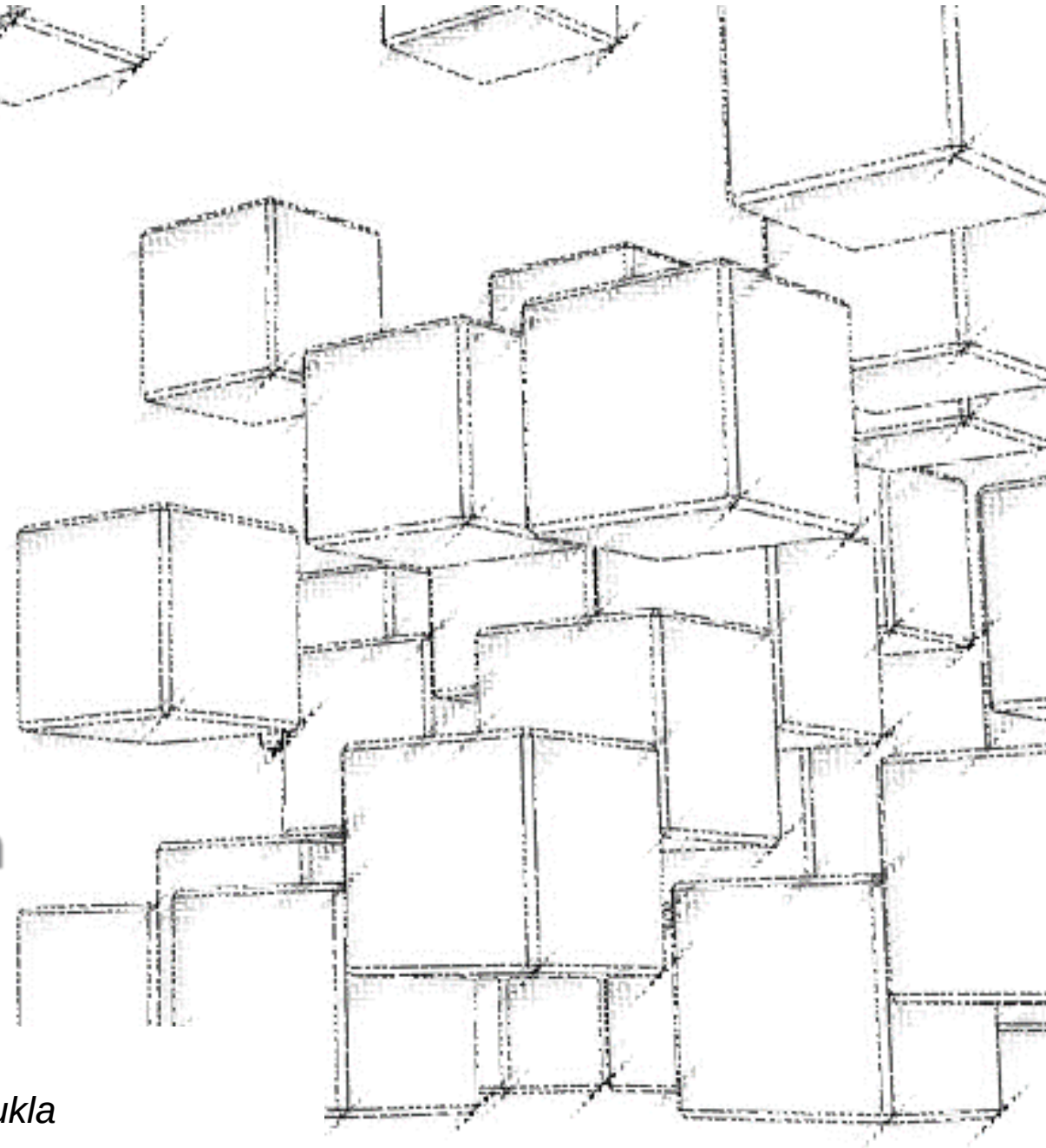
PTV GROUP
the mind of movement

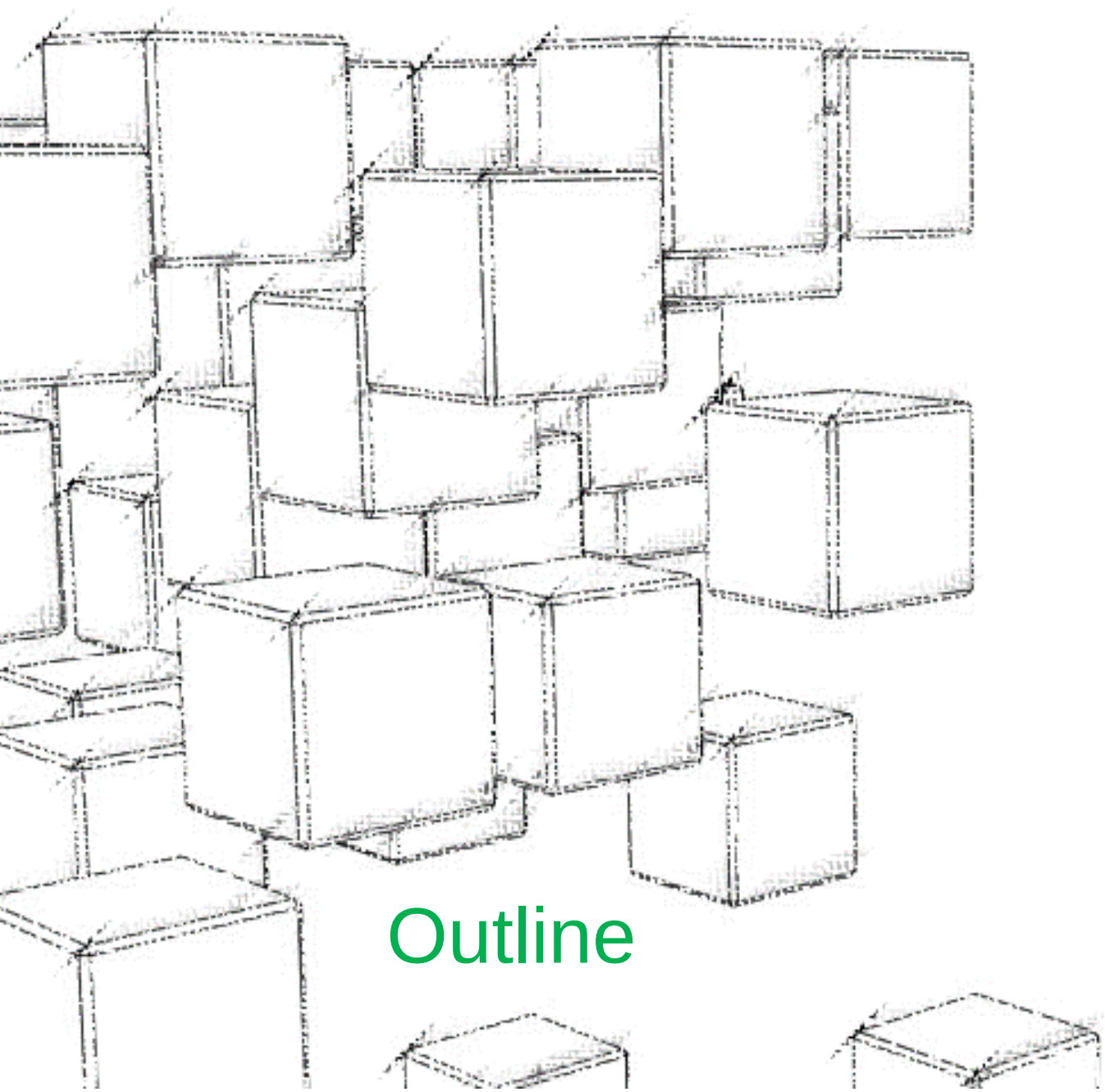


USER GROUP MEETING

05th November 2017
Hyderabad

Environmental Consideration in Assessing LOS of a Signalized Intersection

School of Planning and Architecture, Delhi
Siva Thoyyeti, Dr Sewa Ram, Dr Anuradha Shukla



Outline

1 INTRODUCTION & METHODOLOGY

2 DATA COLLECTION

3 DATA ANALYSIS

4 MICROSIMULATION MODEL

5 CALIBRATION & VALIDATION

6 RESULTS & OUTCOMES

INTRODUCTION & METHODOLOGY

Introduction

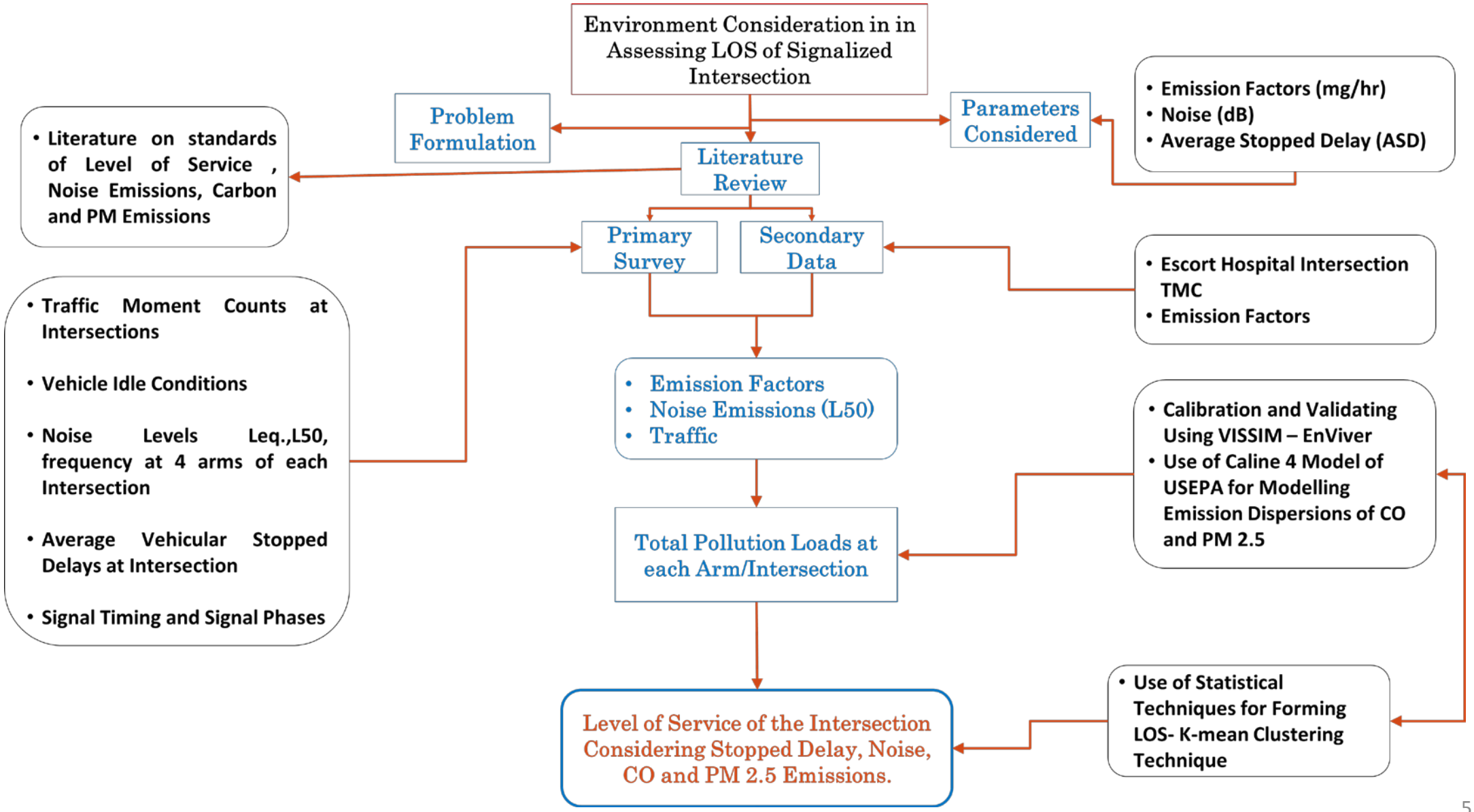
AIM

To asses and to arrive at the Level of service of a Signalized Intersection considering the factors of Environment

OBJECTIVES

- To study various models that consider environment effect.
- To establish an Inter-relationship between LOS of an Intersection and Environment Parameters considered.
- To arrive at the Level of Service standards of a Signalized Intersection using suitable methods.
- **To Develop a Simulation Model that can be utilized to test various traffic (future scenarios) & Signal conditions**
- To incorporate the Environmental Factor as a quantifiable traffic parameter (in terms of Vehicle Carbon Monoxide Emissions)

Methodology



Literature Comparison

Intersections Models	Author / Publication	Cycle Length (or) Delay	LOS Norms	Vehicular Emission	Fuel Consumption	Vehicle Speed, Acceleration & Deceleration Condition
	Highway Capacity Manual	Yes	Yes	No	No	No
	FHWA Model (from HCM)	Yes	Yes	No	No	No
	Indonesian Highway Capacity Manual	Yes	Yea	No	No	No
	Analysis Of Emissions At Congested And Uncongested Intersections Using Moves 2010: Papson, A., S. Hartley, K. Kuo	Yes	Yes	Yes	No	yes
	Tsai-Yun Liao , Randy B. Machemehl, The University of Texas at Austin , Department of Civil Engineering , Austin Tx, USA	Yes	No	No	Yes	No
	Fuel Wastage at Signals KP Tiwari , RN Singh , J B Balwanshi, Indore	Yes	No	Yes	Yes	No
	Dr Anuradha Shukla, Masood Alam, CRRI	Yes	No	Yes	No	No

