

# CITY OF FRISCO LED LIGHTING STUDY

BRIAN MOEN, PE, CITY OF FRISCO

DHARMESH SHAH, PE, PTOE, LEE ENGINEERING



**LEE ENGINEERING**

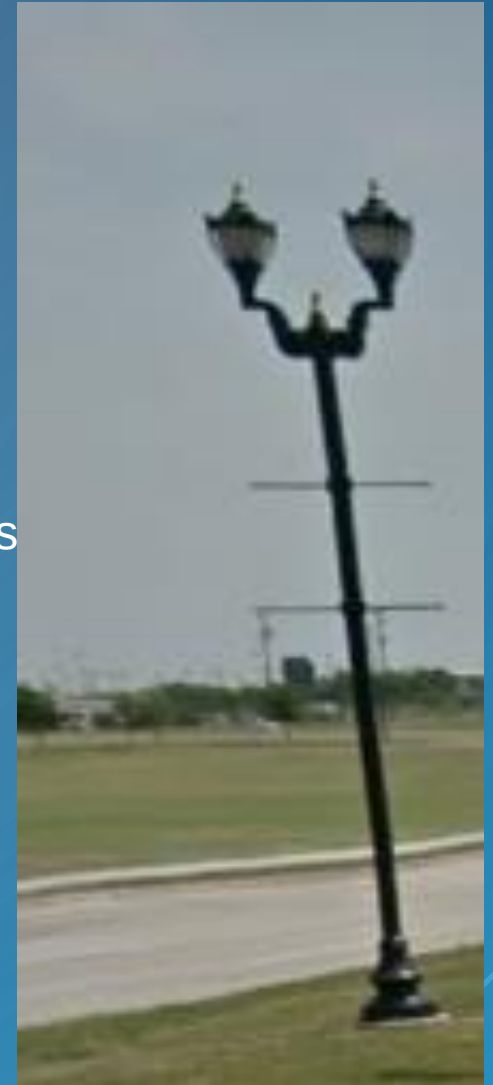
# EXISTING LIGHTING

- 480V
- 30' MH
- 4' Arm



Arterial – 250W MH

5300 Plus Lights



Downtown – 150W  
MH

# OTHER TECHNOLOGIES

- LED



- Energy Savings

- Bold claims?

- Cost

- Worth it?

- New or Retrofit?

- Induc



# STUDY APPROACH

- Request for Information
- Vendor Short List
  - Presentations
- Short List for Pilot Study
  - Install Fixtures
  - Light Level Measurement
- Evaluate & Recommend

# REQUEST FOR INFORMATION

- Application Based
- Buy America Mandate
- Shop Drawings
- Installation & Maintenance Requirements
- List Price
- Warranty – Min 5 Years
- Retrofit Kit
- Small Cell Installation
- Lighting Control Systems

# REQUEST FOR INFORMATION

- 15 Vendors Responded

|            | Induction           | LED                 |
|------------|---------------------|---------------------|
| Vendors    | 4                   | 13                  |
| Cost       | \$240 - \$600       | \$330 - \$1200      |
| Warranty   | 5 – 10 years        | 5 – 10 Years        |
| Retrofit   | Available           | Available           |
| Life       | 50K – 100K<br>Hours | 50K – 100K<br>Hours |
| Input Watt | 120W – 177W         | 88W – 177W          |
| Technology | Proven – No R&D     | Rapidly Improving   |

- Retrofit – Reduced warranty, little cost advantage

# REQUEST FOR INFORMATION

- Vendor Presentation
  - Induction - 2
  - LED – 6
- Induction - Not Considered Further
  - No more technological improvement
  - Market trend
  - Little cost advantage



