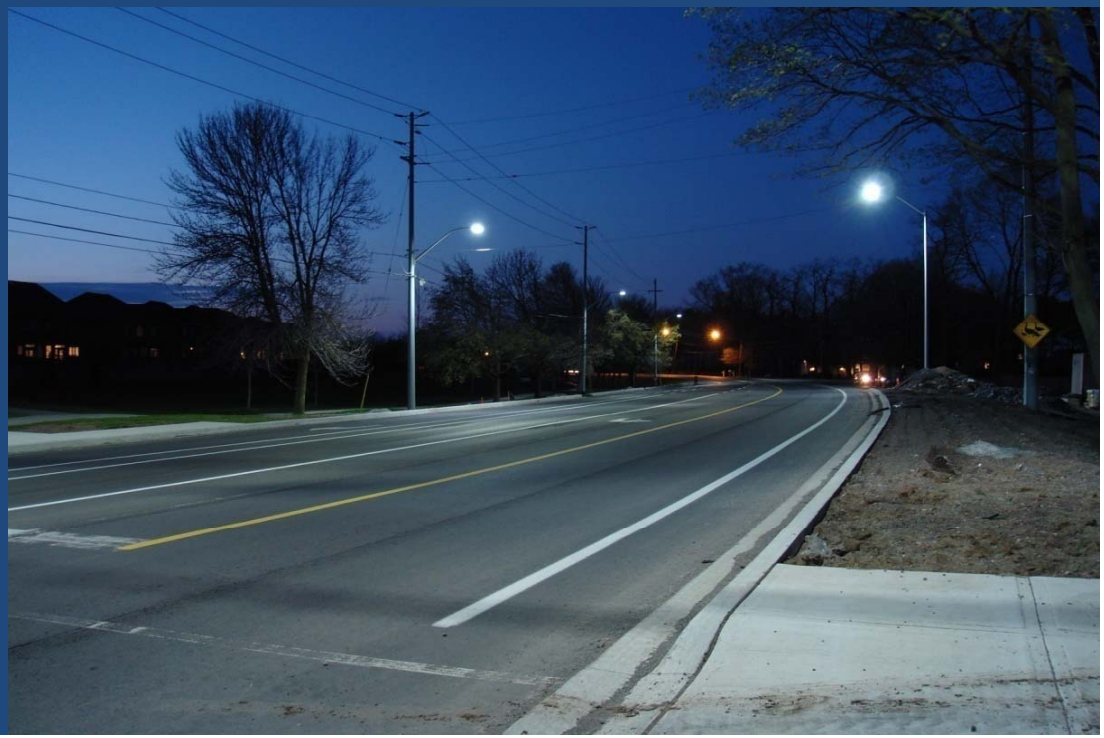
Update on Applying LEDs for Site and Roadway Lighting

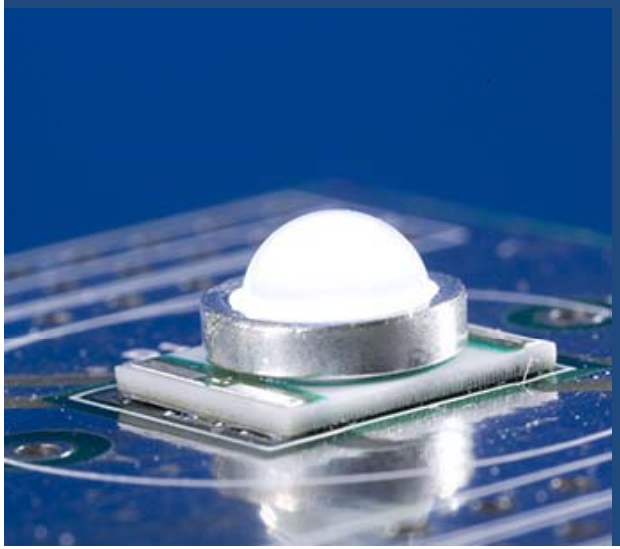
Shirley Coyle, LC
Ruud Lighting / BetaLED



TRB Visibility Symposium
May 2009

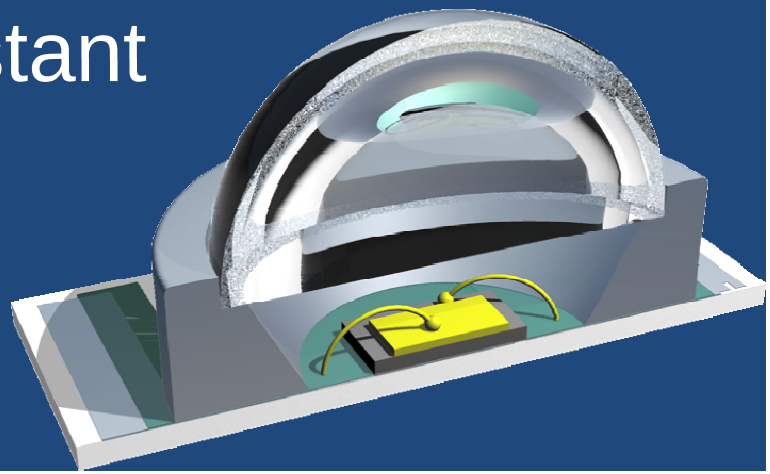
The Potential of LED Lighting Versus Incumbent Technologies

- significant energy savings
- significant maintenance savings
- improved lumen maintenance



Advantages related to Solid State Technology

- High reliability, safety, durability
- Instant on, instant re-strike
- Loves cold temperatures
- Dim or switch easily
- No forward heat; no UV
- Vibration and impact resistant
  (no electrodes)



The Green Factor – Environmental Opportunities

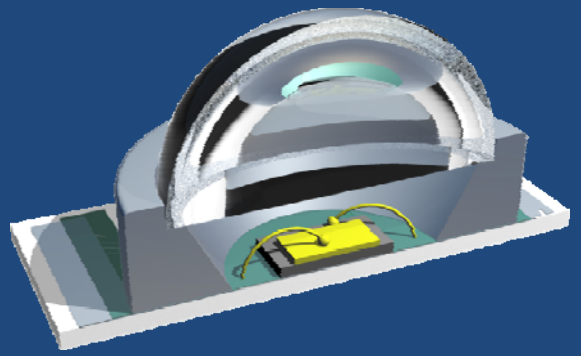
- No mercury
- No lead, RoHS compliance
- Longer lifetime - less environmental waste
- Opportunities for better optical control
- High recycled content
- Energy savings