- Comparison Assessment of Literature Studies for Multiple Parameters

Survey Locations/Intersections

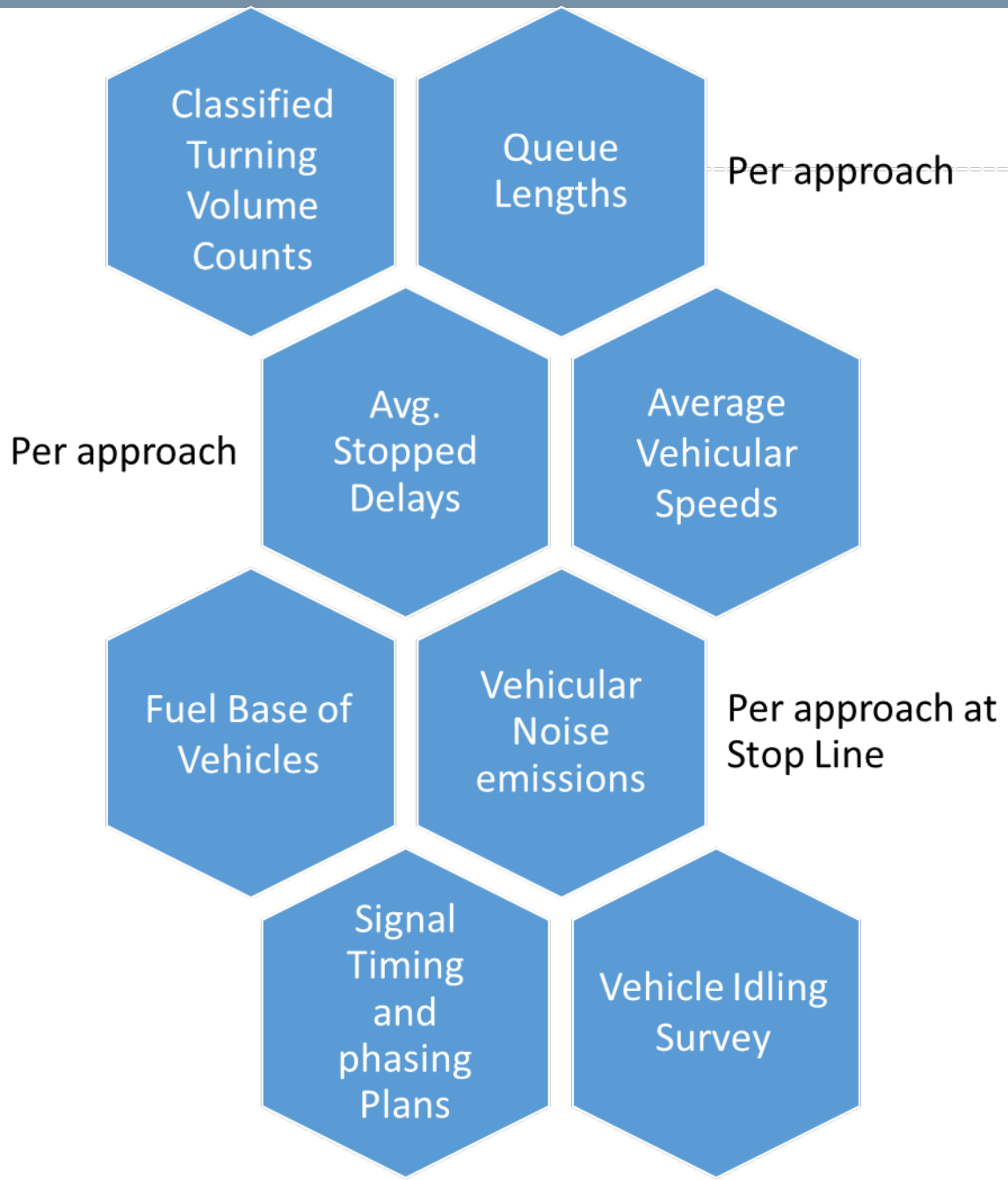
Parameter	KG Marg Intersection	Escorts Hospital Intersection
Location	New Delhi	South Delhi
Type of Network	Arterial- Arterial	Arterial Sub Arterial
Adjoining Land Use	Residential	Mixed Land Use
No. of Arms	4 Arm	4 Arm
Type of Intersection	Isolated	Non Isolated
Signalling Condition	3 Phase	4 Phase
Cycle Length	192 Sec	156 Sec
Channelizing Islands	No	Yes, Two Sides
Median	Only at the Mouth of Intersection for 10 meters from stop-line	Present for the entire length of the road Sections with gap In Median

