EMFAC-HK

Dr. Carol Wong
Senior Environmental Protection Officer
Environmental Protection Department
Hong Kong SAR Government, China
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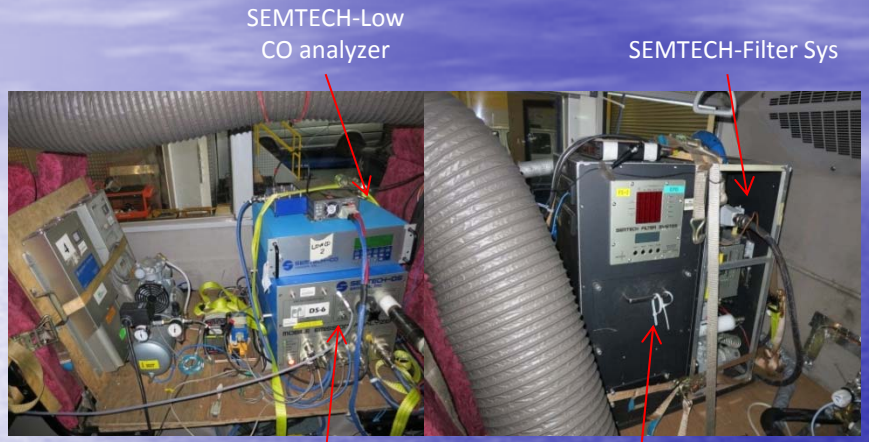
Vehicle Emission Inventory

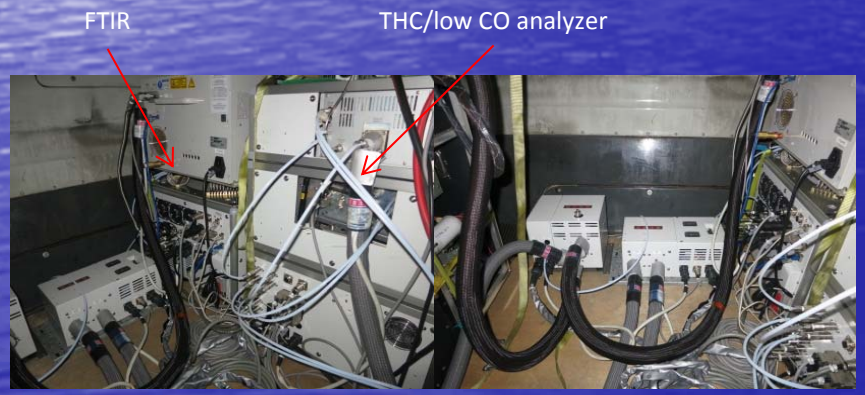
- The methodology used to estimate vehicle emission inventories in Hong Kong

- Making use of traffic data from TD, HyD and EPD's surveys

Real-world vehicle emission measurements using Portable Emission Measurement System (PEMS)

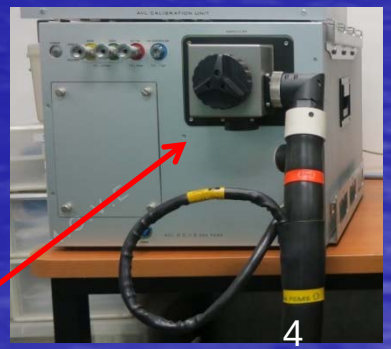
Various PEMS being used in HK





Analyzers	Measurement
7 SEMTECH-DS	CO, CO2, NO, NO2, THC
1 SEMTECH-ECOSTAR	CO, CO2, NO, NO2, THC & PM2.5 on filter
3 A&D portable FTIR	N2O, NH3, CO, CO2, NO, NO2 & various hydrocarbon species
2 SECTECH-Low CO	CO in low conc.
4 AVL M.O.V.E. GAS PEMS	CO, CO2, NO, NO2, THC
5 MPS & 3 SEMTECH-Filter System	PM2.5 on filter
3 AVL M.O.V.E. PM PEMS	Real time PM & PM on filter

AVL PM PEMS



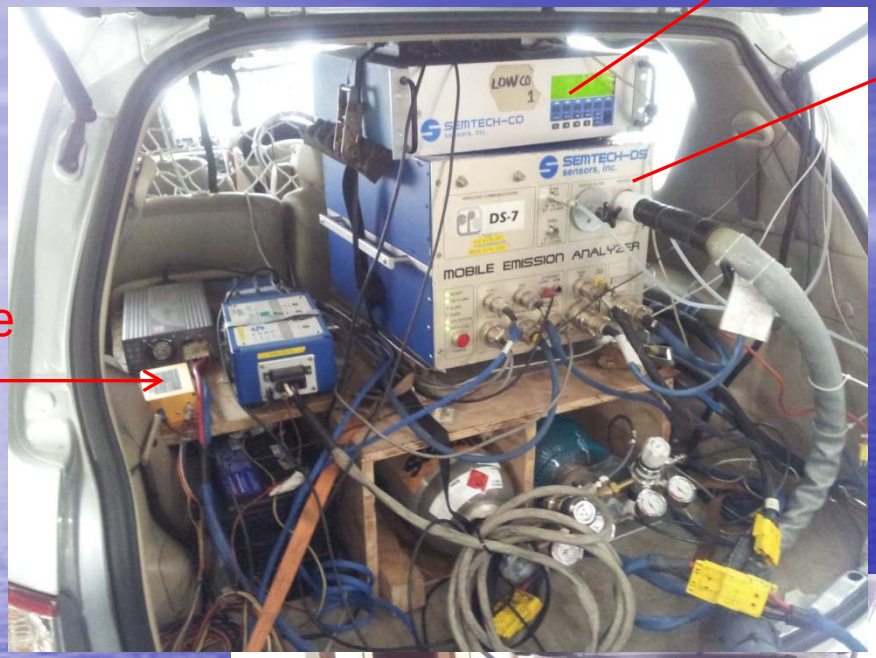
AVL GAS PEMS

Installation

Low CO/THC

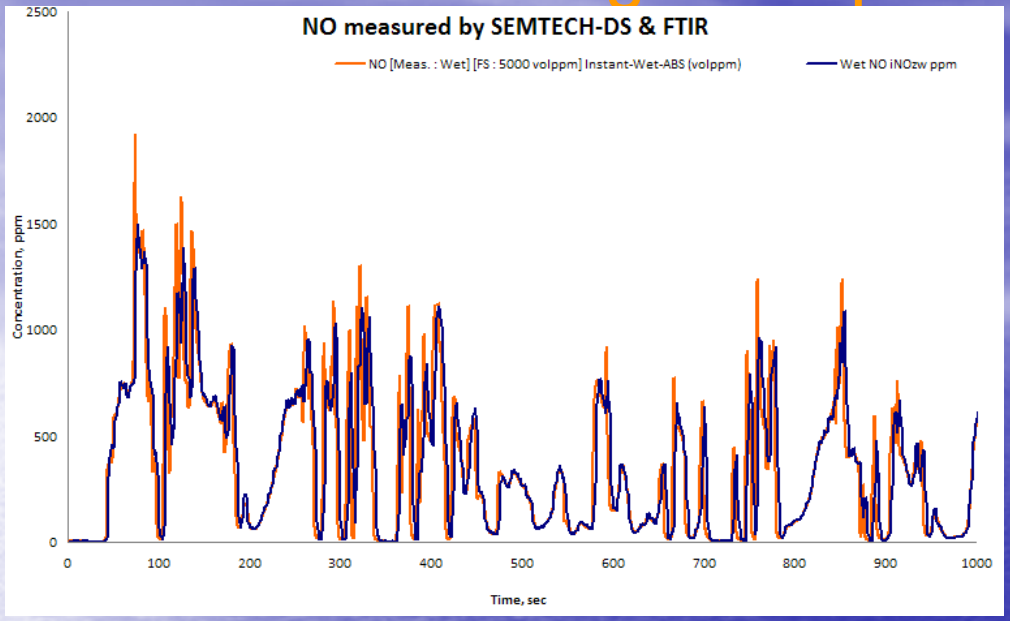
SEMTECH-DS

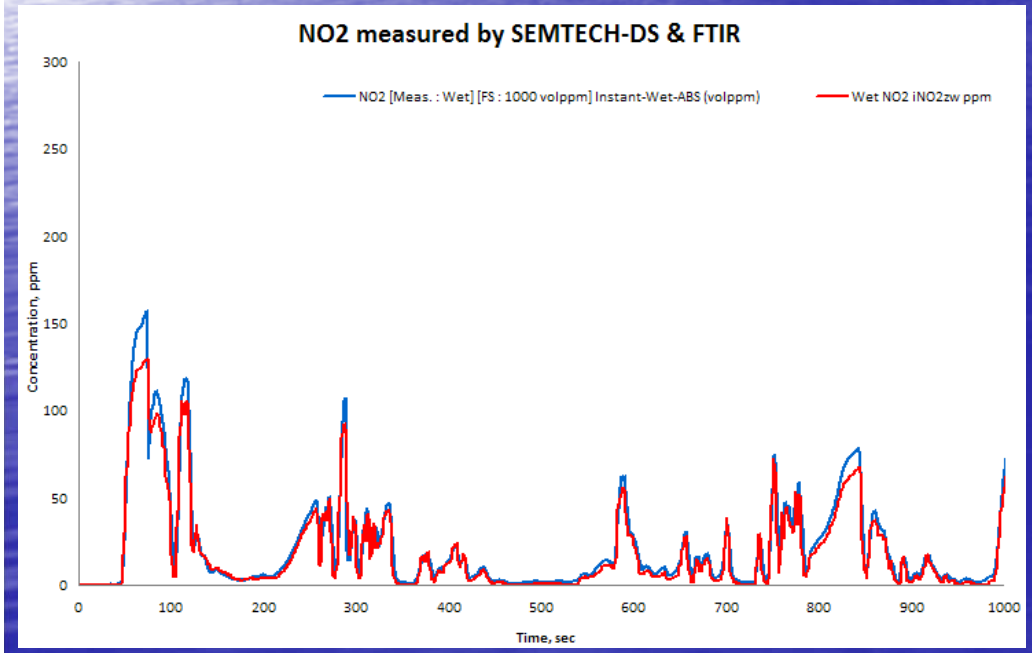
Trimble GPS



Exhaust flow meter

On-Road Testing Example: SCR coach





- On-road testing of an EURO IV coach (w/ SCR)
  - Professional bus drivers
  - Driving on a pre-determined routes as well as following a similar vehicle
  - 50-60 % of maximum payload
  - Traffic are captured by video camera mounted in front of the bus
- Both gaseous pollutants and PM are collected
  - PEMS used – SEMTECH-DS, MPS, Filter System, FTIR, and M.O.V.E. PM PEMS