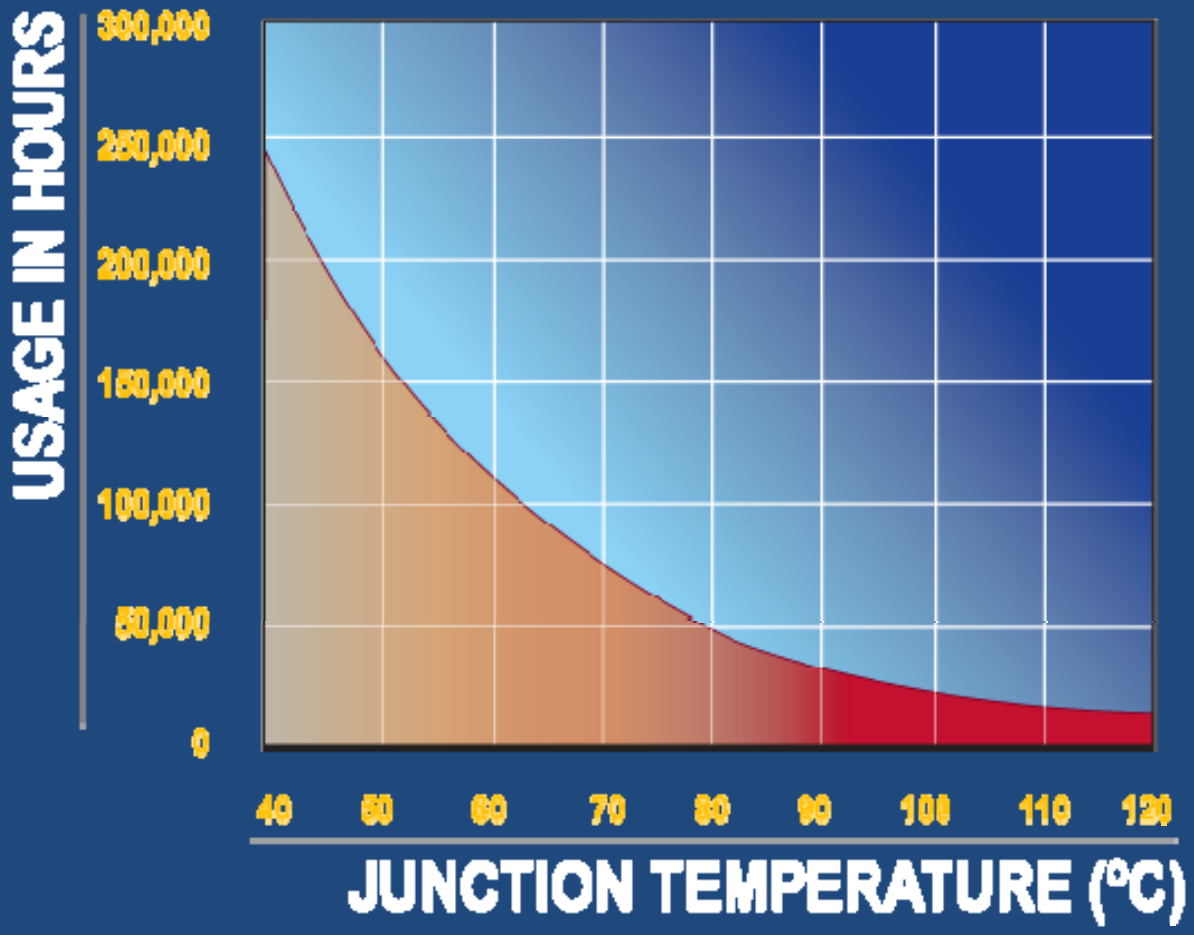
Sounds too good to be true…

Several critical issues in successfully applying LED technology in luminaires:

- Thermal design
- Optical design
- Determining life ratings
- Determining LLF (light loss factors)
- Comparing luminaires

Good technology ≠ Good product



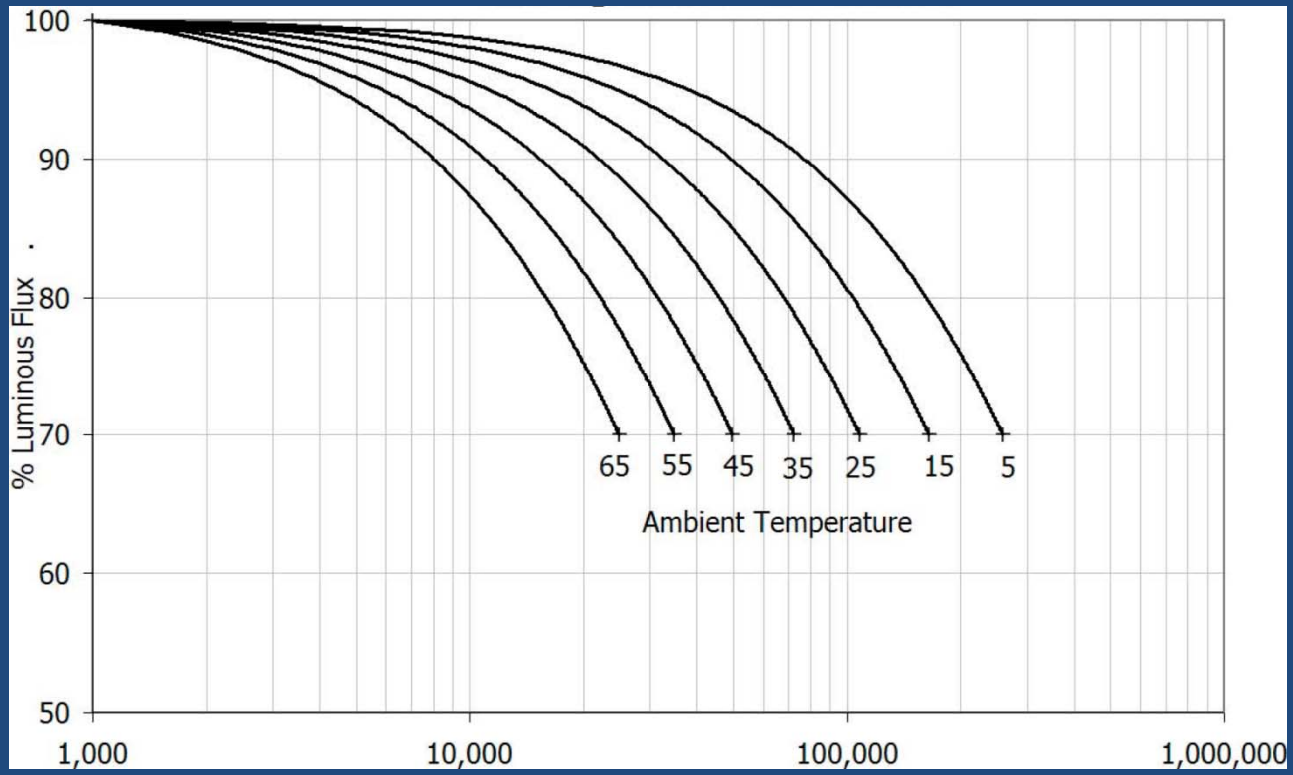


Life

- IESNA: 30% Lumen Depreciation at end of life (L_{70})
- What about system life? – all components must be considered
- Need a finish that will last as long as the LEDs

Life depends on

1) the thermal design and drive current of the individual fixture and
2) on the Ambient Temp of Your Application



Life

(shown-Ruud Edge ™ Performance Curves)

Light Loss Factor -

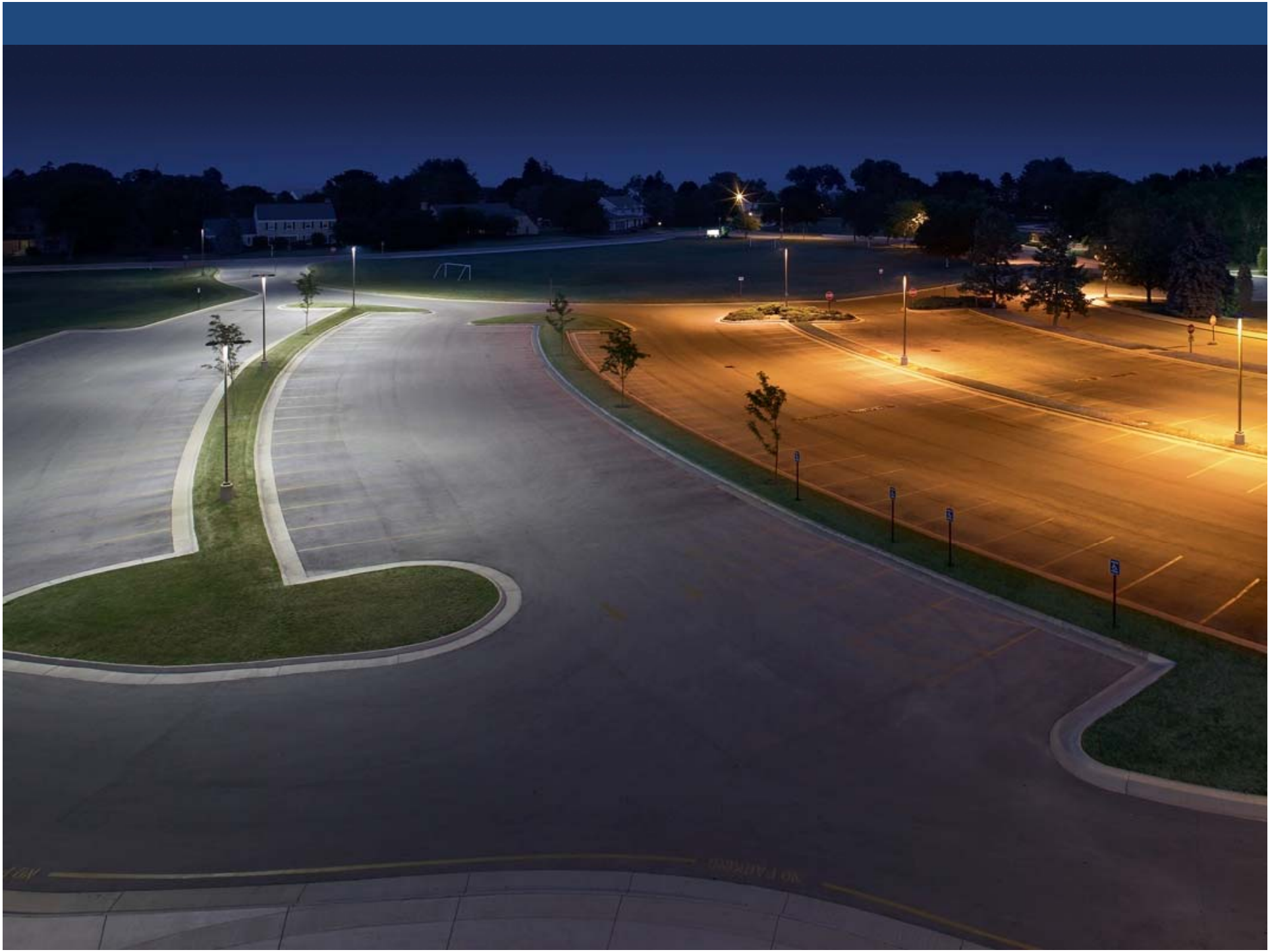
There will not be a standard “one-size – fits-all” LLF for LED – it will vary with the individual product design!