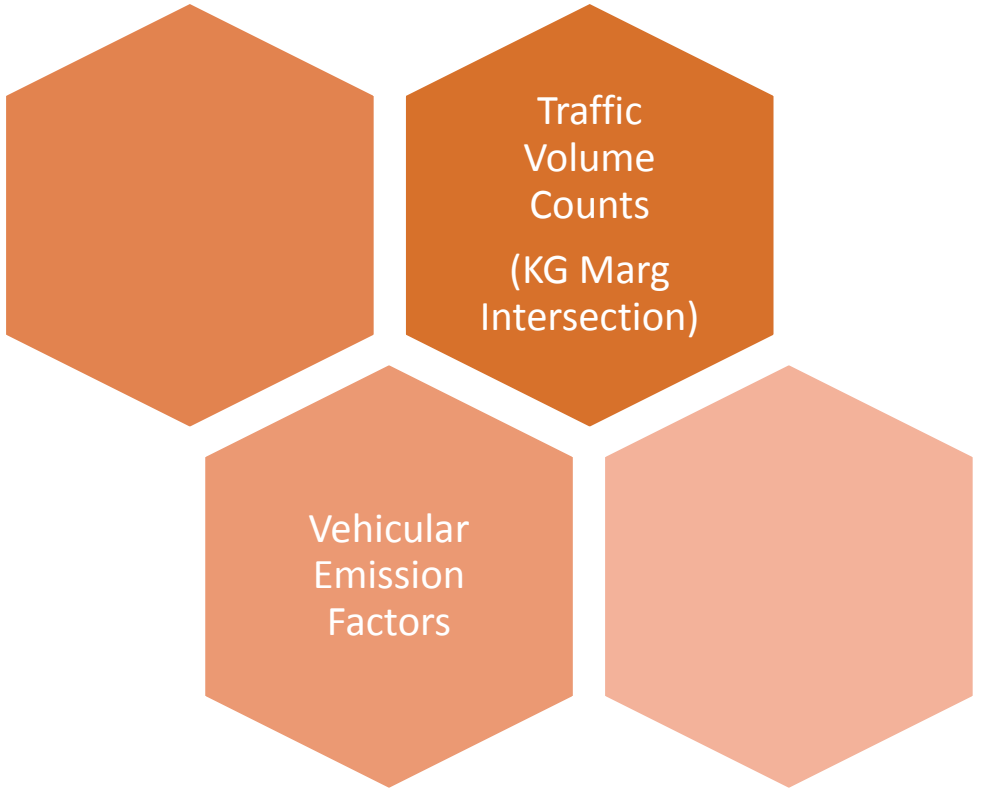
KG Marg- Feroz Shah Road

Escorts Hosp Intersection

Primary Data

Secondary Data

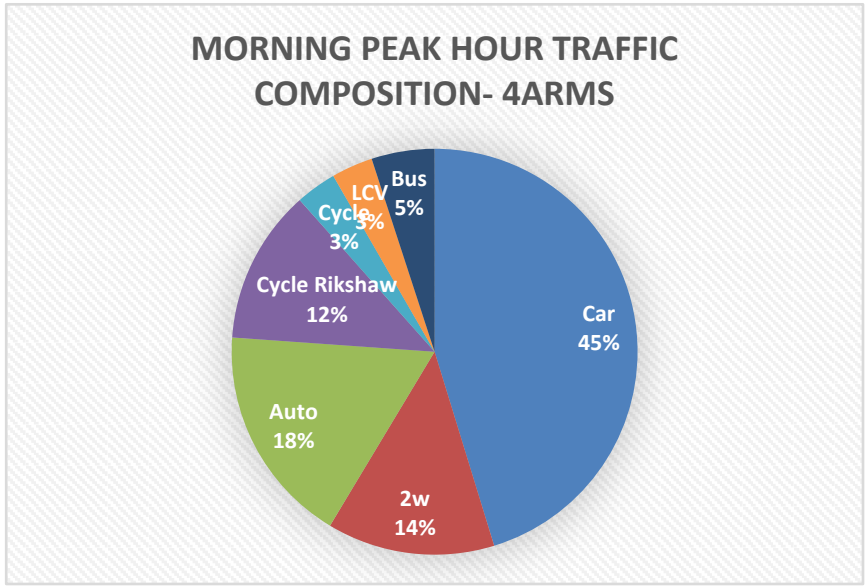


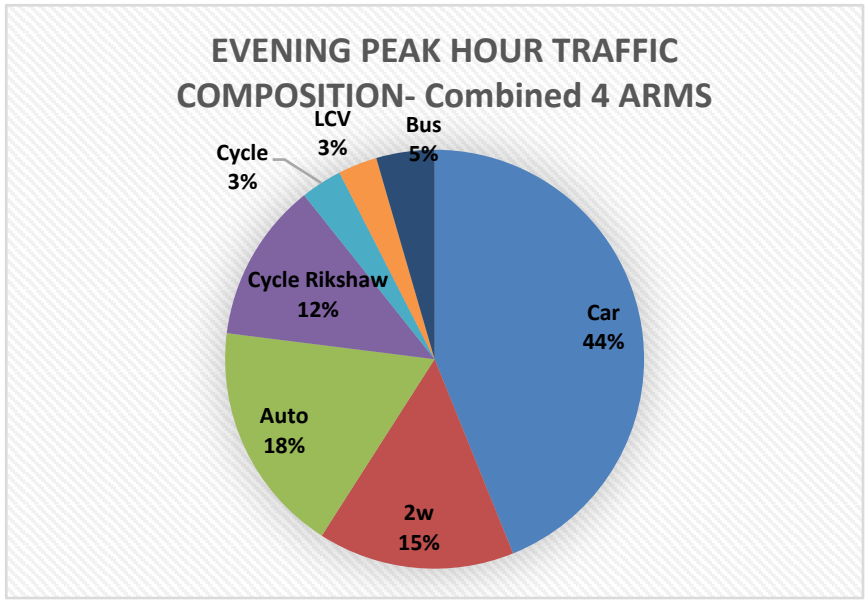


PRELIMINARY ANALYSIS

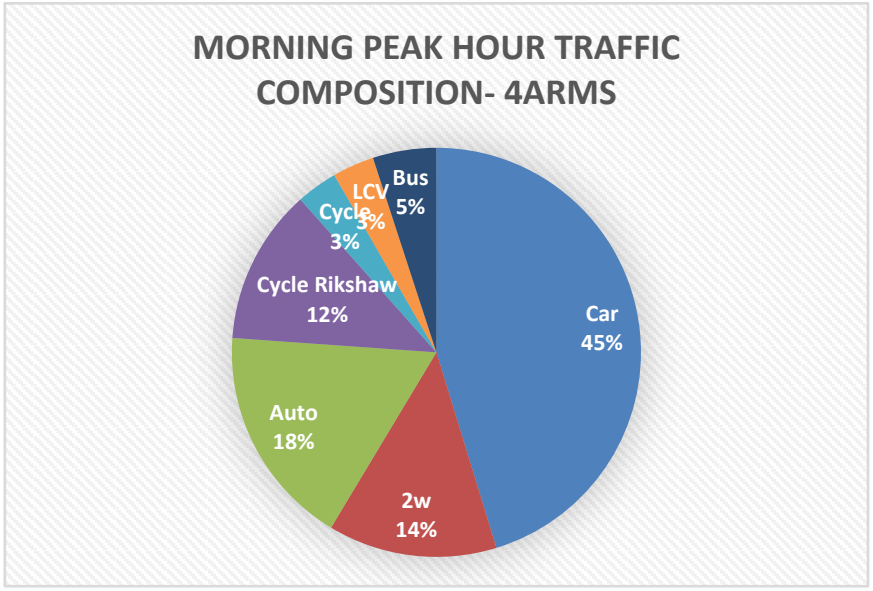
Peak Hour Traffic Shares

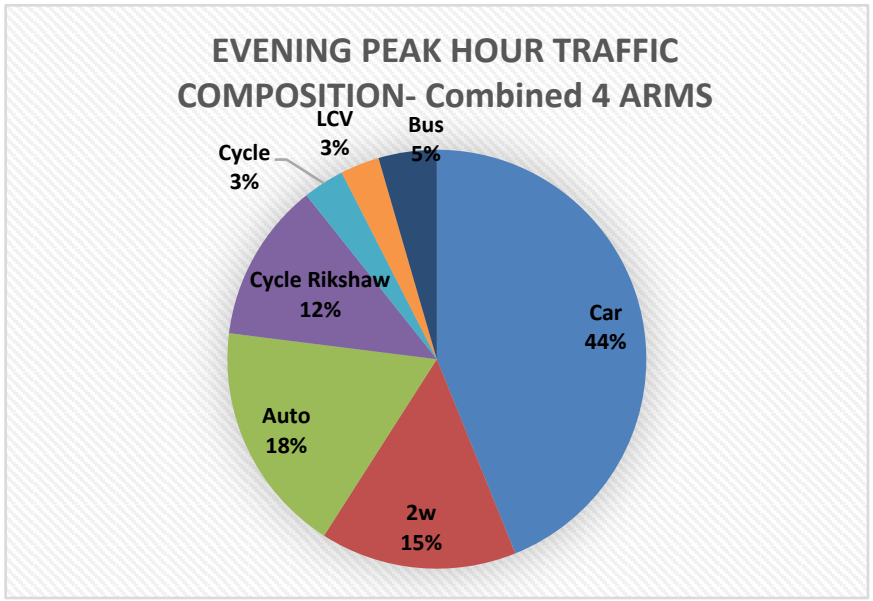
ESCORT HOSPITAL INTERSECTION





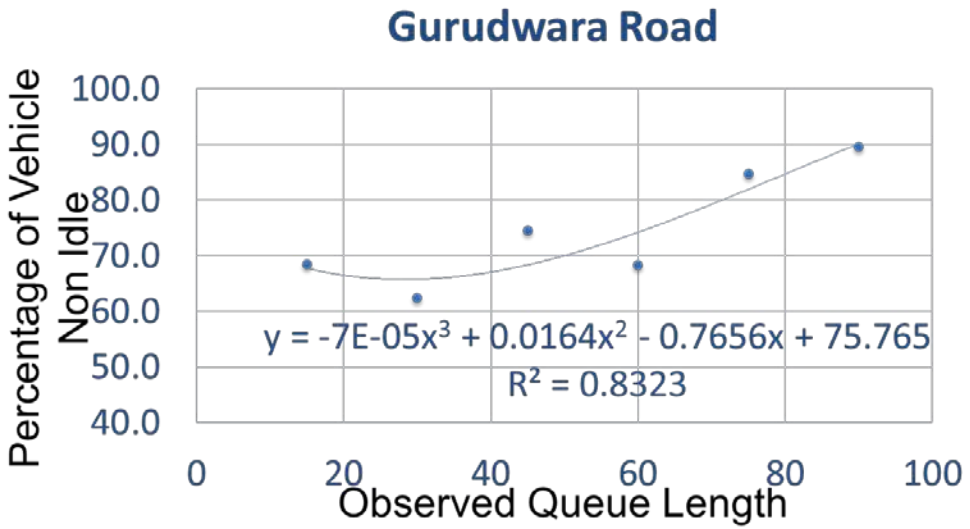
KG MARG- HOSPITAL INTERSECTION

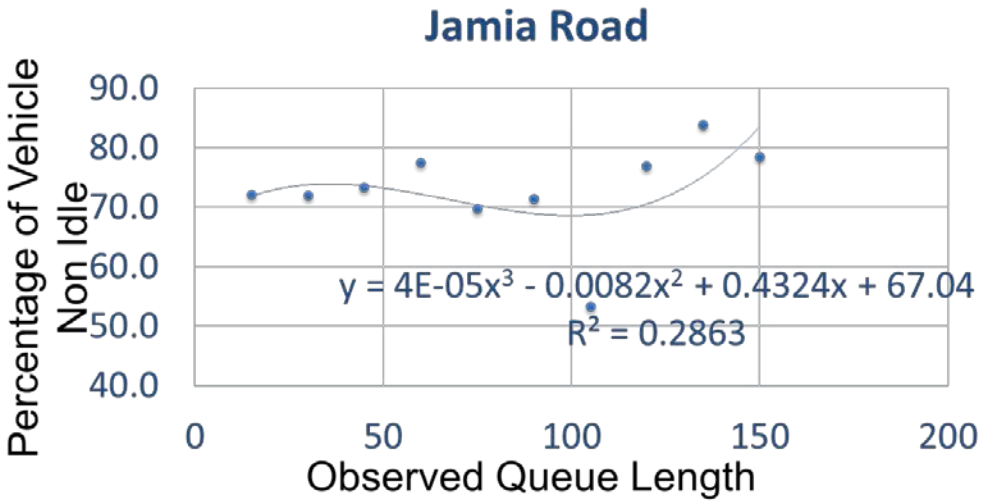


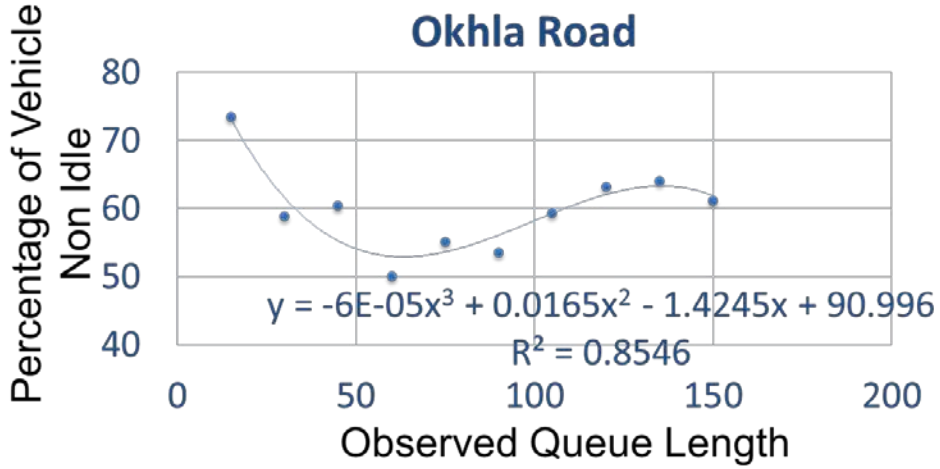


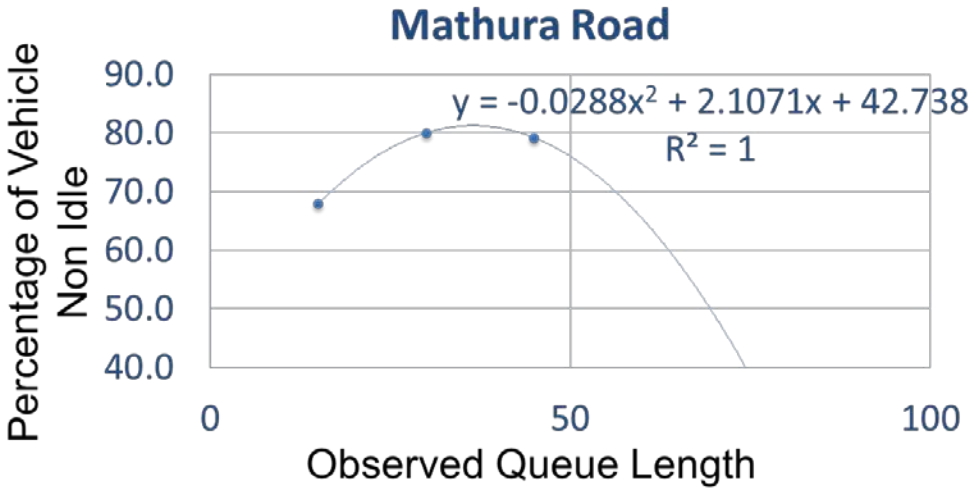
Vehicle Idling Surveys

Escort Hospital Intersection





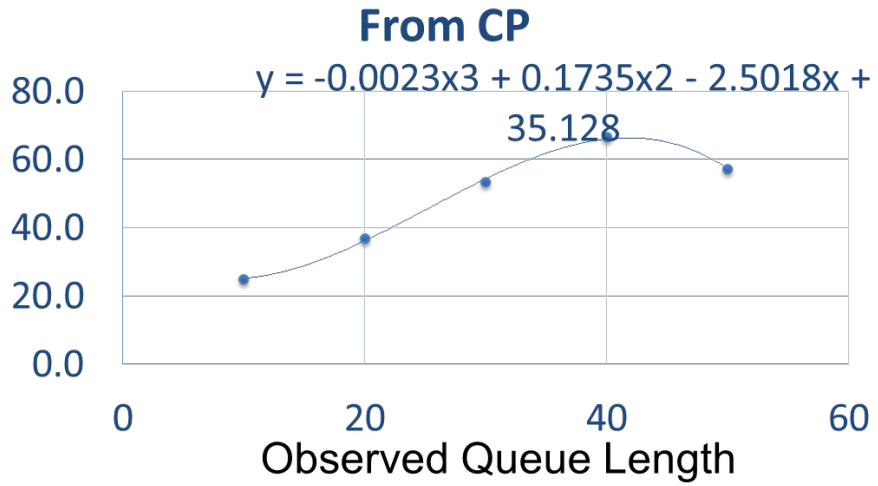


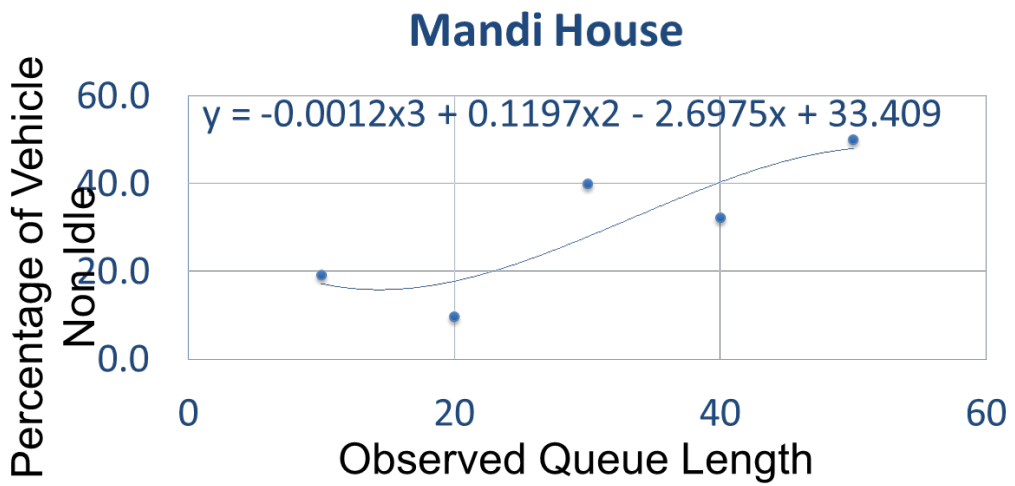


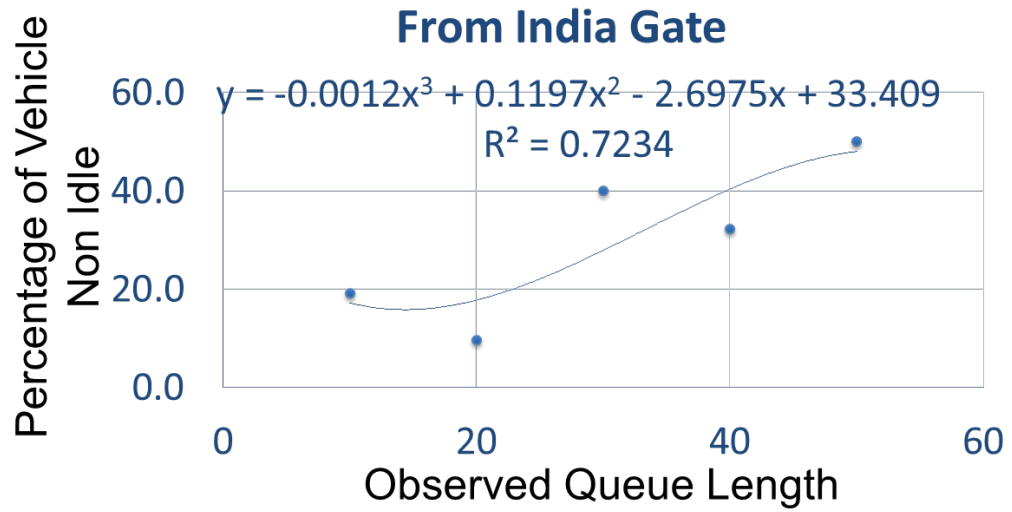
- The general trend follows 3rd degree parabola.