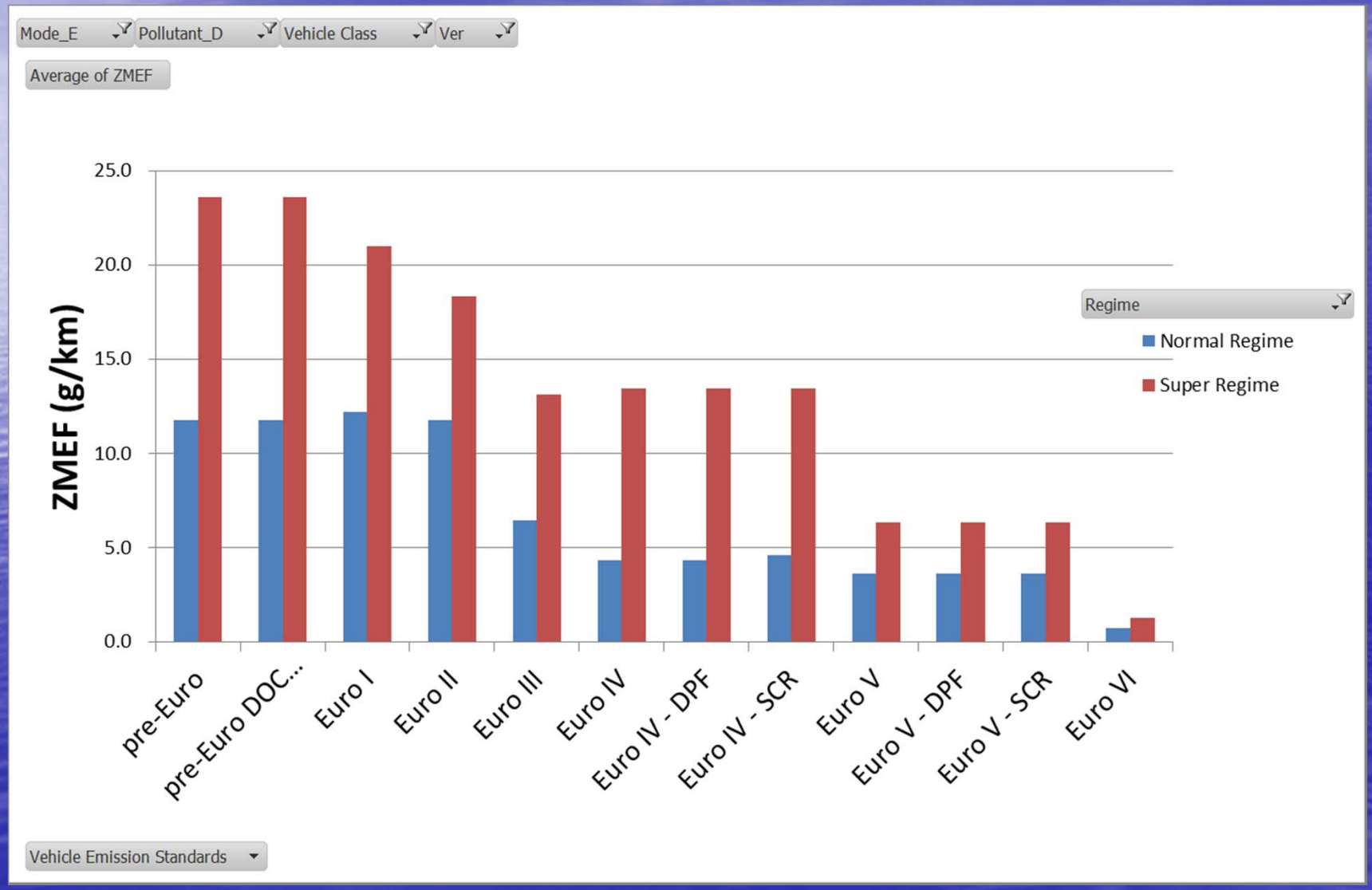
QA/QC for PEMS

- Follow international standards:
  - ISO16183/Euro VI
  - US CFR 1065 Subpart J

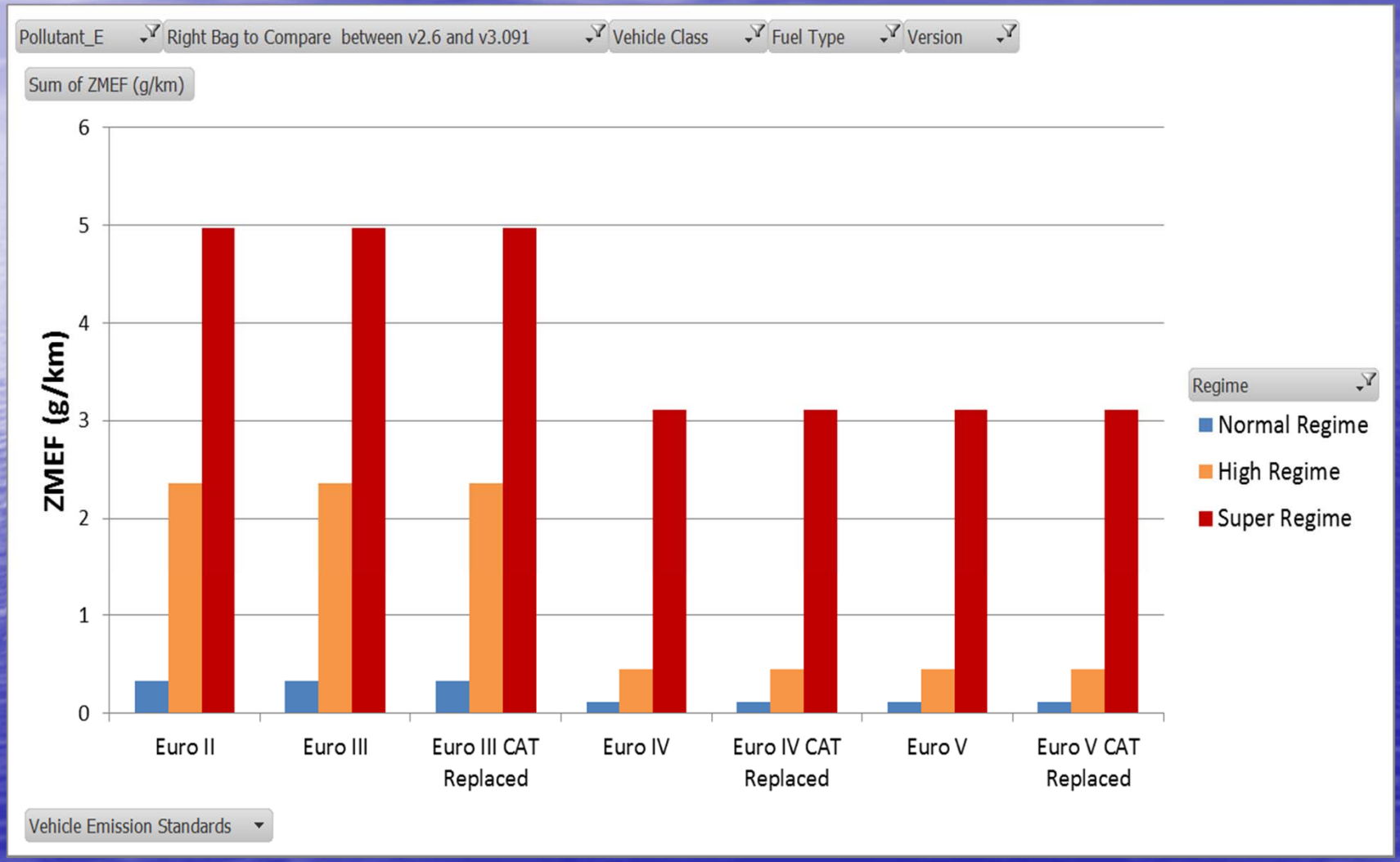
  Including
  - calibrate at least once a day for all the gas analyzers, zero check every hour & audit every three hours
  - linearity check for all gas analyzers every 35 days
  - flow meter calibration every six months
  - cross-interference tests for various gas analyzers every six months

Estimation of Zero Mile Emission Factors (ZMEF) and Deterioration Rates (DR)

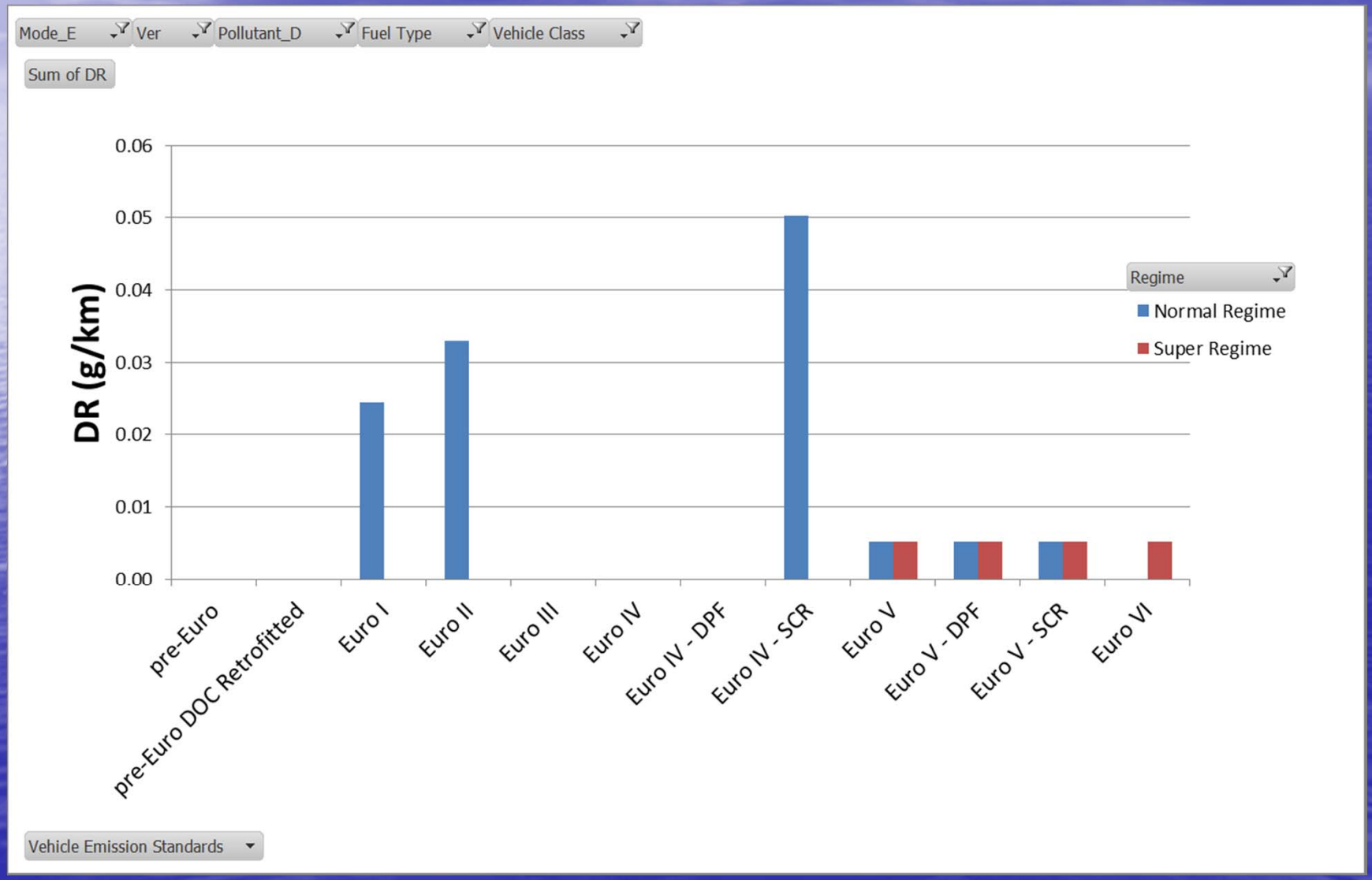
NOx ZMEF for Diesel Heavy Goods Vehicles > 15t (HGV8)