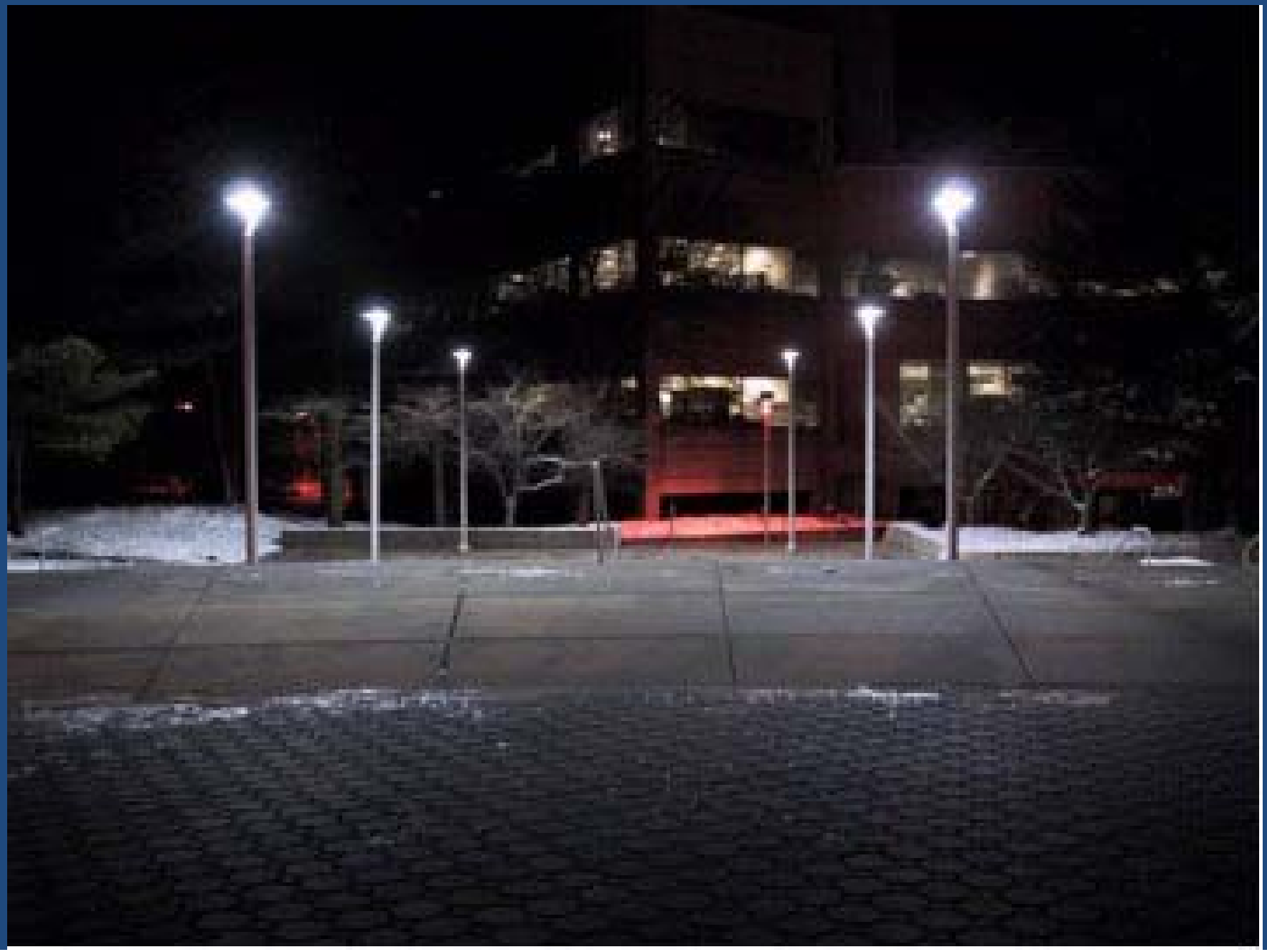
Considerations:

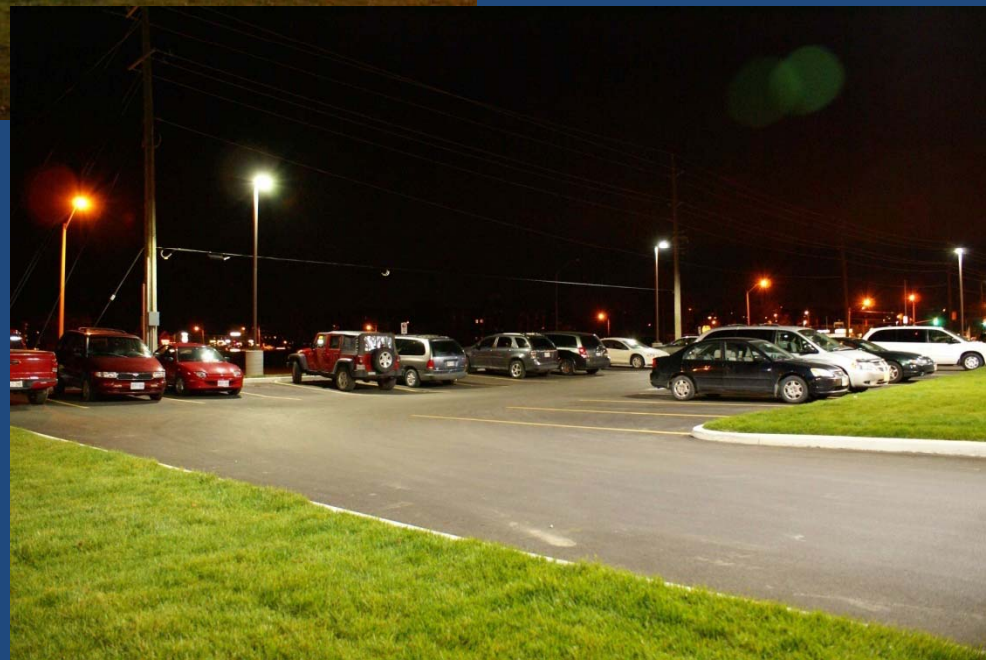
- LLD (lamp lumen depreciation)
- LDD (luminaire dirt deprection)
- Ambient temperature factor
- Drive current factor
- Application life (point in time to design to)

