Illuminating ENGINEERING SOCIETY

CONTINUING EDUCATION AIA

IES Street and Area Lighting Conference

LIGHTING INVENTORY ASSESSMENTS

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SALC September 14-17, 2014 Nashville, TN

OVERVIEW

Review process's and methods which can be applied to an:

- LED Conversion
- Adaptive Lighting System

Review inventory assessment process as it applies to lighting levels and design

Provide options and methods

OVERVIEW

WHAT IS AN INVENTORY ASSESSMENT?

WHY?

HOW?

FINDINGS

WHAT IS AN INVENTORY ASSESSMENT ?

An inventory assessment is a review of the existing lighting system. An inventory system is most often used to manage and maintain the system.

We undertake as part of an LED lighting conversion and / or an adaptive lighting controls system deployment to assess the performance of the existing lighting system and define what new lighting is required.

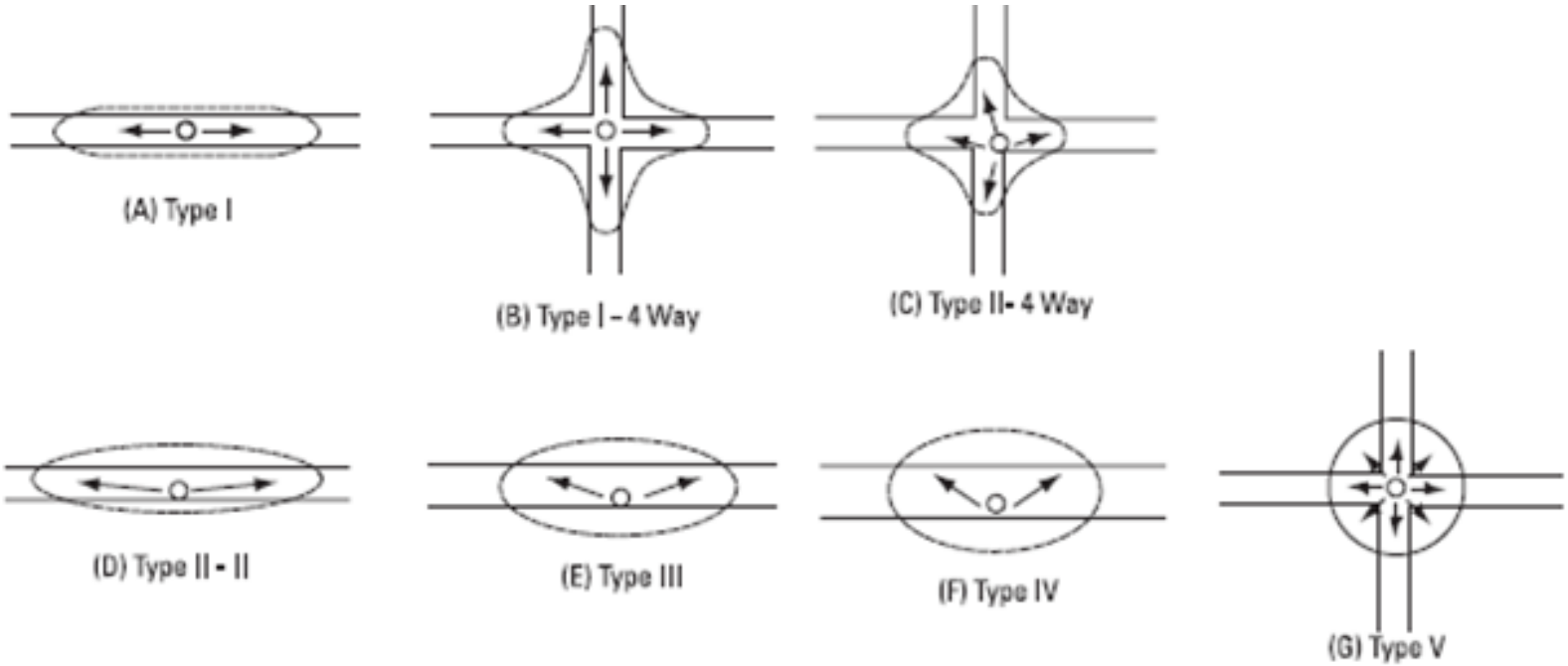
IESNA ROAD LIGHTING LEVELS

Road Area and Pedestrian Activity		Average Luminance cd/m^2	Average-to-Minimum Uniformity Ratio	Maximum-to-Minimum Uniformity Ratio	Maximum-to-Average Veiling Luminance Ratio
Road Type	Pedestrian Activity				
Freeway	--	≥ 0.6	≤ 3.5	≤ 6.0	≤ 0.3
Partial Lighting of Interchange On-Ramps/ Off-Ramps	--	≥ 0.6	≤ 3.5	≤ 6.0	≤ 0.3
Expressway-Highway	High	≥ 1.0	≤ 3.0	≤ 5.0	≤ 0.3
	Medium	≥ 0.8	≤ 3.0	≤ 5.0	≤ 0.3
	Low	≥ 0.6	≤ 3.5	≤ 6.0	≤ 0.3
Arterial	High	≥ 1.2	≤ 3.0	≤ 5.0	≤ 0.3
	Medium	≥ 0.9	≤ 3.0	≤ 5.0	≤ 0.3
	Low	≥ 0.6	≤ 3.5	≤ 6.0	≤ 0.3
Collector	High	≥ 0.8	≤ 3.0	≤ 5.0	≤ 0.4
	Medium	≥ 0.6	≤ 3.5	≤ 6.0	≤ 0.4
	Low	≥ 0.4	≤ 4.0	≤ 8.0	≤ 0.4
Local/Alleyway	High	≥ 0.6	≤ 6.0	≤ 10.0	≤ 0.4
	Medium	≥ 0.5	≤ 6.0	≤ 10.0	≤ 0.4
	Low	≥ 0.3	≤ 6.0	≤ 10.0	≤ 0.4

