

URISA BC Seminar
GIS in Planning and Transportation
December 13, 2004

2003 Greater Vancouver Regional Travel Time Survey

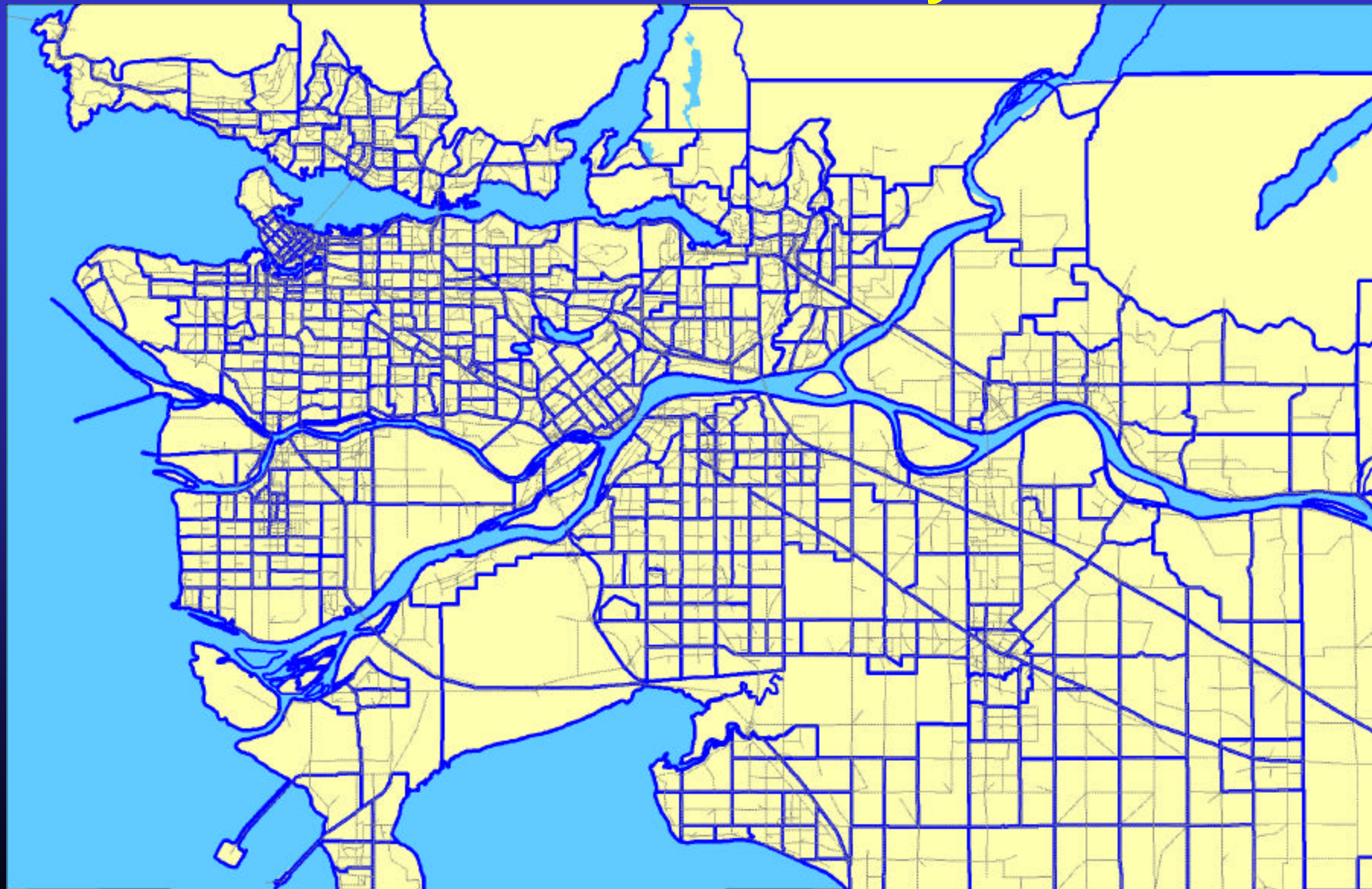
Clark Lim, P.Eng.
Senior Transportation Engineer
Greater Vancouver Transportation Authority
Transportation Research & Technical Services Dept.
Planning Division



EMME/2

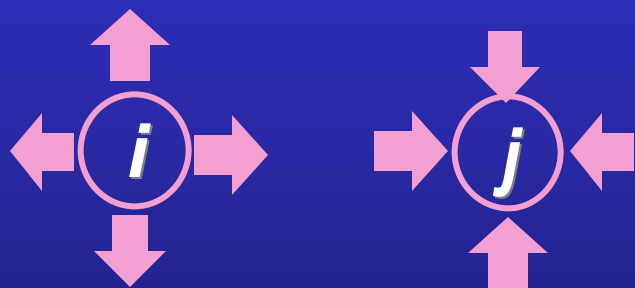
- Traffic Demand Assignment Modelling Environment
- “Greater Vancouver Transportation Model”
- Traffic Zone System
 - pop. & emp.
- Transportation Network
 - road & transit
- A Set of Equations and Rules describing travel choice and behaviour