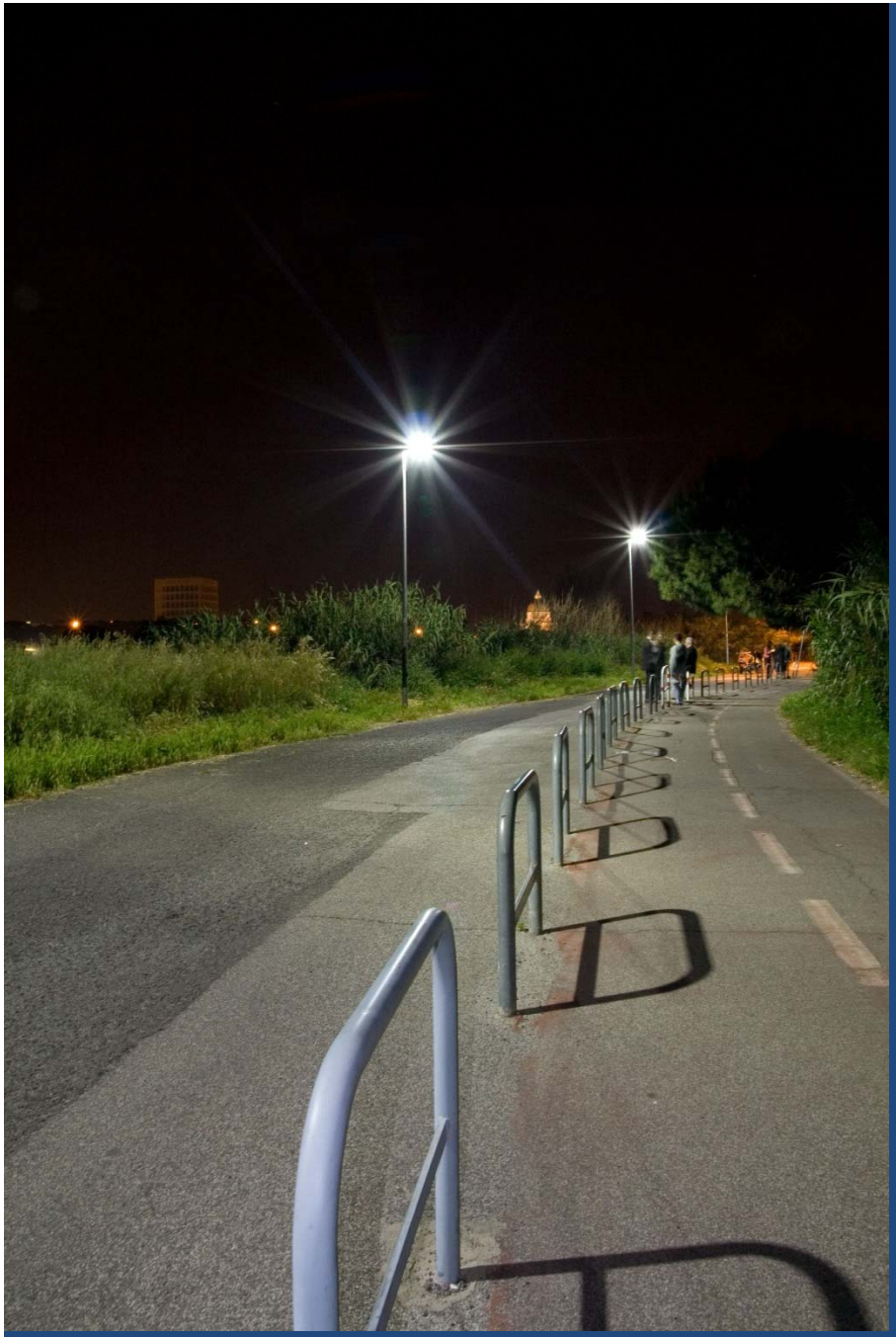
Evaluating Product Design

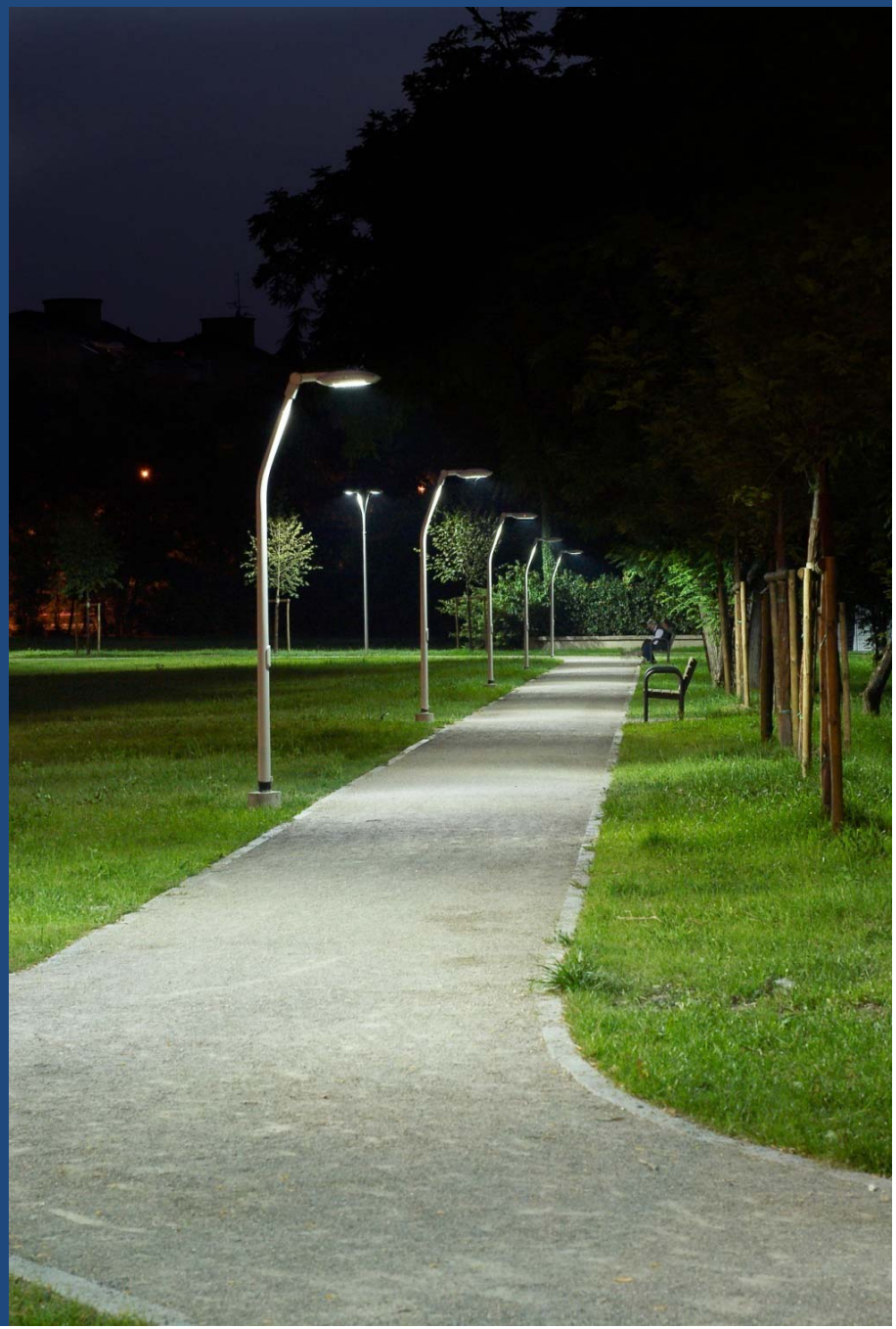
- Thermals
- Optics
- Performance – do the layout
  - photometrics (independent test files)
  - LPW (lumens per watt)
- Life: L_{70}
- Proven – installations?





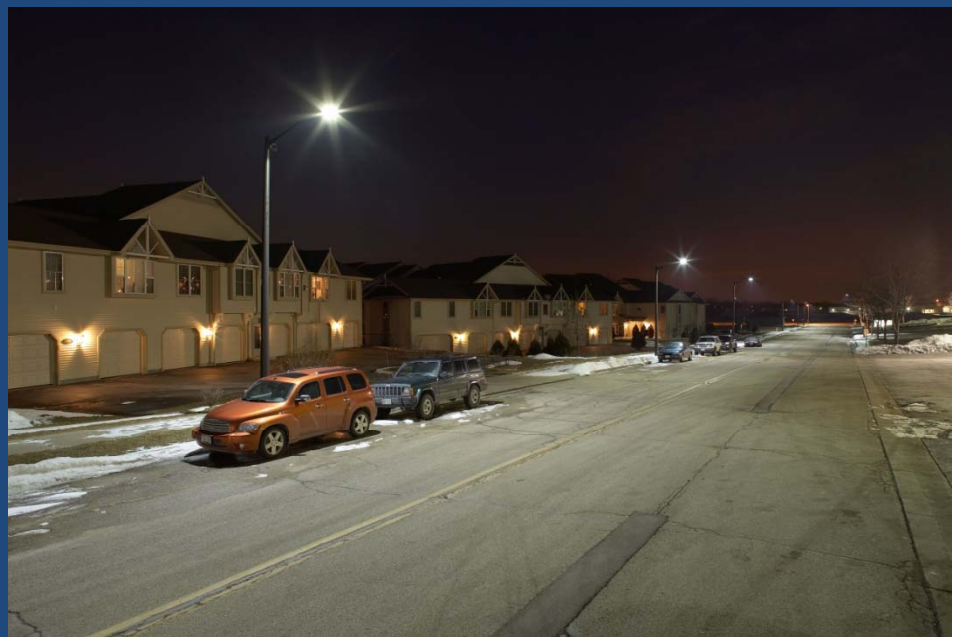






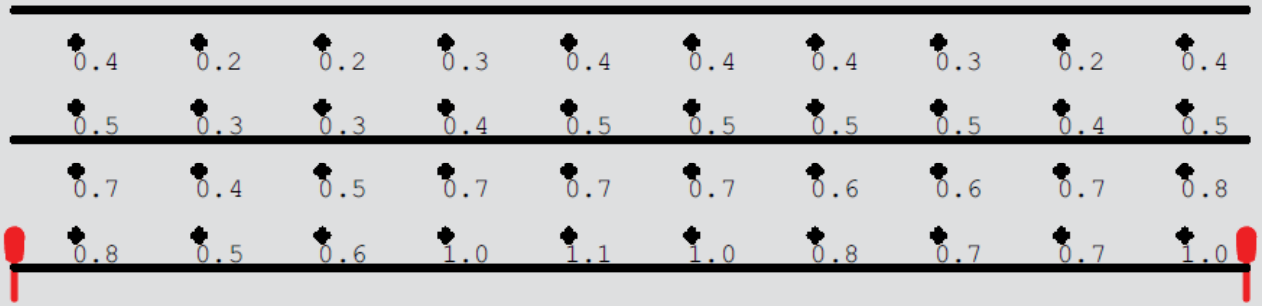
LEDs and Roadway Lighting

- Important to meet RP-8, AASHTO or TAC as required (do the lighting layouts)
- Current performance LED products are most feasible now for residential or collector roads (dollars per lumen)
- No lumen multipliers