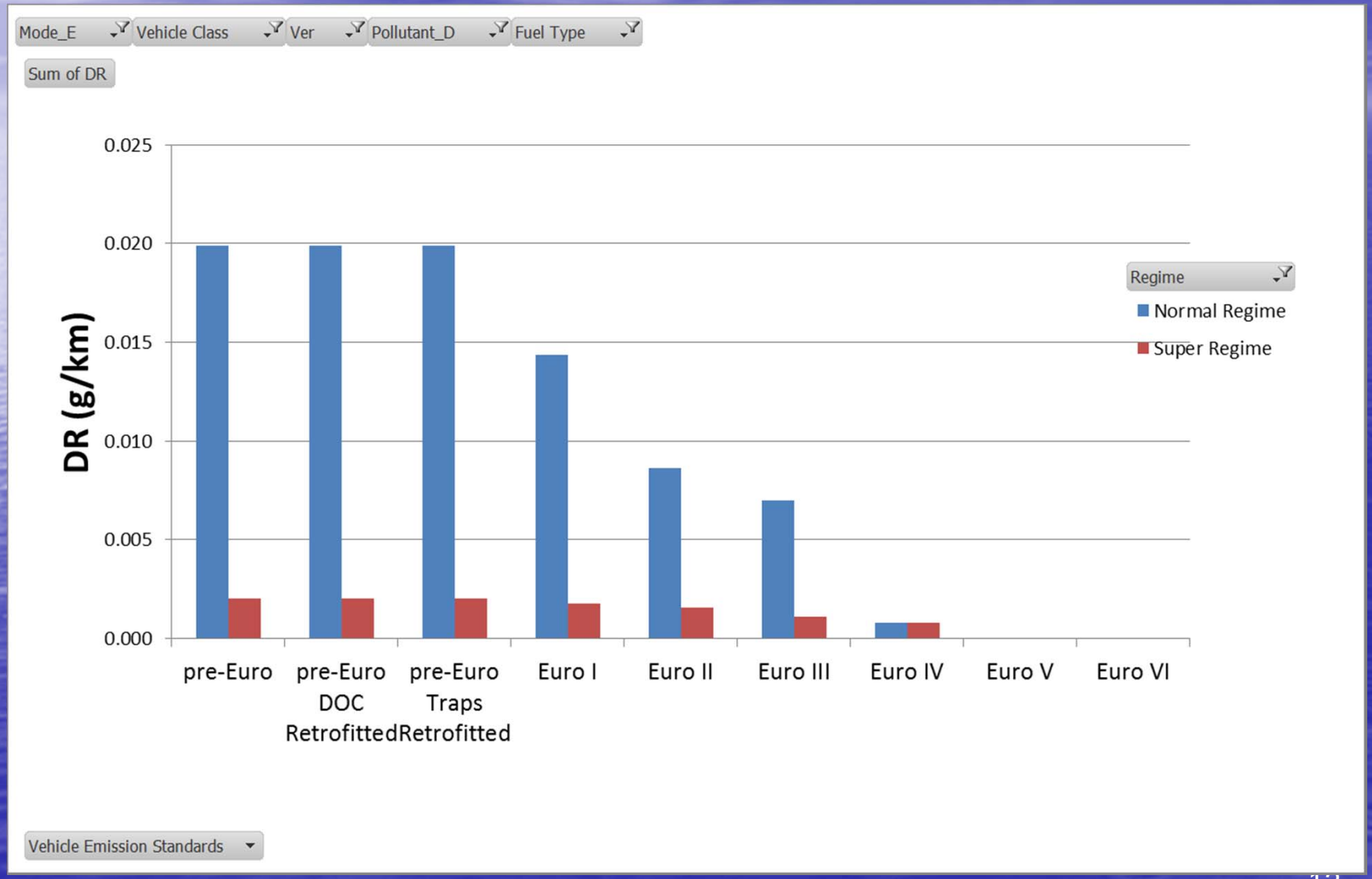
NOx ZMEF for Taxis



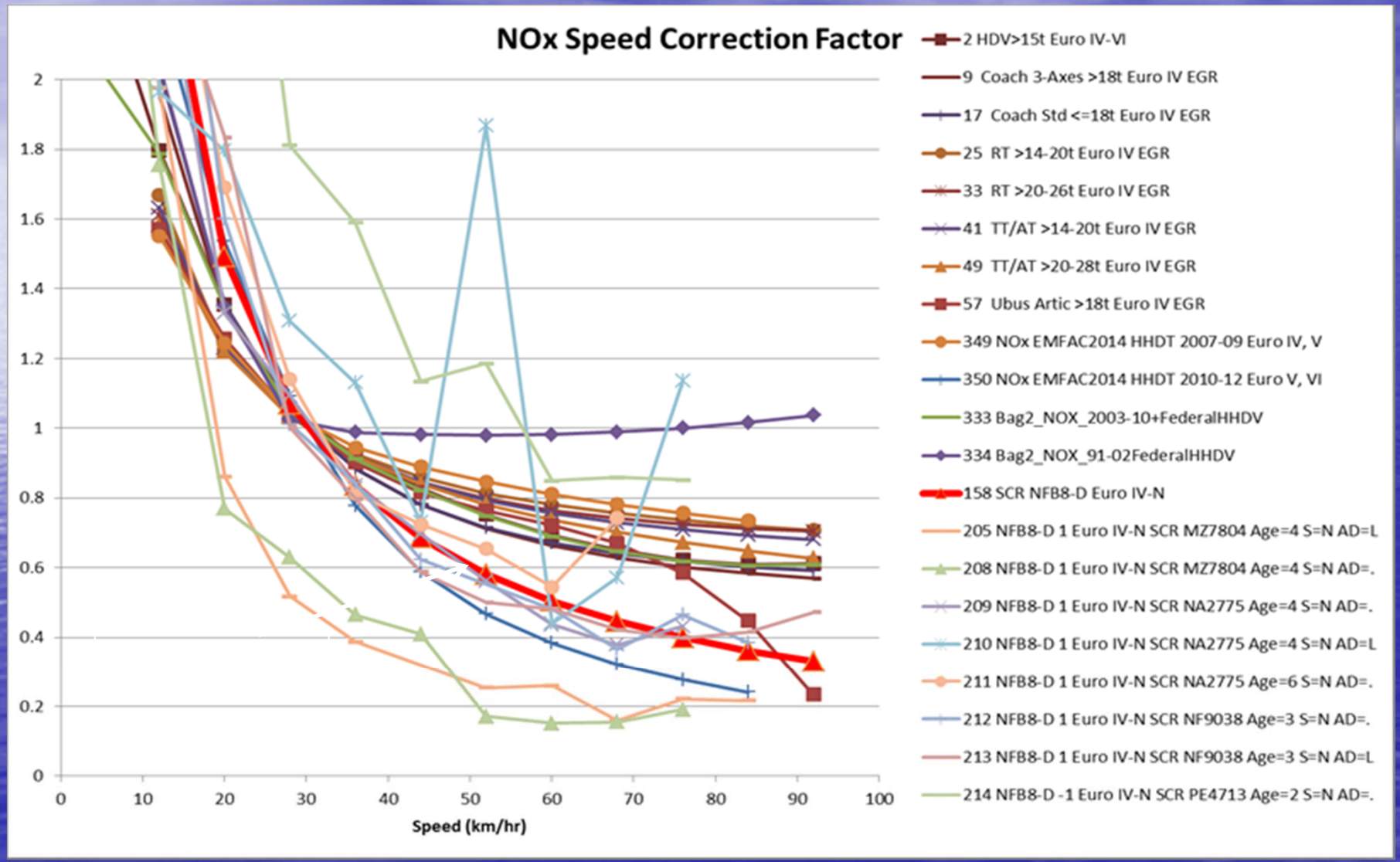
NOx DR for Diesel Heavy Goods Vehicles > 15t (HGV8)



NOx DR for Diesel Public Light Bus (PLB)



NOx Speed Correction Factor for Euro IV Heavy Goods Vehicles and Non-Franchised Bus >15t with SCR



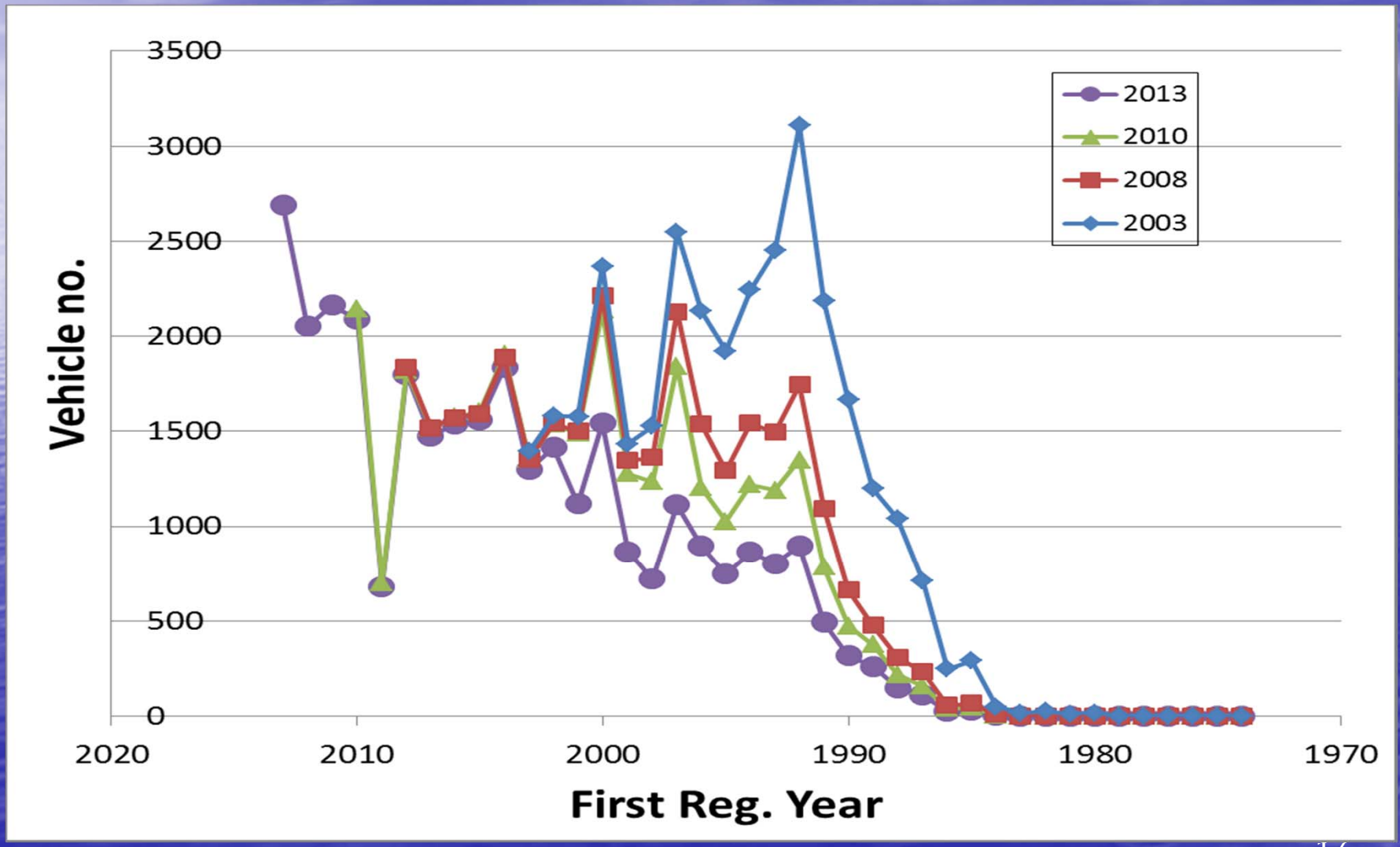
Vehicle Activities

Vehicular Activities

- Vehicle population - Local vehicle licensed data was used
- VKT - methodology in ATC was adopted with modification
- VKT by class - TD's methodology was adopted with modification
- speed fractions – VKT fractions by speed bins

Vehicle Population Distribution

Distribution of Goods Vehicles > 15 t Population vs. 1st Reg. Year



Estimation of VKT

Counter Installation System in ATC

Type of Station	Frequency	Type of Counter Used	Duration of Measurement	Data Obtained
Core	Once a year	Recording	1 week in each of any 3 month	Daily & hourly directional flows
			1 week in each of the remaining 9 months	Daily & hourly non-directional flows
Coverage at cordon/ screenline	Once a year	Recording	1 week	Daily & hourly directional flows
Coverage not at Cordon/ Screenline	Surveyed twice in 5 years	Recording or non-recording	1 weekday (Mon-to-Fri)	Daily non-directional flows

Distribution of Counting Stations in 2013 ATC

District	Type of Station	Road Network		Total
		Major	Minor	
Hong Kong Island	Core	30	8	38
	Coverage	127	54	181
	Total	157	62	219
Kowloon	Core	27	6	33
	Coverage	218	53	271
	Total	245	59	304
New Territories	Core	37	6	43
	Coverage	242	45	287
	Total	279	51	330
Total		681	172	853

Road Types (1)

- Expressway (EX) and Urban (UT) / Rural (RT) Trunk Road
- Primary Distributor (PD)
  - form urban area's major network
- District Distributor (DD)
  - links districts to the PD

Road Types (2)

- Local Distributor (LD)
  - Roads within districts linking developments to DD
- Rural Road
  - Connects the smaller population centres/recreation areas with major road networks