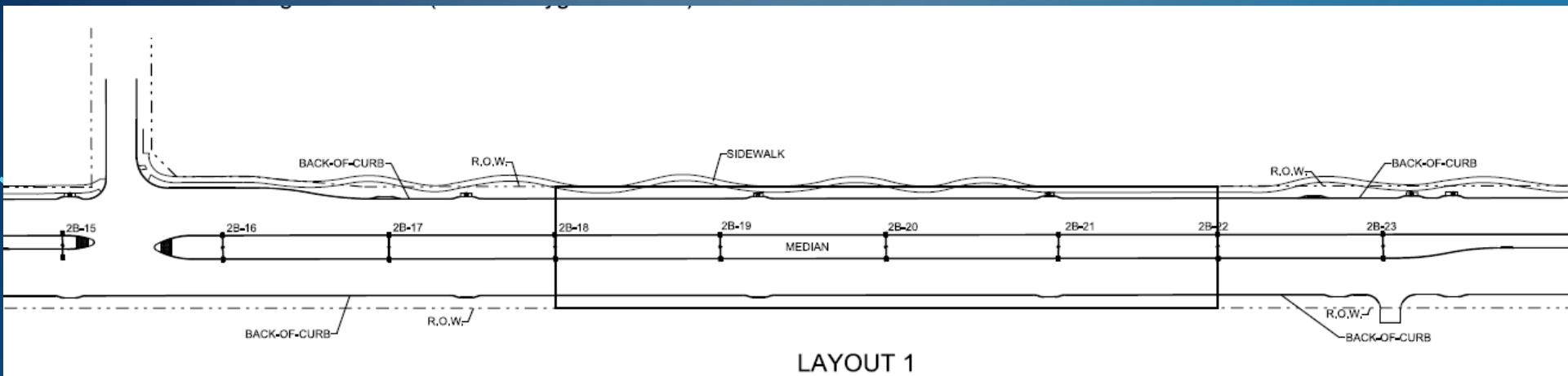
# REQUEST FOR INFORMATION

- Three LED Chip Manufacturers
- LED Driver (Power Supply)
- Surge Protector
- Warranty – Entire fixture?
- Hard to Obtain Cost Information



# PILOT STUDY

- Application Based



- LED – Five Vendors Selected for Pilot Study

- Four Vendors Provided Fixtures

# PILOT STUDY

## Photometric Analysis Criteria

|                                    |                               |
|------------------------------------|-------------------------------|
| Classification of Area             | Major                         |
| Road Surface Classification        | R1 – Portland cement concrete |
| Pedestrian Conflict Area           | Low to Medium                 |
| Minimum Maint. Average Illuminance | 0.6 to 0.9 fc                 |
| Uniformity Ratio (avg/min)         | 3.0                           |
| Total Light Loss Factor (LLF)      | 0.92                          |
| Luminaire Mounting Height          | 30 feet                       |
| Arm Length                         | 4 feet                        |
| Electrical Service                 | 480V                          |

# PILOT STUDY



# PILOT STUDY

- Fixture Assembly
  - 10-15 Minutes
- Fixture Installation
  - 12 to 20 Minutes
- Ease of Installation
  - Wiring
  - Weight

Overall assembly and Installation  
Time Similar – after few installs





# PILOT STUDY



# PILOT STUDY



Vendor 1



Vendor 3



Vendor 2



Vendor 4

# PILOT STUDY

- Photometric Analysis V/S Field Measurement
  - Field Measured fc values – Similar to Photometric Analysis Provided by Vendors
- Visual Observation - Better Than Existing MH
  - Hot spots
  - Sidewalk
- Wattage Measurement