Finding the optimum solution

100W HPS Flat Glass Standard Cobra Head Luminaire



Luminance Grid - Contact RuudLED™ for Illuminance Values

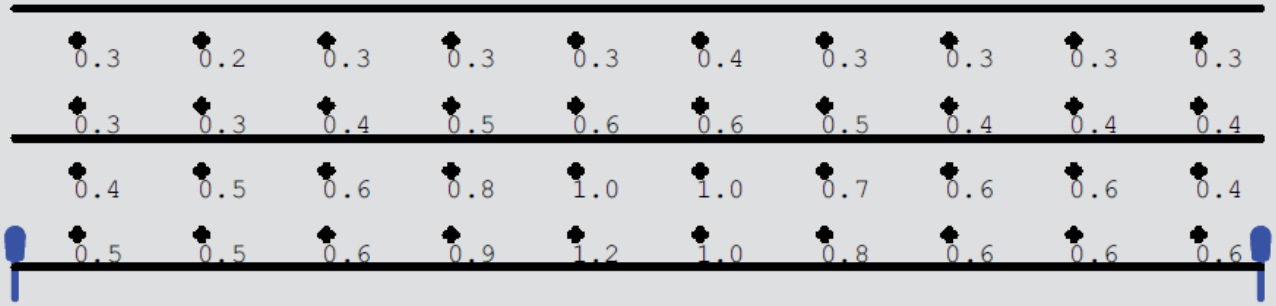
	Average Luminance	Avg/Min	Max/Min	Veiling Luminance Ratio
100 HPS Cobra Head (shown above)	0.56	2.80	5.50	0.25
IES RP-8 (Local, Medium, R3)	≥ 0.5	≤ 6.0	≤ 10.0	≤ 0.4

Initial Lumens: 9,500
LLF: .80
Mounting Height: 27'
Spacing: 120'
Arm Length: 6'
Setback: 3'
Roadway Width: 25'
Lamp Life: 24,000 hours

115 SYSTEM WATTS

One possible solution

40 LED LEDway™ XSL02034B*U



Luminance Grid - Contact RuudLED™ for Illuminance Values

	Average Luminance	Avg/Min	Max/Min	Veiling Luminance Ratio
40 LED LEDway™ (shown above)	0.53	2.65	6.0	0.27
IES RP-8 (Local, Medium, R3)	≥ 0.5	≤ 6.0	≤ 10.0	≤ 0.4

Initial Lumens: 4,140
LLF: .86
Mounting Height: 27'
Spacing: 120'
Arm Length: 6'
Setback: 3'
Roadway Width: 25'
System Life: 121,000 hours L_{70}

84 SYSTEM WATTS

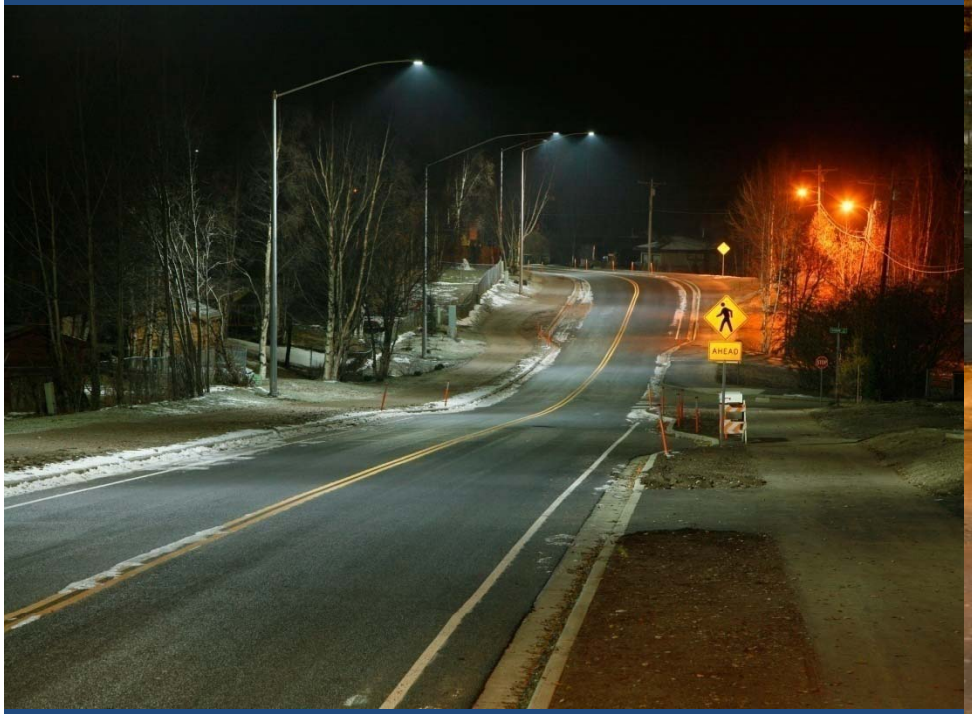
27% ENERGY SAVINGS **97,000** ADDITIONAL LAMP HOURS **4** RELAMPINGS SAVED