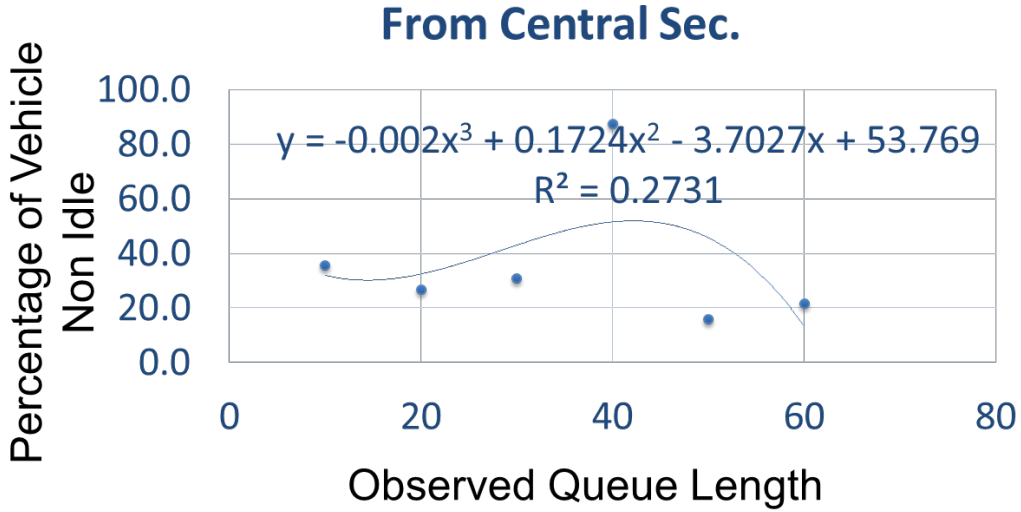
Vehicle Idling Surveys

Kg Marg - Feroz Shah Road Intersection





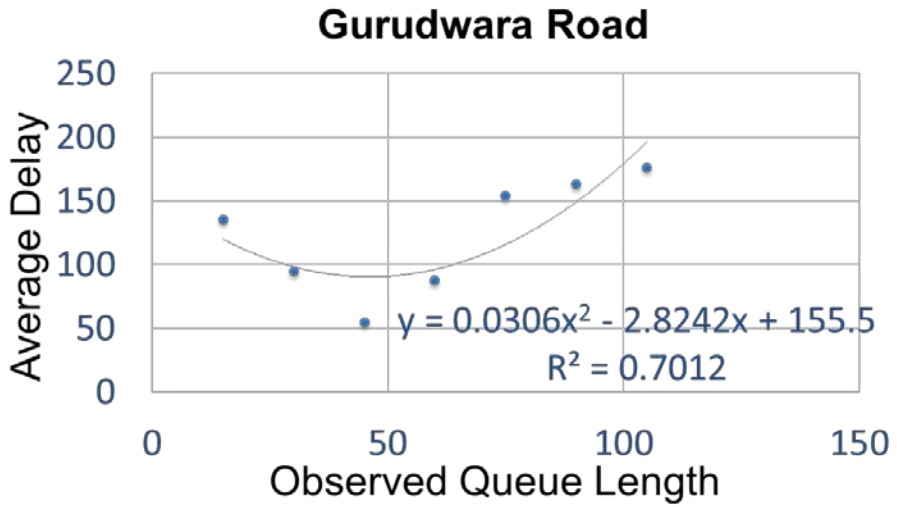


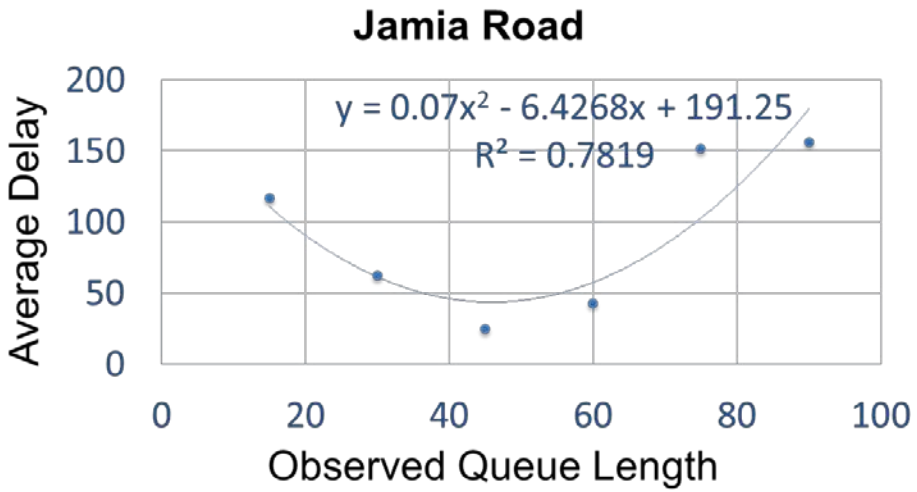


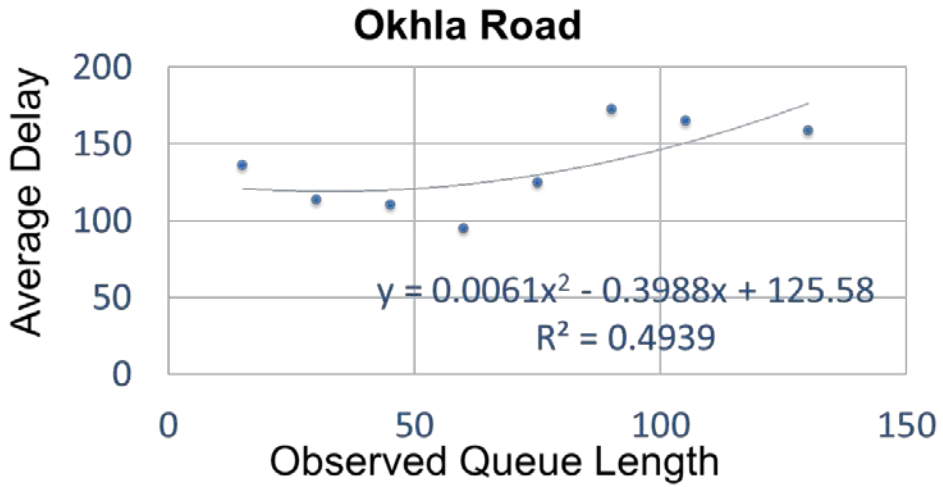
- The general trend follows 3rd degree parabola.

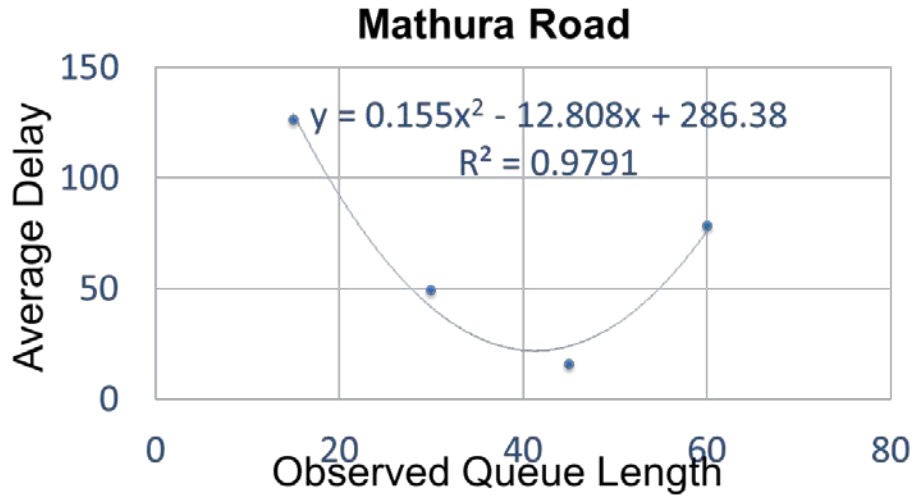
Stopped Delay vs Queue Length

Escort Hospital Intersection





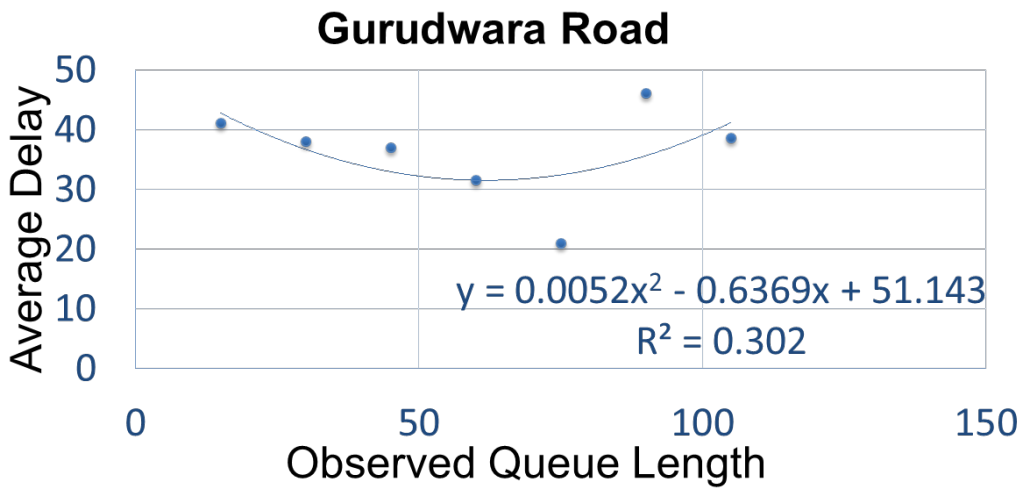


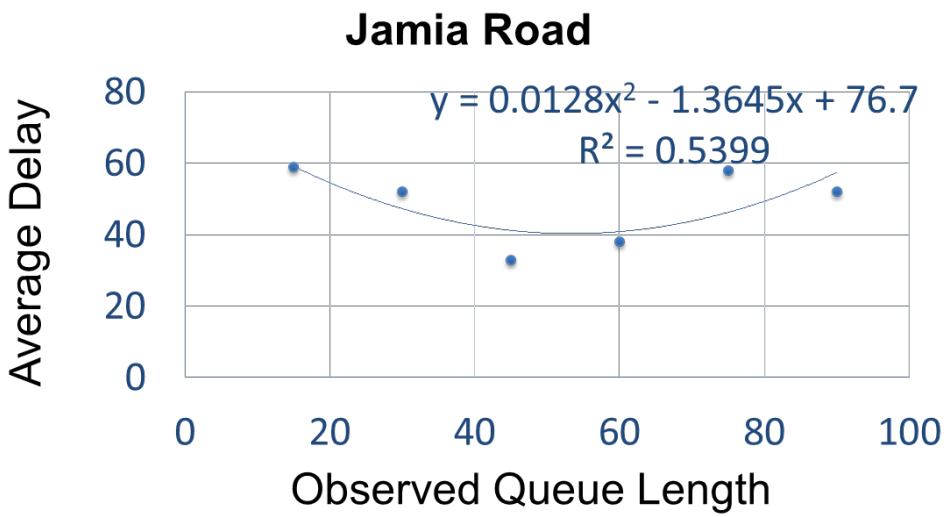


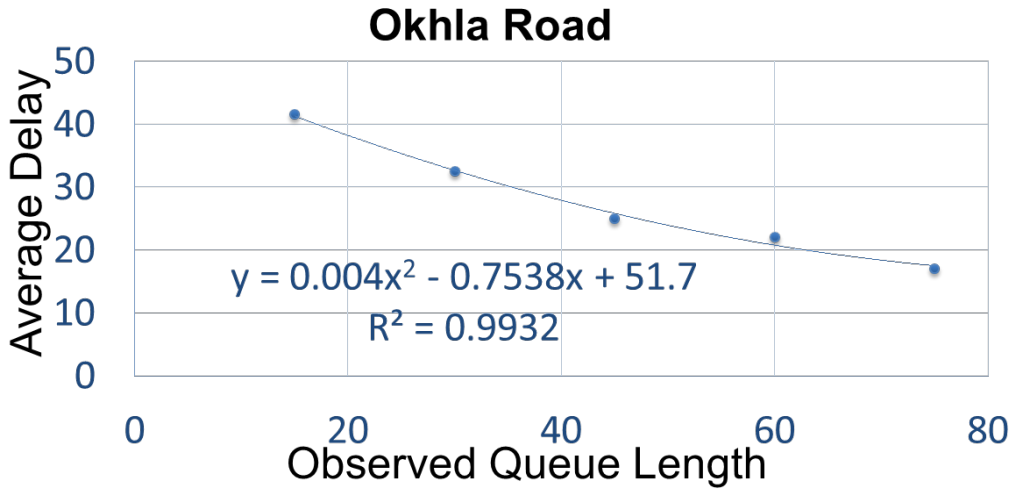
- As the Queue length keeps on Increasing, the Average Delay reduces and later on Increases.
- This is due to the fact that the veh. at back of queue had to stop for second red phase.
- Minimum average delay was found to be similar to the red time of signal