GVRD Traffic Zone System

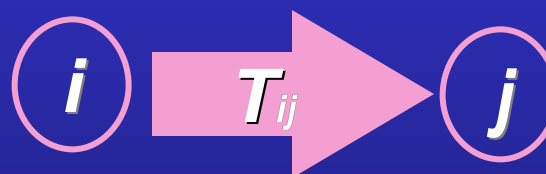


4 Step Method

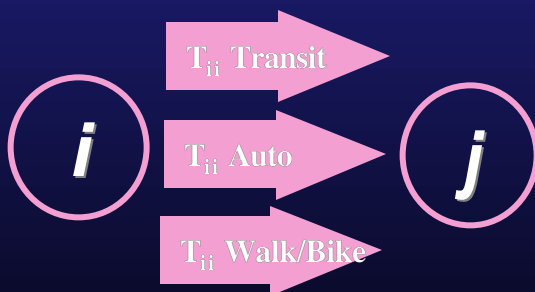
1. Trip Generation



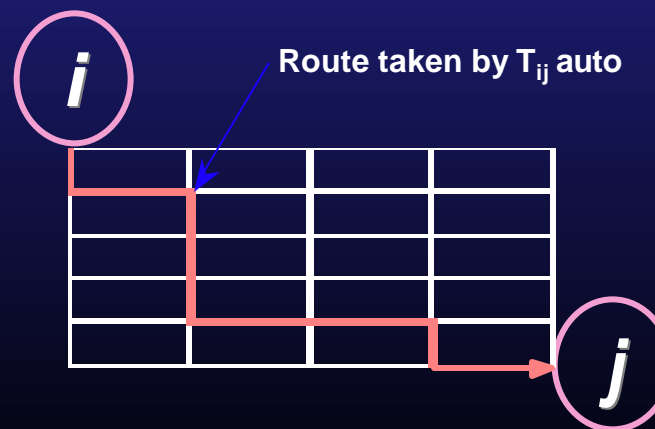
2. Trip Distribution



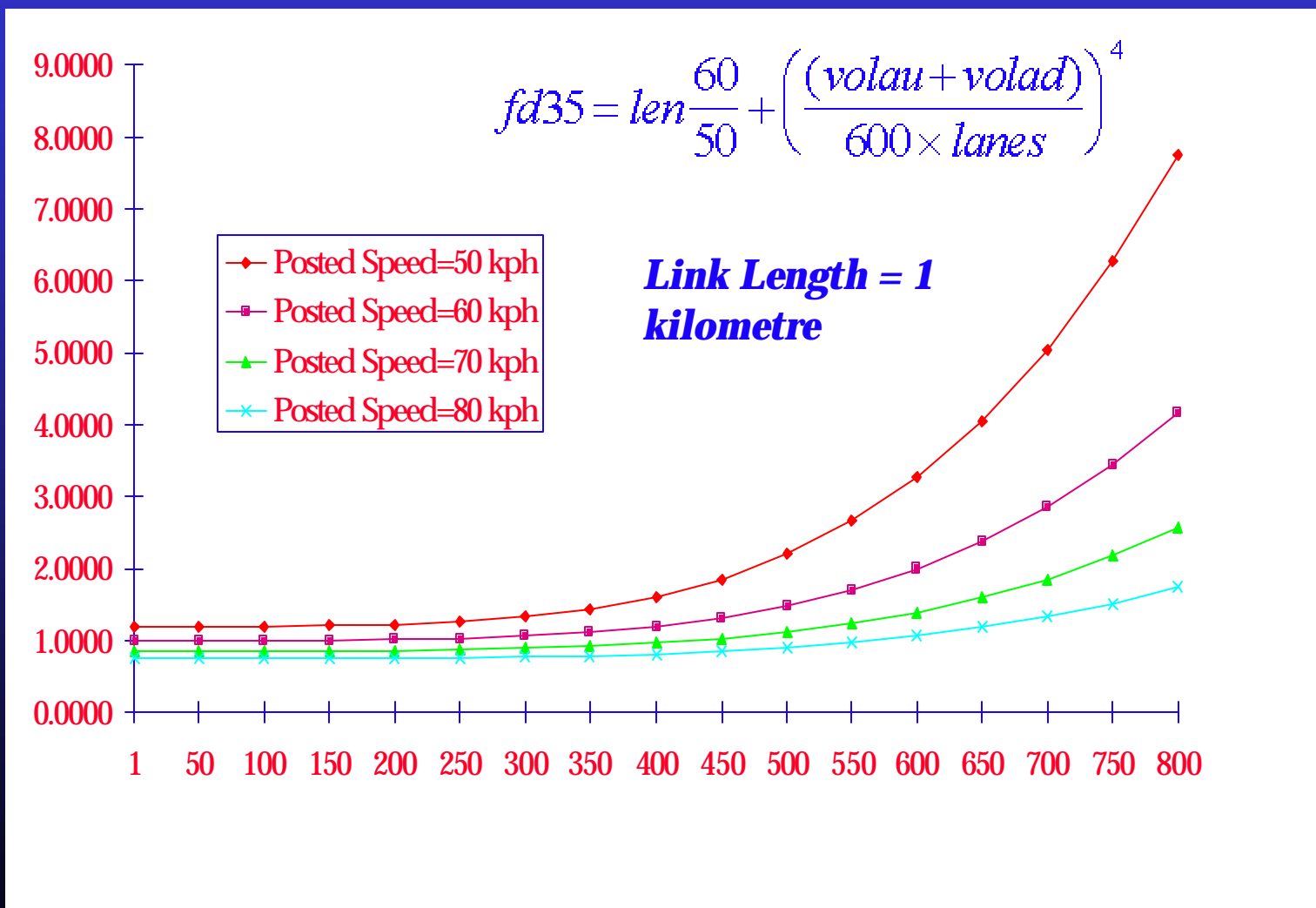
3. Mode Split



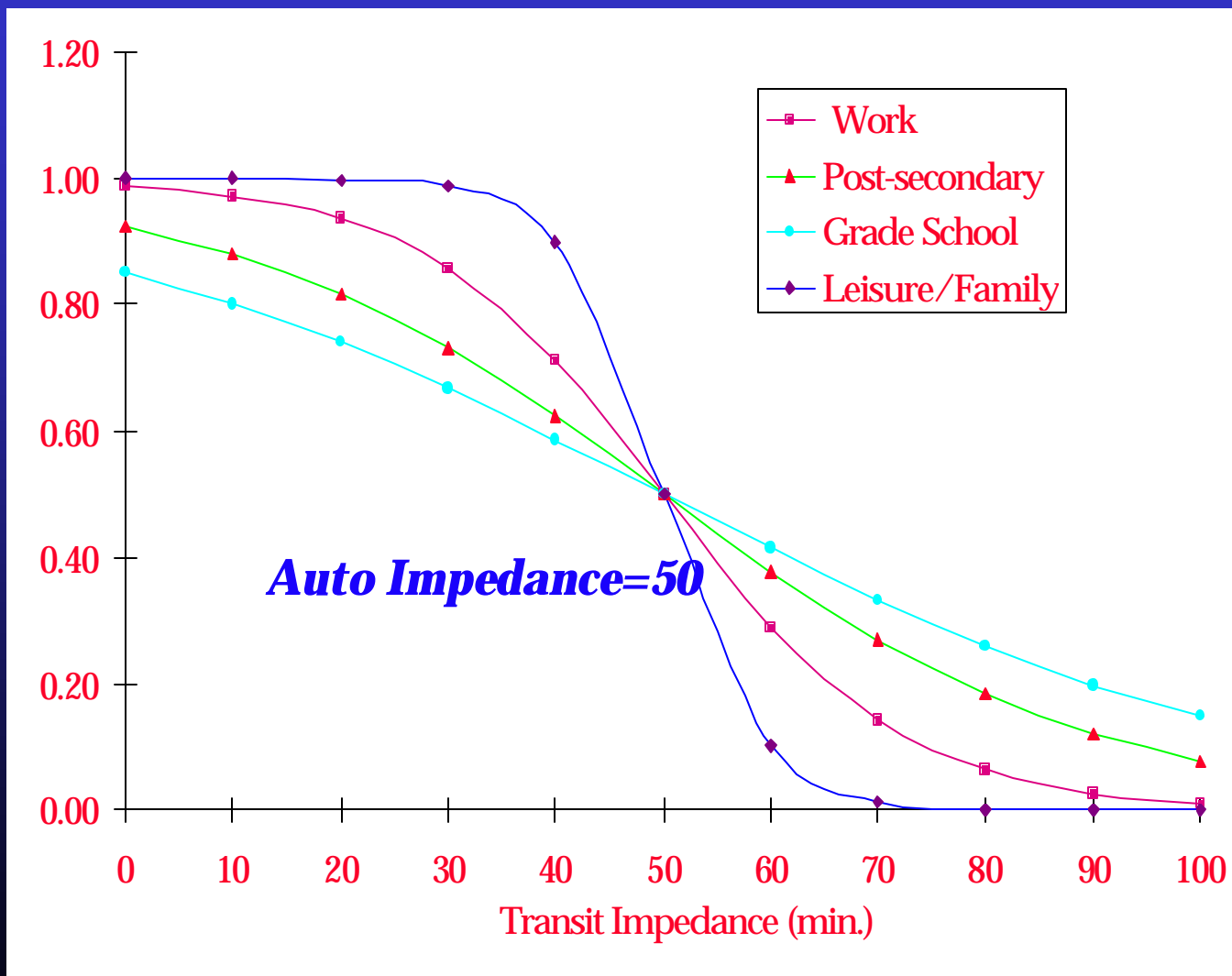
4. Trip Assignment



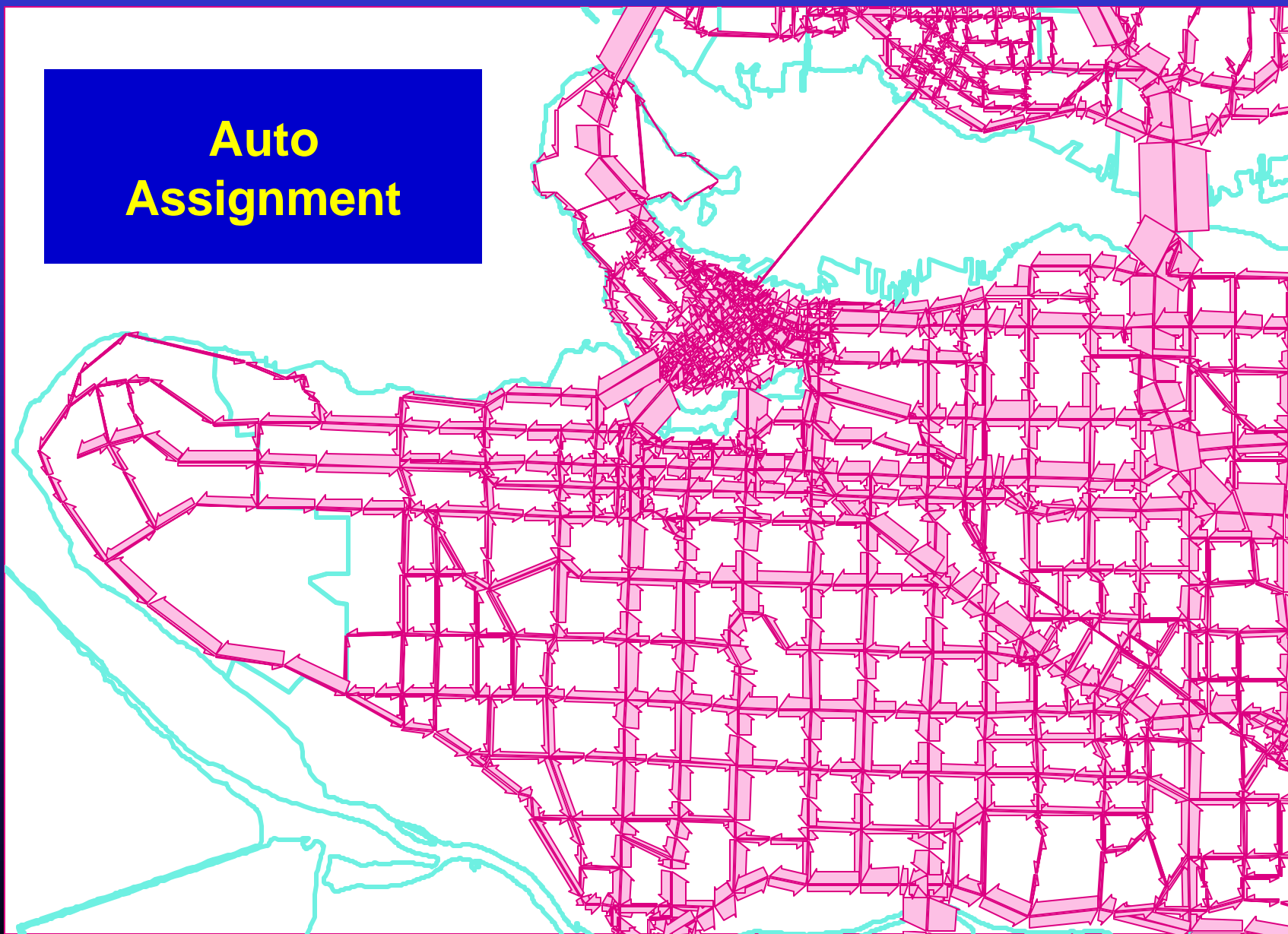
Volume Delay Function – road capacity



Logit Functions – mode choice



Auto Assignment





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Purpose of Travel Time Survey

Monitoring

- develop a regional congestion indicator for Corporate Scorecard and Regional Transportation Monitoring Program
- develop matrices indicating travel times / avg. speed between regional activity centres for AM / PM / weekend peak periods

Planning

- calibrate the regional travel demand model's (EMME/2) link speeds
- develop a data repository of road travel performance of major corridors and infrastructure



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Project Members

- Ryan So Sr. Transportation Planner
- Ken Tseng, P.Eng. Project Coordinator
- Dave Murray Transportation Planning Analyst
- Glen So Applications Developer



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Survey Design



Project Scope

- Main Survey
 - Greater Vancouver Region
 - 3.5 month survey period (Sept-Dec 2003)
 - 4 time periods (AM, Mid-Day, PM, Sat. Mid.)
 - 20 drivers
 - 14 regional “activity centres”
 - 1 second GPS data capture
- 2nd “Sub-survey”
 - City of Vancouver
 - 2 drivers, 18 “activity centres”



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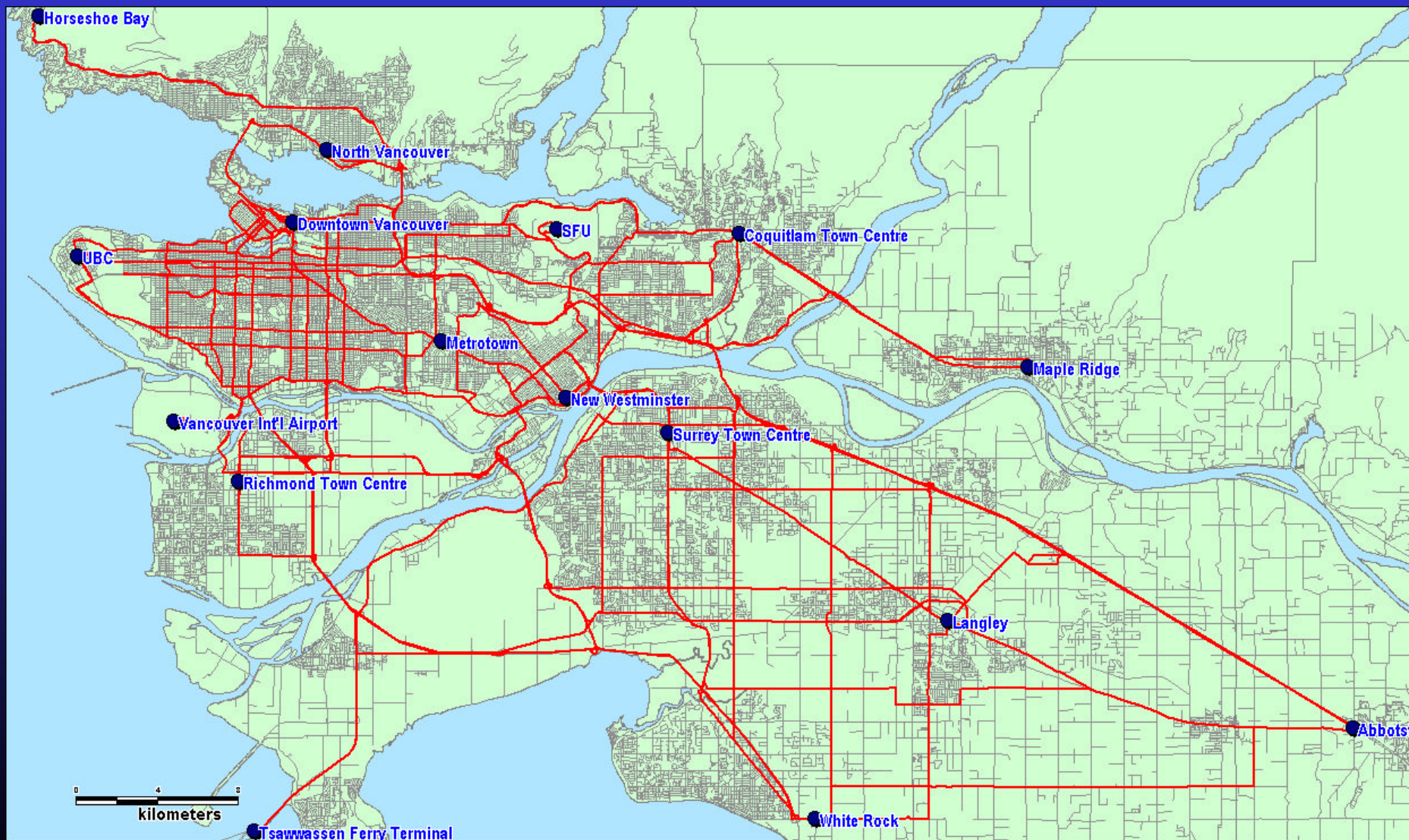
SKYTRAIN

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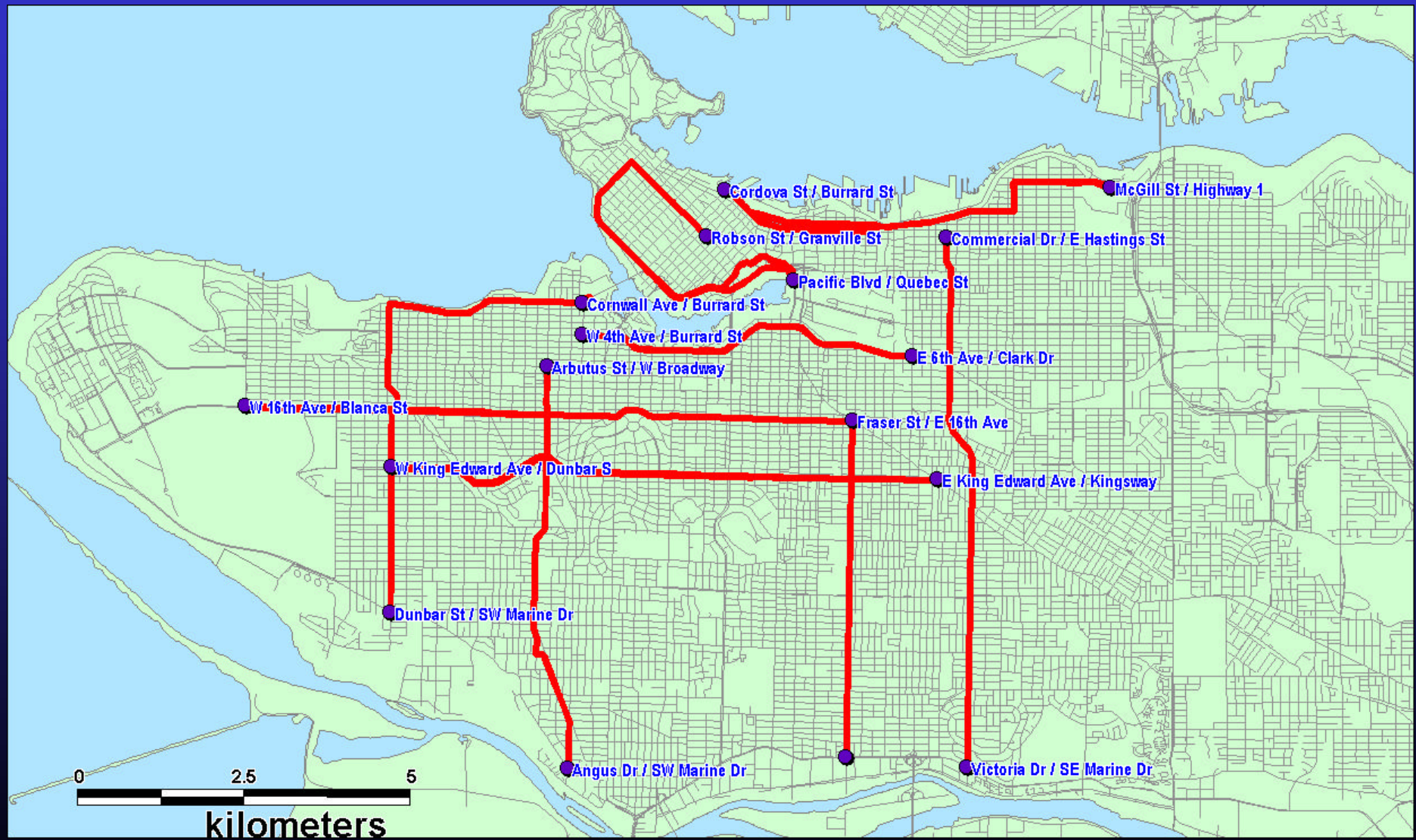
Survey Time Periods

- AM Peak Period: 7 AM – 9 AM
- Mid Day Period: 11 AM – 1 PM
- PM Peak Period: 3 PM – 6 PM
- Weekend Peak Period:
(Saturday) 12 PM – 2 PM

