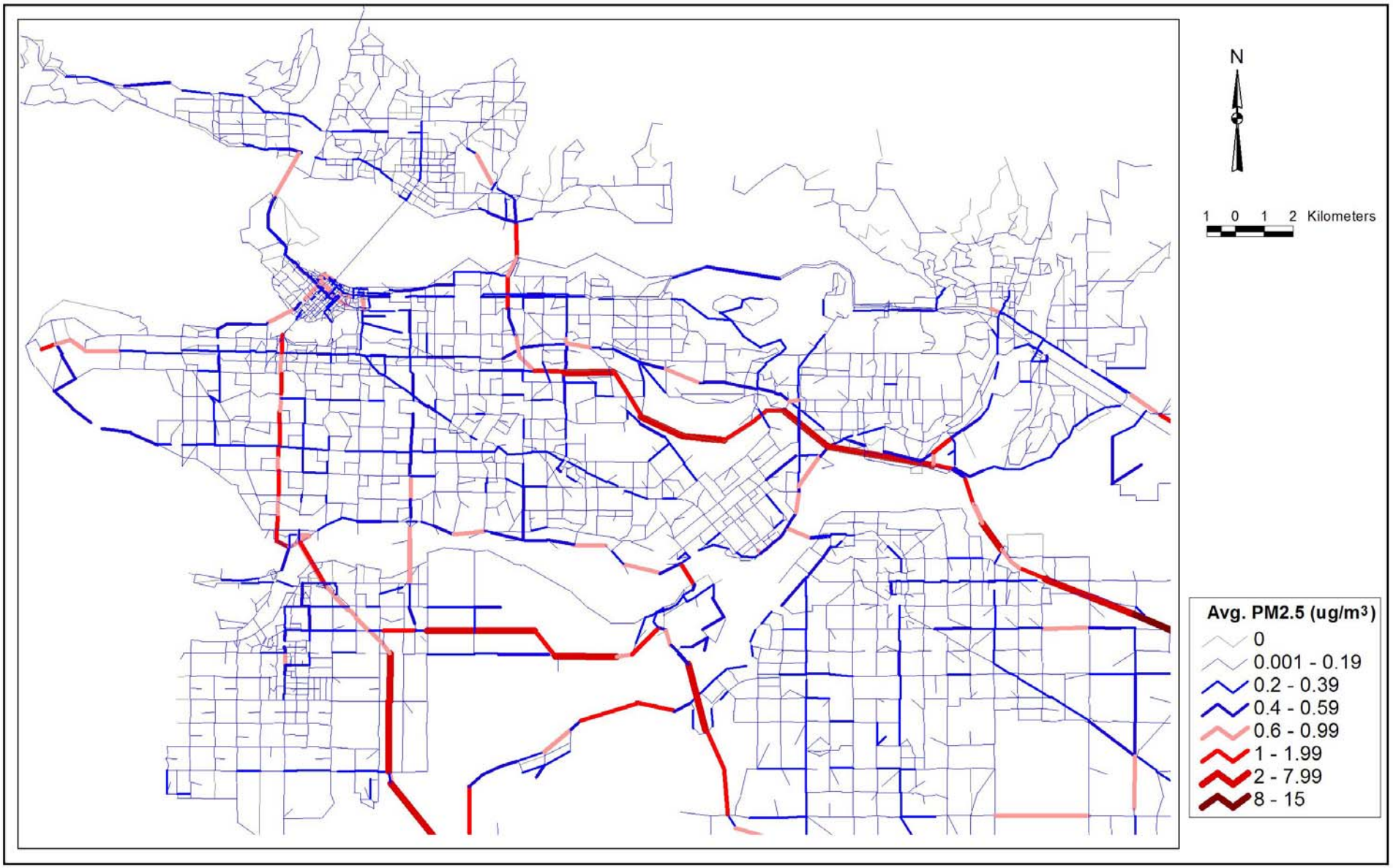
Traffic input from EMME/2 Model

- Upper estimates of dispersion factors used to offset for effects from nearby links not included explicitly in the simplified method.
- Peak AM traffic volume for 2000 from EMME/2 transportation model, scaled to annual average traffic.
- Traffic volume for 8,000, 2-directional road links for all of LFV.
- Two emission cases:
  - Emission factors used for the 2000 emission inventory, net of reduction from the AirCare OnRoad Program (ACOR).
  - Updated emission factors developed in this study.