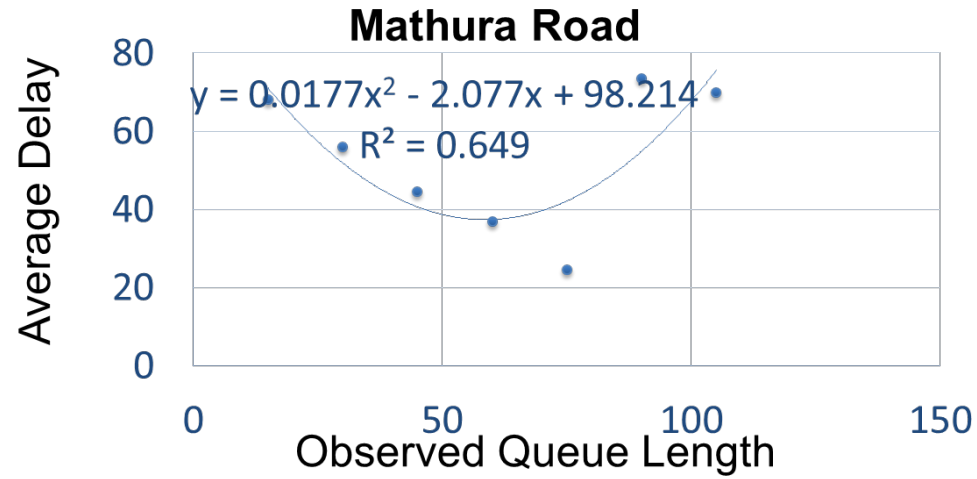
Stopped Delay vs Queue Length

Kg Marg - Feroz Shah Road Intersection









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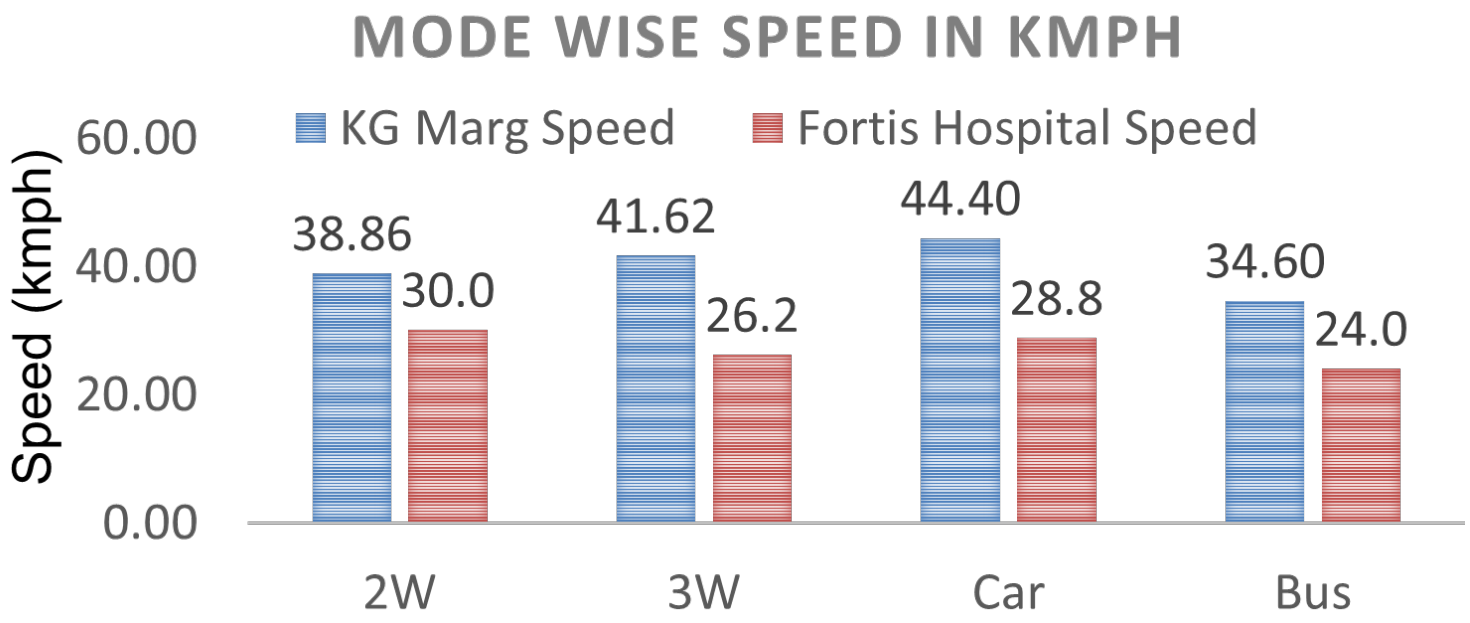
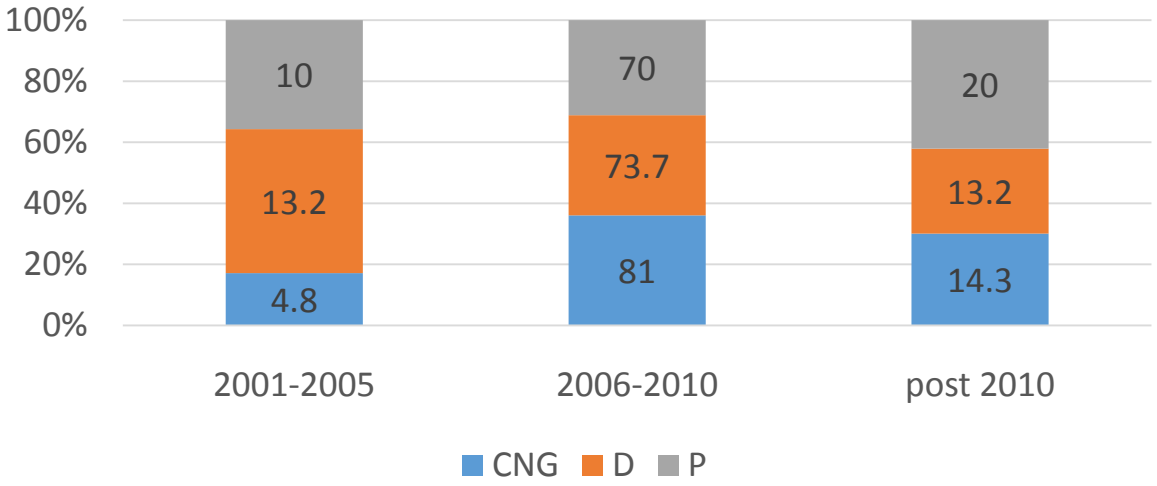
Mode wise Speeds

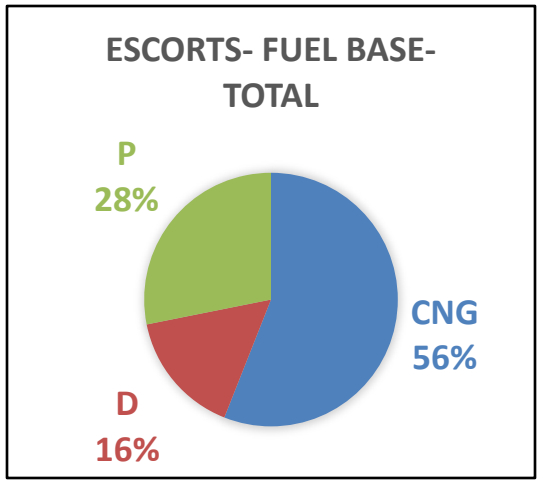


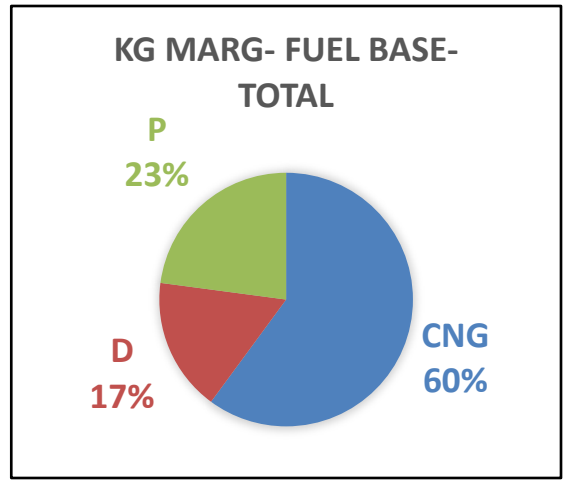
KG Marg - Firoz shah Road and Escort Hospital Intersection				
Mode	**KG Marg Speeds**	**Escorts Hospital Speeds**	**Difference**	**Percentage Difference**
2W	38.86	30.0	8.8	**29%**
3W	41.62	26.2	15.4	**59%**
Car	44.40	28.8	15.6	**54%**
Bus	34.60	24.0	10.6	**44%**

Vehicle Fuel Base

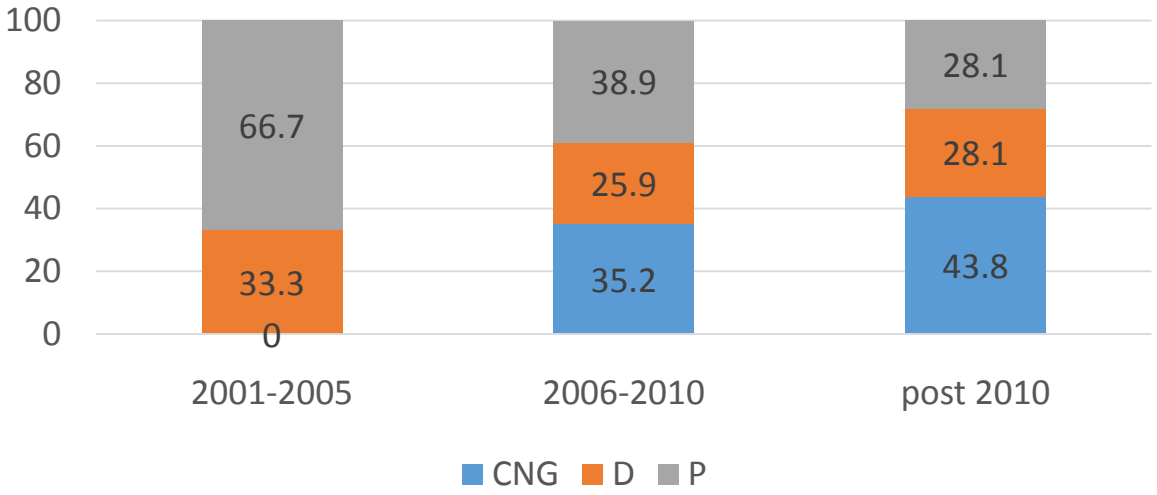
Escort Hospital Intersection





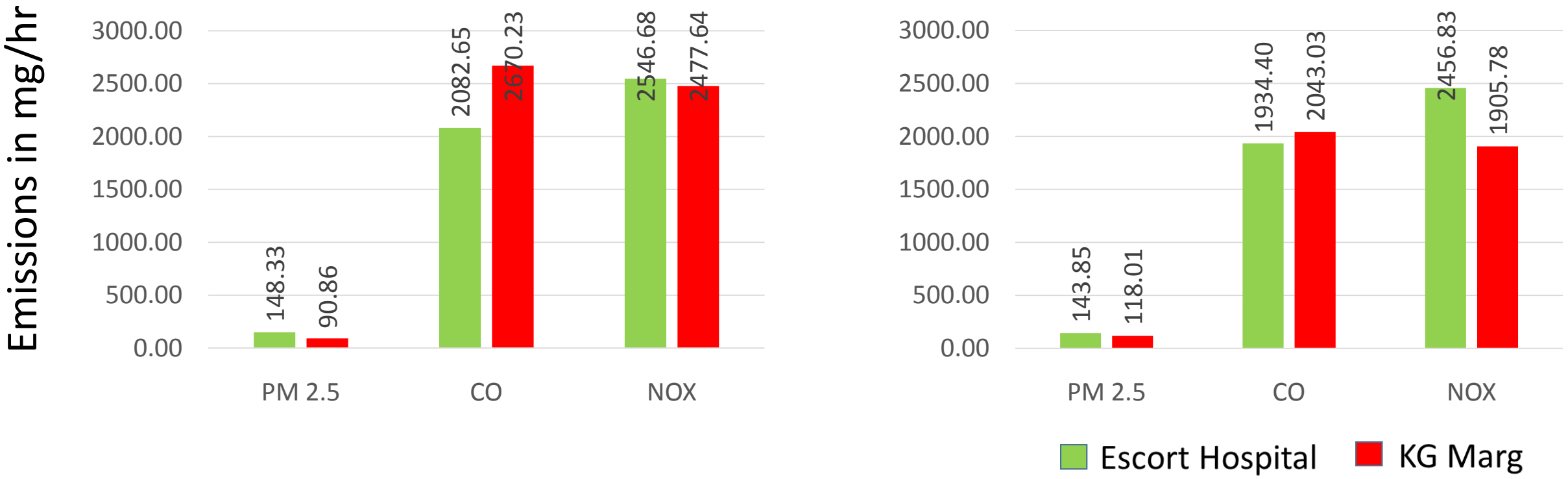


Kg Marg - Feroz Shah Road Intersection



- In KG Marg Intersection, Petrol Vehicles was observed to decrease over time but CNG vehicles show increased trend.
- In Escorts Hosp Int. the diesel vehicles show an Increased Trend.
- KG marg has CNG vehicles 4% higher to that of Escorts Hosp.

Vehicular Emissions



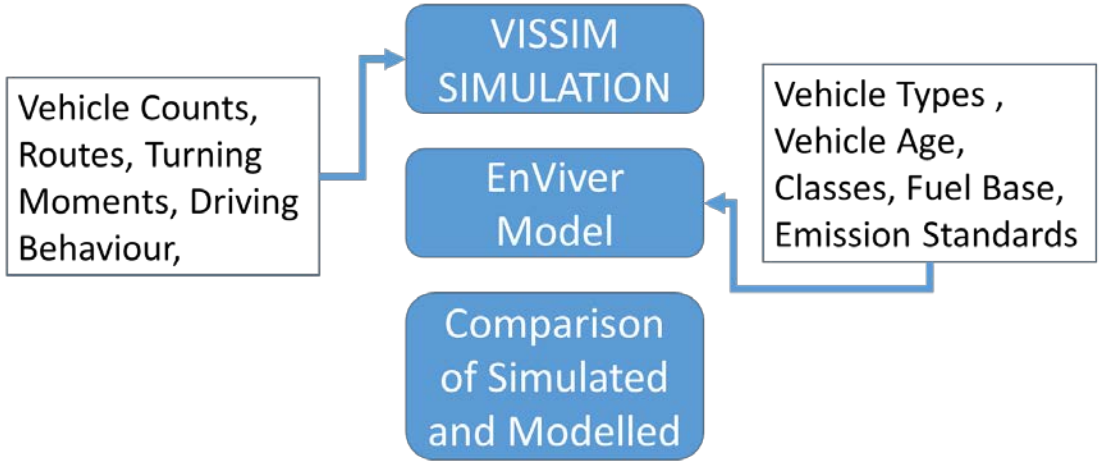
- CO values of KG Marg are higher since KG Marg has 4 percent Higher of CNG Vehicles to that of Escort Hospital Intersection.
- Nox of Escorts Hospital Intersection is comparatively higher as the Buses are higher by 4% in number.
- Gasoline and CNG emits about 9 to 20 times more CO than Other Fuel Types*

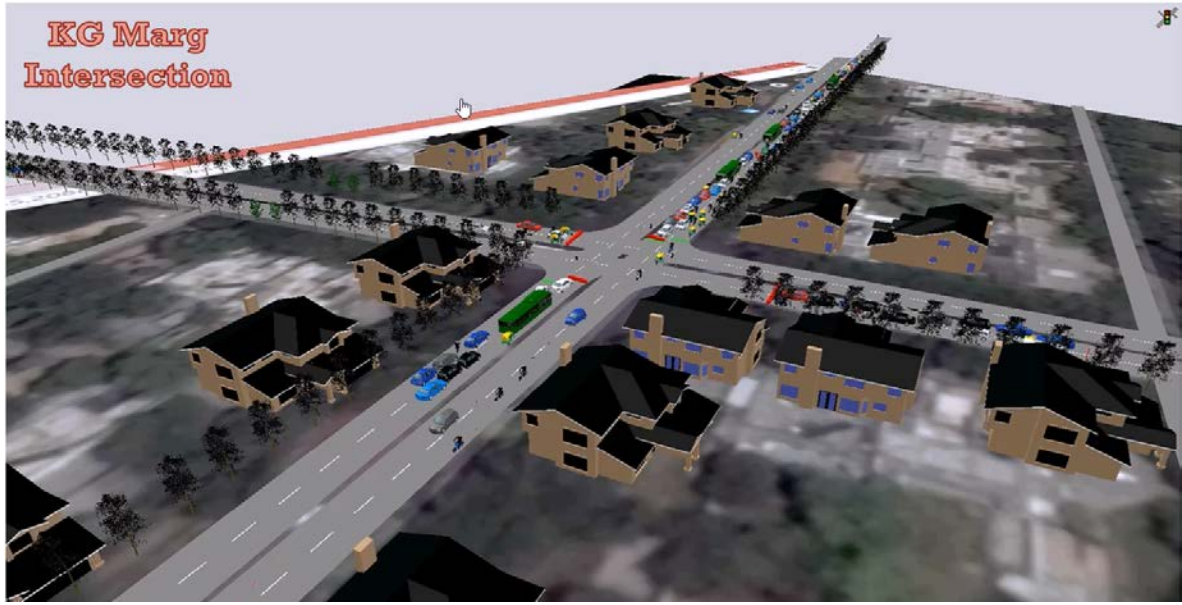
***Source:** Comparison of emissions from Heavy, Medium and Light Vehicles for CNG, Diesel, and Gasoline Vehicles by Abdulla Yasar.*