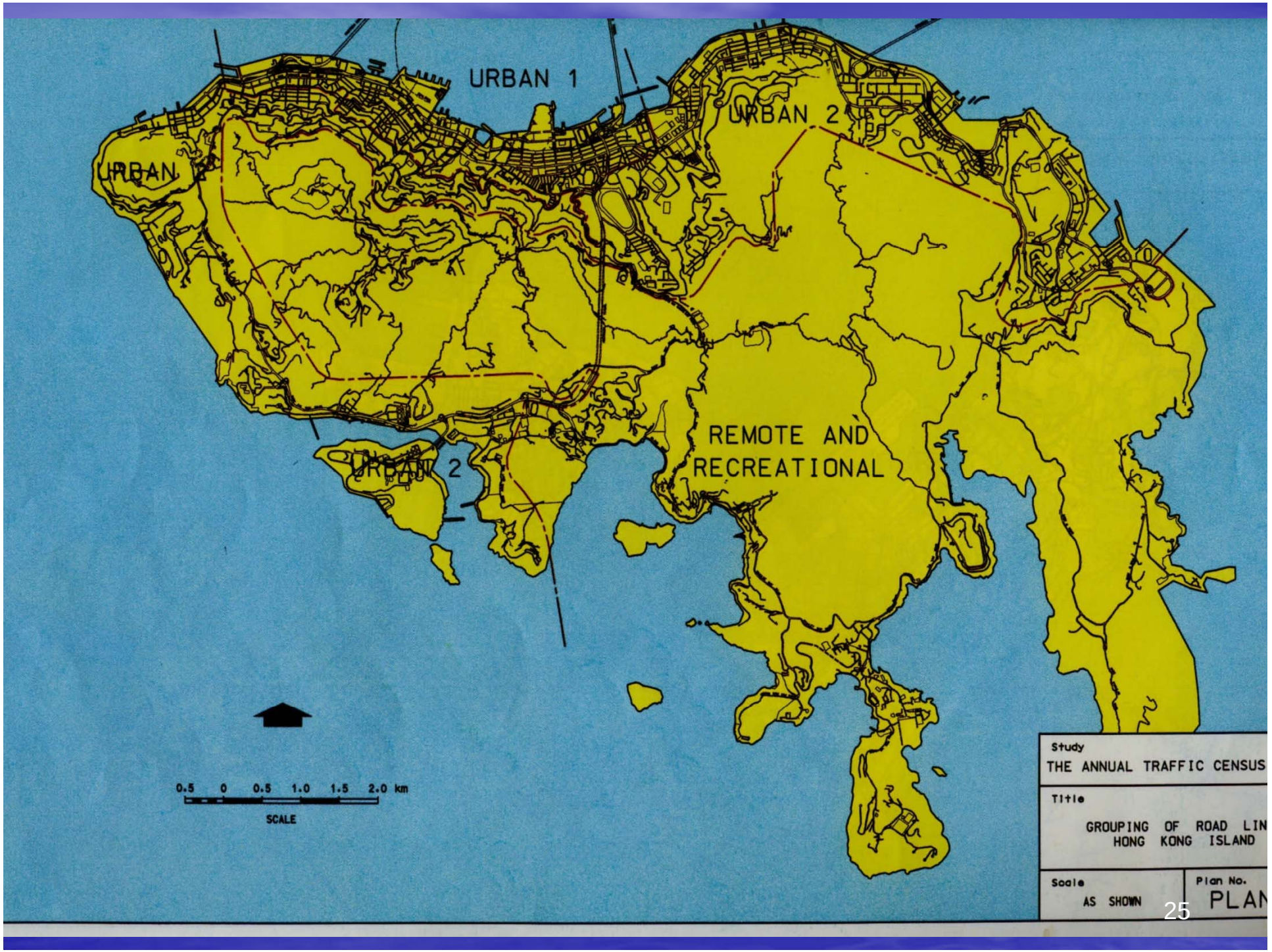
Road Link Groups (1)

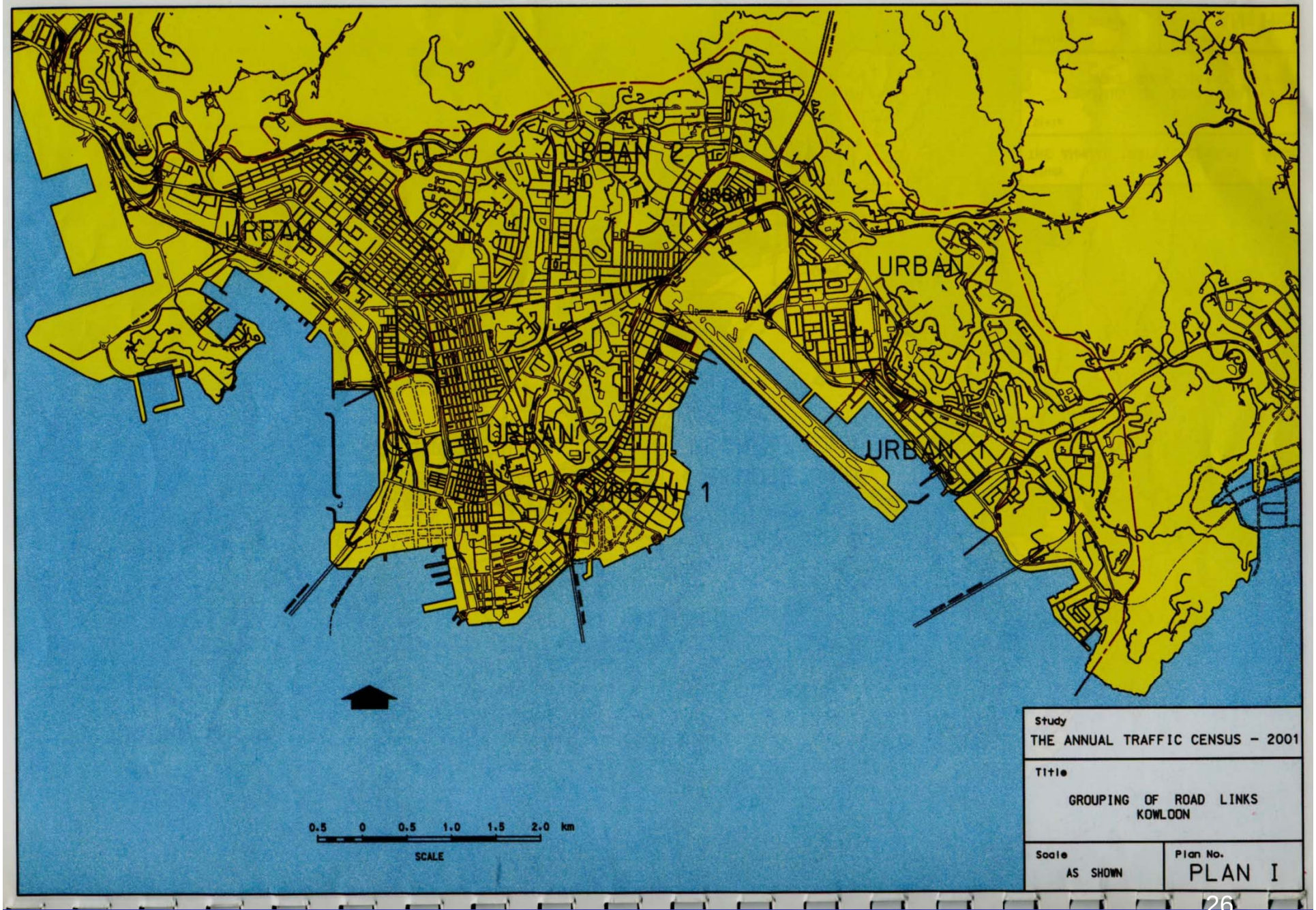
- For coverage stations, AADT estimated by making use of the available information for the core stations.

- The core stations are clustered into groups based on the daily traffic pattern exhibited at each counting stations, called **road link groups**.

Road Link Groups (2)

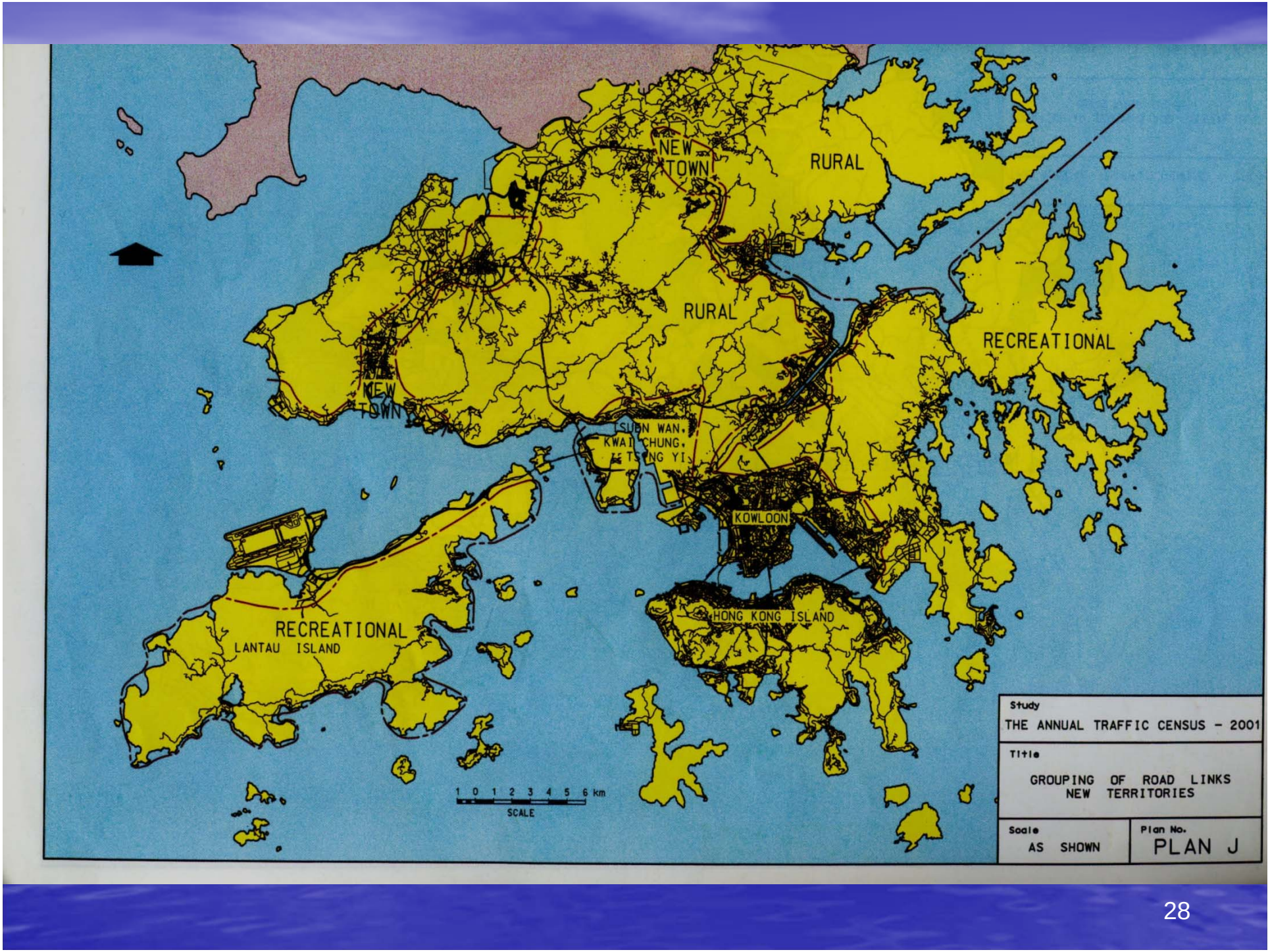
Region	Road Link Group
Hong Kong	Urban 1
	Urban 2 (Major Road Network)
	Urban 2 (Minor Road Network)
Kowloon	Urban 1
	Urban 2 (Trunk Roads and Primary Distributors)
	Urban 2 (District Distributors and Local Distributors)


URBAN 1
URBAN 2
URBAN
URBAN 2
REMOTE AND
RECREATIONAL
0.5 0 0.5 1.0 1.5 2.0 km
SCALE
Study
THE ANNUAL TRAFFIC CENSUS
Title
GROUPING OF ROAD LIN
HONG KONG ISLAND
Scale
AS SHOWN
Plan No.
PLAN