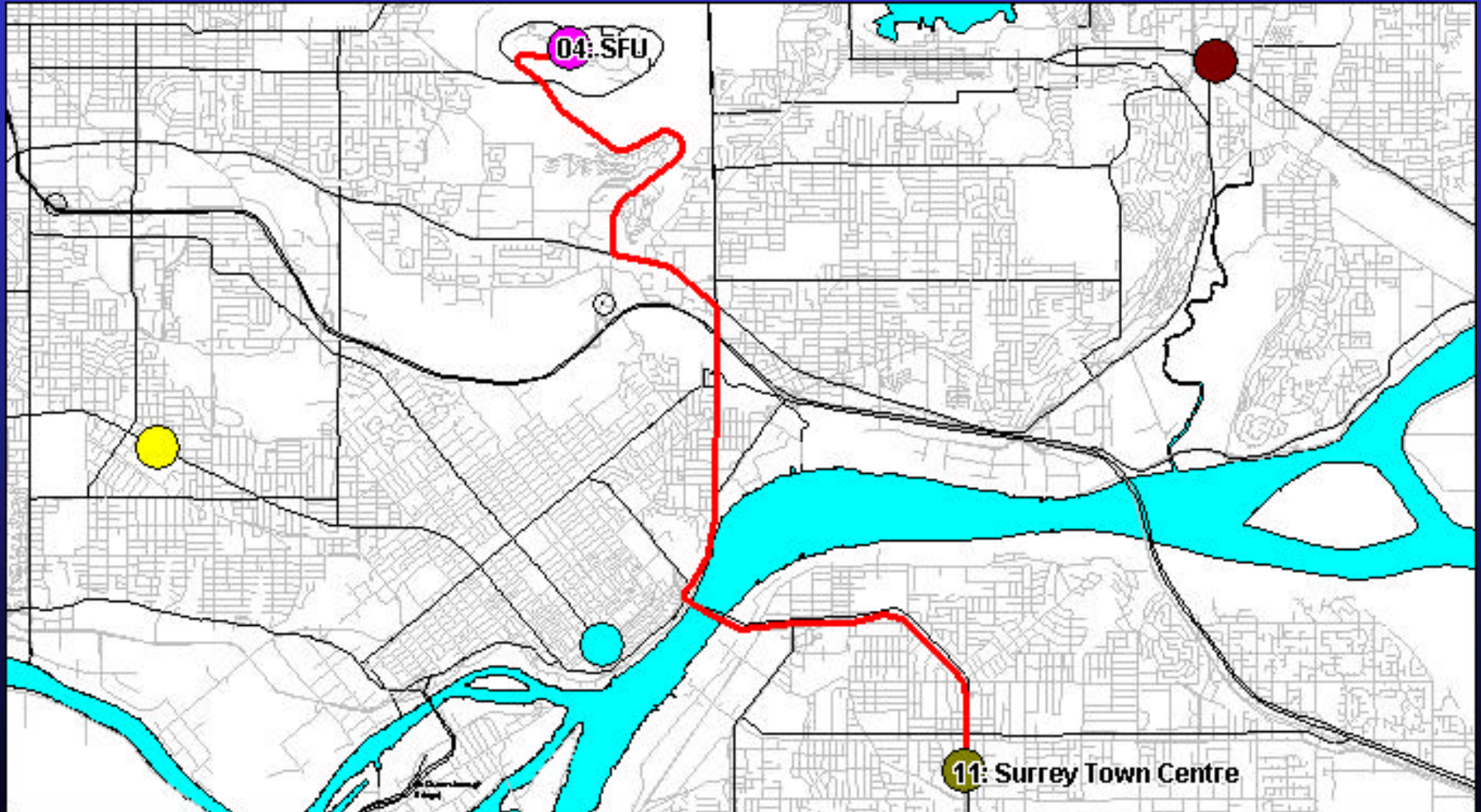
Main Survey Activity Centres & Routes



Vancouver Sub-Survey Activity Centres & Routes



Example Routing





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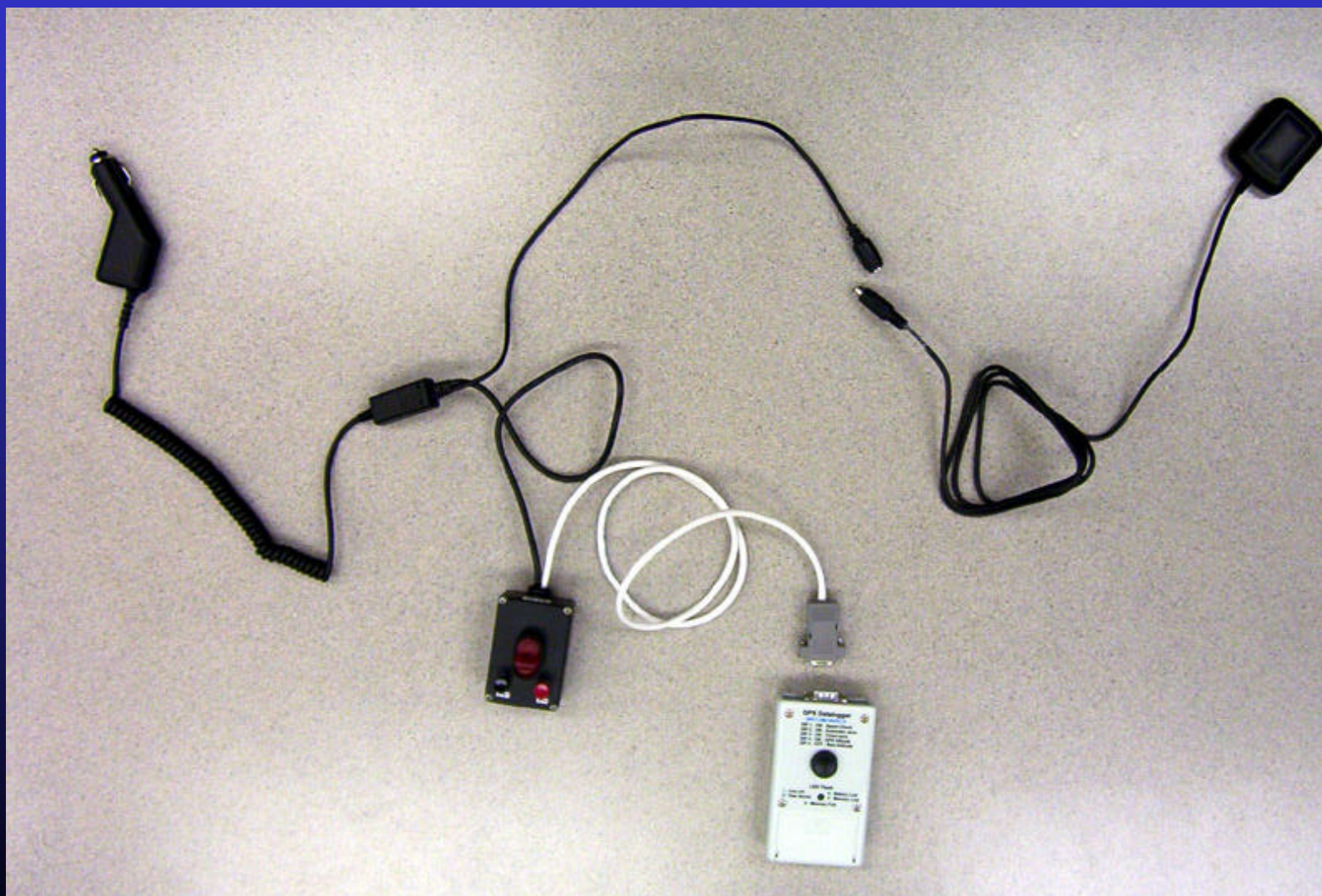


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Survey Design & Apparatus

- “Floating car” method
- Trips from/to activity centre
 - mimic “actual trips”
- Use of electronic equipment
 - minimal interaction

GPS Equipment Setup



GPS Equipment – Logger



GPS Equipment – In Vehicle





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Software Tools

- MapInfo – data analysis & automation
- ArcGIS – route development
- MS FoxPro – data management & analysis
- MS Access – route development
- EMME/2 – initial travel time est.
- FME – data extraction & conversion
- GeoKinetics Engine – data editing & manipulation
- OpenSource – SVG (XML)



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GIS Data

- Digital Road Atlas (GIS Innovations)
- Orthophotos (McElhanney Consulting Services)
- Greater Vancouver EMME/2 network
- GVRD municipal boundary



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Survey Database Management System (DBMS)

Driver Management

- Generate daily and weekly survey schedules for each driver
 - weekly trip summary sheet
 - individual “trip detail” sheets
- Calculate survey hours and distance per week to determine payment totals
- Allows for schedule adjustment

Data Management

- Store raw and processed GPS data
- Utilities to “clean up” and “massage” the GPS data
- Verification of collected data vs. assigned trips
- Produce reports and summaries

GPS Data Management System

Select trips for printing
by driver
by specific run

Vancouver Transportation Authority - Strategic Planning Department

Travel Time Survey - Assignment and detail sheet printing utility

Select trips by driver and survey week

Driver Name: Wayne Gretzky

Survey week: 99

Select trip by record ID and seg ID

Record ID: []

Run ID: Run #1 Run #3 Run #5
 Run #2 Run #4 Run #6

You have selected
Driver Wayne Gretzky
Schedule week of 99

Close

Trip Assignment sheets

Send to Printer
Print Preview

Trip Detail sheets

Send to Printer
Print Preview

Info box displays
selection from
schedule table

Print
assignment
sheet

Printing trip
detail sheets

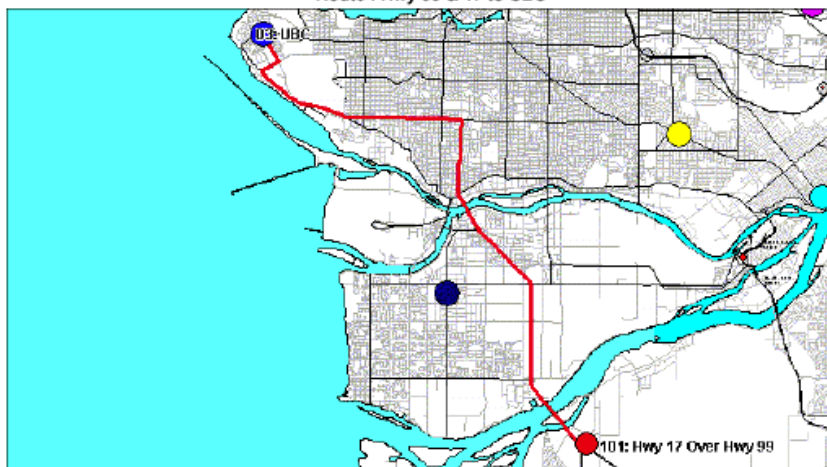
Trip Detail Sheet

2003 Greater Vancouver Travel Time Survey Trip Detail Sheet

Conducted by
Greater Vancouver Transportation Authority
Strategic Planning Department

Survey date : Sep 12, 2003 (Fri) Driver ID : 99 GPS ID : GPS_06 Record ID : 281
 Survey time : 7:00 AM Driver name : Wayne Gretsky Cable ID : BOX_06 Run ID : 1
 Logger ID : LOG_06 Trip ID : 146

Route : Hwy 99 & 17 to UBC



Origin 101: Hwy 99 & 17



Check point:
On-ramp to NB Hwy
99 from WB Hwy 17

Destination 3: UBC



Check point:
Through intersection of
University Blvd. /
Westbrook Mall

Trip itinerary : [Start: Hwy 17 over Hwy 99] -> Hwy 17 on-ramp to NB Hwy 99 -> NB George Massey Tunnel -> NB Hwy 99 -> NB Oak St Bridge -> NB Oak St -> LT WB 41st St -> RT to WB SW Marine Dr -> RT to EB 16 Ave -> LT to NB Westbrook Mall -> [End: Westbrook Mall @ University Blvd, UBC]

Survey time: Start : _____ End : _____ Duration : _____	Weather (please circle) : 1. Sunny day 2. Cloudy/overcast 3. Light showers 4. Rain 5. Fog 6. Hail 7. Snow 8. Other: _____	Incident log : 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____	A-Road work/construction B-Vehicle breakdown C-Accident D-Detour E-Police check F-Other (please specify)
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Weekly Trip Assignment Summary Sheet (1)

2003 Greater Vancouver Travel Time Survey Trip Assignment Sheet

Conducted by
Greater Vancouver Transportation Authority
Strategic Planning Department

Driver name : Wayne Gretzky (99) Start date : Sep 16, 2003 End date : Sep 23, 2003

Record ID	Run ID	Start Time	Start location	End location	Trip Length	Completed
Survey date: Sep 16, 2003 (Tue)						
372	1	3:00 PM	3 - UBC	7 - Coquitlam Centre	35.0 km	<input type="checkbox"/>
372	2	4:30 PM	7 - Coquitlam Centre	3 - UBC	37.6 km	<input type="checkbox"/>
Daily total distance : 73.6 km						
Survey date: Sep 17, 2003 (Wed)						
407	1	7:00 AM	3 - UBC	12 - Langley City	95.8 km	<input type="checkbox"/>
408	1	11:00 MID	3 - UBC	1 - North Vancouver City (Lonsdale Quay)	20.9 km	<input type="checkbox"/>
408	2	11:45 MID	1 - North Vancouver City (Lonsdale Quay)	9 - Richmond Town Centre	25.5 km	<input type="checkbox"/>
Daily total distance : 103.4 km						
Survey date: Sep 18, 2003 (Thu)						
443	1	7:00 AM	3 - UBC	13 - Peach Arch / Truck Border Crossing	53.1 km	<input type="checkbox"/>
444	1	3:00 PM	3 - UBC	8 - Maple Ridge	53.7 km	<input type="checkbox"/>
Daily total distance : 106.9 km						
Survey date: Sep 19, 2003 (Fri)						
479	1	7:00 AM	5 - Metrotown	4 - SFU	13.2 km	<input type="checkbox"/>
479	2	7:30 AM	4 - SFU	3 - UBC	27.5 km	<input type="checkbox"/>
480	1	3:00 PM	3 - UBC	12 - Langley City	56.8 km	<input type="checkbox"/>
Daily total distance : 97.6 km						
Survey date: Sep 20, 2003 (Sat)						
510	1	12:00 SAT	2 - Vancouver CBD / Vancouver Ports	10 - Tsawwassen Ferry Terminal	36.3 km	<input type="checkbox"/>
Daily total distance : 36.3 km						
Survey date: Sep 22, 2003 (Mon)						
533	1	11:00 MID	3 - UBC	13 - Peach Arch / Truck Border Crossing	53.1 km	<input type="checkbox"/>
534	1	3:00 PM	4 - SFU	3 - UBC	27.6 km	<input type="checkbox"/>
Daily total distance : 80.7 km						
Survey date: Sep 23, 2003 (Tue)						
569	1	7:00 AM	6 - New Westminster	2 - Vancouver CBD / Vancouver Ports	18.0 km	<input type="checkbox"/>
570	1	11:00 MID	3 - UBC	14 - Abbotsford	71.1 km	<input type="checkbox"/>

page : 1

Weekly Trip Assignment Summary Sheet (2)