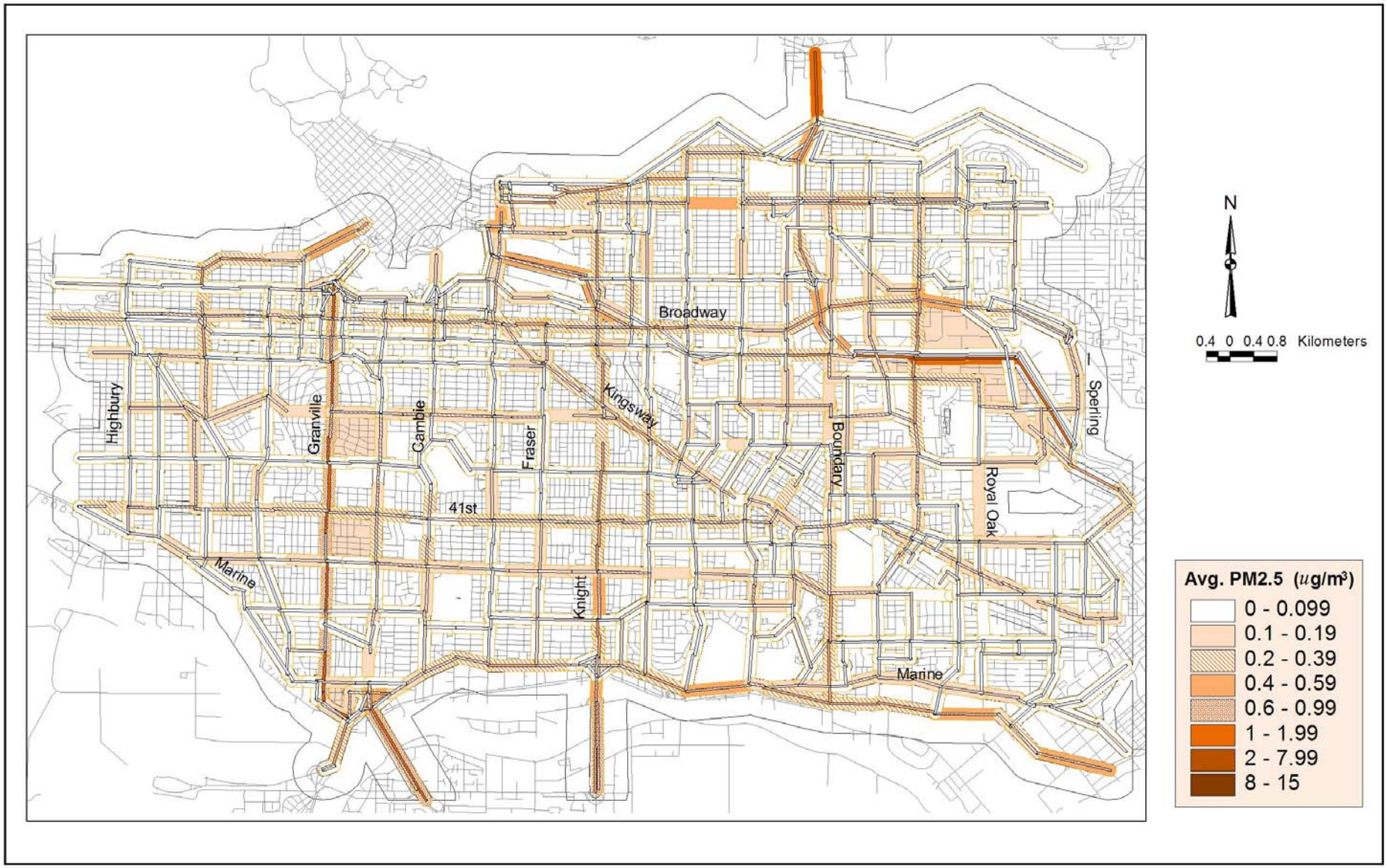
Estimated Exhaust PM2.5 from HDDV

	Predicted Annual Average $PM_{2.5}$ Concentration ($\mu g/m^3$)			
	GVRD Emission Factors with ACOR		Updated Emission Factors & no ACOR	
	Zone 1 <20 m	Zone 2 20-100 m	Zone 1 <20 m	Zone 2 20-100 m
Transit Buses				
Maximum	1.70	1.14	1.32	0.88
98th Percentile	0.40	0.27	0.31	0.21
95th Percentile	0.24	0.16	0.19	0.13
Trucks				
Maximum	15.32	10.28	26.94	18.08
98th Percentile	0.60	0.40	1.05	0.71
95th Percentile	0.30	0.20	0.51	0.34
All HDDV				
Maximum	15.32	10.28	26.94	18.08
98th Percentile	0.78	0.53	1.09	0.73
95th Percentile	0.49	0.33	0.61	0.41

Annual Avg Exhaust PM2.5 – Zone 1



Annual Avg Exhaust PM2.5 – Zones 1-3



Conclusions

- The three largest onroad HDDV categories are Class 8a+b (29.9%), Class 2b (22.7%) and Class 3 (19.6%), totalling 72.2% of HDDVs.
- 12,138 vehicles, or 37% of HDDVs are part of a vehicle fleet.
- Emissions of criteria pollutants forecast to decrease by 60% to 90% between 2000 and 2020.
- Air toxic emissions, excluding diesel particulate matter and ammonia, are forecast to decrease 57% by 2020.
- GHGs are forecast to increase by 35% by 2020.

Conclusions

- 196 kilometers of road have predicted annual PM2.5 concentrations from HDDVs above 1 $\mu g/m^3$ beyond 20 m of the edge of the road - an increase of 300 in a million lifetime risk (70 yrs) of cancer.
- This is 5% of the 4,266 km included in the EMME/2 model of LFV traffic network.
- These and other results can be used to guide monitoring and assessment of effects of PM from HDDVs.

Project Funding Partners

- Greater Vancouver Regional District
- Fraser Valley Regional District
- BC Ministry of Water, Land and Air Protection
- Environment Canada
- Greater Vancouver Transportation Authority
- Clean Air Research Fund
- Clean Energy