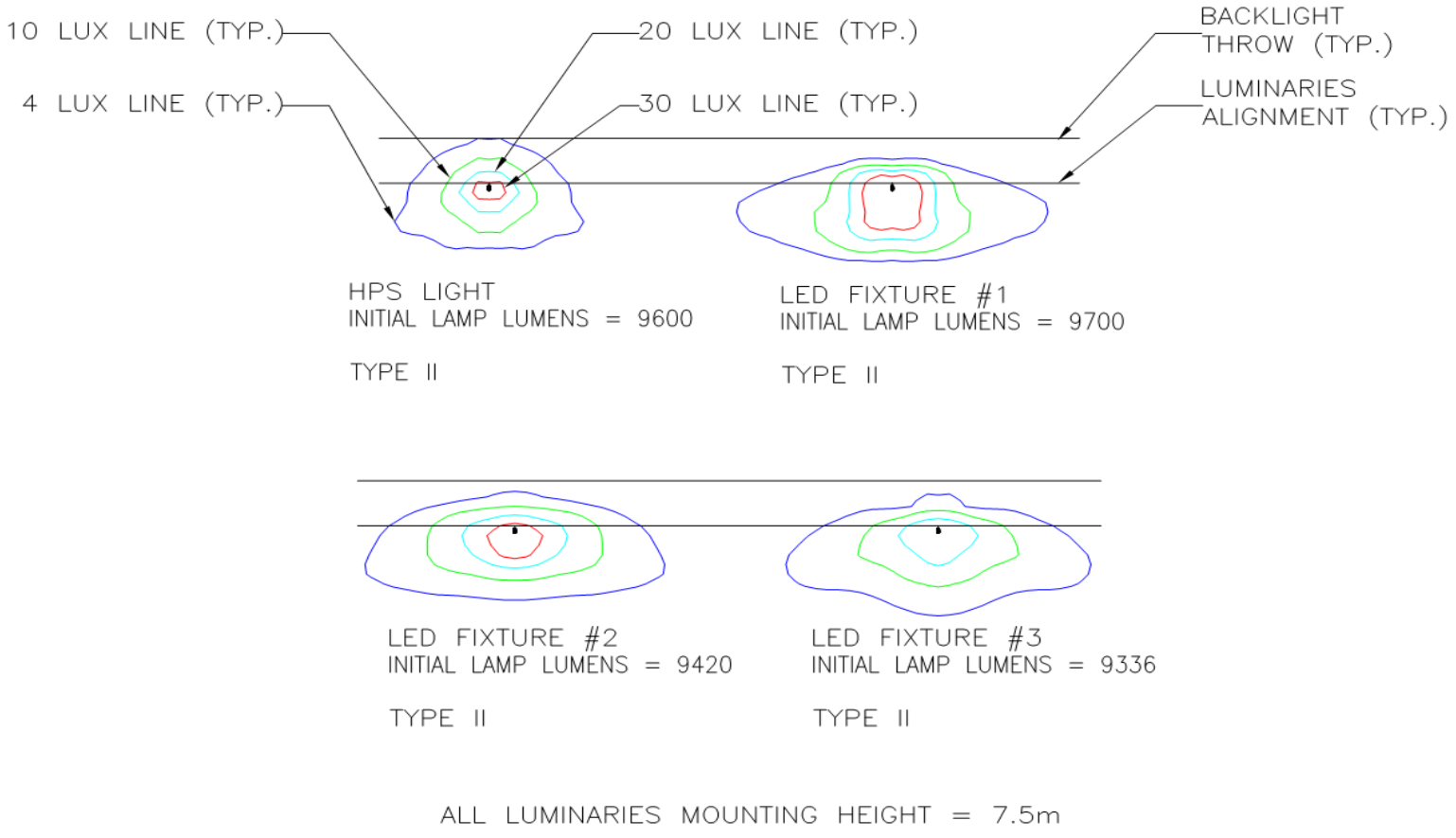
IESNA SIDEWALK LIGHTING LEVELS

Pedestrian Activity	Maintained Average Horizontal Illuminance (lux)	Average-to - Minimum Horizontal Uniformity Ratio	Minimum Maintained Vertical Illuminance (lux)
High	≧ 20.0	≦ 4.0	≧ 10.0
Medium	≧ 5.0	≦ 4.0	≧ 2.0
Low	≧ 3.0	≦ 6.0	≧ 0.8

IESNA LIGHT DISTRIBUTIONS



WHY? – LED OPTICS ARE DIFFERENT



THE HOW

Calculation Method - Use City Geographic information system (GIS), As built drawings, maps to obtain the required data and then undertake lighting calculations.

Field Data Collection Method – Meters on vehicle which measure and record light levels while driving. Used for validation. Can also use calculations.

REFERENCE

IESNA RP-8

Transportation Association of Canada Roadway Guide for the Design of Roadway Lighting

Lighting Efficiency and Power Reduction Guide (August 2013)