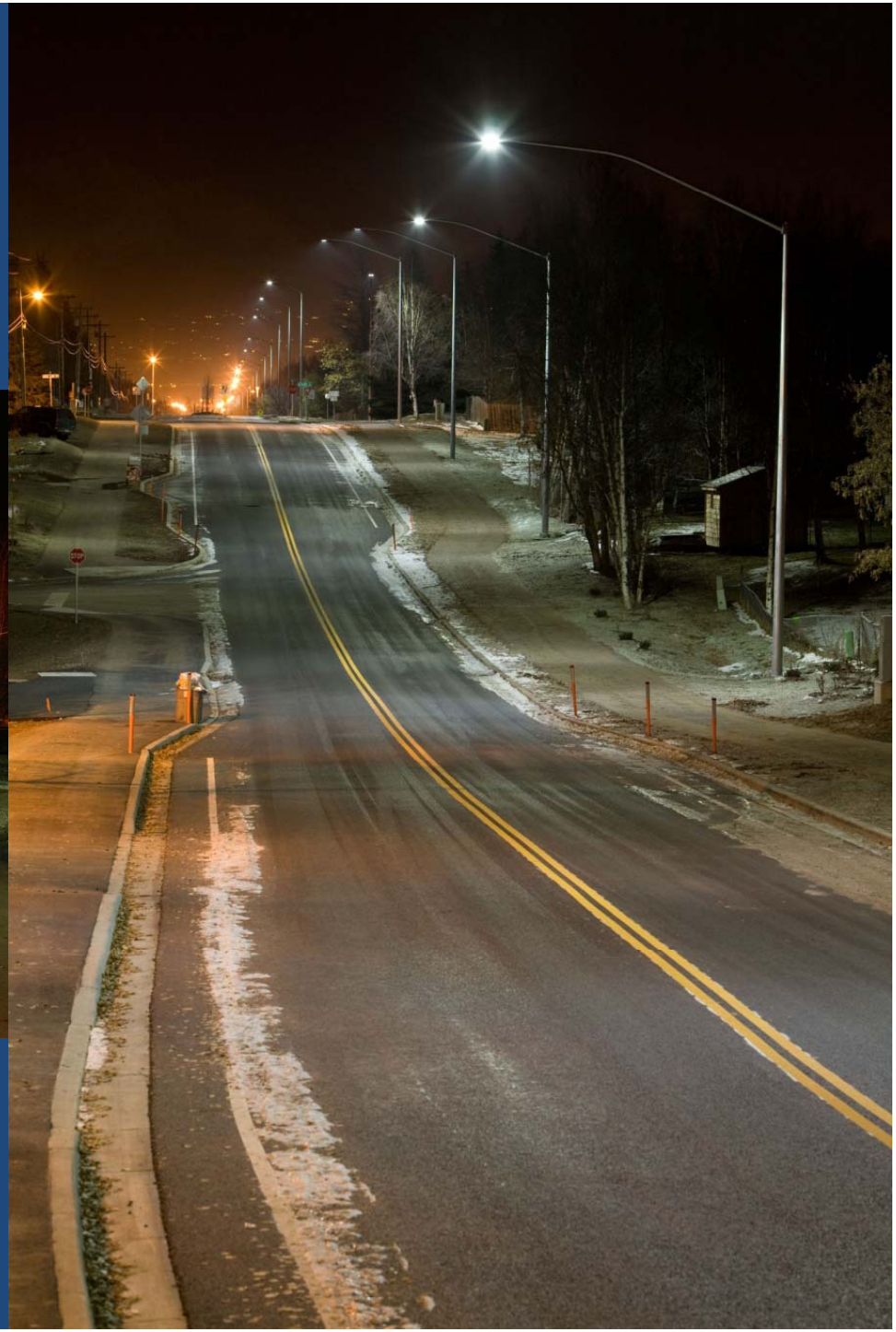
3 possible solutions vs 100W HPS

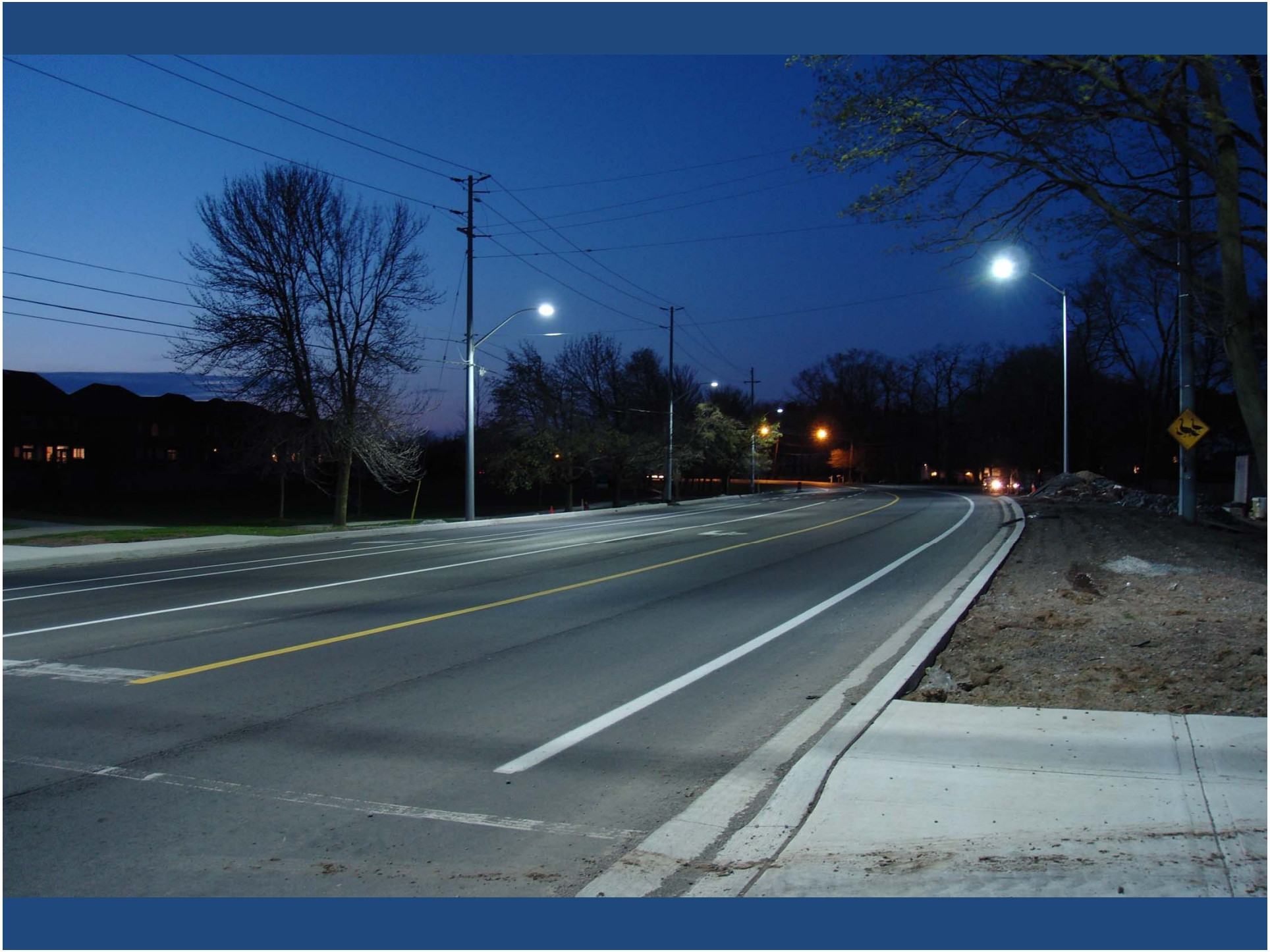
IES RP-8 (Local, Medium, R3)	≥ 0.5	≤ 6.0	≤ 10.0	≤ 0.4

LEDway™ Models That Meet IES RP-8 as Outlined Above

	Model	Initial Lumens	System Wattage	First Cost	System Life - L_{70}
30 LED LEDway™ at 700mA	XSL02025B*UD	3,705	82W	$	64,000
40 LED LEDway™ at 525mA	XSL02034B*U	4,140	84W	$$	121,000
50 LED LEDway™ at 350mA	XSL02042B*UH	4,000	66W	$$$	> 150,000


AHEAD





Oakland Streetlight Study – Phase III

City of Oakland – Per Head Power Consumption

Fixture	HPS	LED-Phase II	LED-Phase III
Power (W)	121W	78W	58W
Savings	_	43W	63W
% Reduction	_	36%	52%

City of San Francisco – LED Streetlighting Test

Pacific Gas and Electric Company

Emerging Technologies Program

Application Assessment Report #0727

LED Street Lighting
San Francisco, CA

Issued:	December 2008
Project Manager:	Mary Matteson Bryan, P.E. Pacific Gas and Electric Company
Prepared By:	Tyson Cook, Project Manager Jordan Shackelford, Project Manager Terrance Pang, Director Energy Solutions 1610 Harrison St. Oakland, CA 94612 (510) 482-4420

City of San Francisco – LED Streetlighting Test

Table VI: Summary of Computer Modeled Photopic Lighting Performance Results at 150' Spacing

Luminaire	Grid Points Illuminated	Average Illumination (All Modeled Points, footcandles)	Coefficient Of Variation	Average-to-Minimum Uniformity (All Modeled Points)
HPS	100%	0.63	0.87	9 : 1
LED A	99%	0.30	0.71	6 : 1
LED B	72%	0.34	1.31	165 : 1
LED C	100%	0.15	0.62	2 : 1
LED D	79%	0.35	1.07	22 : 1

Lighting Performance Metrics

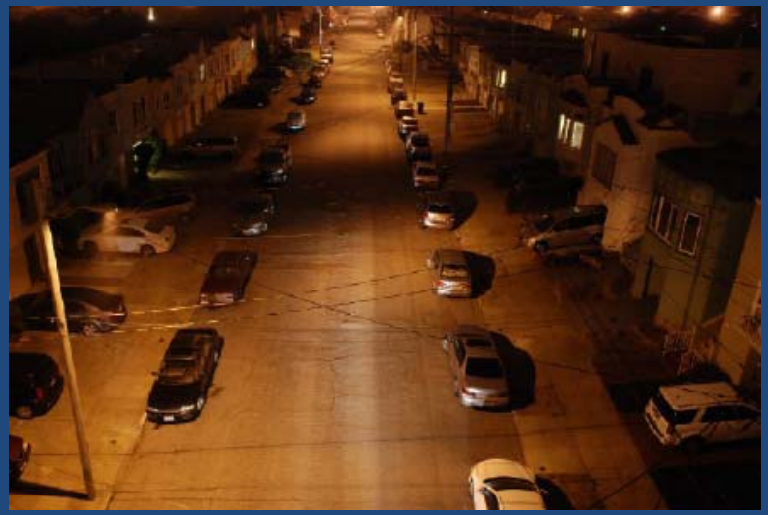
City of San Francisco – LED Streetlighting Test

Table I: Average Luminaire Power and Estimated Savings

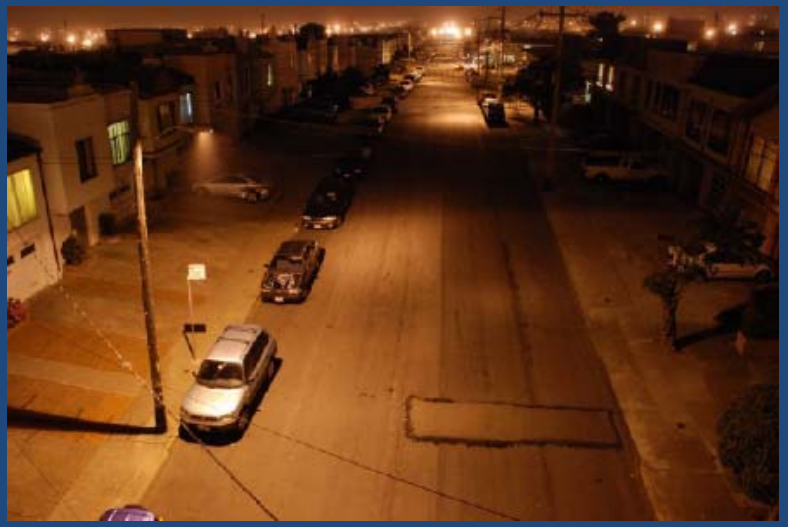
Luminaire Type	Power (W)	Power Savings (W)	Estimated Annual Energy Savings (4100 hr/yr, kWh)	Energy Cost Savings
HPS Type II cut-off	138.32	-	-	–
LED A	58.66	79.66 (57.6%)	321	$30.20
LED B	62.22	76.10 (55.0%)	342	$28.45
LED C	41.25	97.07 (70.2%)	398	$38.77
LED D	69.21	69.11 (50.0%)	283	$25.01