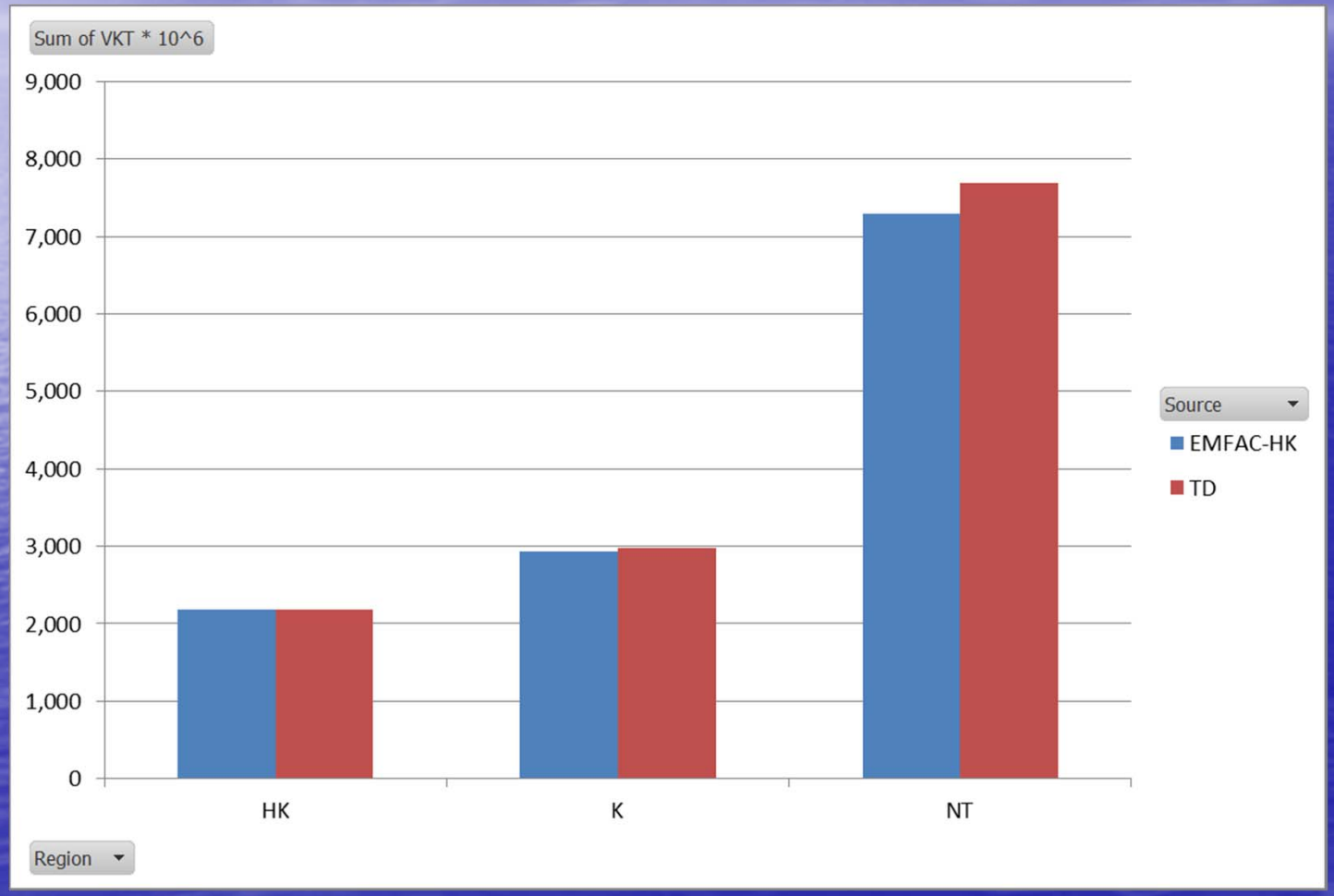

URBAN 2
URBAN 1
URBAN 2
URBAN 1
URBAN 2
URBAN 1
URBAN 1
0.5 0 0.5 1.0 1.5 2.0 km
SCALE
Study
THE ANNUAL TRAFFIC CENSUS - 2001
Title
GROUPING OF ROAD LINKS
KOWLOON
Scale
AS SHOWN
Plan No.
PLAN I

Road Link Groups (3)

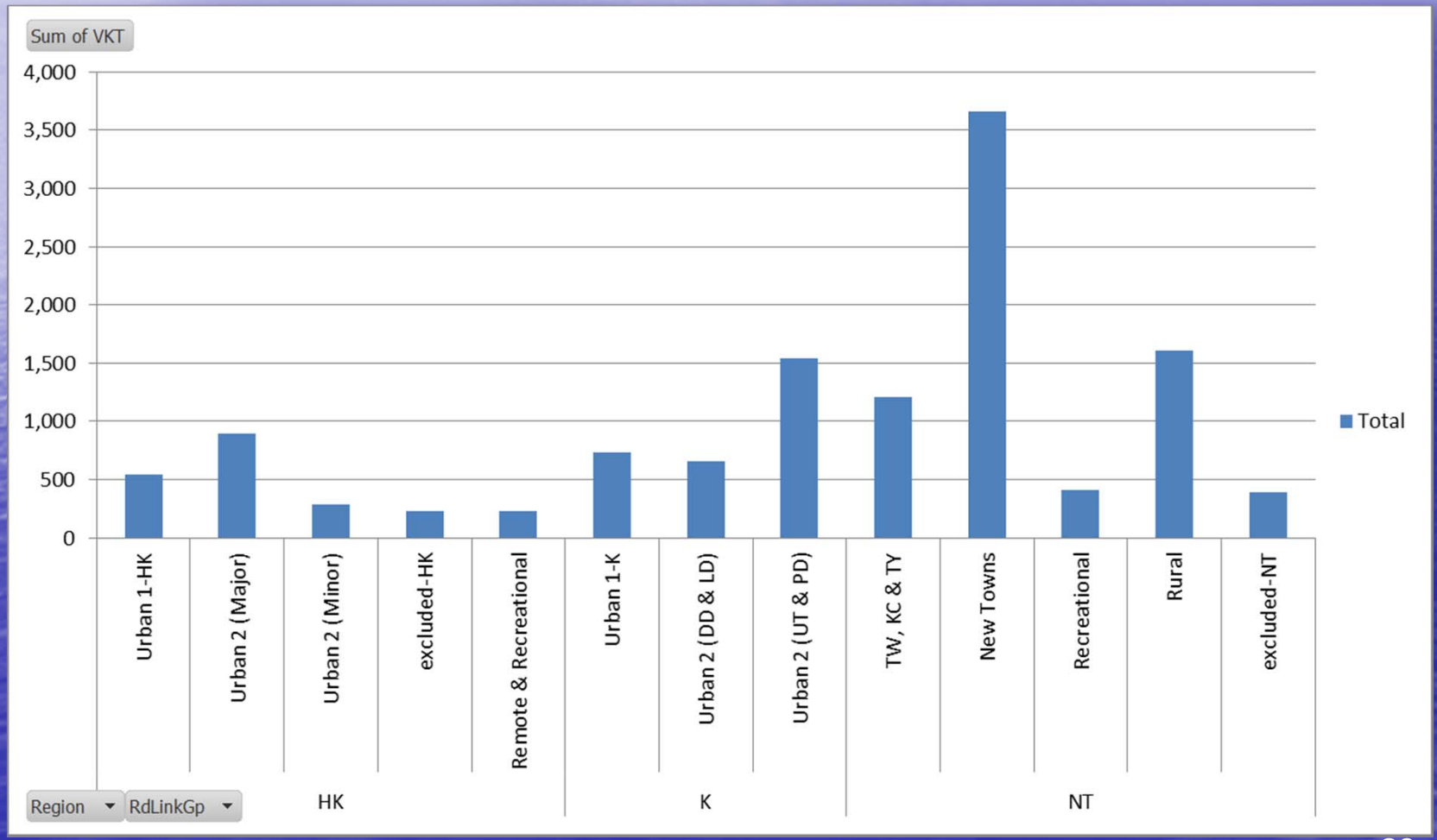
Region	Road Link Group
Hong Kong	Remote & Recreational
New Territories	New Towns
	Tsuen Wan, Kwai Chung & Tsing Yi
	Recreational
	Rural


NEW TOWN
RURAL
RURAL
RECREATIONAL
NEW TOWN
TSUEN WAN,
KWAI CHUNG,
TSING YI
KOWLOON
HONG KONG ISLAND
RECREATIONAL
LANTAU ISLAND
1 0 1 2 3 4 5 6 km
SCALE
Study
THE ANNUAL TRAFFIC CENSUS - 2001
Title
GROUPING OF ROAD LINKS
NEW TERRITORIES
Scale
AS SHOWN
Plan No.
PLAN J