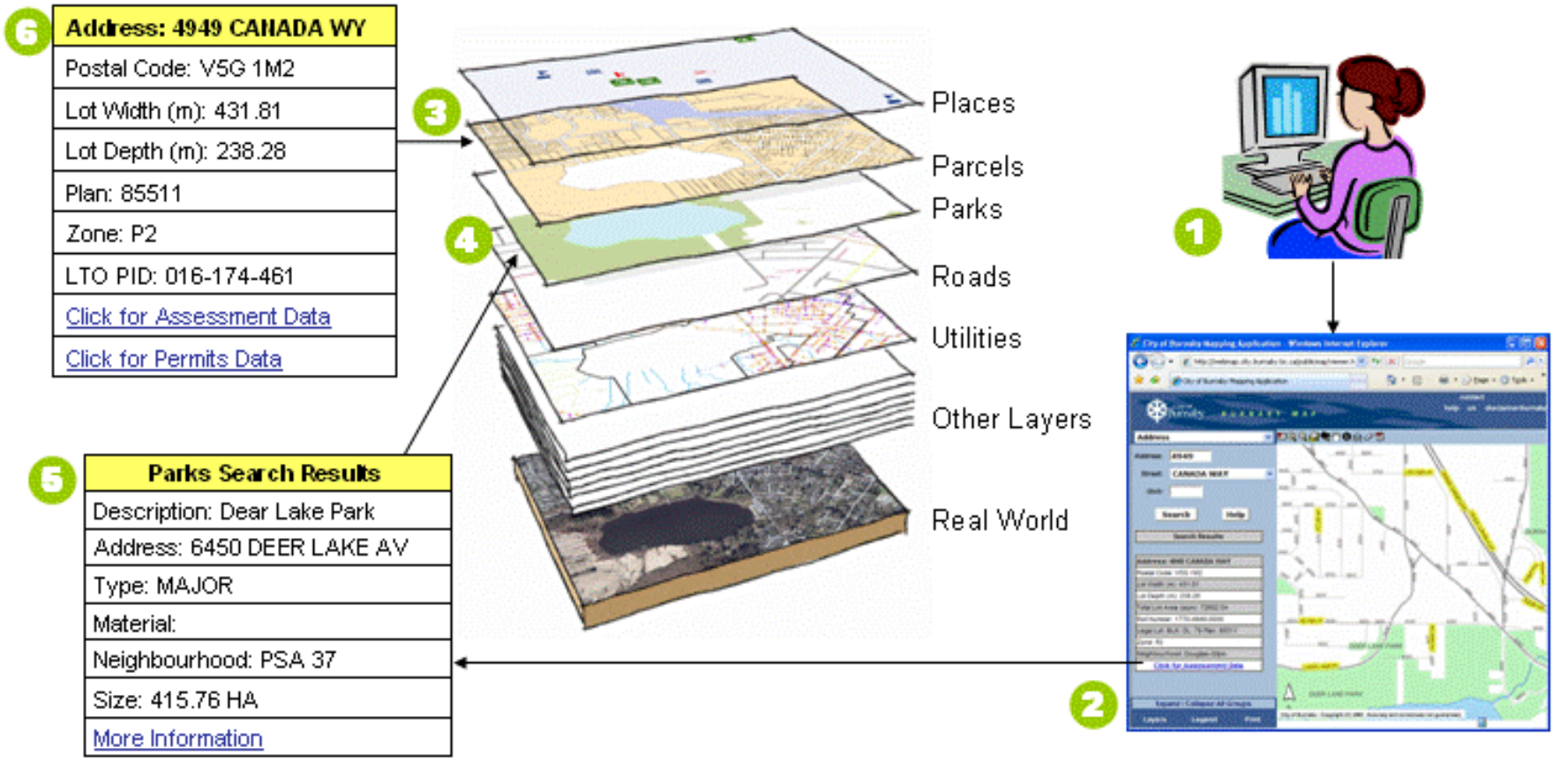
CALCULATION METHOD

GEOGRAPHIC INFORMATION SYSTEMS

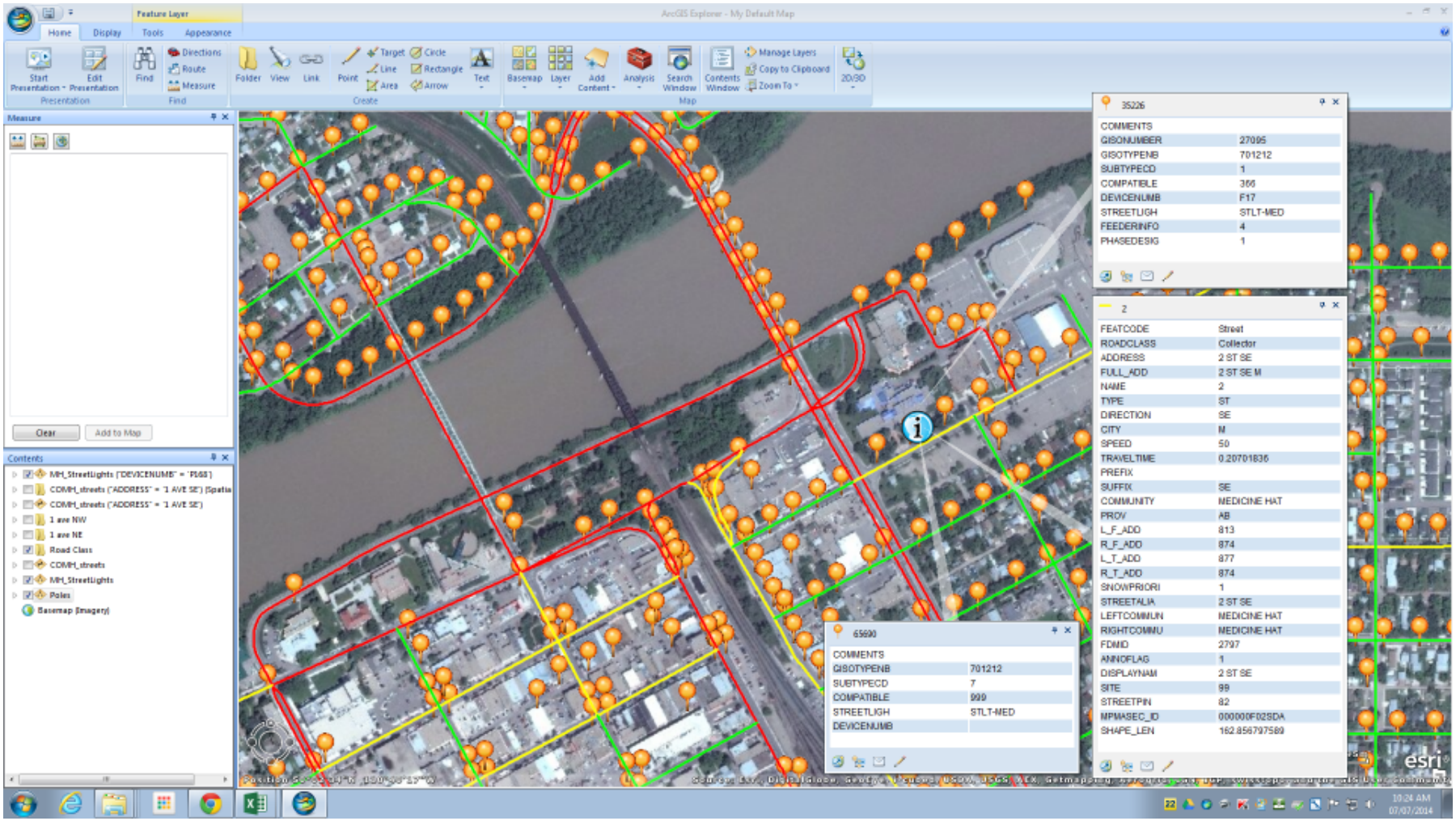
Obtain Geographic Information System (GIS) information in shape file format (.shx), also can use maps, drawings and spreadsheets from jurisdiction.

Import the road shape file into ArcGIS Software or other GIS software

GEOGRAPHIC INFORMATION SYSTEMS



GEOGRAPHIC INFORMATION SYSTEMS



CALCULATION METHOD

Analyse the road shape file, perform queries and extract the following information:

- *Road Classification (Local, Collector, Arterial, etc)*
- *Pole Locations. This information will typically be found in GIS data Base. Pole locations will be by Global Position System (GPS) coordinate locations which will need to be converted to a pole spacing.*
- *Locations can also be exported to maps (Drawings) in AutoCAD format. Location can be scaled off.*

CALCULATION METHOD

Information often missing from GIS data bases. May need to use Google Maps along with field review to validate.

- *Pedestrian activity level - Land use*
- *Road Geometry - Number of lanes and lane width, medians, bike lanes, etc*
- *Sidewalk width and location, median width?*
- *Pole offset from road – to define luminaire location*
- *Pole height and arm length*

This information is required to undertake lighting calculations.

CALCULATION METHOD

Group roads and define lighting criteria (levels, uniformity, veiling luminance). What is required?

Analyze and group pole spacing(s) to reduce calculations

Undertake calculation using computer design software.

CALCULATION METHOD

The pole locations can be exported to spreadsheets and poles can be tagged by GPS location which can be linked to actual fixture model numbers. Useful for installer.

Data can be used to compare fixtures.

Can also use info and compare unit power density (Watts Per Area) to maximize efficiency.

LED SPECIFICATIONS

Roadway Type **	Pedestrian Activity Level	Luminaire overhang (m) *	Median	Pole Height (m)	Arrangement - Staggered (S), Opposite (O), One sided (OS), Median (M)	# of lanes and width (m)	Sidewalk width (m)	Sidewalk Offset from Curb (m)	Existing HPS Wattage (W)	Avg. Pole Spacing - Cycle Length (m)	Pole Spacing - Cycle Length (m) (WORST CASE)
1. Arterial	H	2	1.5	12	S	5 - 3.8	2.5	1	200	48	58
2. Arterial	H	1.5	0	9.14	O	6 - 3.5	2	1.5	200	30	31
3. Arterial	M	2.5	1	12	M	4 - 5.0	0	0.5	400	67	73
4. Arterial	L	1	6	12	O	4 - 6.5	0	2	250	52	59
5. Collector	H	2	0	9.14	O	2 - 7.5	3.5	1	200	28	32
6. Collector	M	2	0	9.14	OS	2 - 7.0	2	1	100	36	41
7. Collector	L	1.5	0	9.14	OS	2 - 7.5	1.5	1.5	200	51	55
8. Local	H	1	0	9.14	OS	2 - 7.5	1.8	2	200	46	51
9. Local	M	0.5	0	9.14	OS	2 - 5.0	2	2.5	100	51	57
10. Local	L	0.5	0	9.14	OS	2 - 5.0	2	2.5	100	50	55