MICROSIMULATION MODEL

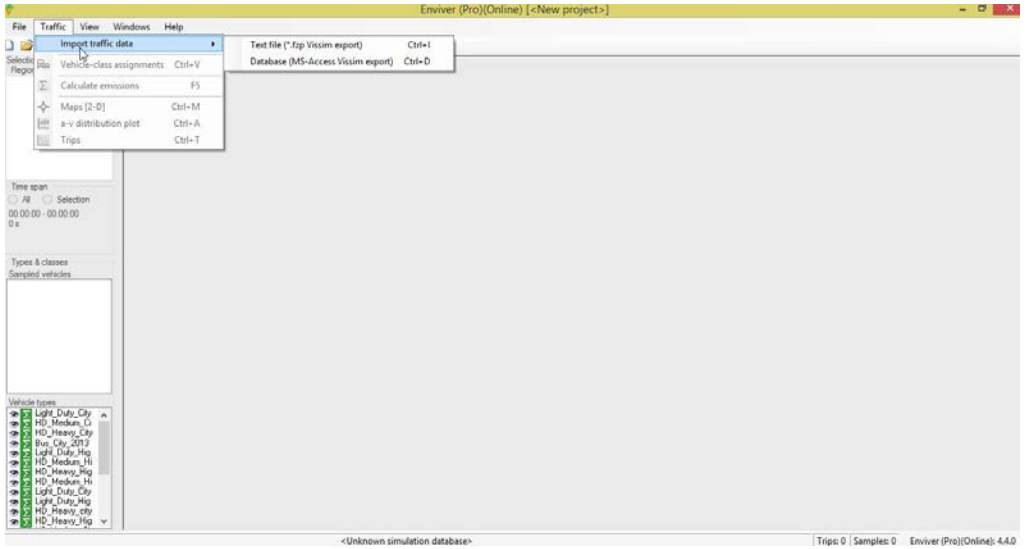
Microsimulation Model

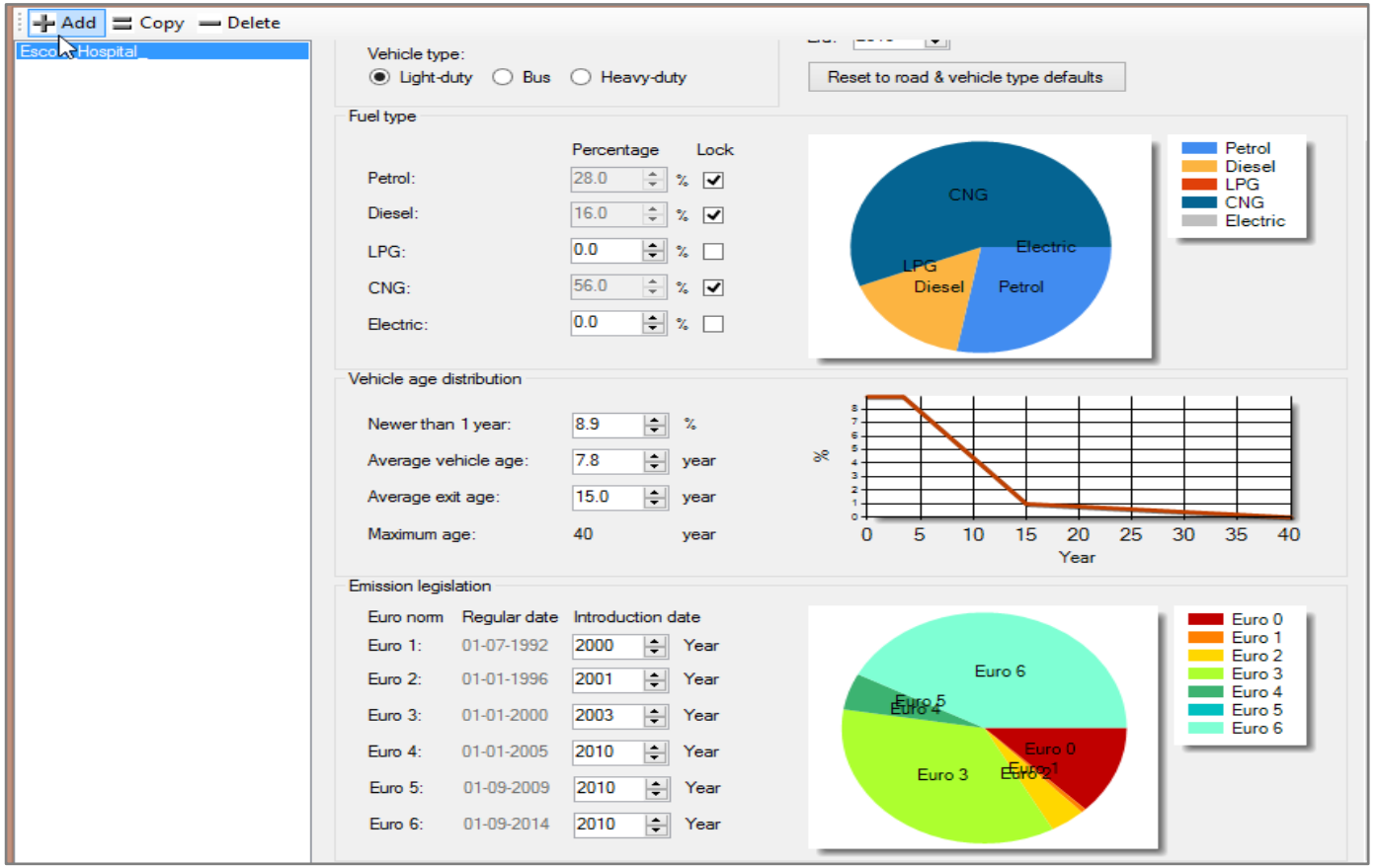
- Compare and validate the Ground count and Simulated Model Emissions.
- To compare the future scenarios or by changing the Input parameters like the Signal Timing, Vehicle composition to get the Emissions





Emissions Modeling- Enviver Pro





Emissions Modeling- Enviver Pro

Enviver (Pro)(Online)

nfc

-

Date: 27-02-2015

Description: -
Remarks:
Traffic data: C:\Users\Public\Documents\PTV Vision\PTV Vissim 7\Escorts Hosp\Escorts Hosp Junction_070.fzp

Application version: 4.4.0 [Release date: 14-05-2014]
VERSIT+micro version: TNO Versit+micro [Release date: 29-8-2013]
Licenced for: school Delhi - Siva Teja Thoyyeti
Mplan Transportation Planning
School of Planning and Architecture, Delhi.

Emission

CO_2	NO_X	PM_{10}
412.939 kg	4023.491 g	130.800 g
2511.116 kg/h	24.467 kg/h	795.405 g/h
834.637 g/km	8.132 g/km	264.374 mg/km

Era: 2015
Time span: 12:00:04-12:09:56

Traffic data

	Total			Calculated			Excluded		
	Trips	Samples	Distance	Trips	Samples	Distance	Trips	Samples	Distance
Light_Duty_City_2013	127	5954	77.5 km	127	5954	77.5 km	0	0	0.0 km
HD_Medium_City_2013	684	30807	417.3 km	684	30807	417.3 km	0	0	0.0 km
Unassigned	149	8775	82.2 km	0	0	0.0 km	149	8775	82.2 km
Total	960	45536	577.0 km	811	36761	494.8 km	149	8775	82.2 km

Emission totals per class

	CO_2	NO_X	PM_{10}
Light_Duty_City_2013	20.890 kg 5.1%	37.455 g 0.9%	4.717 g 3.6%
HD_Medium_City_2013	392.049 kg 94.9%	3986.035 g 99.1%	126.083 g 96.4%
Total	412.939 kg	4023.491 g	130.800 g

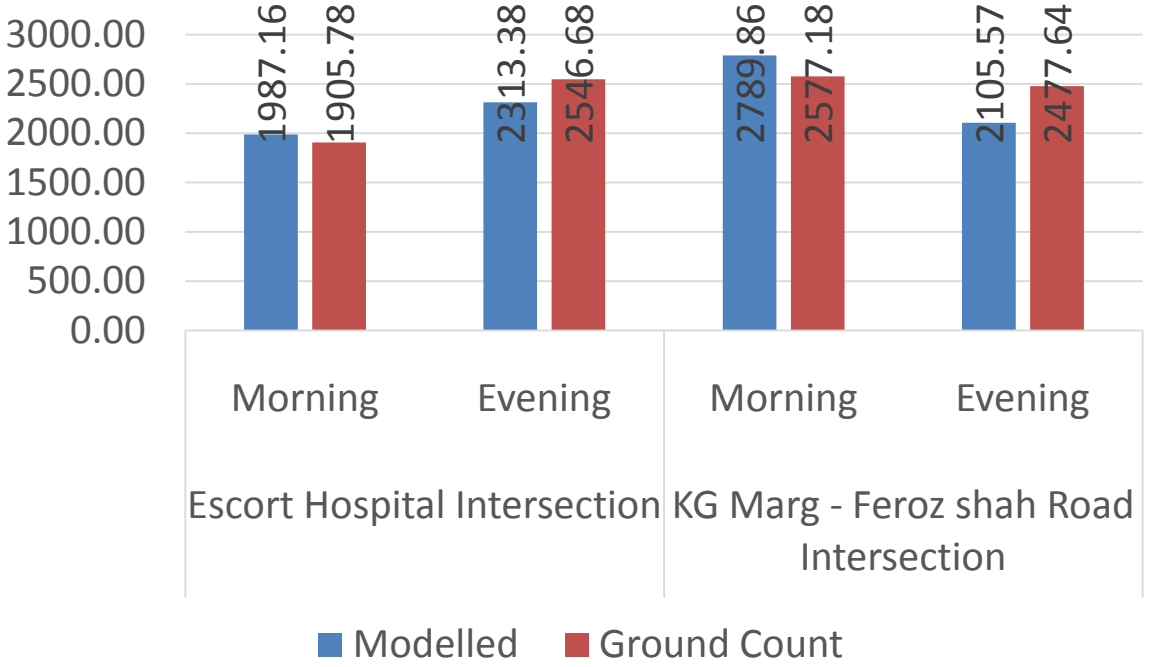
Emission per class per hour

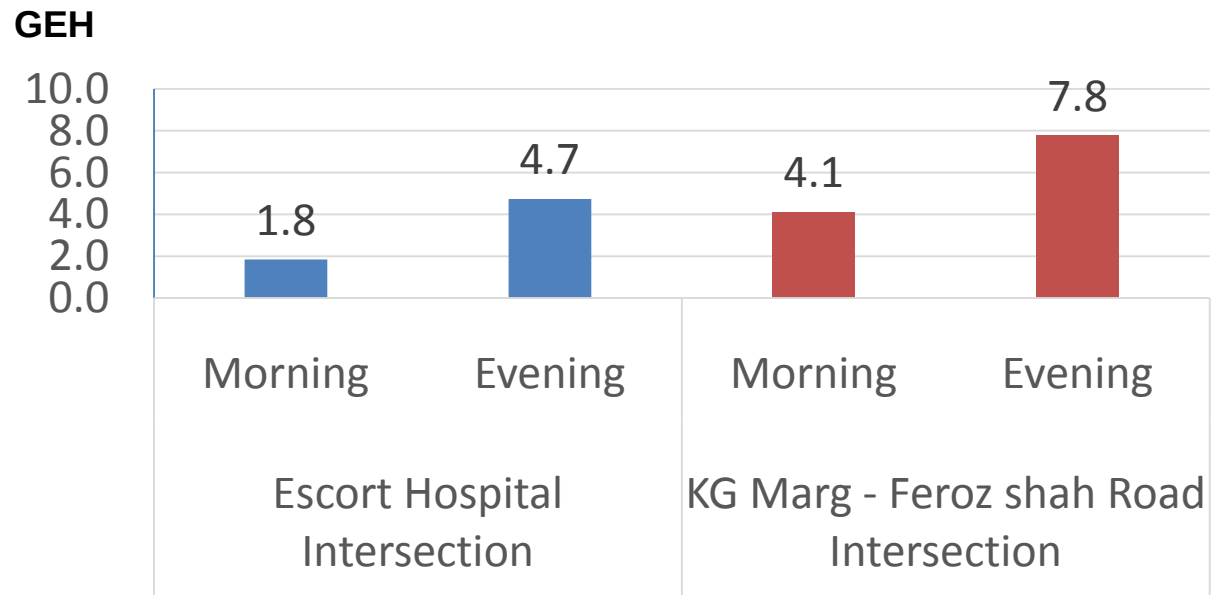
	CO_2	NO_X	PM_{10}
Light_Duty_City_2013	127.036 kg/h	227.770 g/h	28.685 g/h
HD_Medium_City_2013	2384.080 kg/h	24.239 kg/h	766.721 g/h

Emission per class per km.