2003 Greater Vancouver Travel Time Survey Trip Assignment Sheet

Conducted by
Greater Vancouver Transportation Authority
Strategic Planning Department

Driver name : Wayne Gretzky (99)

Record ID	Run ID	Start Time	Start location	End location	Trip Length	Completed
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Daily total distance : 89.2 km

Total scheduled distance : 587.8 km

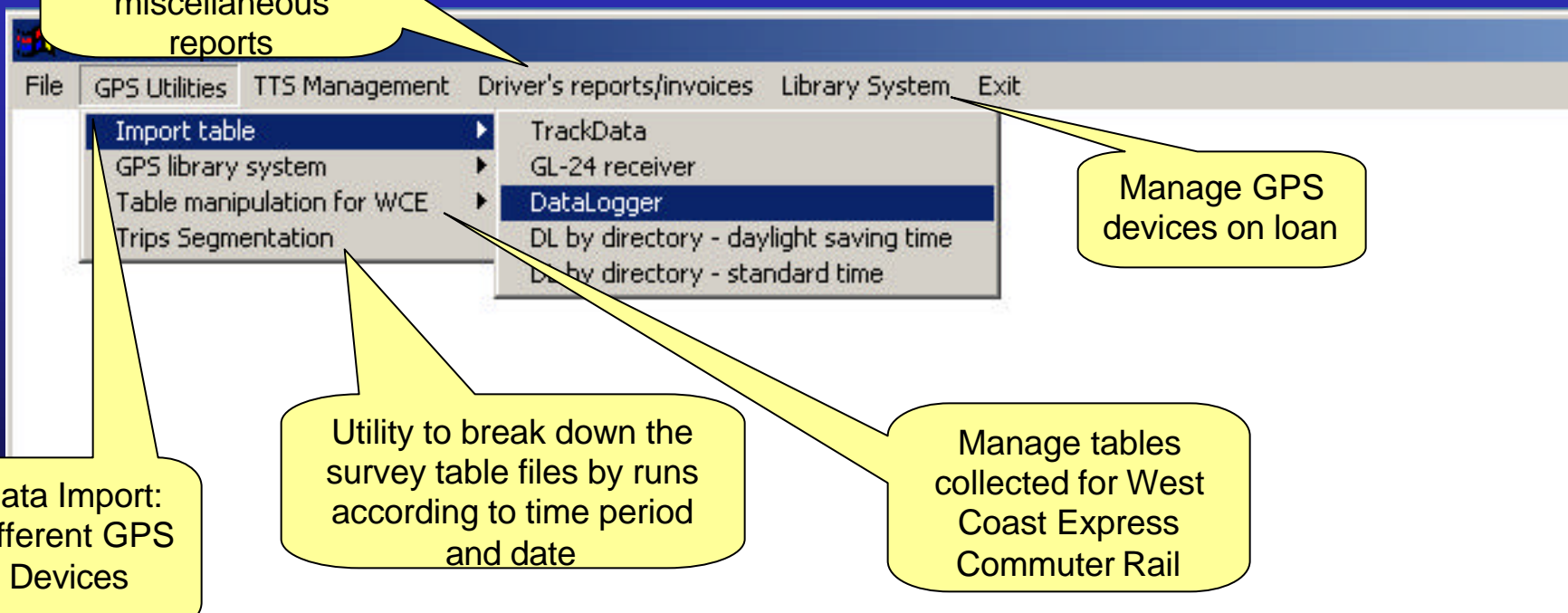
Total scheduled time : 28.00 hr.

Total TO/FROM home distance : 487.86 km

***** Next drop off time : 1:15 PM

GPS Utility – Data Management System

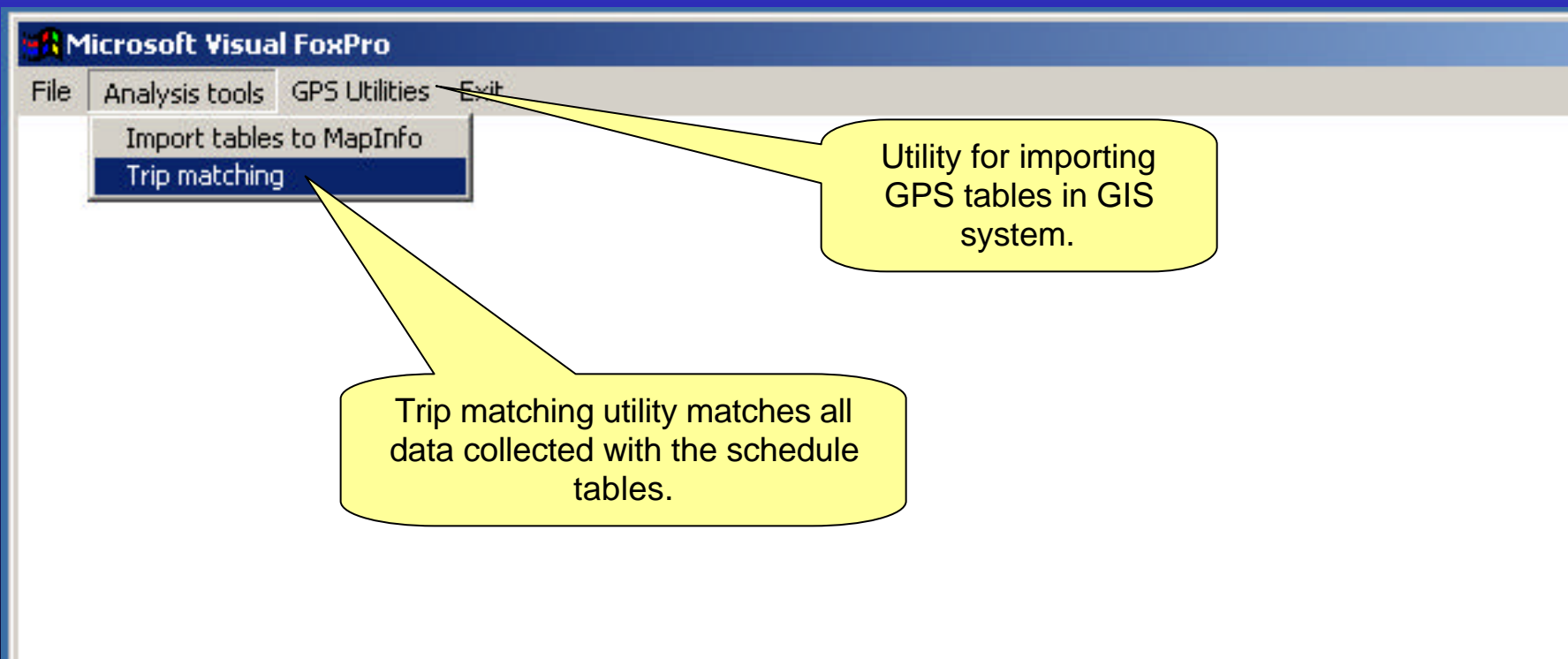
Utility to manage driver invoices and miscellaneous reports



The screenshot shows a software window with a menu bar containing: File, GPS Utilities, TTS Management, Driver's reports/invoices, Library System, and Exit. The 'GPS Utilities' menu is open, showing a list of options: Import table, GPS library system, Table manipulation for WCE, and Trips Segmentation. The 'Import table' option is expanded, showing a sub-menu with: TrackData, GL-24 receiver, DataLogger, DL by directory - daylight saving time, and DL by directory - standard time. Five yellow callout boxes provide descriptions for various features:

- Utility to manage driver invoices and miscellaneous reports**: Points to the 'Driver's reports/invoices' menu item.
- Manage GPS devices on loan**: Points to the 'Library System' menu item.
- Data Import: Different GPS Devices**: Points to the 'Import table' menu item.
- Utility to break down the survey table files by runs according to time period and date**: Points to the 'Table manipulation for WCE' menu item.
- Manage tables collected for West Coast Express Commuter Rail**: Points to the 'DataLogger' sub-menu item.

GPS Data Analysis Tools





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Survey Crew & Data Collection

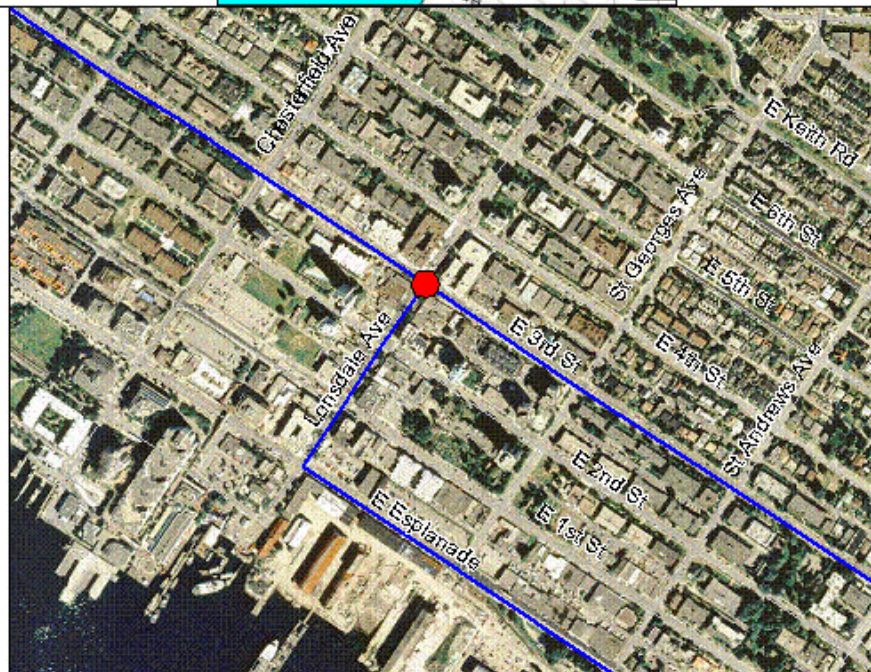
Orientation & First Week of Survey

- 1st time that this type of survey was conducted
- Orientation sessions with drivers
- Most drivers were not professional drivers.
- Driver's knowledge of technical and map skills varied
- The first week of data was expected to be mostly unusable and erroneous.
- “Erroneous” travel time was affected by:
 - Loss of direction
 - Unfamiliarity with route or area
 - Usage of equipment

Survey Manual: Check Point Definitions

1 North Vancouver

Check Point: Lonsdale Avenue & E. 3rd Street



South end of Chesterfield Ave -> SeaBus drop-off



SeaBus passenger pick-up & drop-off area
McDonalds in SE corner.





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Extreme Weather Conditions

- encountered a variety of weather conditions and solar activity

Heavy Rain

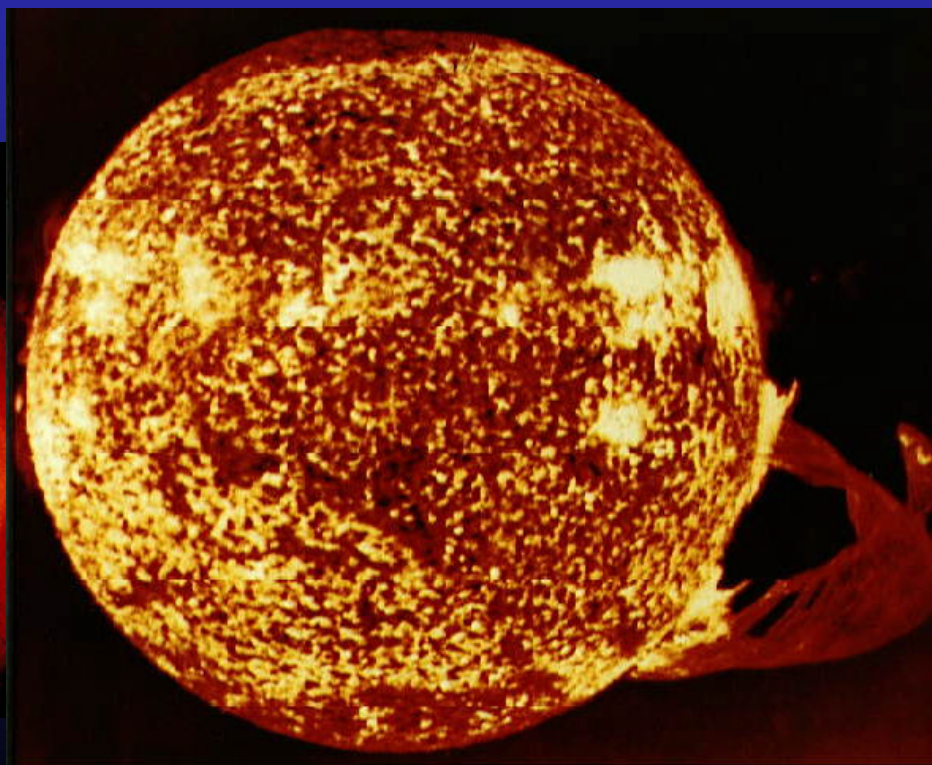
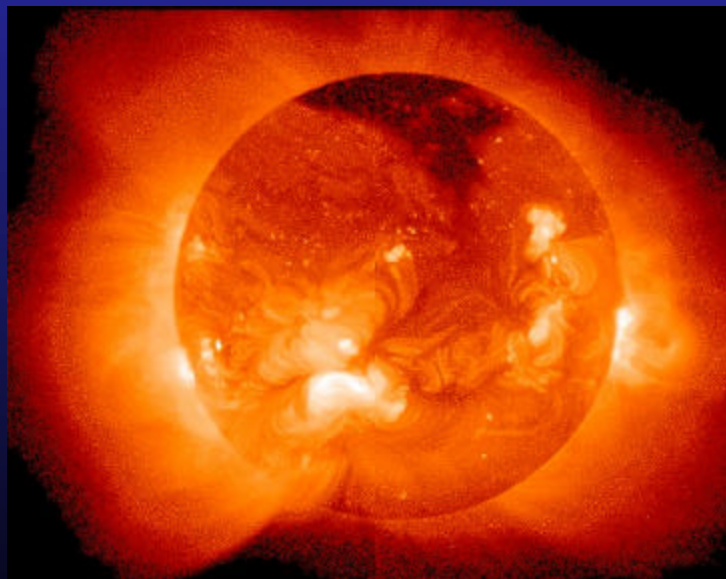
- The heavy rainfall resulted in road closures along low lying routes



High Solar Flare Activity

(Late October – Early November)

- Solar flares known to create havoc on electronic equipment.
- Equipment continued to perform during these events
- Data problems?