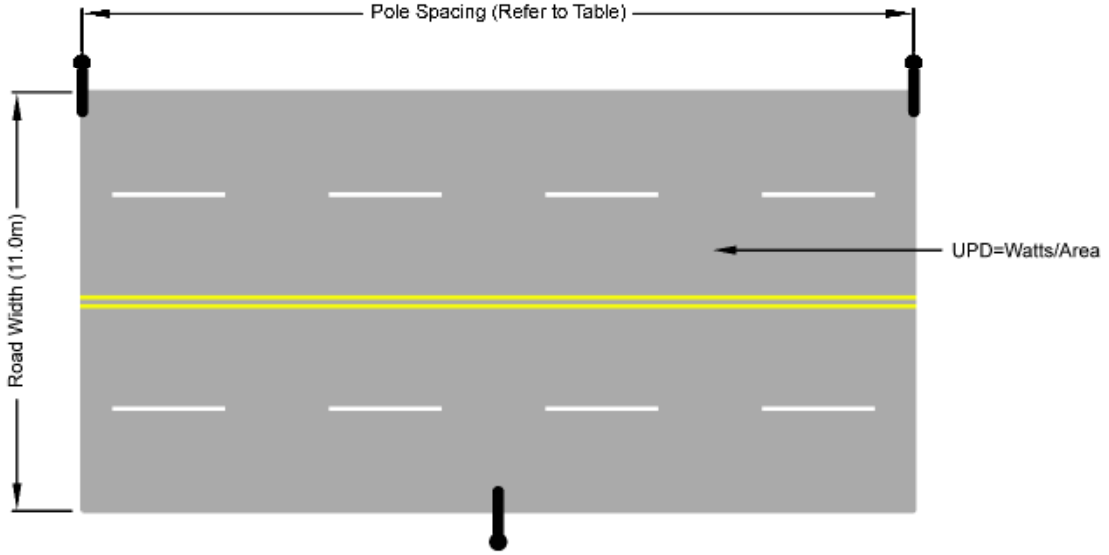
RESULTS

Manufacturer	1		2		3		4		5		6		7		8	
Pole Spacing	46	10.62	30	6.92	52	0.00	65	15.00	33	7.62	31	7.15	50	11.54	54	12.46
UPD	0.156	15.00	0.161	14.58	0.1766	0.00	0.241	9.74	0.2	11.81	0.246	9.54	0.20545	11.40	0.175	13.38
UPD Submitted	0.182		0.432		0.176		0.33		0.27		0.28		0.25		0.476	
Fixture Watts	79		53		101		172		72		83.73		113		104	
Actual UPD	0.156		0.161		0.1766		0.241		0.2		0.246		0.20545		0.175	

Avg	0.5		0.51		0.5		0.7		0.51		0.51		0.5		0.5	
A:m	3.13		1.31		2.78		2.28		1.38		1.24		2.94		1.92	
M:m	6.13		1.82		6.89		5.03		1.68		1.46		5.41		3.69	
Lv	0.26		0.2		0.36		0.3		0.28		0.18		0.26		0.38	

UPD Threashold 0.35

Calc Criteria	0.5 Avg
	8 A:m
	10 M:m
	0.4 Lv



Road Type - Collector, 4 Lane

Field Validation Method

FIELD VALIDATION METHOD

Virginia Tech Transportation Institute (VTTI) provided measurement equipment and undertook measurements

Equipment mounts on vehicle, measures and records illuminance, luminance and uniformity.

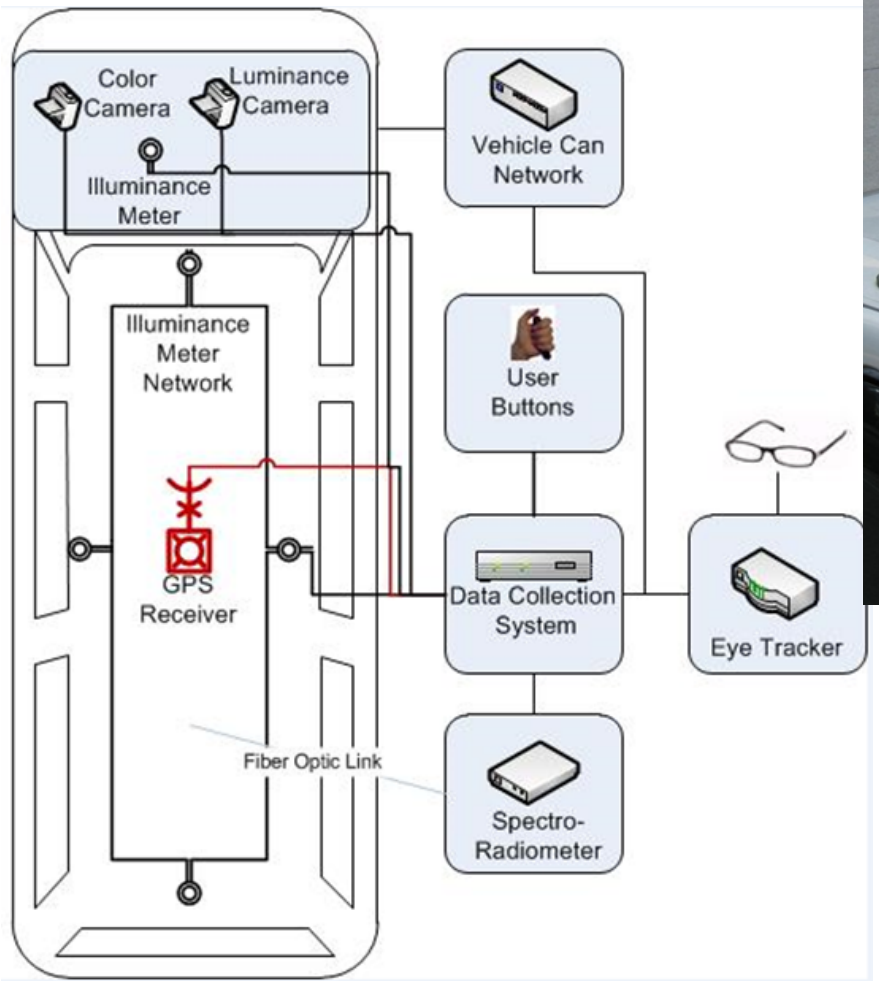
Data provided to define existing lighting levels or to validate new system

VALIDATION METHOD

VTTI (Virginia Tech Transportation Institute) developed RLMMS **R**oadway **L**ighting **M**obile **M**easurement **S**ystem