	CO_2	NO_X	PM_{10}
Light_Duty_City_2013	269.567 g/km	483.322 mg/km	60.868 mg/km
HD_Medium_City_2013	939.586 g/km	9.553 g/km	302.171 mg/km

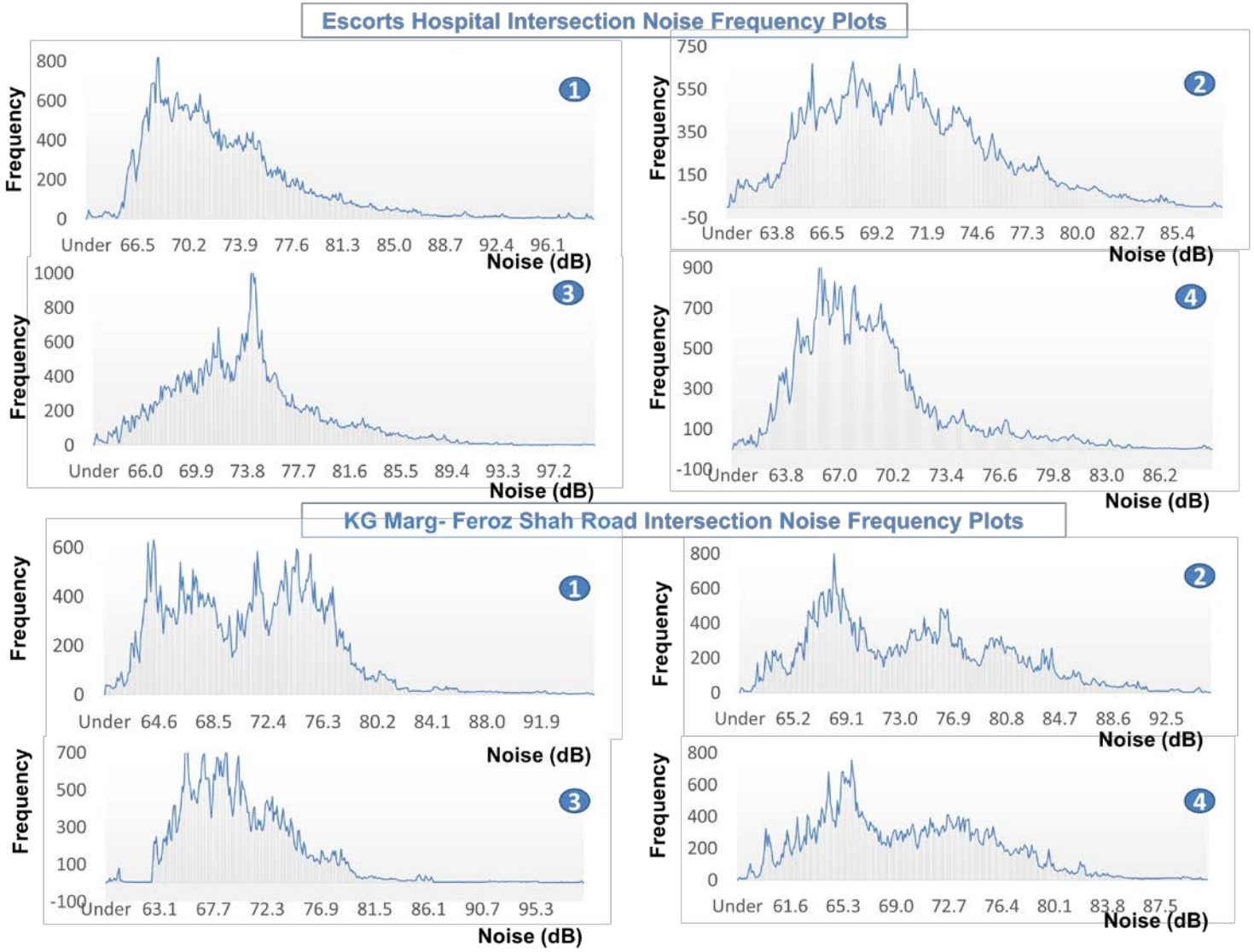
Emissions Modeling- Model Calibration





	Escort Hosp		KG Marg	
Peak Hour Totals	Morning Emissions	Evening Emissions	Morning Emissions	Evening Emissions
Calc. NOX (mg/h)	1905.78	2546.68	2577.18	2477.64
Simulated Nox (mg/h)	1987.16	2313.38	2789.86	2105.57
Change in Sim vs Obs	4.3	-9.2	8.3	-15.0
GEH (Index)	**1.8**	**4.7**	**4.1**	**7.8**

Noise Emissions



Location	Data Point	Peak Intensity (dB)	L equivalent (db)
Escort Hospital	1	113.1	79.7
	2	113.1	79.1
	3	102.1	73.9
	4	104.1	72.3
KG Marg	1	112.7	75.9
	2	110.7	79.5
	3	113.3	76.9
	4	107.5	74.4

Arriving at Level of Service

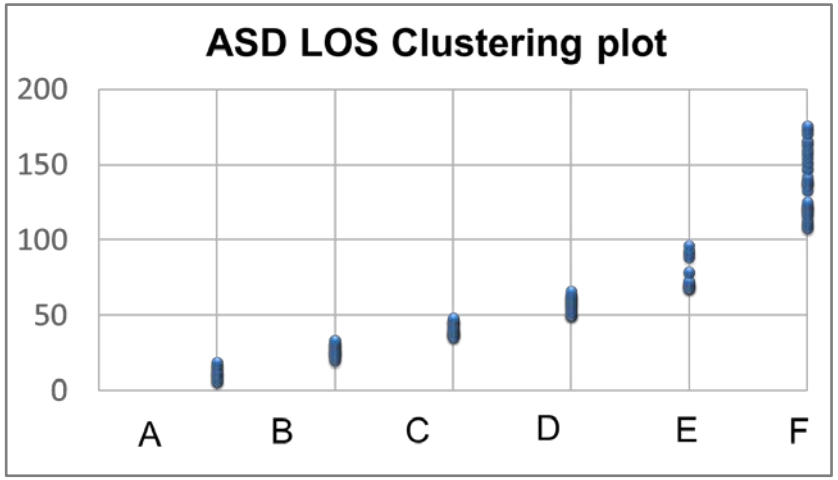
Graph of various occurrences of ASD, Noise Frequency Occurrences

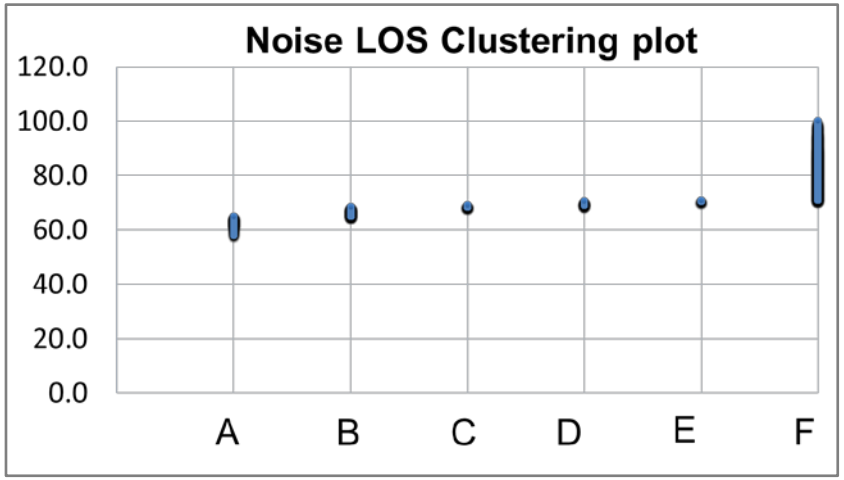
K-Mean Clustering Technique

Weight Position Plots

Statistical Data Reduction Method /Clustering Method

Level of Service Standards





Level of Service Standard	Average Stopped Delay (Sec per Vehicle)
LOS A	Upto 20
LOS B	21 to 35
LOS C	36 to 50
LOS D	50 to 70
LOS E	71 to 100
LOS F	>100

Level of Service Standard	Noise Level Emission Ranges in dB
LOS A	Up to 60
LOS B	60 to 65
LOS C	65 to 68
LOS D	68 to 70.5
LOS E	70.5 to 71.6
LOS F	Over 71.6

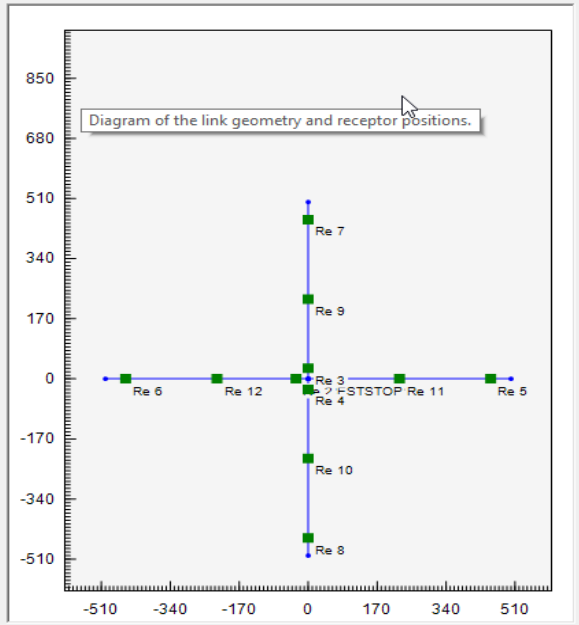
Conversion of Vehicular Emissions to Ambient Air Pollution

- CALINE4 - a dispersion model that predicts carbon Monoxide (CO) and PM impacts along and near roadways.
- To anticipate adverse effects of excessive CO & PM exposure.
- Simple line source Gaussian plume dispersion model.
- Inputs required are
  - roadway geometry,
  - worst-case meteorological parameters,
  - anticipated traffic volumes,
  - receptor positions.

Meteorological Factors	Escort Hospital Intersection	KG Marg- Feroz Shah Road Intersection
Wind Direction Angle	292	292
Atmospheric Stability Class (fn of wind speed)	5	5
Mixing Height (m)	1500	1000
Ambient Temperature (Deg. Centigrade)	27	27
Ambient CO Concentration (PPM)	3.25	3.25

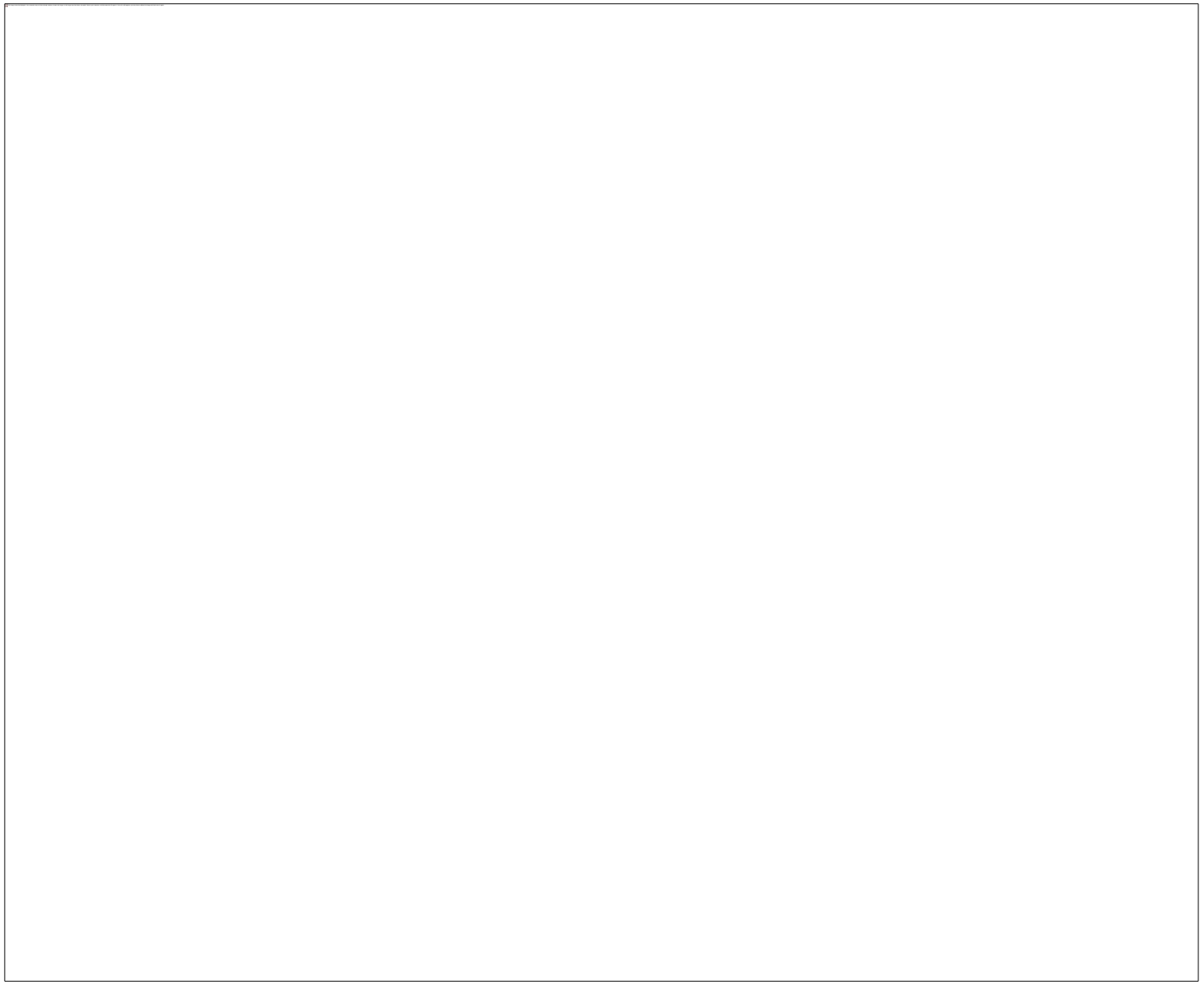
	Receptor Name	X	Y	Z
▸	RESTSTOP1	30	0	1.8
	Re 2	-30	0	1.8
	Re 3	0	30	1.8
	Re 4	0	-30	1.8
	Re 5	450	0	1.8
	Re 6	-450	0	1.8
	Re 7	0	450	1.8
	Re 8	0	-450	1.8
	Re 9	0	225	1.8
	Re 10	0	-225	1.8
	Re 11	225	0	1.8
	Re 12	-225	0	1.8