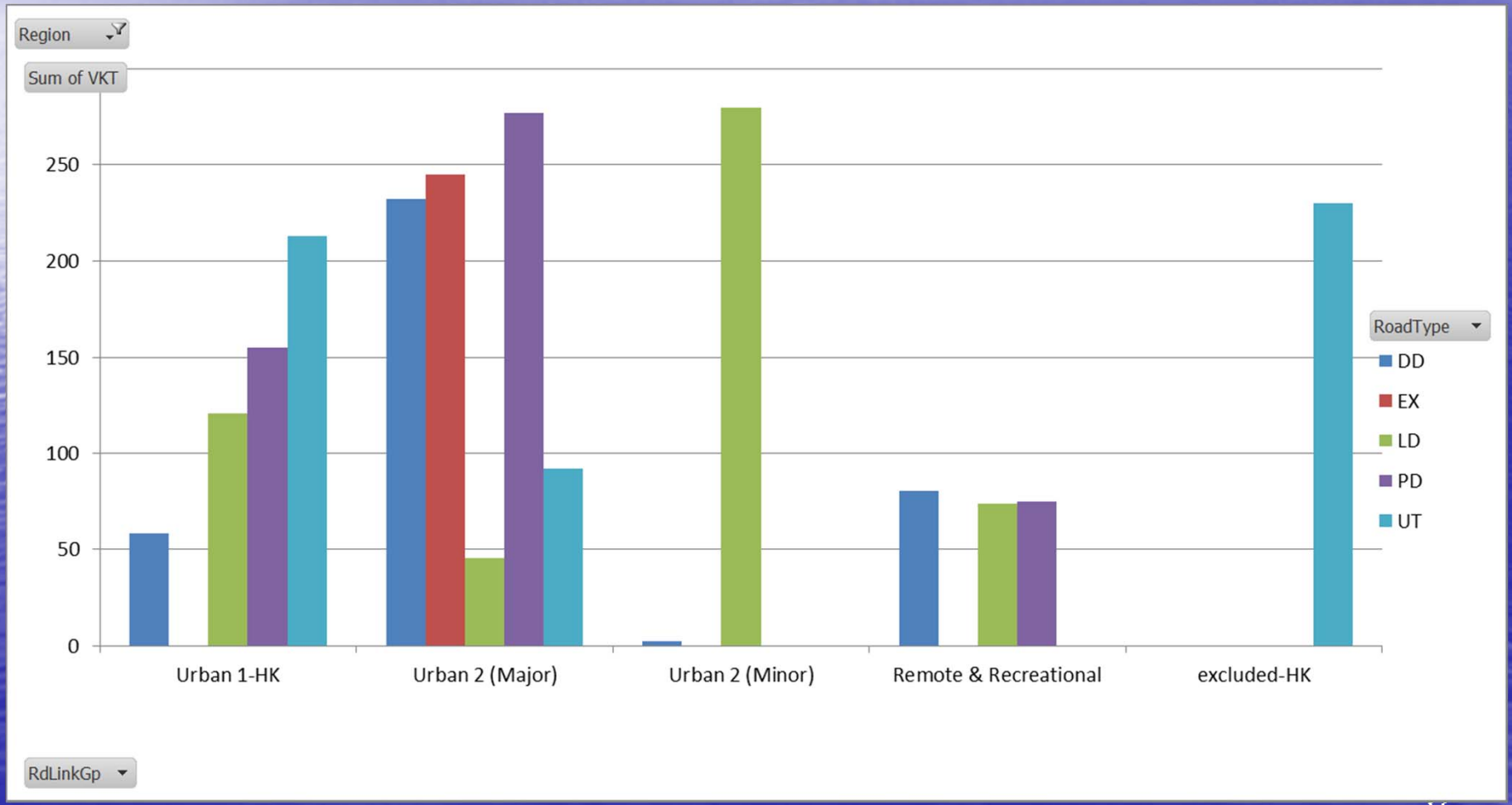
Comparison of VKT in 2013



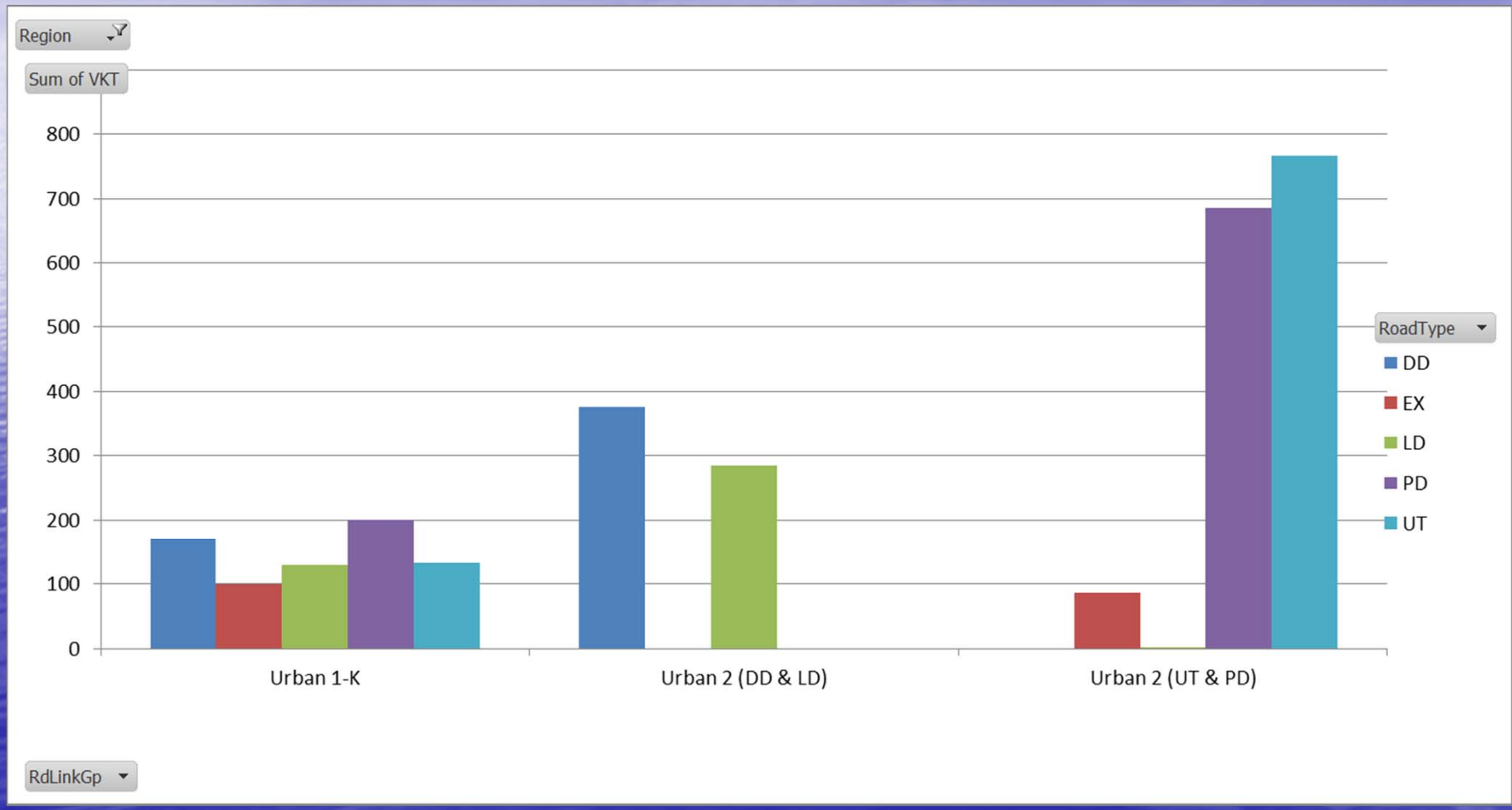
VKT Distribution by Road Link Group in 2013



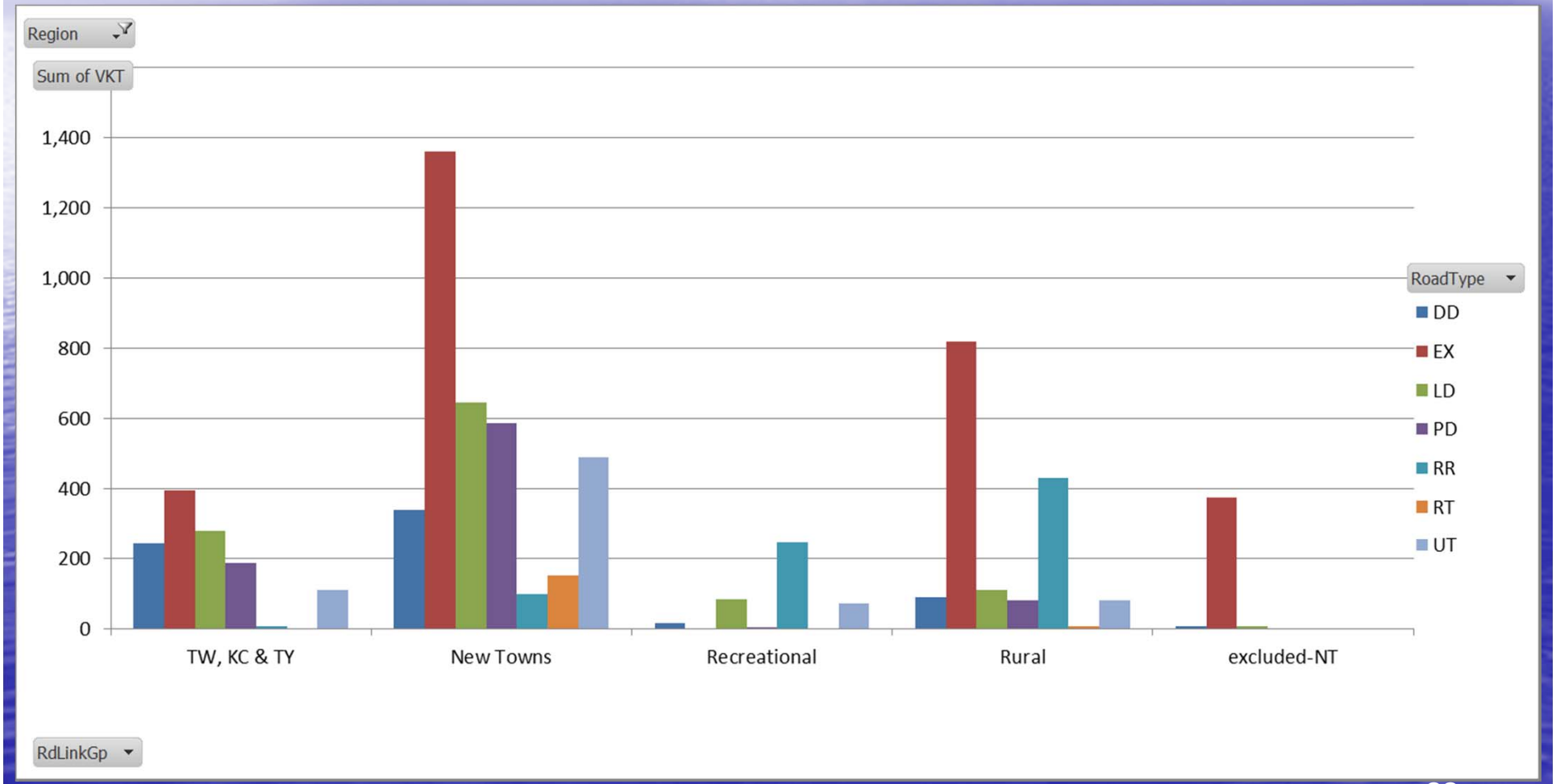
VKT Distribution by Road Link Group & Road Type in HKI in 2013



VKT Distribution by Road Link Group & Road Type in Kln in 2013



VKT Distribution by Road Link Group & Road Type in NT in 2013



Estimation of VKT by Vehicle Class

Vehicle Classification

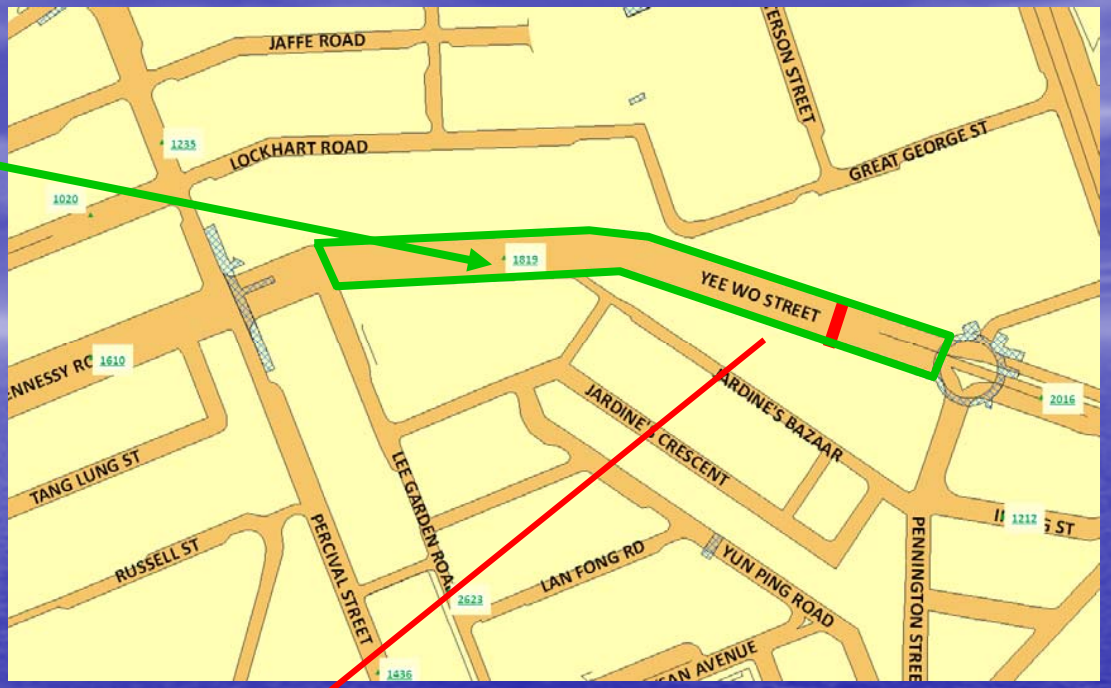
Percentage of Vehicles by class

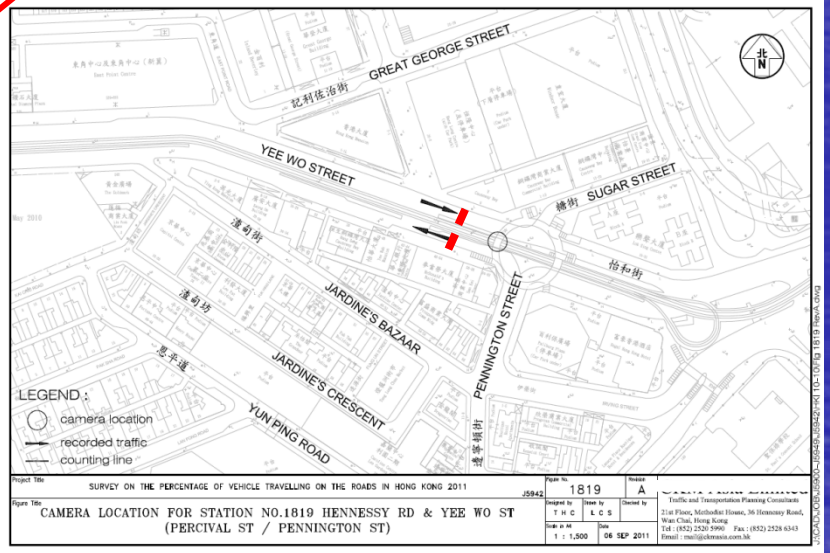
- obtained by manual counts for ~ 170 count stations (TD & EPD surveys)
- 24 hours
- one typical weekday each year
- at core stations and coverage stations falling on a cordon or screenline

Traffic Counting Station locating on one of our proposed Low Emission Zones

(Yee Wo Street, Causeway Bay)

-Traffic flow before the implementation of low emission zone can then be monitored and evaluated.