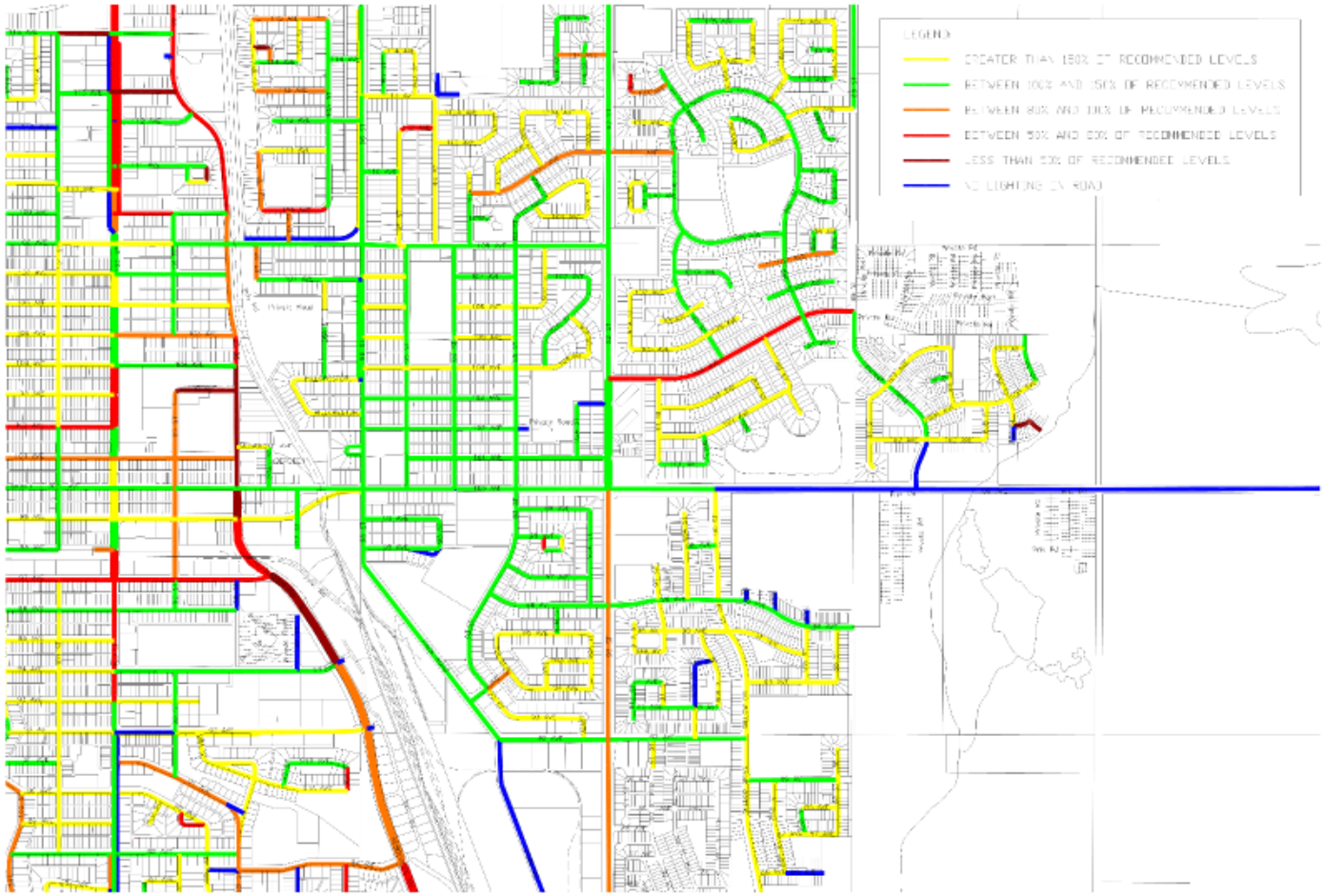
- GPS
- 4 rooftop illuminance sensors
- Glare meter
- Luminance and Color cameras
- Spectrometer Based Measurement of Color Temperature
- Eye tracker to track where the driver is looking
- Can network interface to get vehicle speed, accelerations (if available) throttle input, etc.
- Buttons to place markers in the data