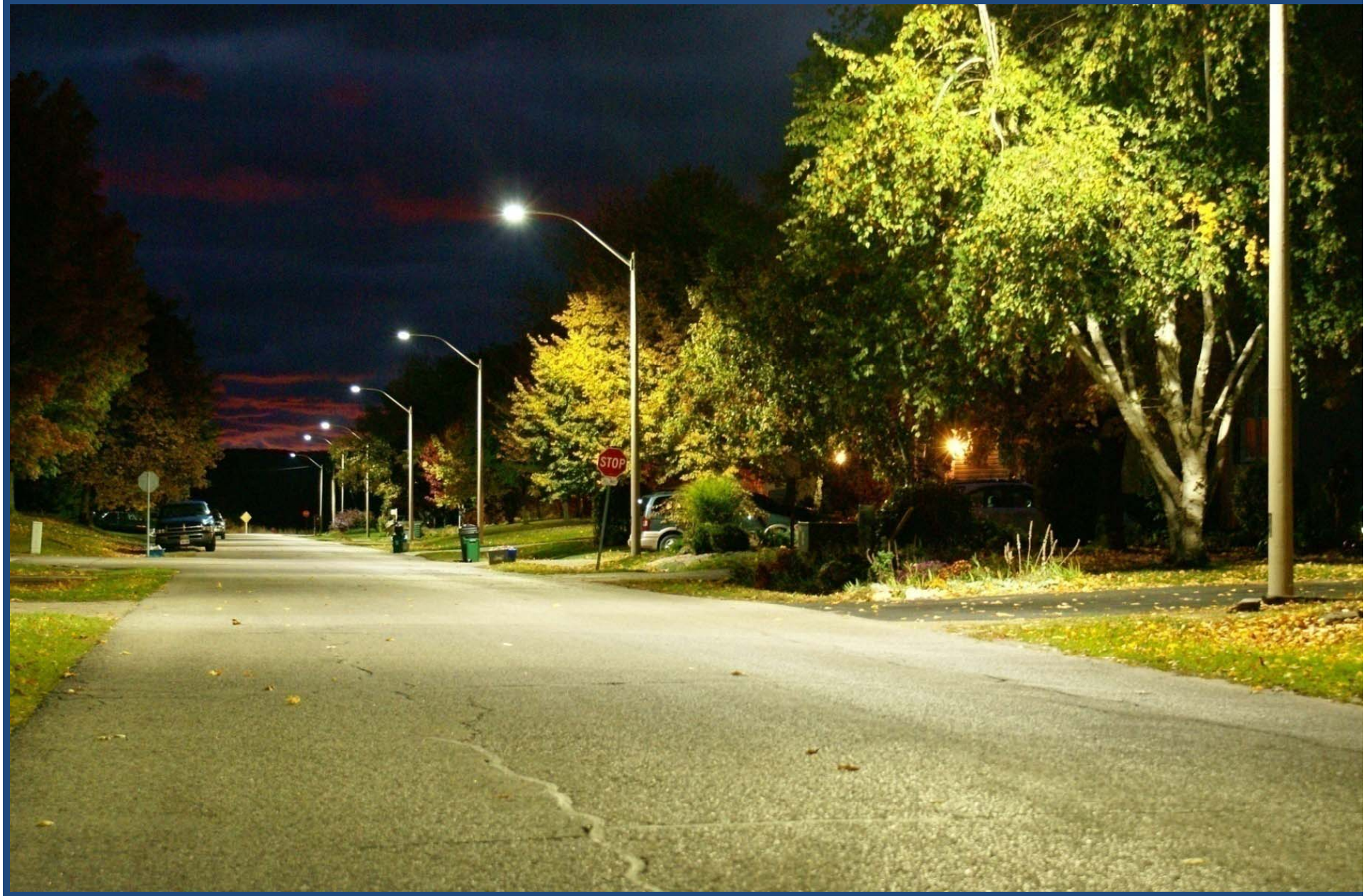
Energy Metrics

City of San Francisco – LED Streetlighting Test

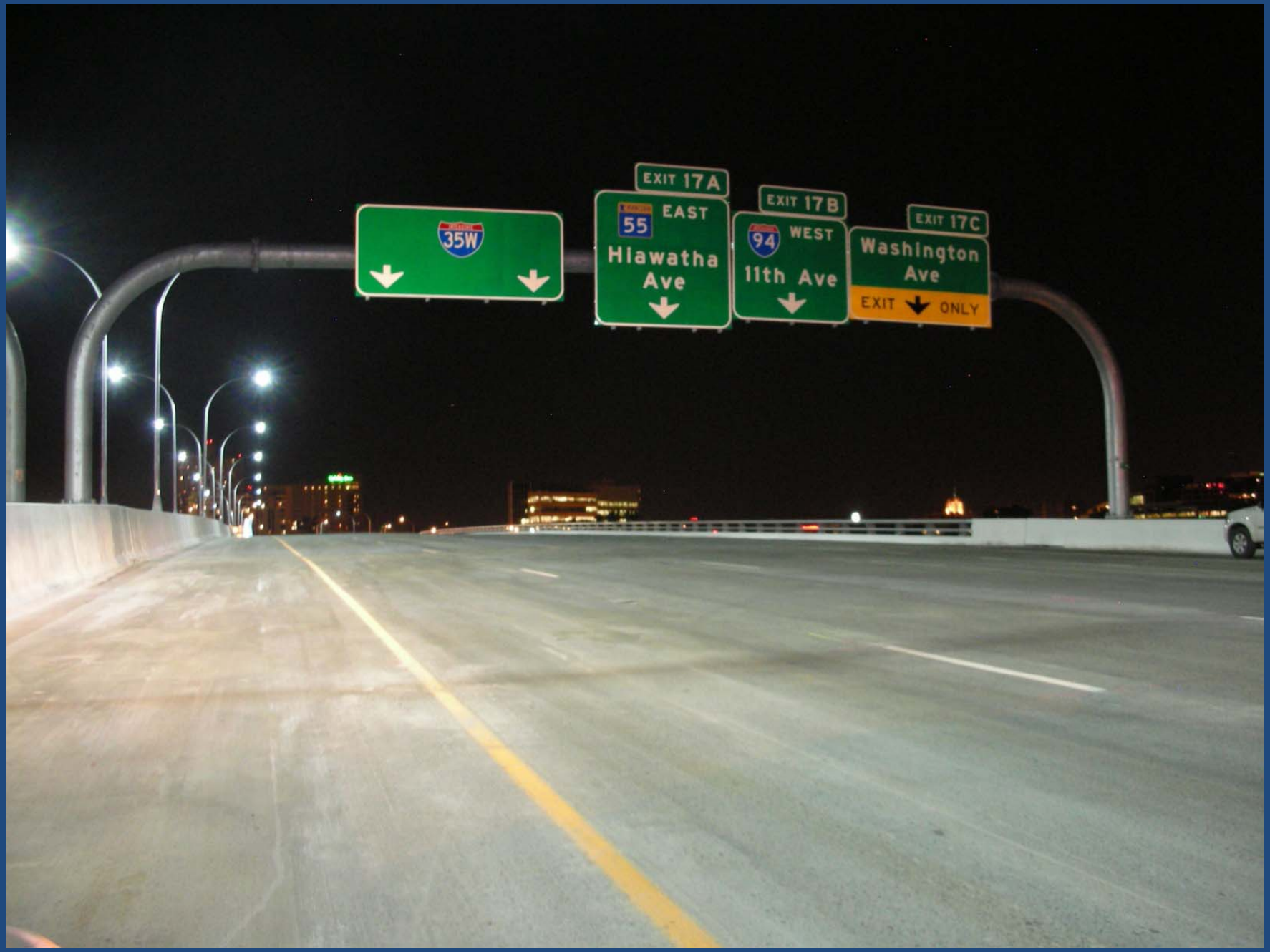


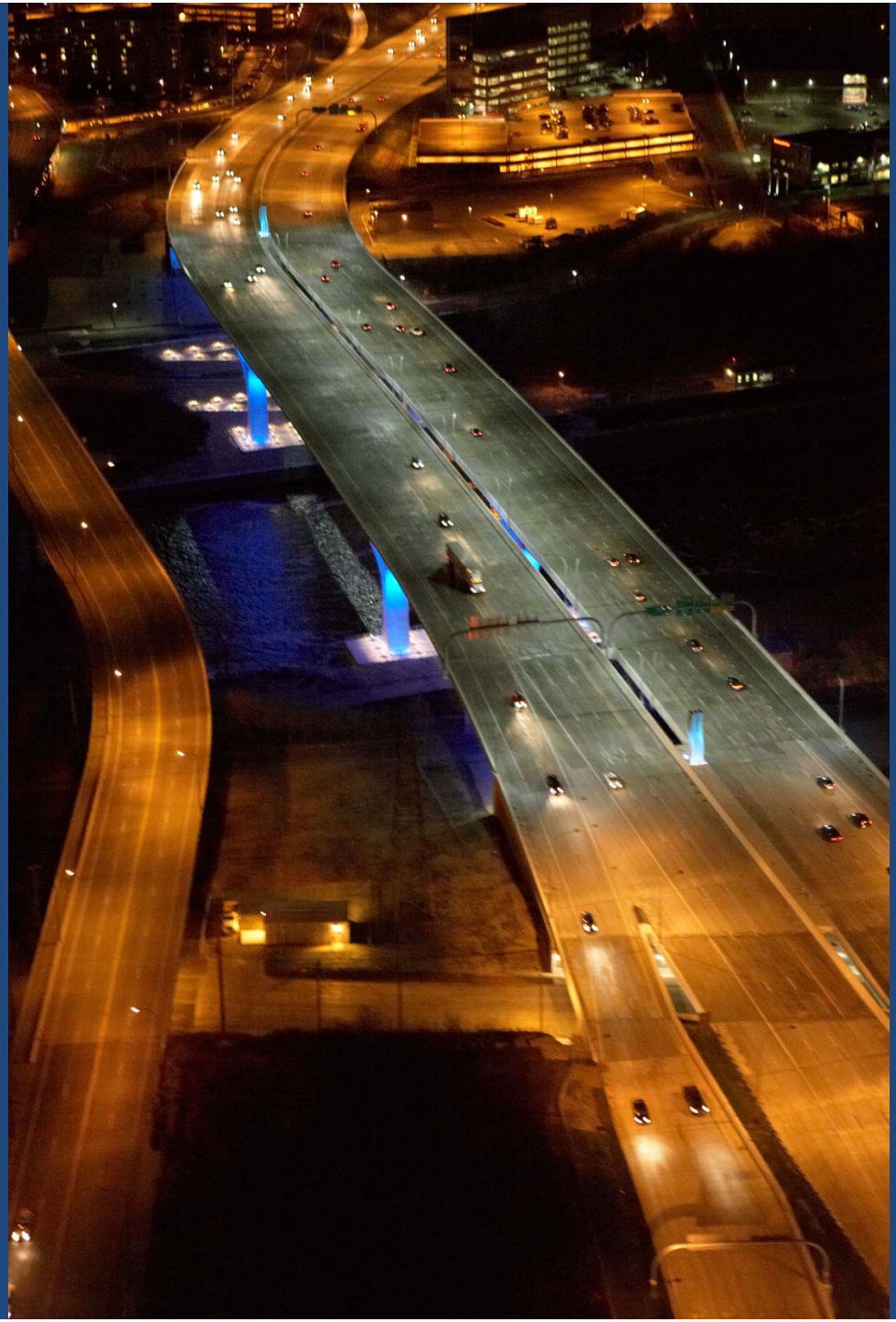
City of San Francisco – LED Streetlighting Test




STOP

Adaptive Controls– “smart” fixtures


35W
EXIT 17A
55 EAST
Hiawatha Ave
EXIT 17B
94 WEST
11th Ave
EXIT 17C
Washington Ave
EXIT ONLY




Crocina
160 m

Triggers for Considering LED

- Long hours of operation (24/7)
- Long periods of inactivity in space
- Hard-to-maintain and high-vibration locations
- Low light level requirements, especially where uniformity is important
- Overlighted existing sites – re-design to meet IES standards

Possible today, but there are barriers…

Barriers to LED for Site & Roadway

- For designers, lack of experience with LEDs, lack of knowledge of LEDs, and lack of confidence in LEDs