Estimation of VKT by Class (e.g. taxi)

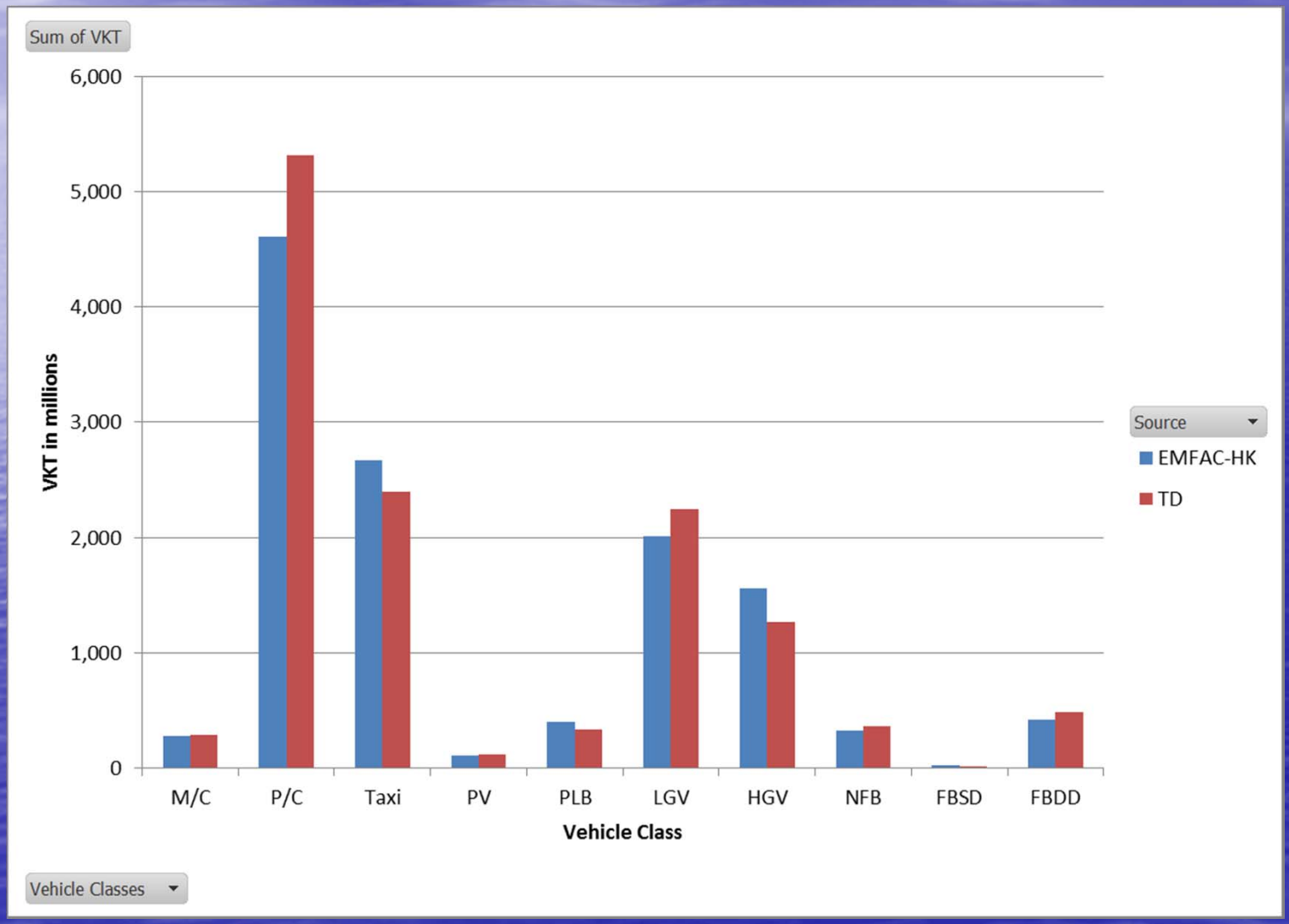
Traffic flow of $taxi_{r,t,i,m}$ at hr_i at road $type_t$ at stn_m in $link\ group_r$

= (AADT * % of taxi at hr_i

* % of diurnal variation of traffic flow at hr_i)

- lump together to give VKT by class
- provide diurnal variations of VKT

Comparison of VKT in 2013

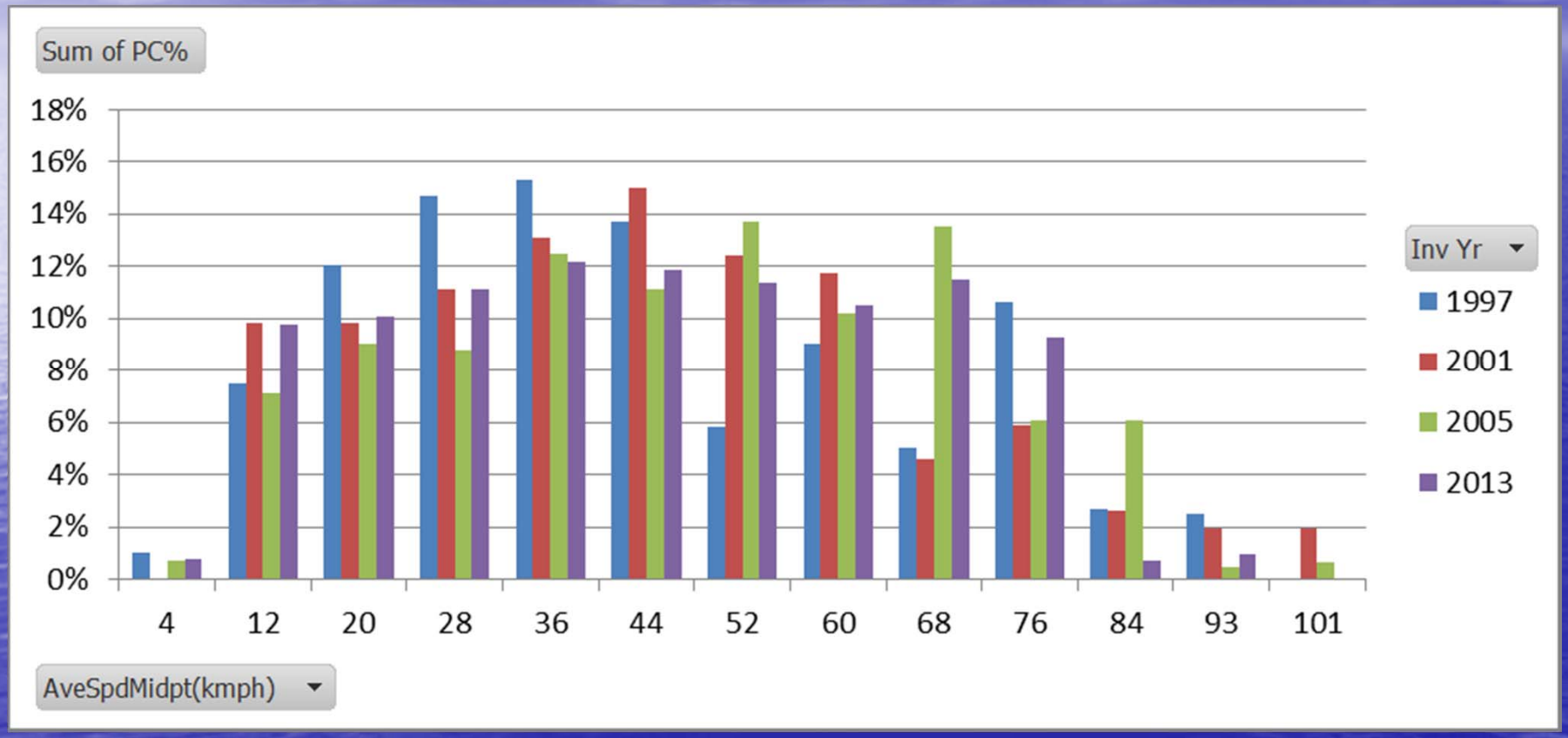


Estimation of Speed Fractions

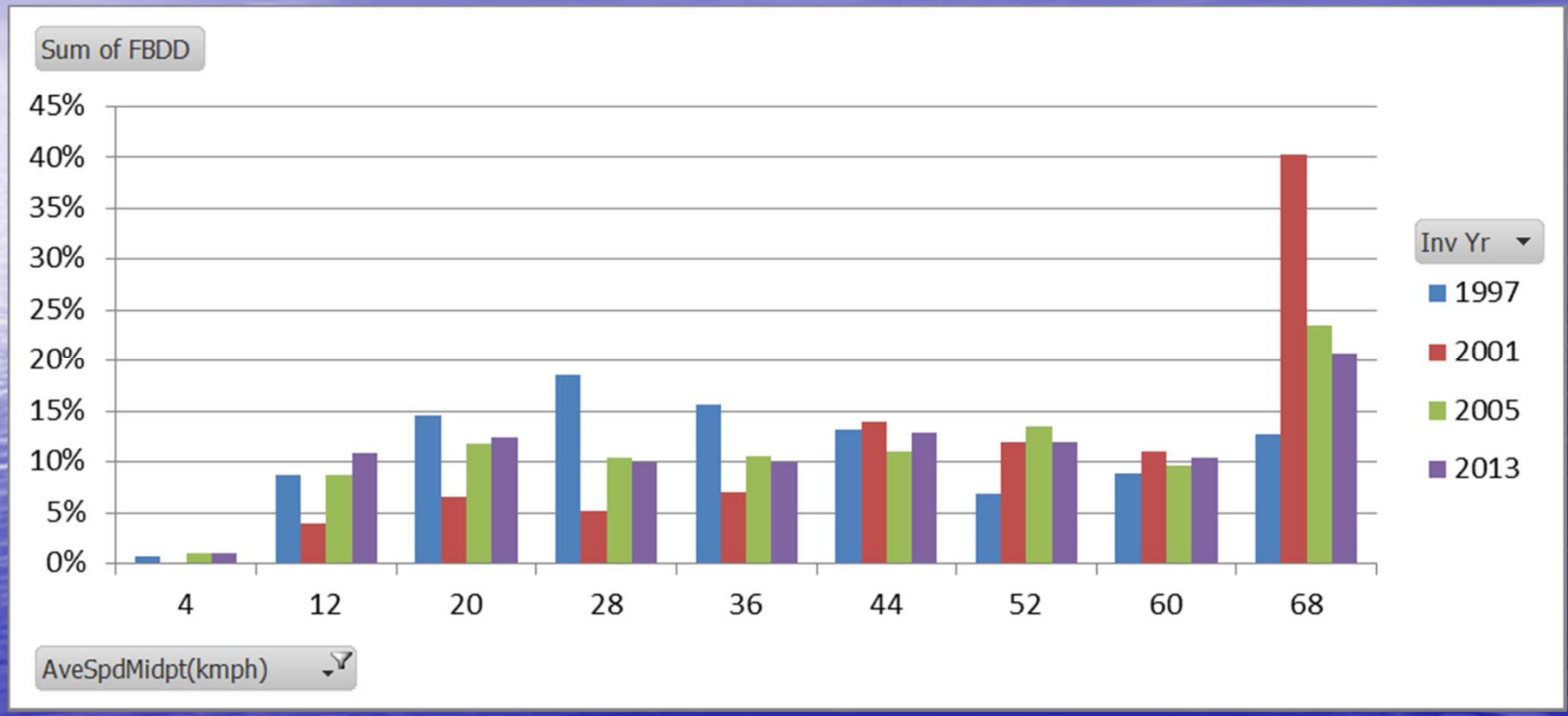
Data Sources

- Congested speeds at 0800-0930 from TD's Car Journey Time Surveys
- Speed limits (HyD or TD)
- Speed vs. volume/capacity ratio from CTS-3