Incidents

- Majority of the incidents were accidents and roadwork related
- “Event button” & documentation
- Incidents subcategorized into major and minor delays

Major Accidents

- 7 hour delay at 2nd Narrows Bridge due to a fatal accident



Roadwork

- Delay due to “normal” congestion or roadwork?
- Roadwork and similar delays recorded to ensure analysis of GPS data took this into account





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GPS Equipment Issues

- Power connection / contact issues – loss of continuous GPS signal
- Severed cables – window closed on GPS wire too tightly
- Event button broken - drivers wanted a clicking feature to acknowledge that event was registered



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Survey Stats

- Unique Trips
 - 181 (Regional: 163; Van: 18)
- Total Trips
 - 4,185 (Regional: 3,590; Van: 595)
- Entire Survey – Duration
 - 2,467.25 hours or 102.8 days (24hr)
- Entire Survey – Distance
 - 125,503.91 km



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Survey Data & Results

Raw GPS Data Sample

```

dv10wk04axm19.csv - Notepad
File Edit Format Help
A,4911.2719,N,12250.8640,W,215833,240903,,00085,,,,,
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← Event button triggered

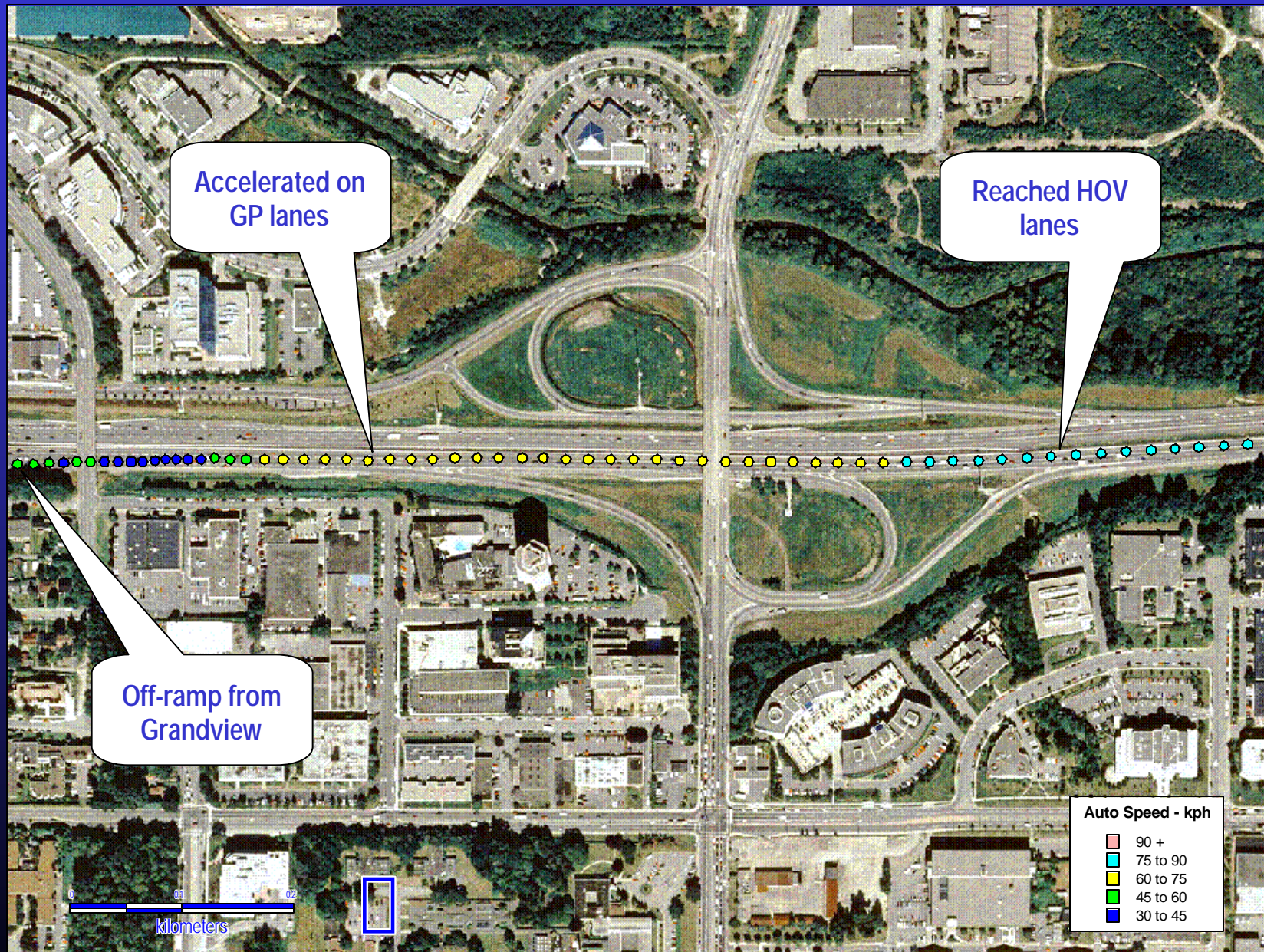
Latitude

Longitude

Time (GMT)

Date (GMT)

Altitude





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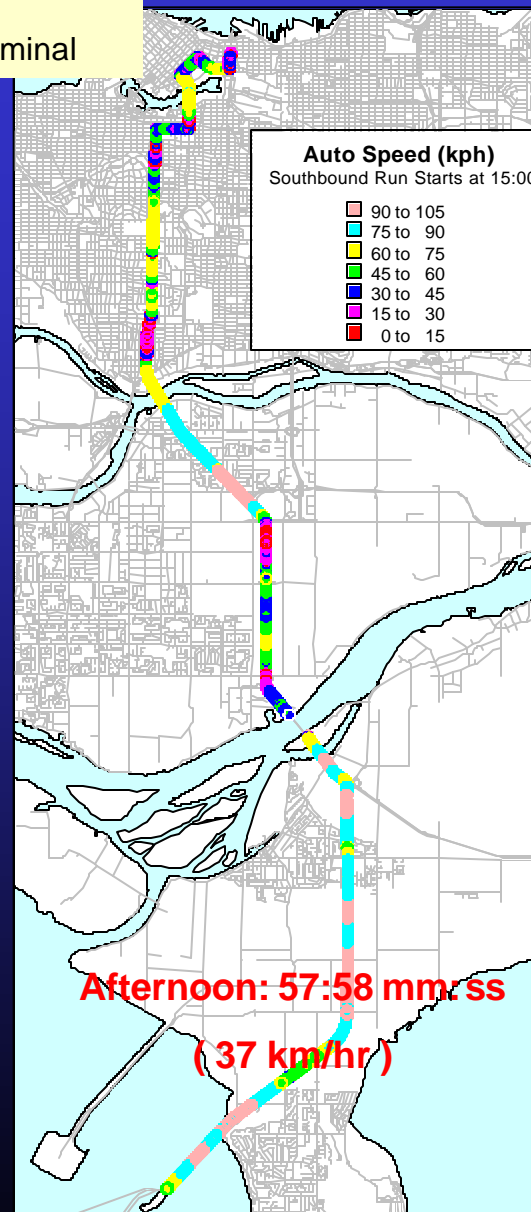
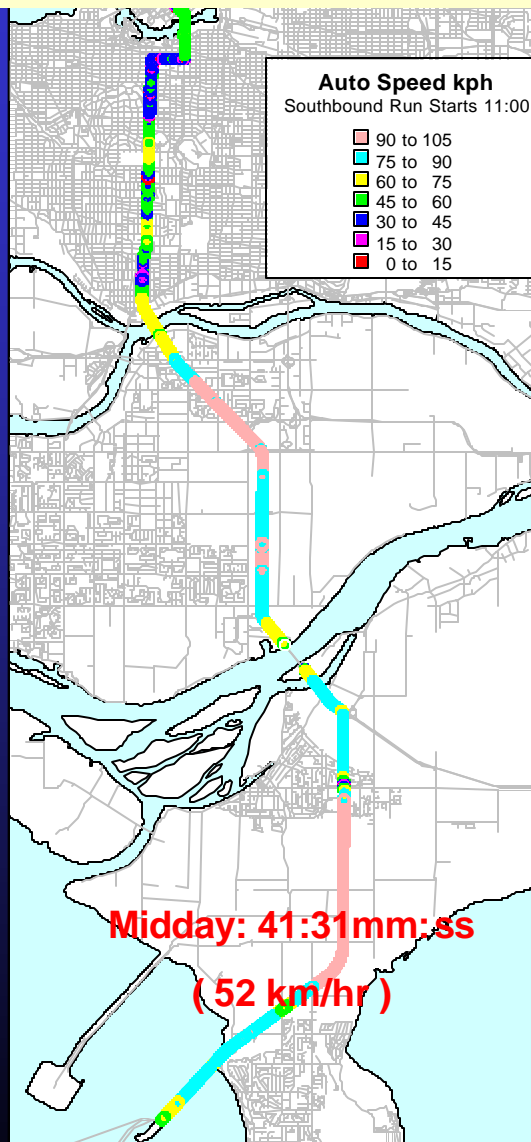
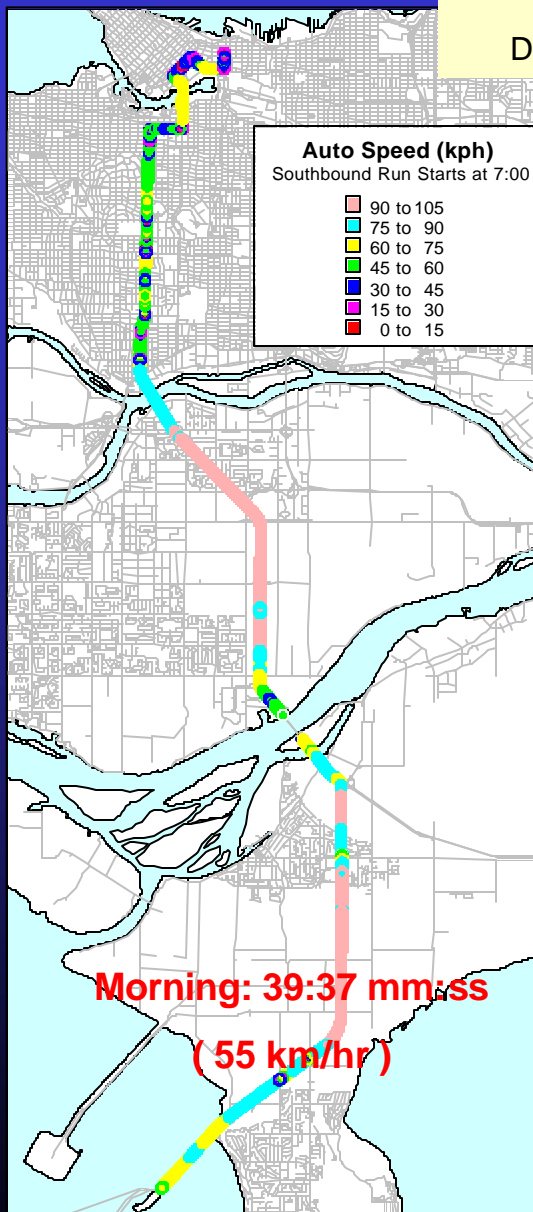
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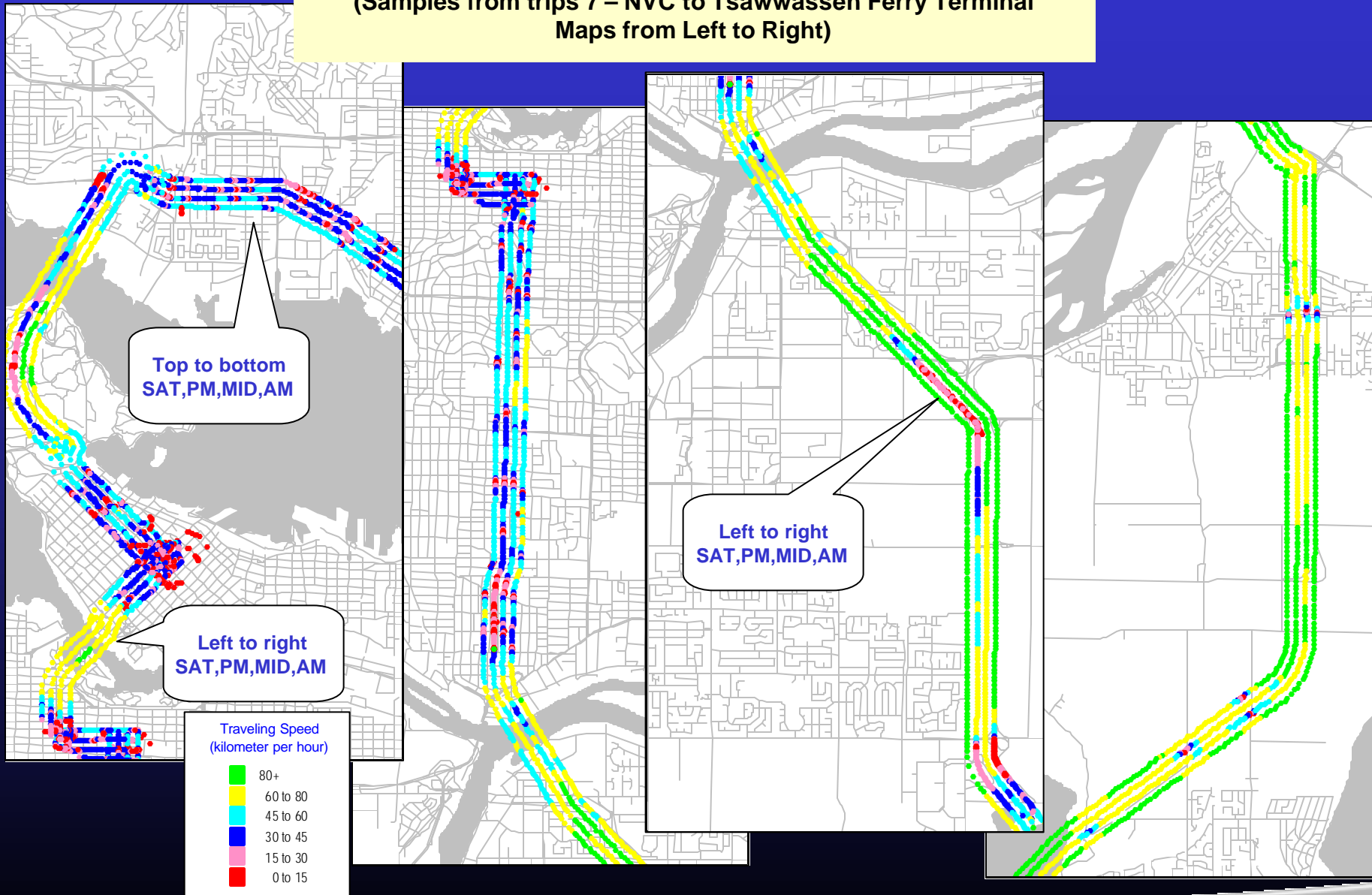
GPS Survey Examples

Sample Survey Run

Downtown Vancouver to Tsawwassen Ferry Terminal



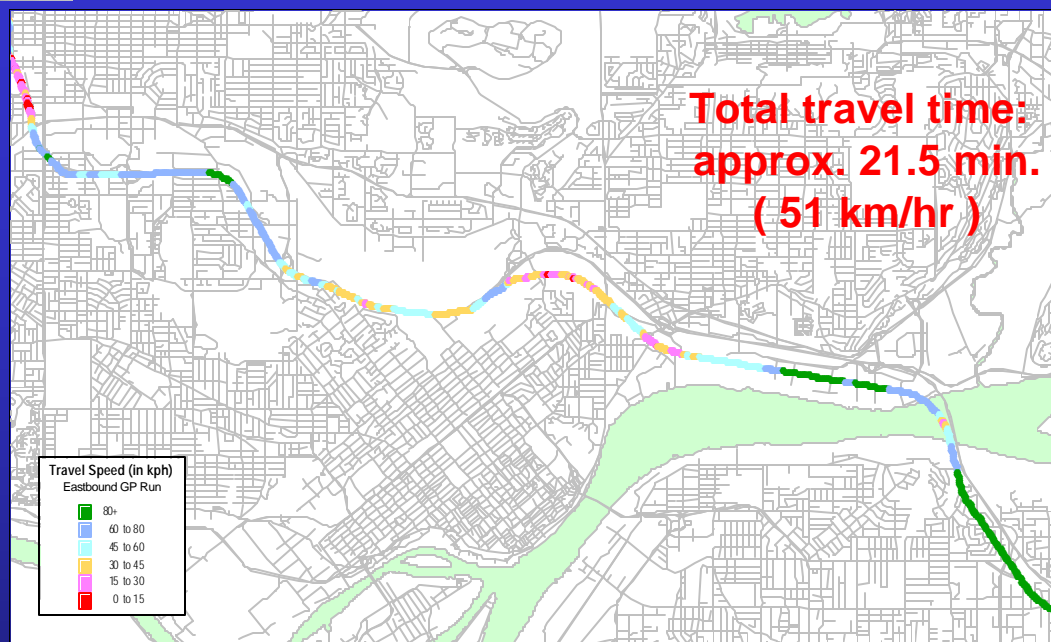
**Comparison of traveling time from different time period
(Samples from trips 7 – NVC to Tsawwassen Ferry Terminal
Maps from Left to Right)**



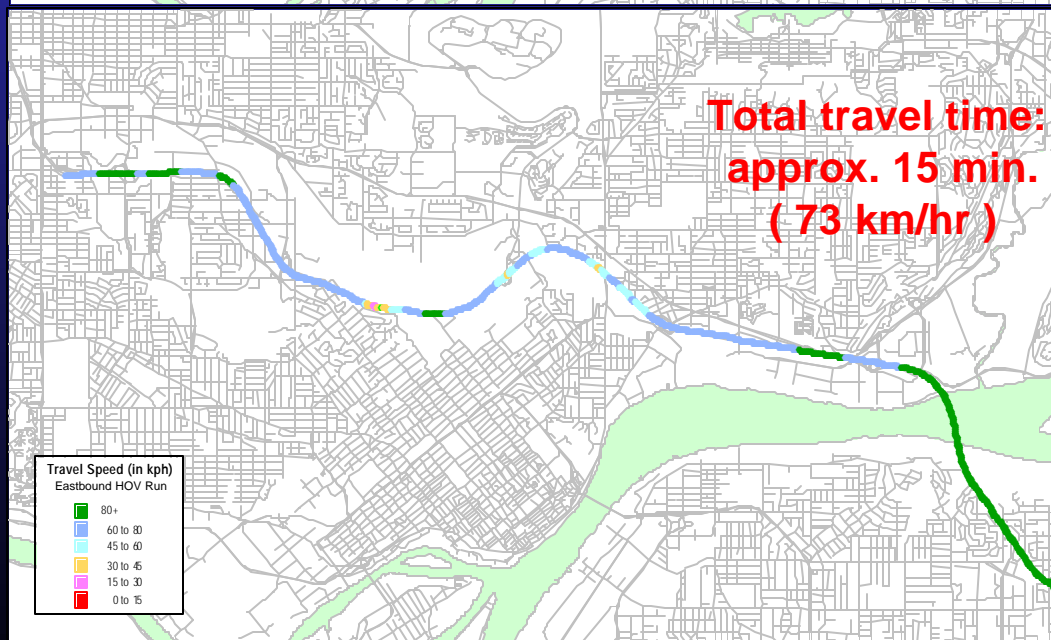
Sample Survey Run

Boundary to South end of Port
Mann Bridge on Hwy 1

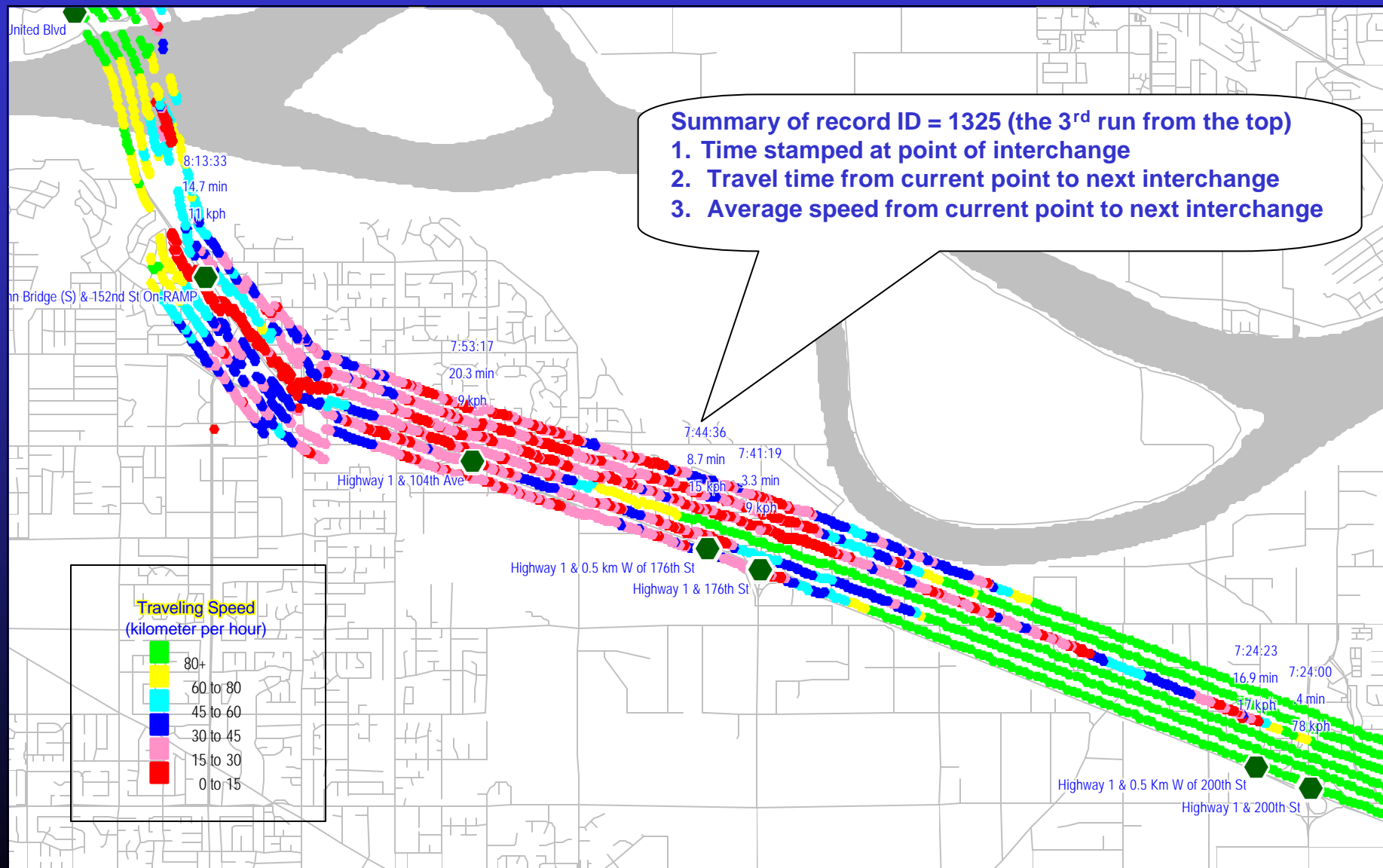
Travel on General Purpose Lanes



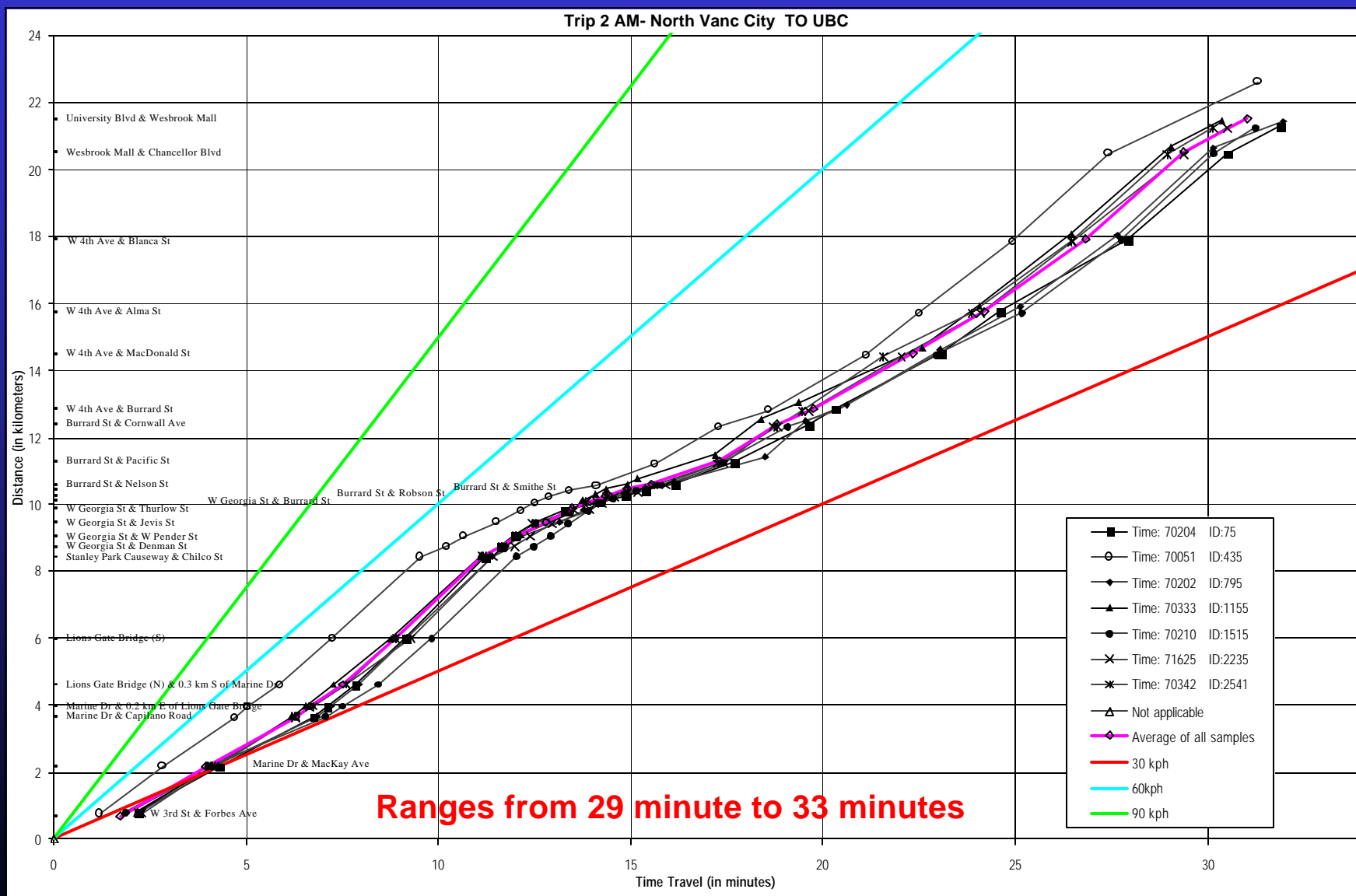
Travel on HOV Lanes



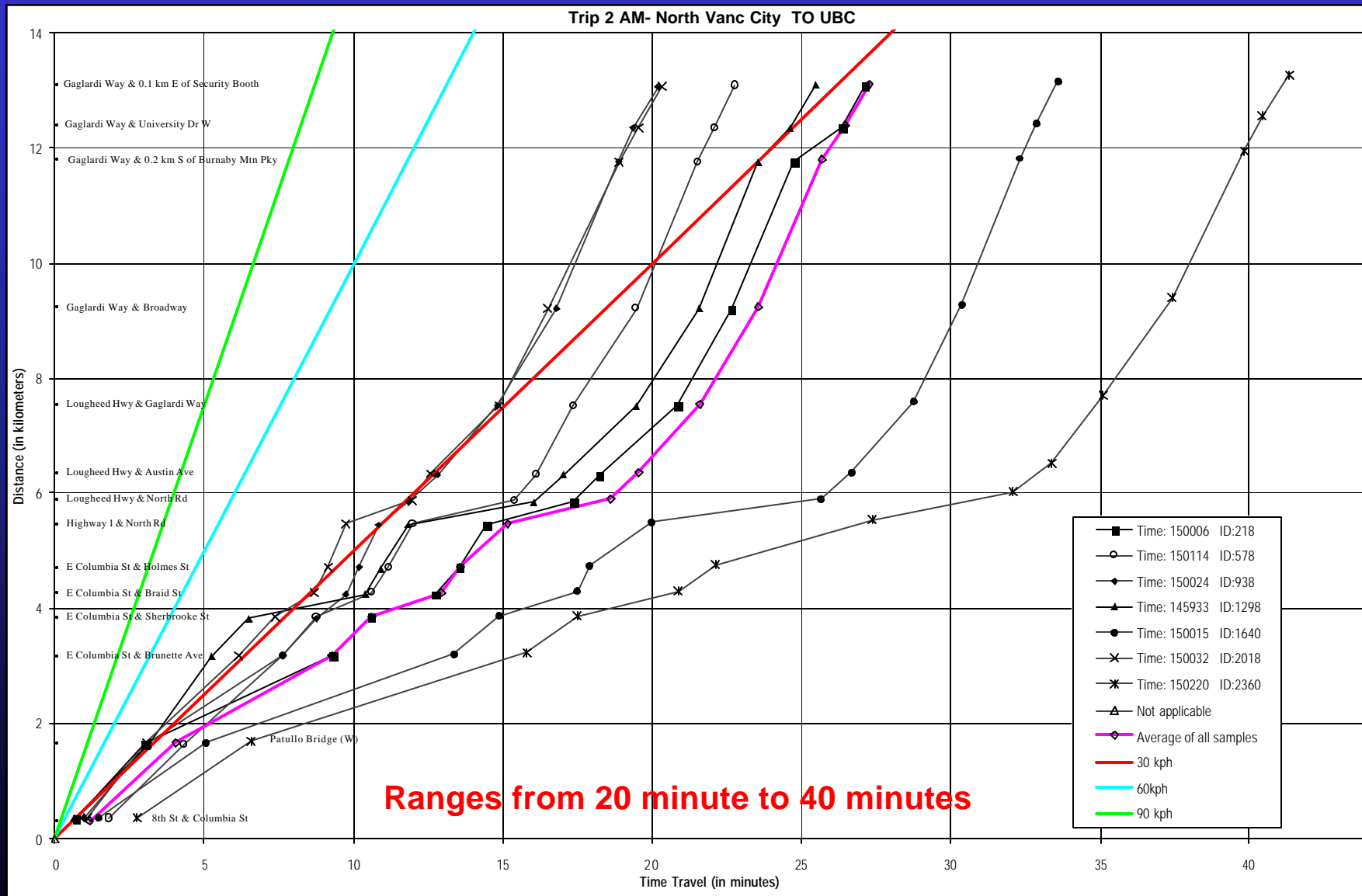
Queuing at Port Mann Bridge during AM Peak Period (Samples from trips 127 – Abbotsford to UBC)

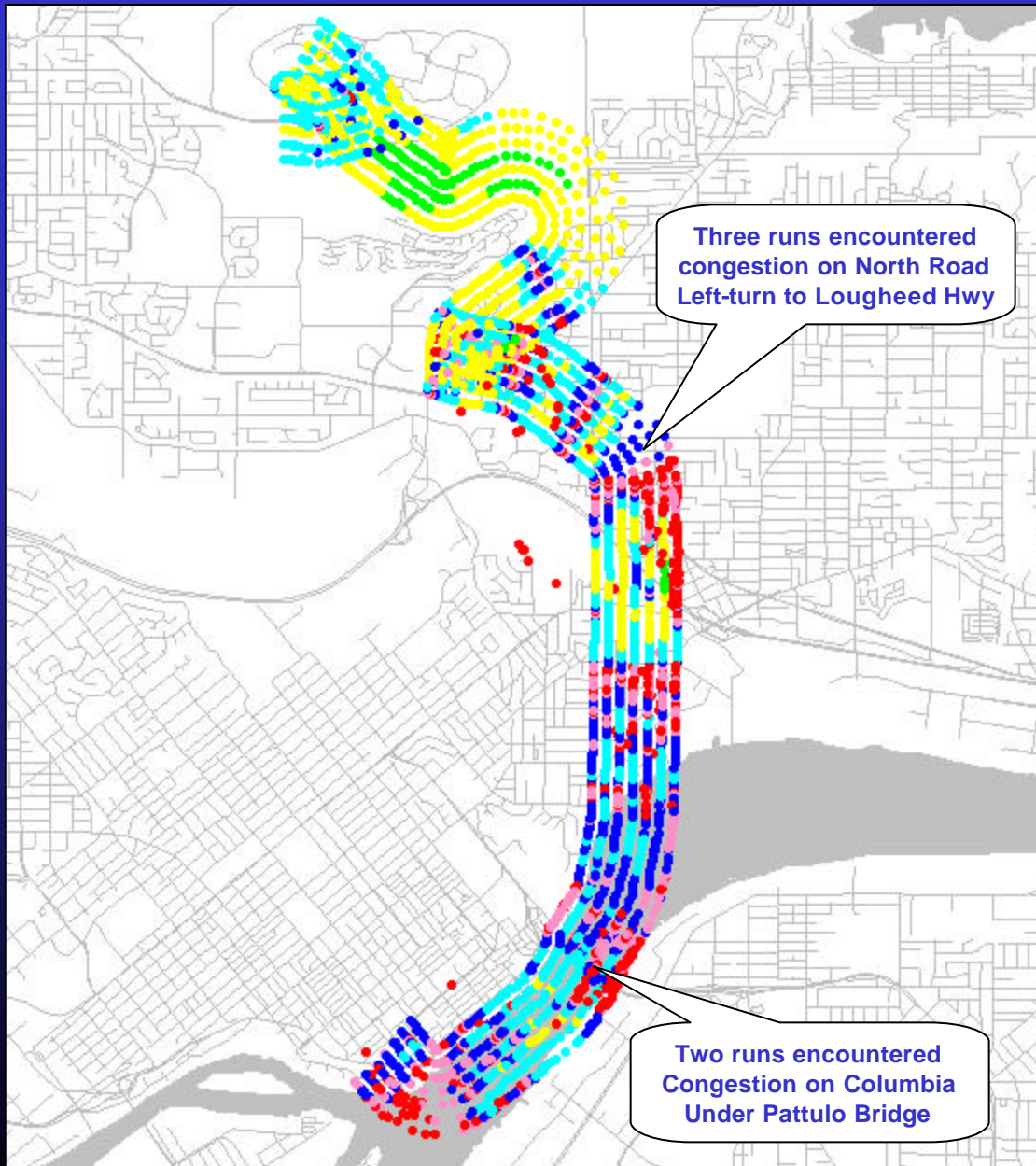


Travel Time Variability – N. Van to UBC



Travel Time Variability – New West. to SFU