VALIDATION METHOD



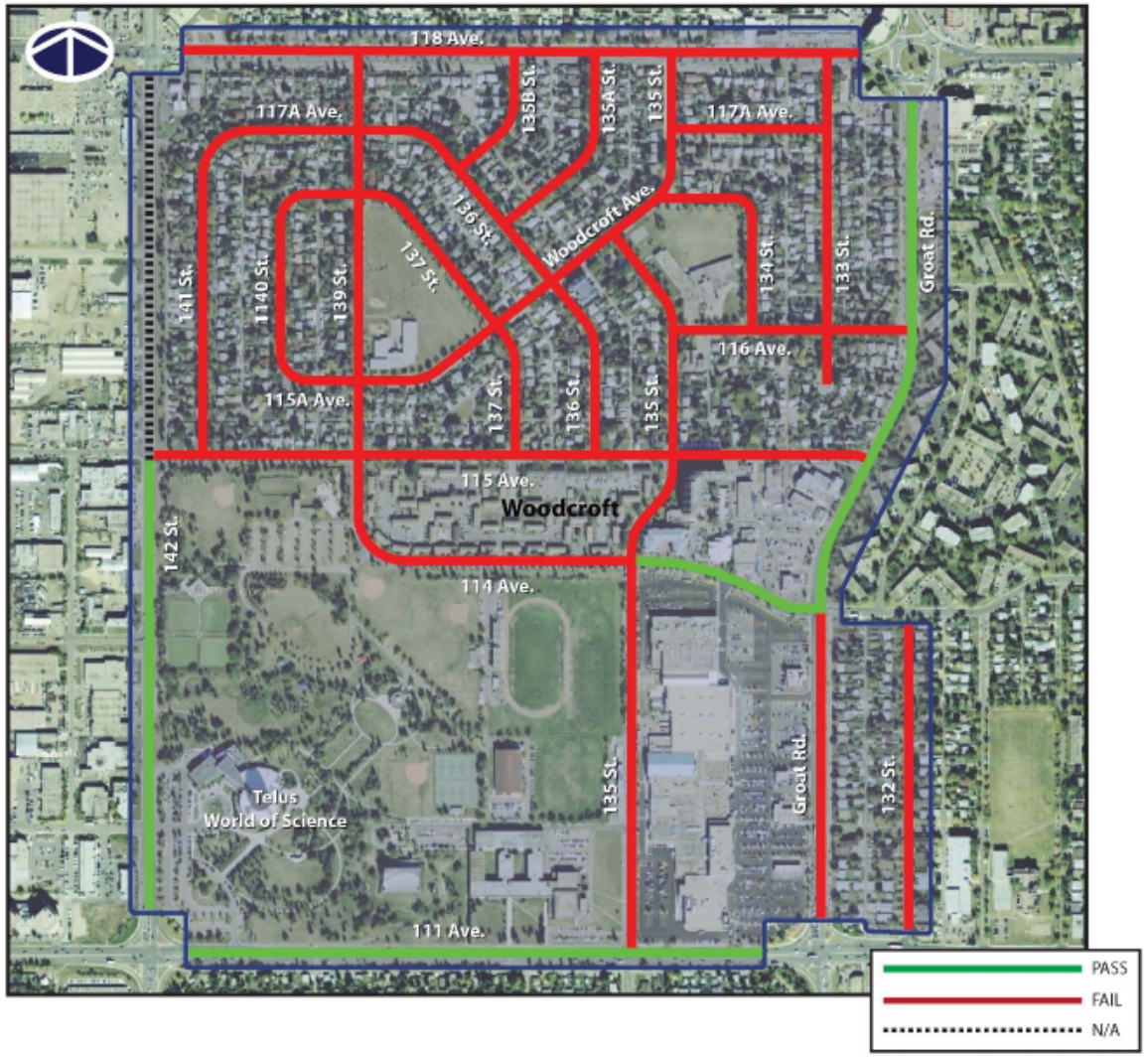
FINDINGS FROM PAST PROJECTS

FIELD VALIDATION



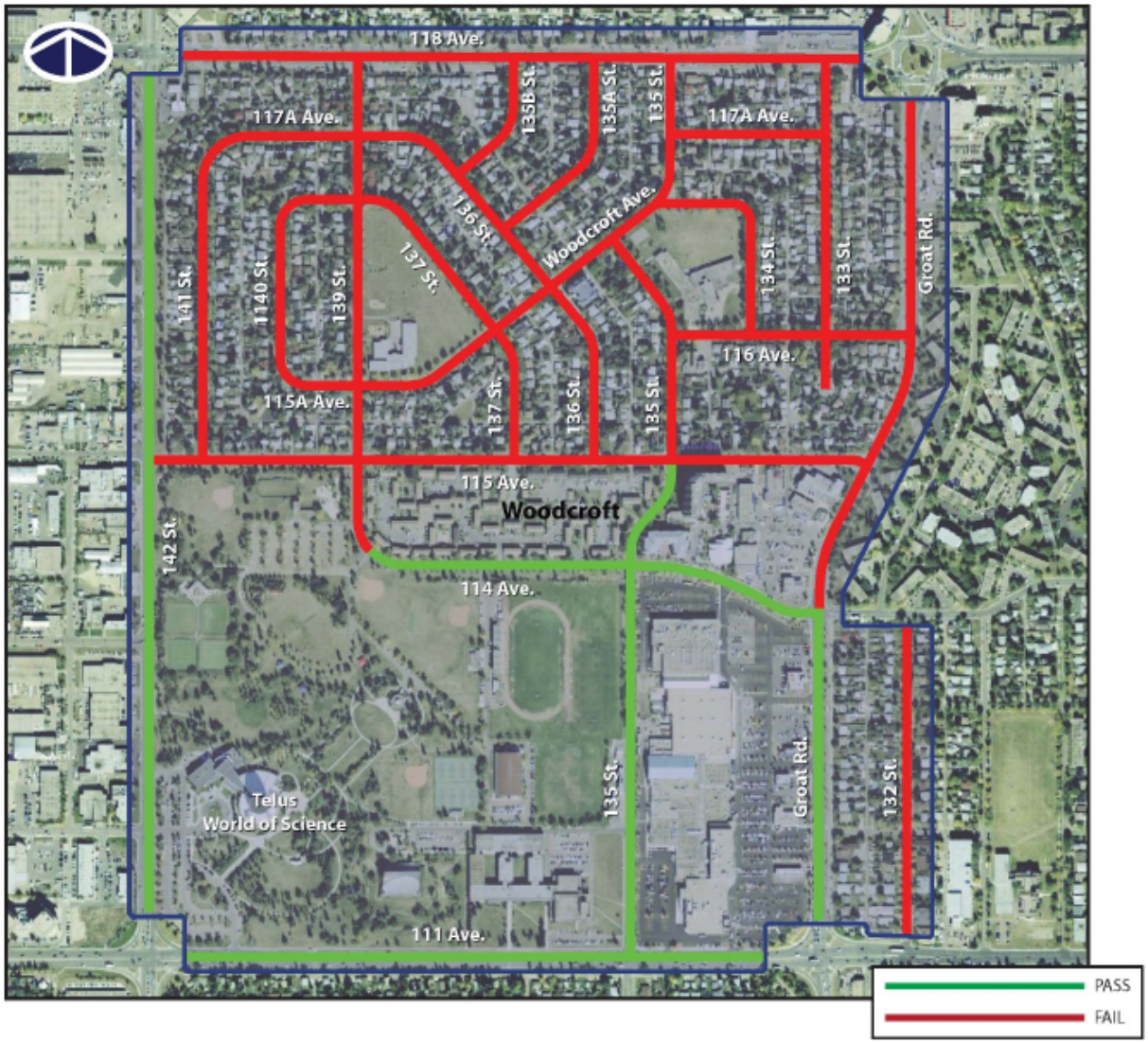
CALCUATION METHOD

Roadway
Horizontal
Average
Maintained
Illuminance

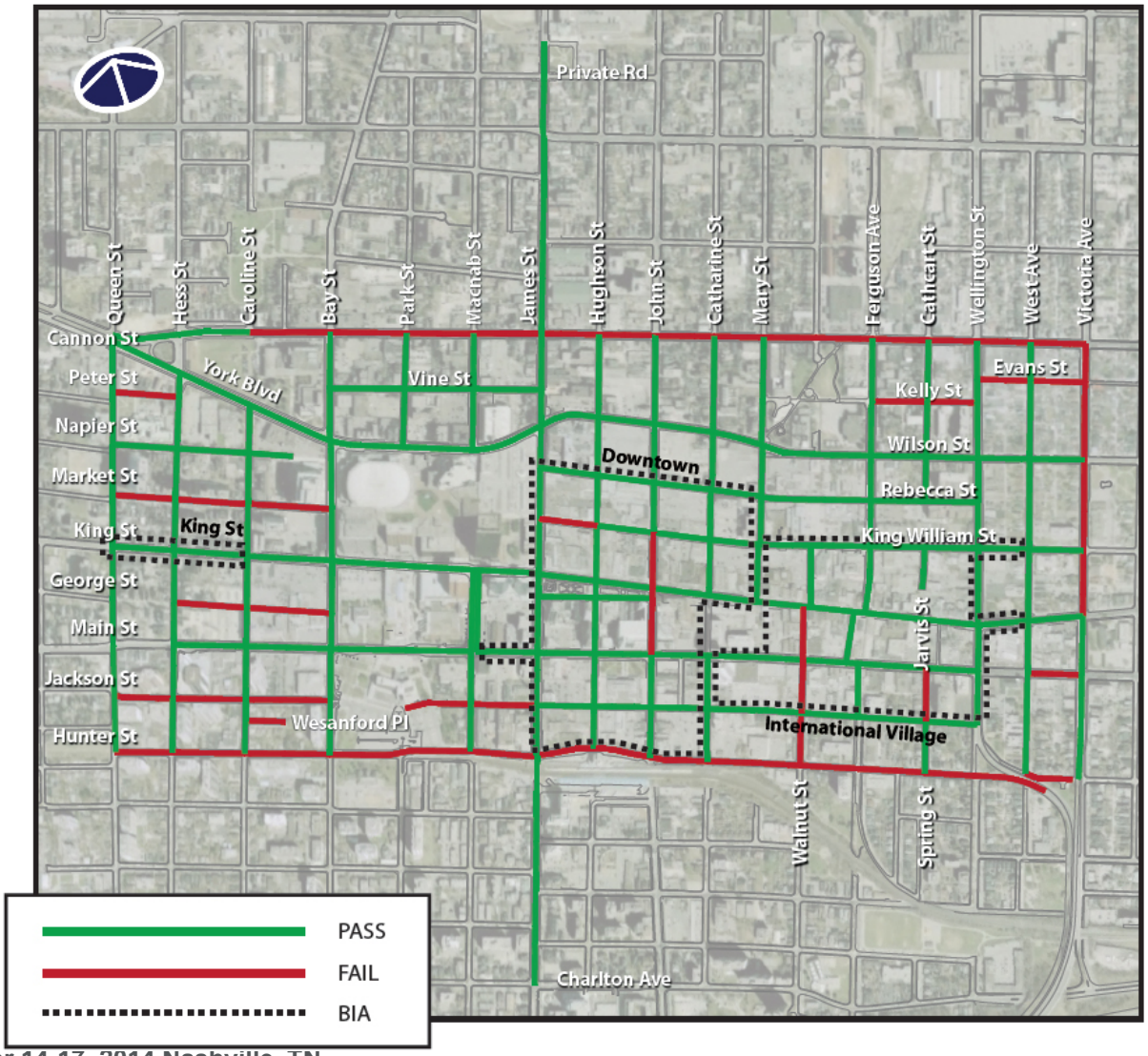


CALCULATION METHOD

Roadway Uniformity

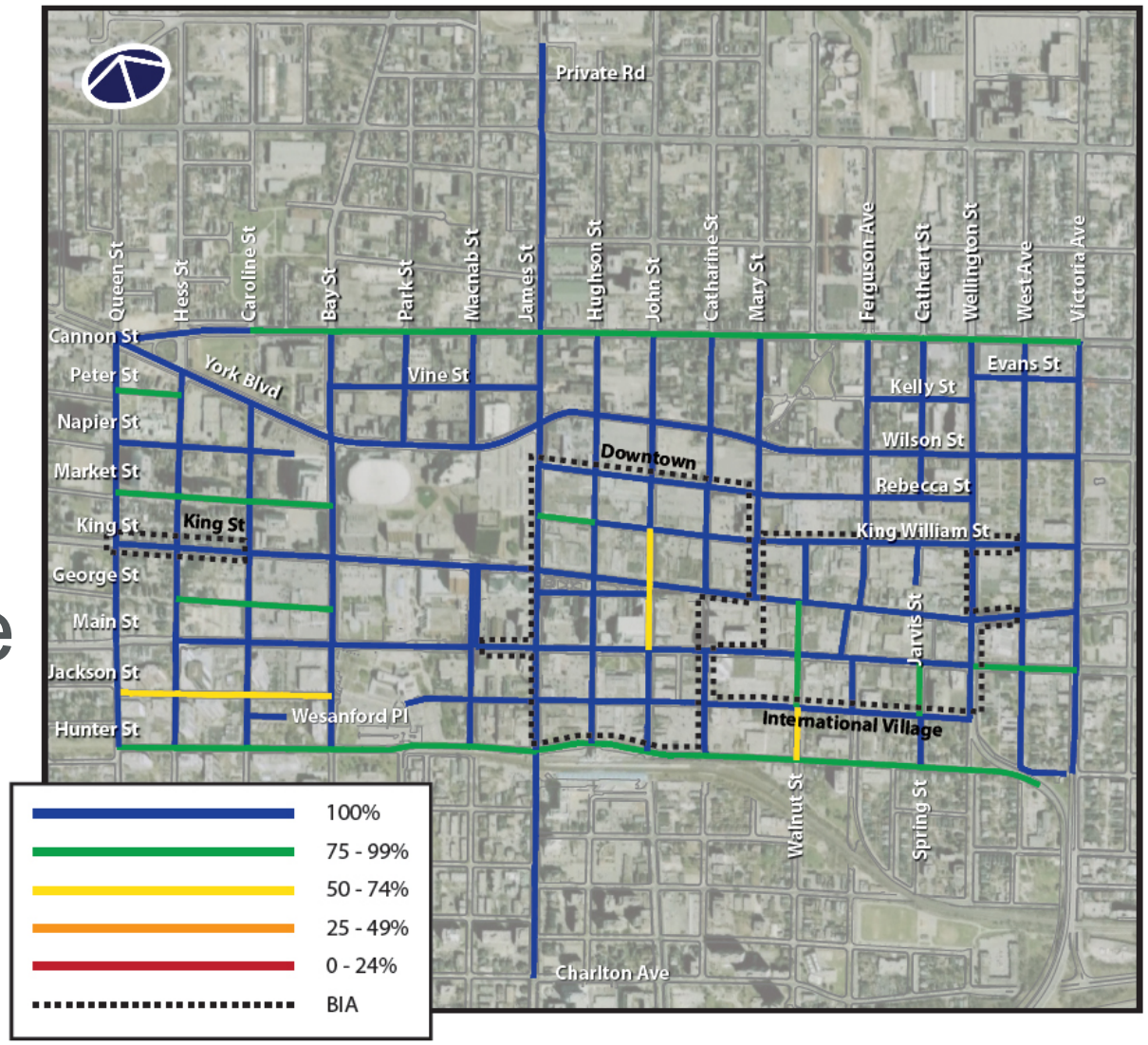