Speed Fractions for Private Cars at Peak Hours



Speed Fractions for Franchised Buses at Peak Hours

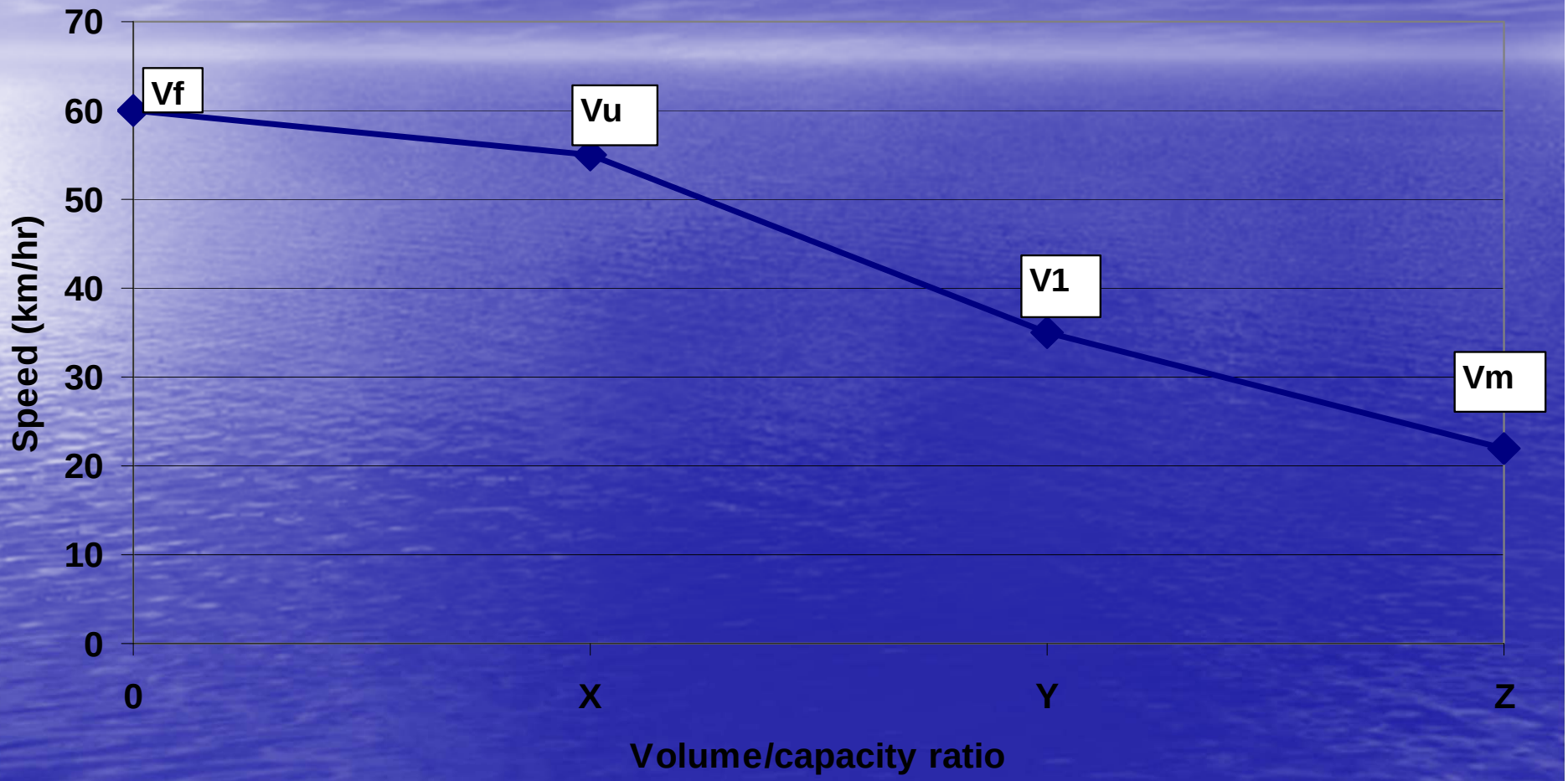


Non Peak (1)

Data Sources

- Speed limits (Highway Dept)
- Speed vs. volume/capacity ratio from CTS-3

Link Speed Flow Curves



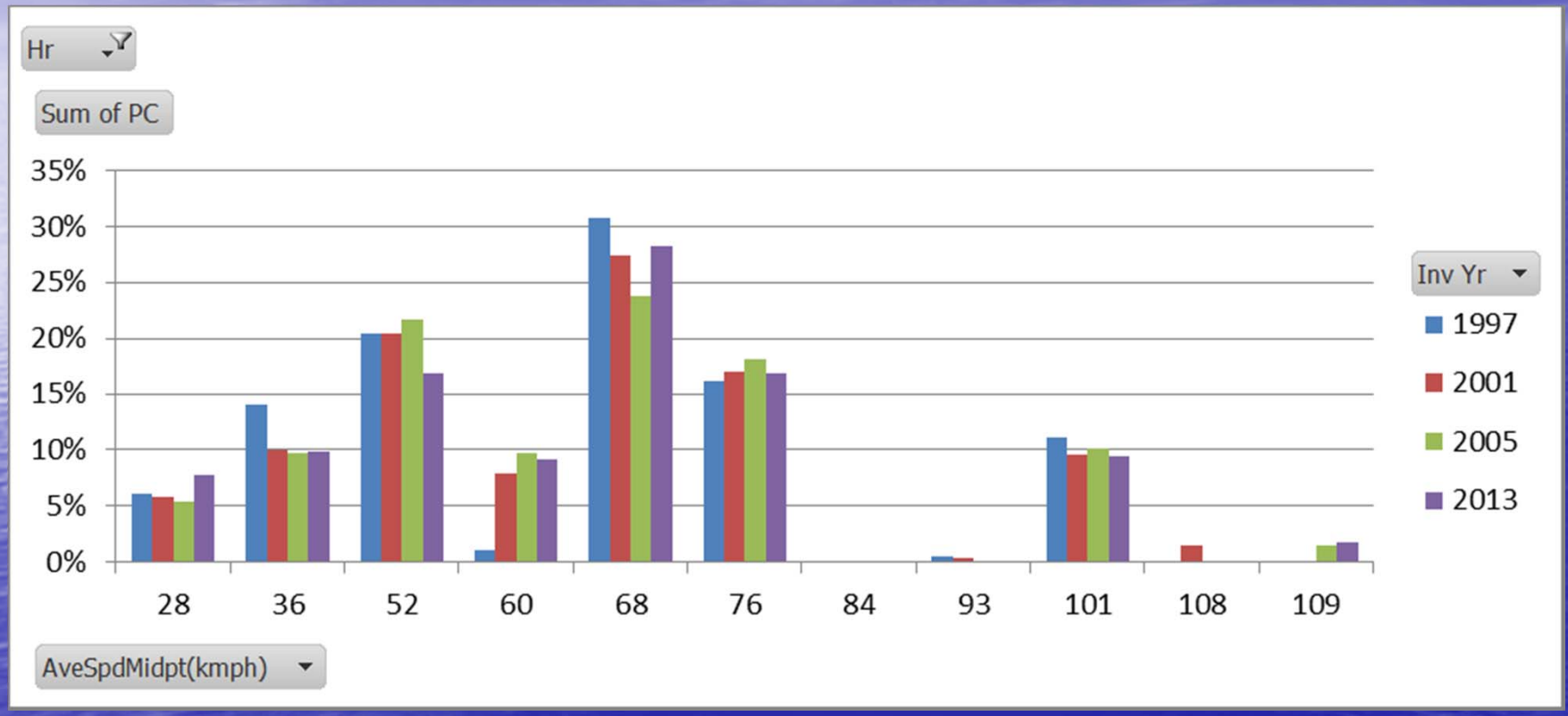
Link Speed Flow Curves

Road Type	Vf	Vu	V1	Vm	X	Y	Z
Rural Road A	60	55	35	22	0.4	1.0	1.2
Rural Trunk Road	75	70	45	30	0.4	1.0	1.2
Urban Local Distributer	30	30	12	5	0.1	1.0	1.2
Urban District Distributer	40	40	22	11	0.1	1.0	1.2
Urban Primary Distributer	50	50	27	16	0.2	1.0	1.2
Urban Trunk Road	70	70	45	30	0.4	1.0	1.2
Expressway	90	85	65	40	0.4	1.0	1.2

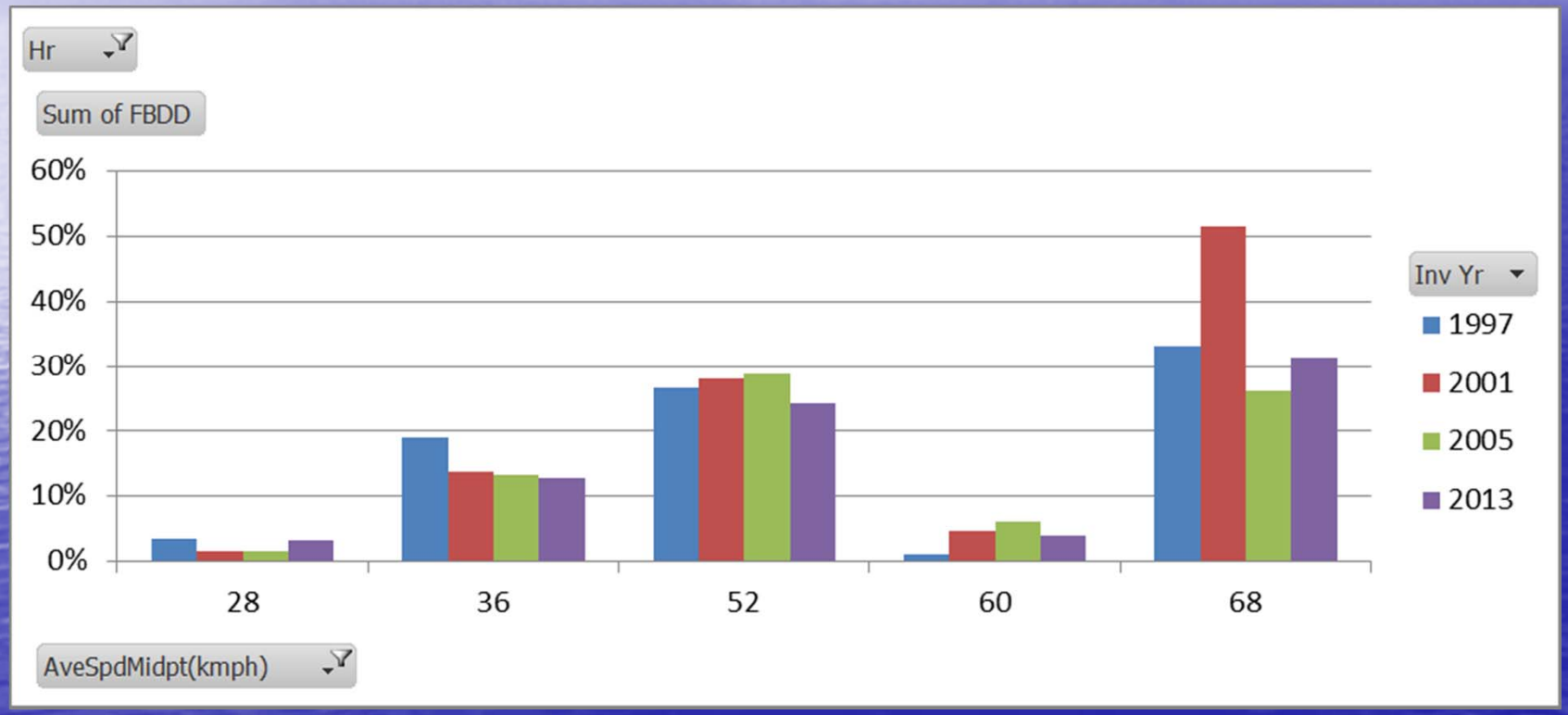
Passenger Car Unit Conversion Factors

Vehicle Type	PCU Conversion Factors
Car	1
Taxi	1
Bus	3
PLB	1.5
Light Van	1.25
Light Goods Vehicle	1.5
Medium Goods Vehicle	2
Heavy Goods Vehicle	2.5

Speed Fractions for Petrol Cars at Daytime non-peak Hours (using speed limit)



Speed Fractions for Franchised Buses at Daytime non-peak Hours (using speed limit)



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