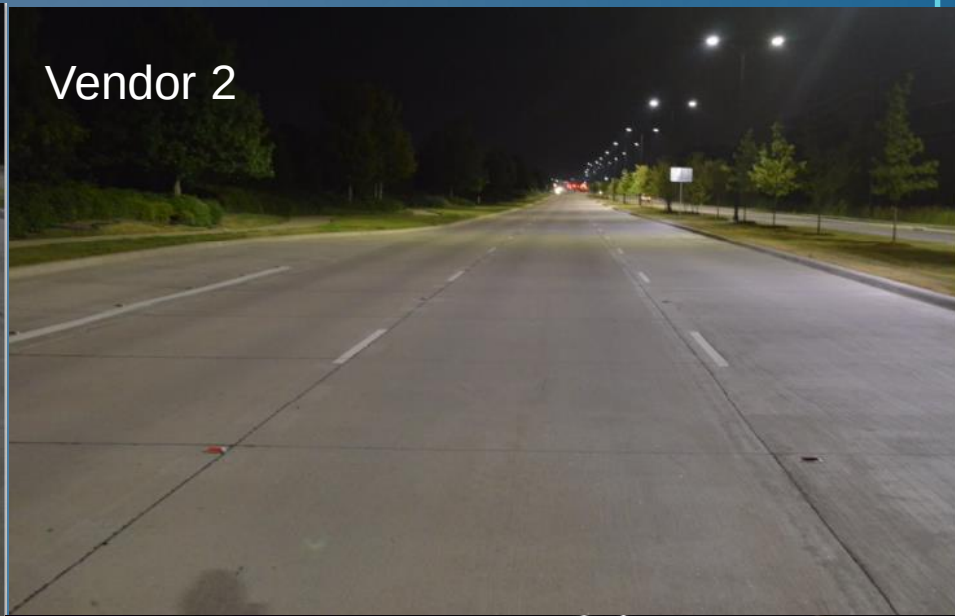


# PILOT STUDY

Vendor 1



Vendor 2



Vendor 3



Vendor 4



# PILOT STUDY

Media



| Min  | Max  | Avg  | Uniformity |
|------|------|------|------------|
| 0.16 | 2.68 | 0.71 | 4.45       |

|      |      |      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.36 | 0.43 | 0.52 | 0.97 | 1.31 | 1.97 | 2.68 | 1.92 | 1.37 | 0.91 | 0.57 | 0.37 | 0.33 |
| 0.37 | 0.32 | 0.49 | 0.74 | 1.22 | 1.68 | 2.17 | 1.49 | 1.25 | 0.87 | 0.57 | 0.32 | 0.37 |
| 0.42 | 0.41 | 0.53 | 0.82 | 1.14 | 1.31 | 1.56 | 1.16 | 1.11 | 0.83 | 0.49 | 0.37 | 0.44 |
| 0.46 | 0.43 | 0.5  | 0.88 | 1.05 | 1.03 | 1.11 | 0.8  | 0.87 | 0.83 | 0.53 | 0.42 | 0.46 |
| 0.47 | 0.46 | 0.5  | 0.83 | 0.88 | 0.76 | 0.79 | 0.59 | 0.72 | 0.56 | 0.42 | 0.42 | 0.44 |
| 0.47 | 0.39 | 0.58 | 0.69 | 0.63 | 0.56 | 0.57 | 0.51 | 0.49 | 0.6  | 0.63 | 0.45 | 0.41 |
| 0.5  | 0.46 | 0.58 | 0.72 | 0.54 | 0.45 | 0.28 | 0.27 | 0.16 | 0.34 | 0.19 | 0.3  | 0.17 |

3'

21'

36'

46'

# PILOT STUDY

Vendor 1 – 190W

Median



| Min  | Max  | Avg | Uniformity |
|------|------|-----|------------|
| 0.14 | 2.13 | .82 | 5.88       |