- Incomplete standards: LM-79, LM-80, and more coming (TM-21) - what to use now?
- First cost of luminaires / payback
- Variability in luminaire design & performance – challenging to evaluate

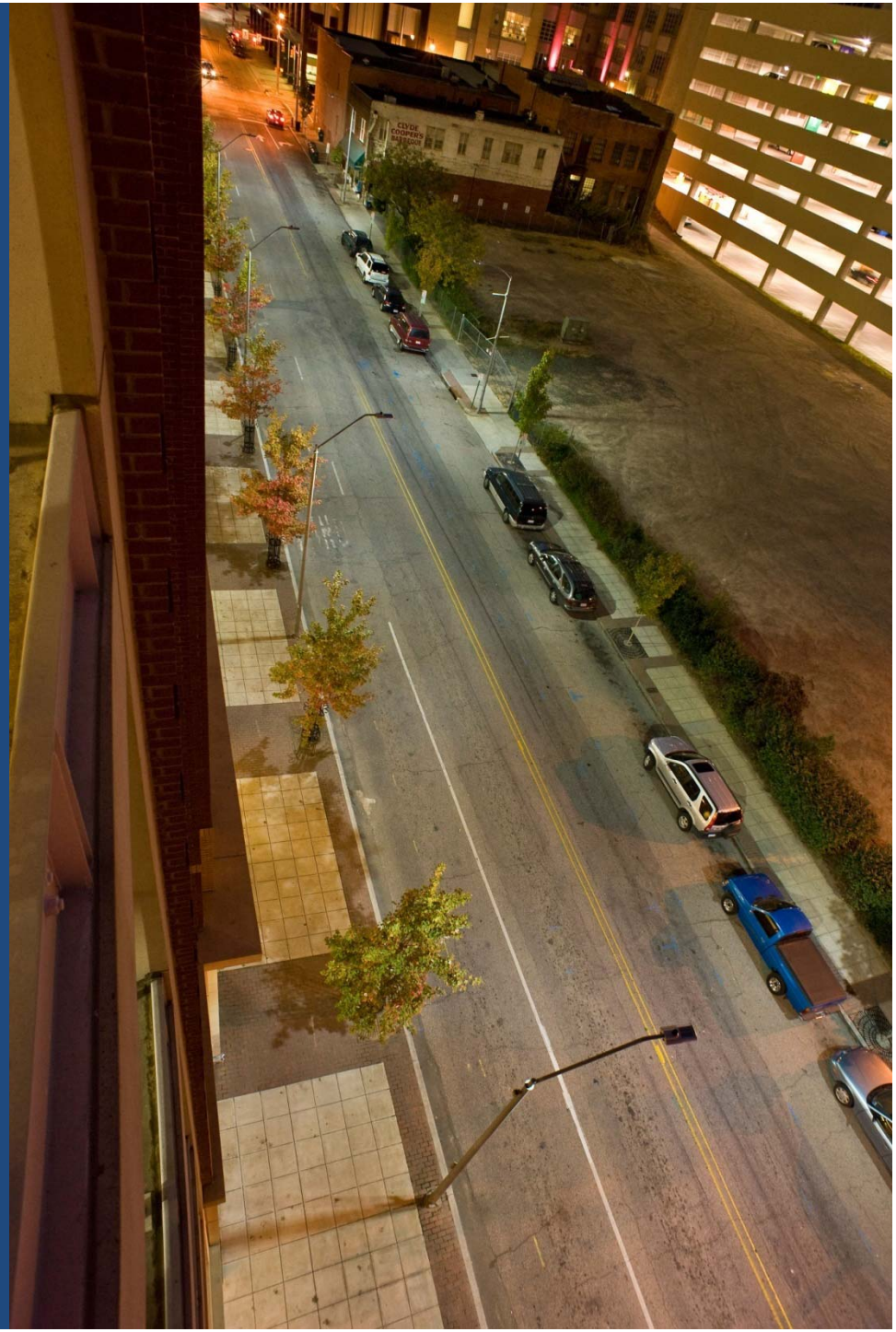
Evaluating LED luminaires

- Photometrics (independent test data)
- Evaluation/Layout for the application
- Life: what is the L_{70}
- Economic Analysis
- Installations / Proven
- Warranty

The View Ahead: Potential for Improvements through using LED Technology

- Better Lumen Maintenance – longer life
- Reduced Equipment Maintenance
- More use of Adaptive Controls
- Reduced Energy Use
- More effective target distribution of light
- Improved Vandal Resistance

Update on Applying LEDs for Site & Roadway Lighting



TRB Visibility Symposium
May 2009

Shirley Coyle
shirley.coyle@ruud.ca