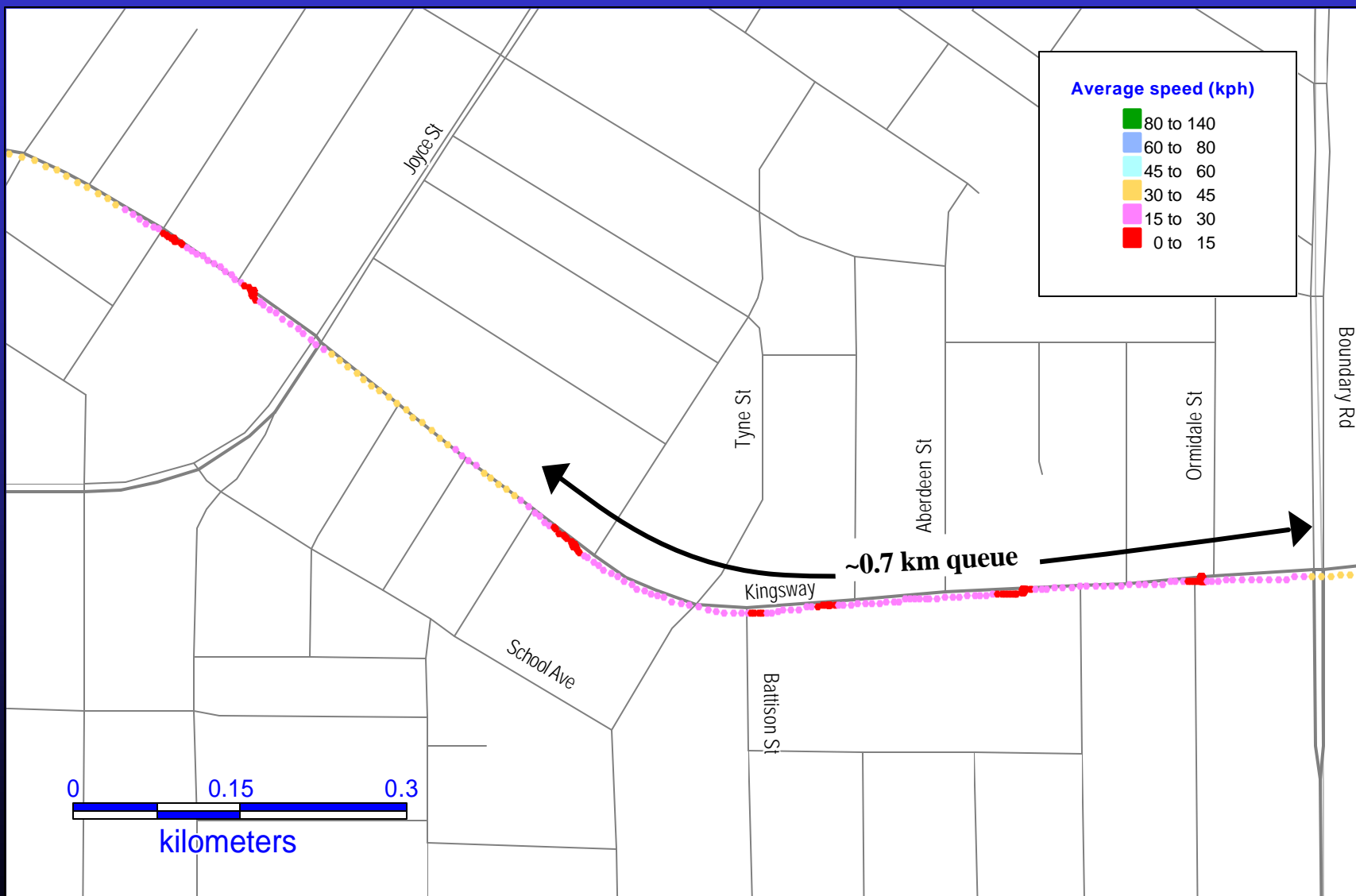




**Trip 53:
New Westminster
to SFU
- Congested
areas**

Queue Lengths

(Eastbound Kingsway at Boundary Rd.- PM Peak Period)





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EXPRESS

C.2

Regional Summaries

AM

Average Travel Time [minutes]

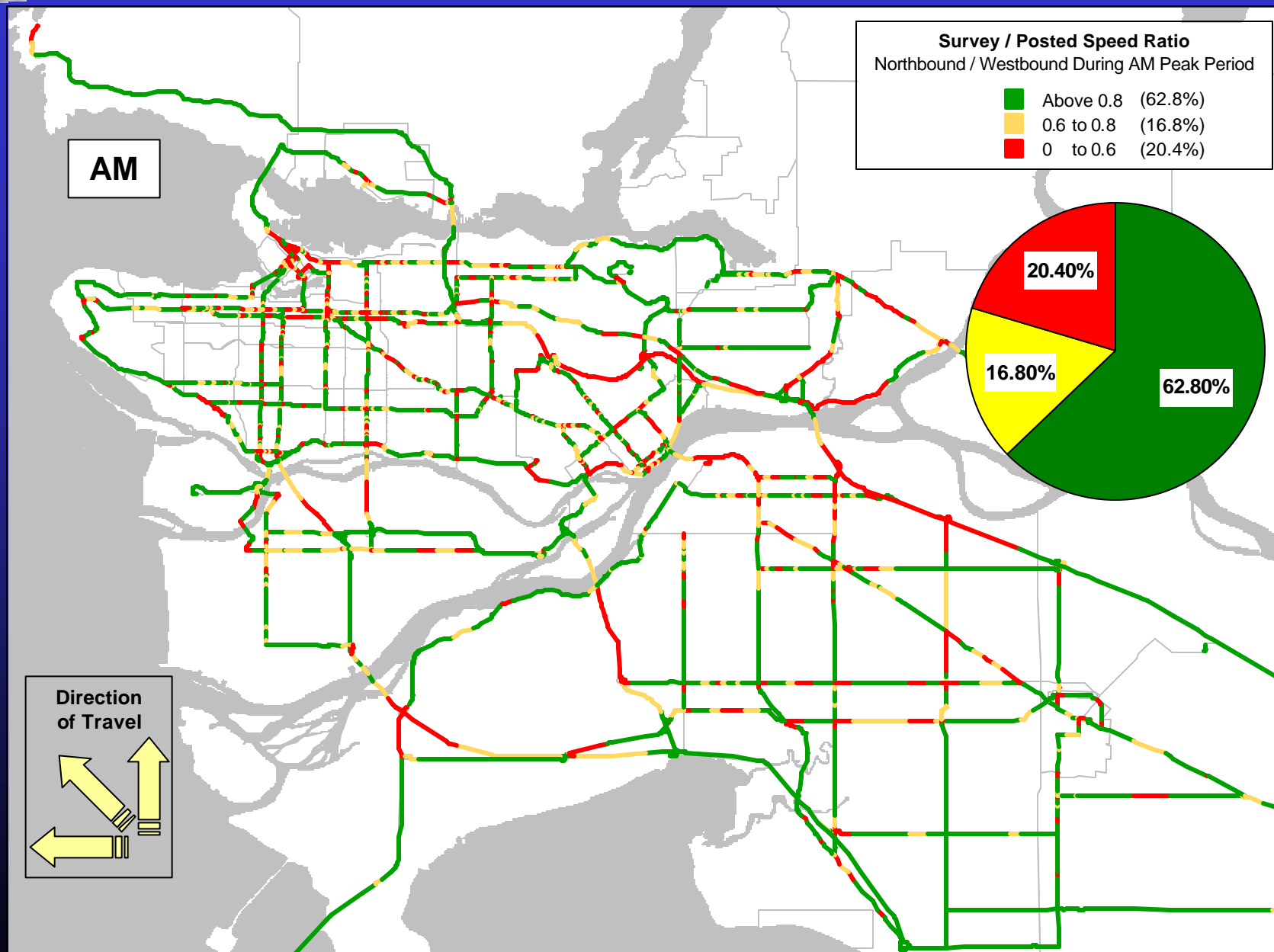
Reliability/
Variability
of Traffic
Conditions

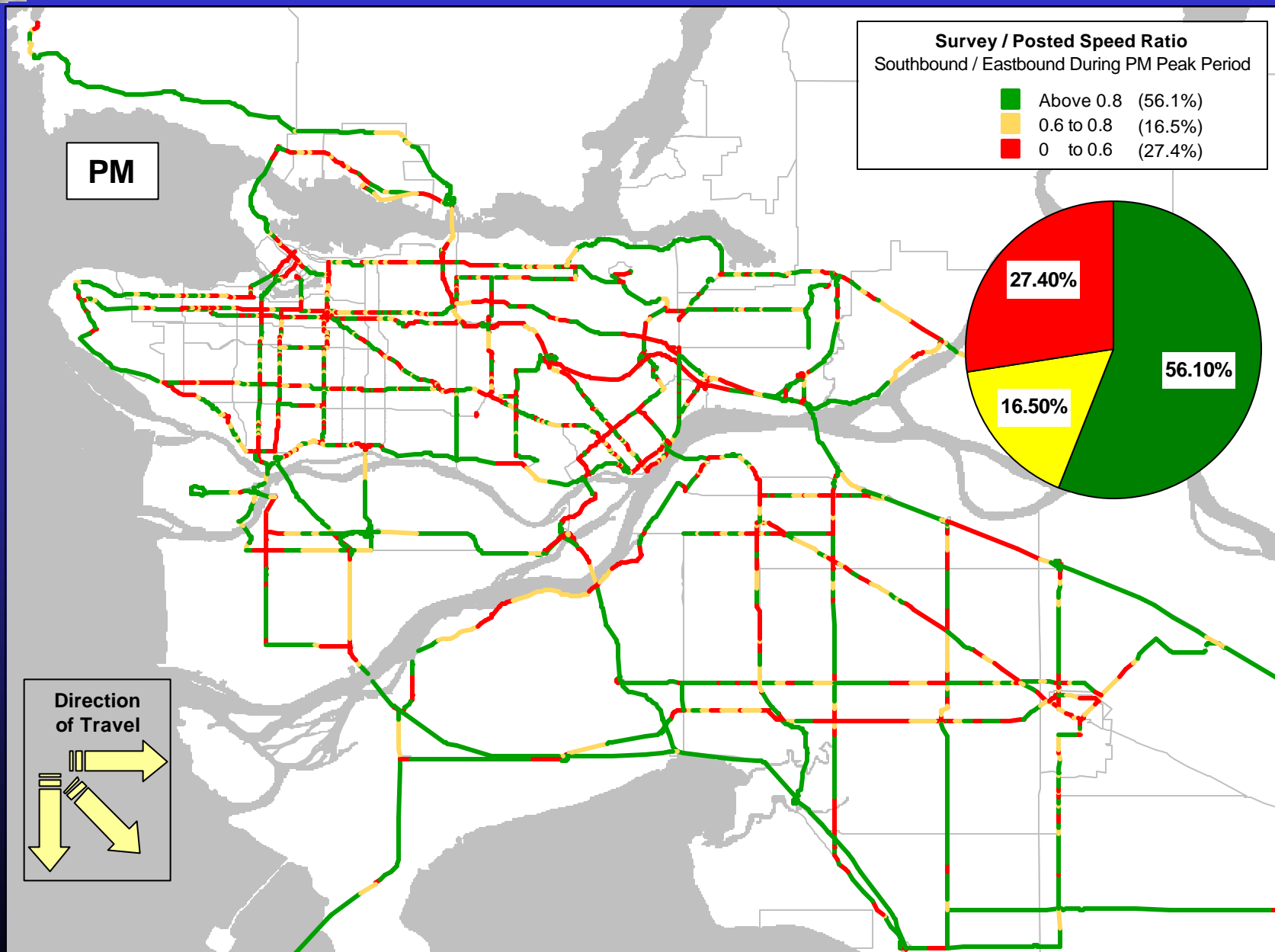
WORST
>30%

10 - 30%

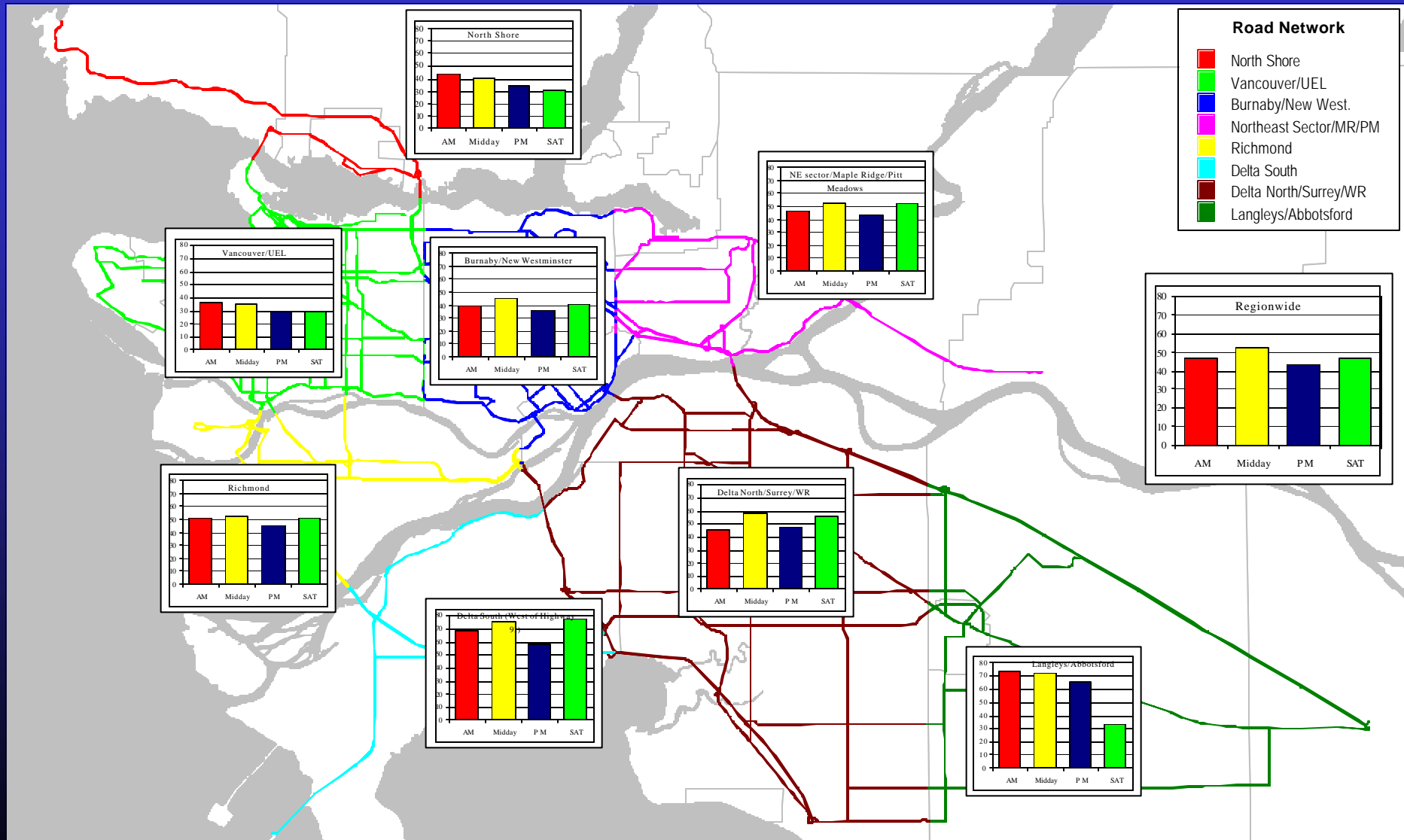
BEST
<10%

		Destination													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
O/D		N Van	Van CBD	UBC	SFU	Metro town	New West	Coq Centre	Maple Ridge	Richmond	Tsaw'n Ferry	Surrey Central	Langley City	CAN/US Border	Abbotsford
Origin	1	N Van	18	31	29	24	26	32	50	37	55	35	42	57	46
	2	Van CBD	23	23	25	20	33	33	54	26	41	40	40	44	43
	3	UBC	40	28	41	38	31	53	74	37	35	48	71	42	59
	4	SFU	27	25	51	25	20	19	34	52	55	25	36	51	37
	5	Metro town	20	25	30	19	18	21	35	21	33	24	34	30	37
	6	New West	27	31	47	19	13	21	31	31	37	11	38	33	37
	7	Coq Centre	42	34	58	20	36	25	18	58	71	26	32	43	37
	8	Maple Ridge	70	68	94	41	55	47	31	83	99	41	61	71	69
	9	Richmond	48	46	31	46	32	26	53	63	19	33	43	30	64
	10	Tsaw'n Ferry	71	49	51	64	44	53	68	93	37	39	43	29	60