Units are in meters



Click and drag a box to zoom - Click once to unzoom

Emission Dispersion Results- CALINE 4



LOS Standards	CO in mg/m^3	PM 2.5 in ug/m^3
A	Up to 3.25	55
B	3.25 to 5	55 to 60
C	5 to 7.5	60 to 65
D	7.5 to 9.5	65 to 70
E	9.5 to 12	70 to 75
F	> 12	>75
	Ambient Air Concentrations	

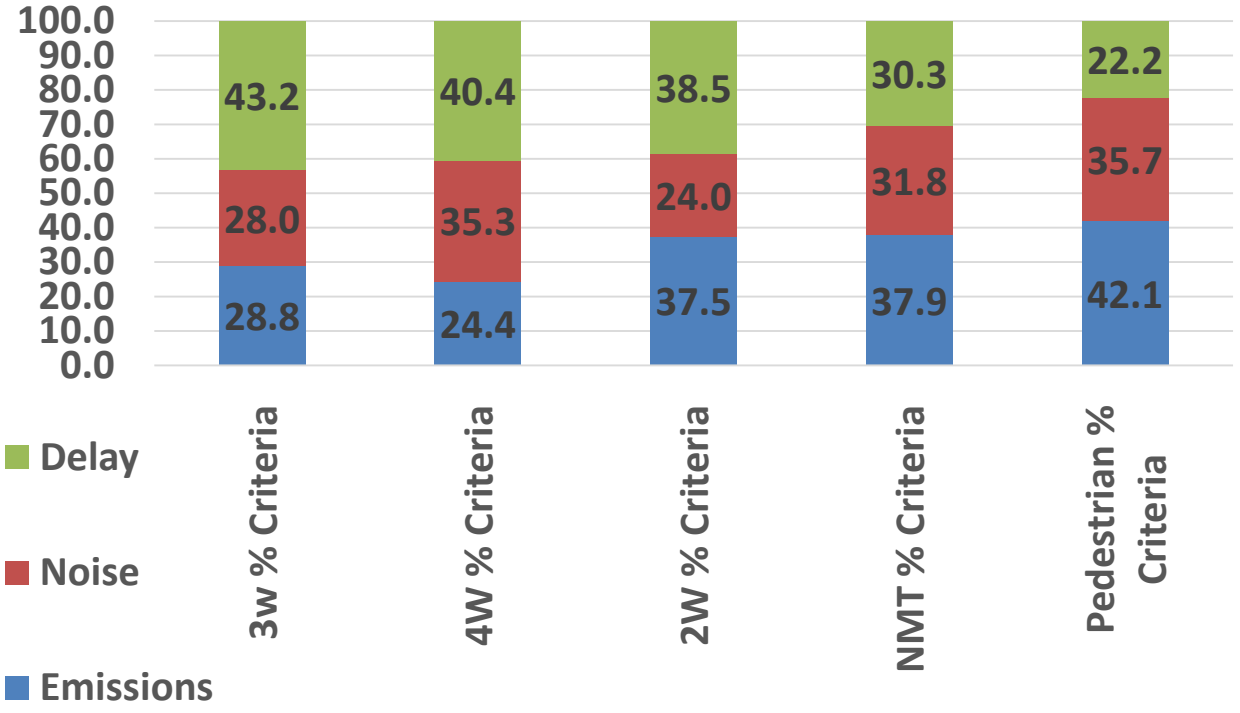
Level of Service Standards

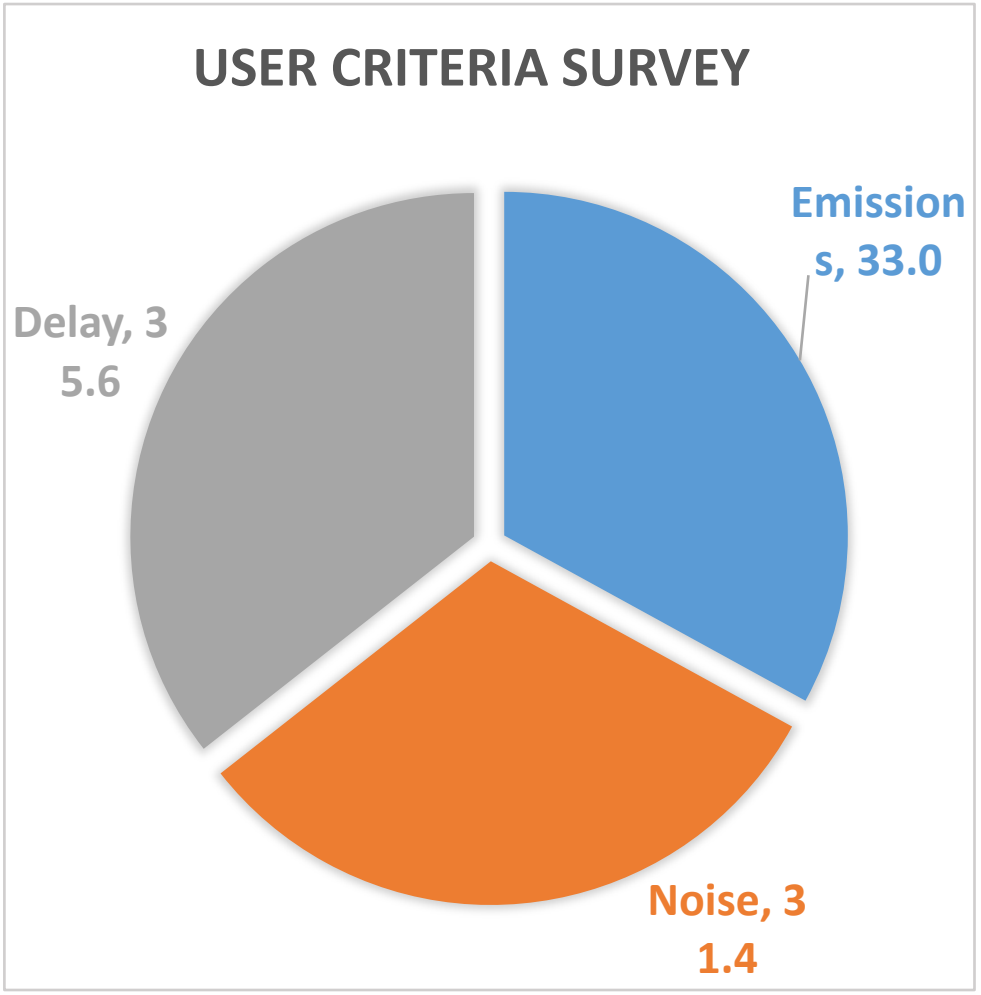
LOS Criteria	Average Stopped Delay (Sec per Vehicle)	Noise Emissions (dB)	CO in mg/m^3	PM 2.5 in ug/m^3
LOS A	Up to 20	Up to 60	Up to 3.25	Up to 55
LOS B	21 to 35	60 to 65	3.25 to 5	55 to 60
LOS C	36 to 50	65 to 68	5 to 7.5	60 to 65
LOS D	50 to 70	68 to 70.5	7.5 to 9.5	65 to 70
LOS E	71 to 100	70.5 to 71.6	9.5 to 12	70 to 75
LOS F	>100	Over 71.6	> 12	>75

Road User Criteria Survey for Level of Service

Around 100 samples for criteria of each Intersection LOS with respect to various modes like

- 3 Wheeler
- 2 Wheeler
- 4 Wheeler drivers
- NMT Pullers
- Pedestrians





Conclusion: Combined Level of Service Standards- Weighted Averages

KG Marg	LOS	Avg Stopped Delay (sec/veh)
	A	Upto 20
	B	21 to 35
	C	36 to 50
	D	50 to 70
	E	71 to 100
	F	>100

Enter	Calculated LOS of Intersection	C
	Criteria	33

LOS	Noise Level Range in dB (L50)
A	Upto 60
B	60 to 68.4
C	68.4 to 69
D	69 to 70.5
E	70.5 to 71.6
F	Over 71.6

Enter	Calculated LOS of Intersection	D
	Criteria	31.4

LOS	PM 2.5 (ug/m^3)	CO in PPM
A	up to 55	Up to 3.25
B	55 to 60	3.25 to 5
C	60 to 65	5 to 7.5
D	65 to 70	7.5 to 9.5
E	70 to 75	9.5 to 12
F	> 75	> 12

Enter	Calculated LOS of Intersection	4	5	E
	Criteria	17.80	17.80	35.6

Final Result	
Combined Result	Combined LOS
5	E

Escort Hospital	LOS	Avg Stopped Delay (sec/veh)
	A	Upto 20
	B	21 to 35
	C	36 to 50
	D	50 to 70
	E	71 to 100
	F	>100

Enter	Calculated LOS of Intersection	C
	Criteria	33

LOS	Noise Level Range in dB (L50)
A	Upto 60
B	60 to 68.4
C	68.4 to 69
D	69 to 70.5
E	70.5 to 71.6
F	Over 71.6

Enter	Calculated LOS of Intersection	C
	Criteria	31.4

LOS	PM 2.5 (ug/m^3)	CO in PPM
A	up to 55	Up to 2
B	55 to 60	2 to 4
C	60 to 65	4 to 7.5
D	65 to 70	7.5 to 9.5
E	70 to 75	9.5 to 12
F	> 75	> 12

Enter	Calculated LOS of Intersection	3	6	E
	Criteria	17.80	17.80	35.6

Final Result	
Combined Result	Combined LOS
4	D

Acknowledgement

School of Planning and Architecture, New Delhi

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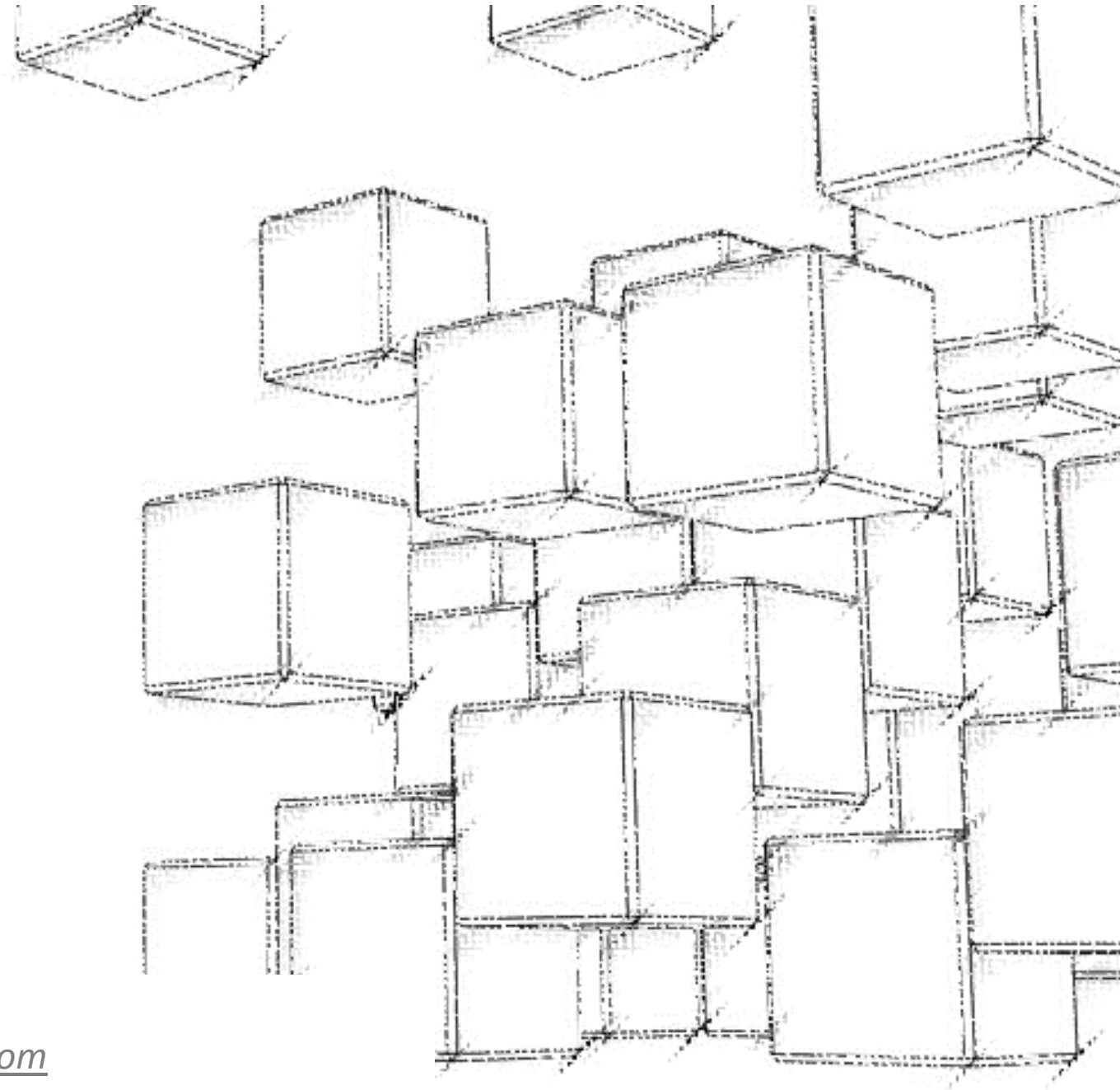

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