CALCULATION METHOD



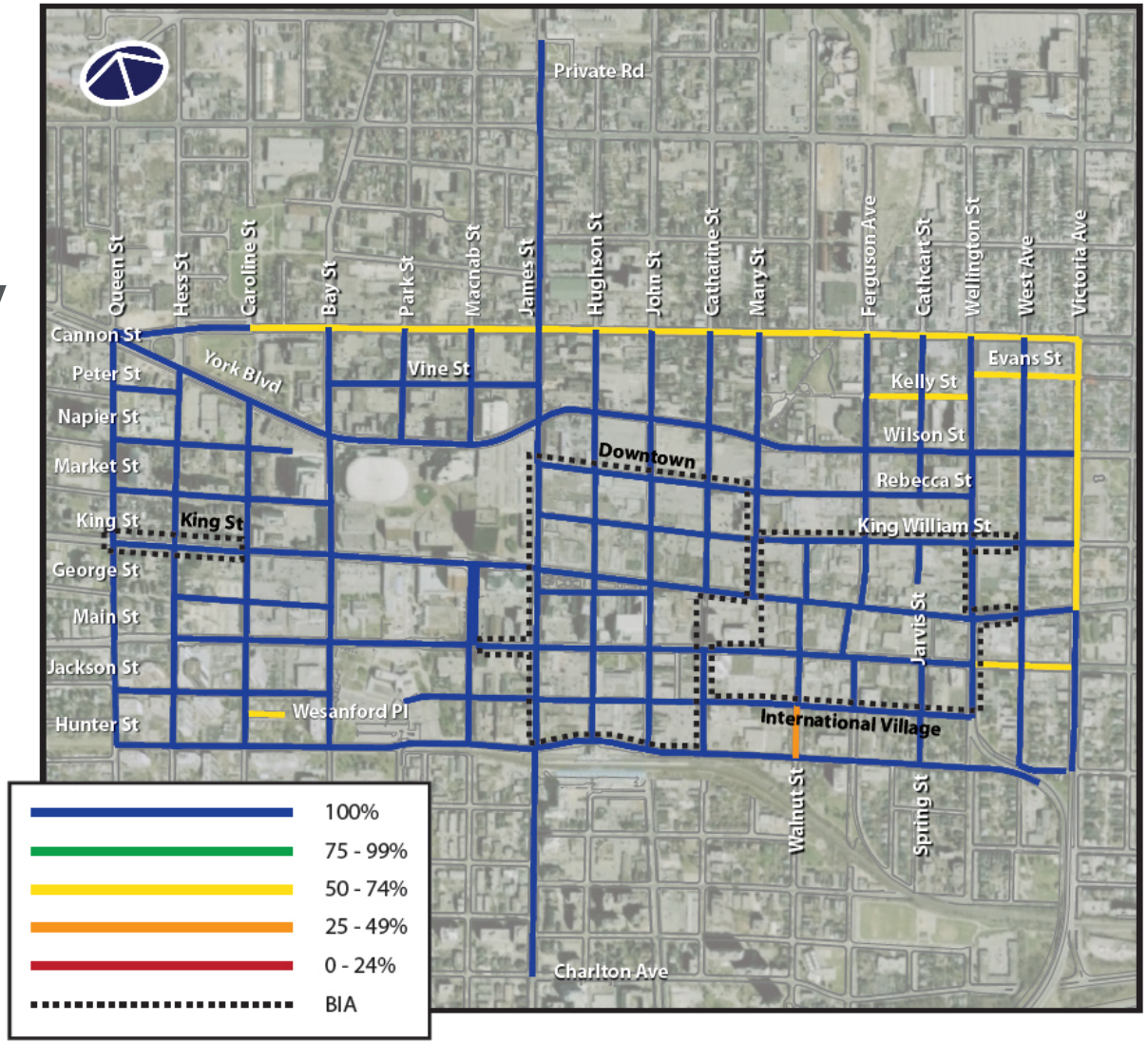
CALCULATION METHOD

Roadway Horizontal Average Maintained Illuminance



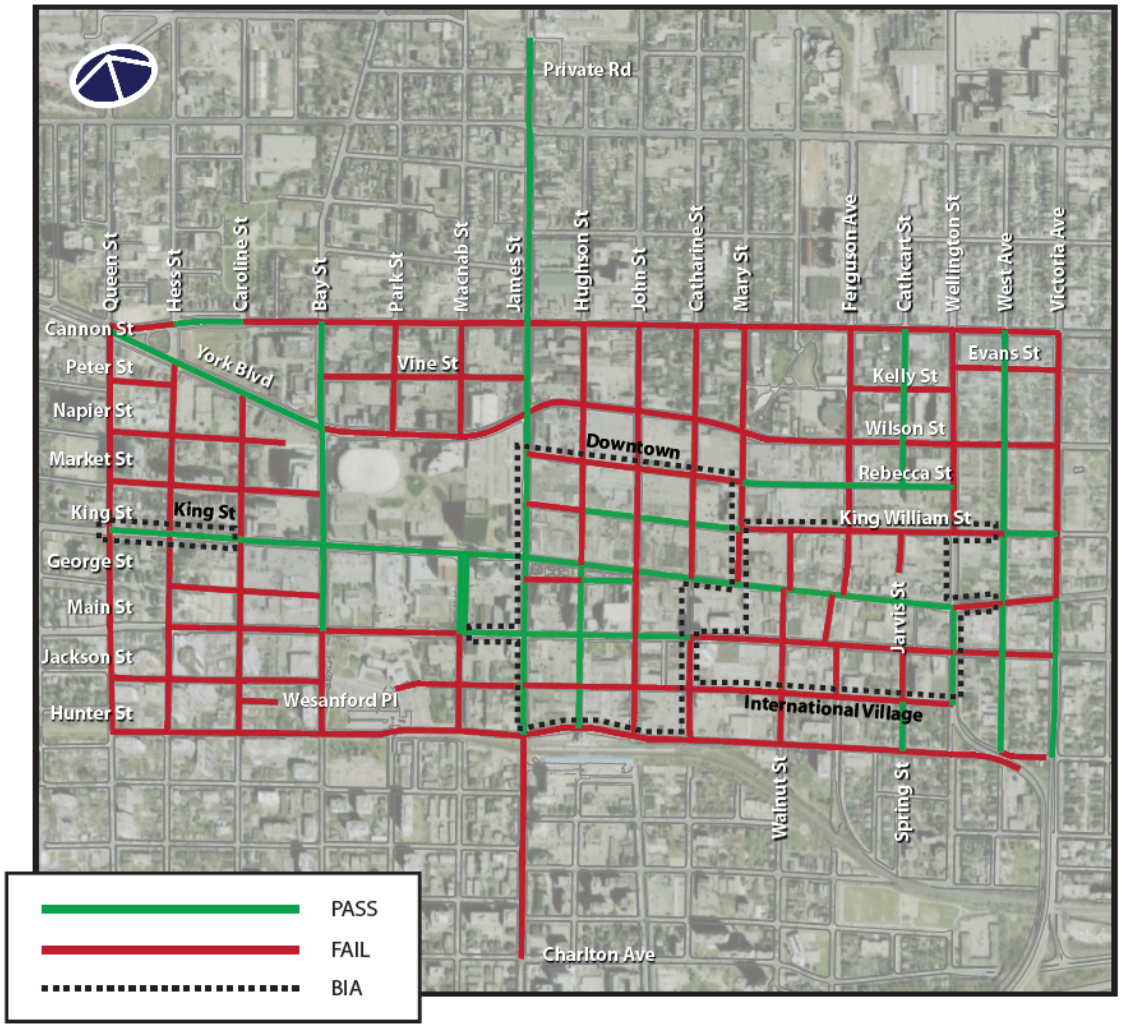
CALCULATION METHOD

Roadway Uniformity



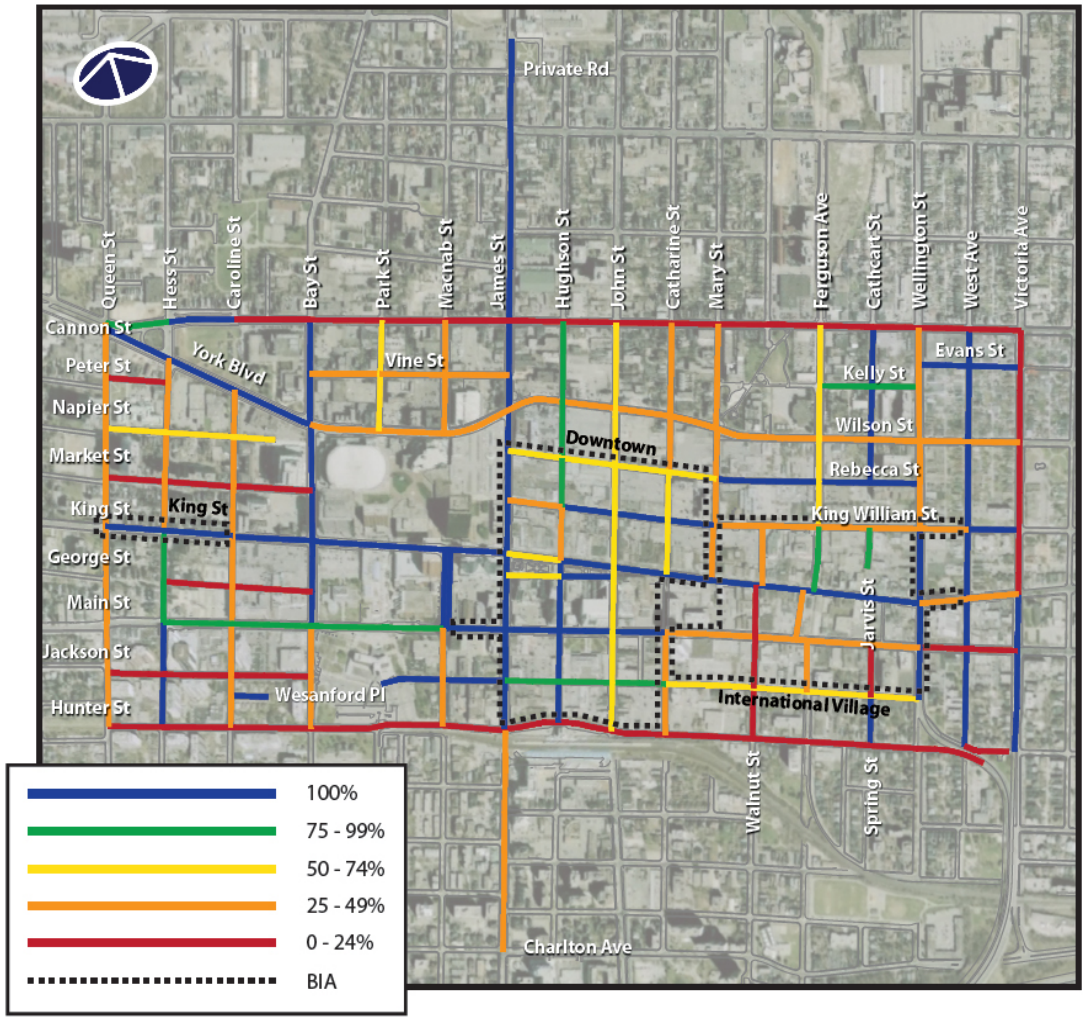
CALCULATION METHOD

Sidewalk Lighting



CALCULATION METHOD

Sidewalk Maintained Horizontatal Illuminance



SUMMARY

SUMMARY

LED performance varies from product to product.

There is a far greater choice of LED optics.

We have found many roads are over or under lit. Sidewalks are also an issue.

Simply replacing a 100W HPS with a 50W LED may lead to improperly lit roads.

A conversion to LED and or Adaptive Control is a huge investment. Analysis Recommended!