	11	Surrey Central	41	58	68	25	35	17	36	49	43	38	25	37	25
	12	Langley City	84	63	84	49	63	53	43	61	55	44	28	20	17
	13	CAN/US Border	83	57	58	42	38	34	52	79	36	33	25	19	29
	14	Abbotsford	104	82	106	51	68	62	49	63	85	67	38	22	29





Speed Profile by Subareas





AIRCARE



BUS



RIDE SHARE

MAJOR ROADS
AND BRIDGES

SEASIDE



SKYTRAIN

WEST COAST
EXPRESS

Congestion: Definitions

- **Congestion**
 - Occurs when vehicles impede the progress of other vehicles. It is experienced as delay by road users.
- **Free Flow Speed (FFS)**
 - The average speed experienced with no interference by traffic (middle of the night)



AIRCARE



BUSSES



RIDE SHARE



MAJOR ROADS
AND BRIDGES



SEASIDE



SKYTRAIN



WEST COAST
EXPRESS

Regional Congestion Index

- **RCI** (surveyed network)
 - AM Peak Period: **0.70**
 - Mid-Day: **0.78**
 - PM Peak Period: **0.65**
 - Saturdays: **0.74**

$$\text{Space-Mean Speed} = \frac{\sum \text{distance travelled}}{\sum \text{travel time}}$$



AIRCARE



BUS



RIDE SHARE



MAJOR ROADS
AND BRIDGES



SEASIDE



SKYTRAIN



WEST COAST
EXPRESS

HOV Web Animation Example



AIRCARE



BUS



RIDE SHARE



MAJOR ROADS
AND BRIDGES



SEASIDE



SKYTRAIN



WEST COAST
EXPRESS



The End