|      |      |      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.57 | 0.58 | 0.66 | 0.9  | 1.48 | 2.04 | 1.95 | 2.13 | 1.65 | 0.96 | 0.75 | 0.65 | 0.59 |
| 0.72 | 0.69 | 0.77 | 0.83 | 1.39 | 1.87 | 1.93 | 1.96 | 1.57 | 1    | 0.94 | 0.76 | 0.72 |
| 0.89 | 0.83 | 0.79 | 1    | 1.26 | 1.67 | 1.86 | 1.34 | 1.45 | 1    | 1.04 | 0.99 | 0.82 |
| 1.02 | 0.89 | 0.81 | 0.95 | 1.2  | 1.41 | 1.75 | 1.54 | 1.37 | 1.02 | 1.07 | 1.02 | 0.92 |
| 0.9  | 0.85 | 0.81 | 0.85 | 0.99 | 1.14 | 1.18 | 1.1  | 1.29 | 0.91 | 0.83 | 0.85 | 0.84 |
| 0.67 | 0.65 | 0.54 | 0.61 | 0.64 | 0.64 | 0.69 | 0.69 | 0.65 | 0.65 | 0.66 | 0.74 | 0.72 |
| 0.5  | 0.47 | 0.49 | 0.44 | 0.48 | 0.43 | 0.43 | 0.41 | 0.44 | 0.47 | 0.55 | 0.63 | 0.6  |
| 0.14 | 0.17 | 0.15 | 0.17 | 0.14 | 0.16 | 0.16 | 0.17 | 0.15 | 0.23 | 0.24 | 0.27 | 0.27 |

Vendor 2 – 95W

Median



|      |      |      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.66 | 0.65 | 0.63 | 0.82 | 1.07 | 1.44 | 1.84 | 1.65 | 1.34 | 1.34 | 0.99 | 0.75 | 0.53 |
| 0.71 | 0.66 | 0.65 | 0.71 | 0.89 | 1.08 | 1.34 | 1.18 | 1.1  | 1.1  | 0.94 | 0.8  | 0.6  |
| 0.74 | 0.71 | 0.61 | 0.71 | 0.87 | 1.01 | 1.17 | 1.14 | 1.04 | 1.04 | 0.83 | 0.79 | 0.68 |
| 0.72 | 0.7  | 0.65 | 0.72 | 0.81 | 0.96 | 1.03 | 1.04 | 1.03 | 1.03 | 0.88 | 0.76 | 0.68 |
| 0.76 | 0.68 | 0.64 | 0.7  | 0.74 | 0.82 | 0.9  | 0.96 | 0.92 | 0.92 | 0.84 | 0.85 | 0.7  |
| 0.8  | 0.75 | 0.71 | 0.62 | 0.67 | 0.76 | 0.83 | 0.83 | 0.82 | 0.82 | 0.87 | 0.92 | 0.75 |
| 0.85 | 0.77 | 0.87 | 0.66 | 0.66 | 0.75 | 0.82 | 0.8  | 0.74 | 0.74 | 0.99 | 0.93 | 0.82 |
| 0.74 | 0.73 | 0.57 | 0.48 | 0.51 | 0.6  | 0.66 | 0.57 | 0.43 | 0.43 | 0.54 | 0.6  | 0.62 |

| Min  | Max  | Avg  | Uniformity |
|------|------|------|------------|
| 0.43 | 1.84 | 0.83 | 1.93       |

# PILOT STUDY

Vendor 3 - Median



| Min  | Max  | Avg  | Uniformity |
|------|------|------|------------|
| 0.29 | 0.28 | 0.26 | 0.23       |
| 0.17 | 0.15 | 0.06 | 0.11       |
| 0.12 | 0.14 | 0.18 | 0.21       |
| 0.24 | 0.21 | 0.18 | 0.21       |

|      |      |      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.75 | 0.79 | 0.99 | 1.52 | 2.68 | 3.96 | 4.03 | 3.79 | 2.57 | 1.52 | 1.06 | 0.88 | 0.87 |
| 0.75 | 0.8  | 1.03 | 1.5  | 2.28 | 3.11 | 3.4  | 2.97 | 2.14 | 1.44 | 1.08 | 0.91 | 0.93 |
| 0.77 | 0.84 | 1.03 | 1.49 | 1.93 | 2.46 | 2.51 | 2.38 | 1.85 | 1.35 | 1.03 | 0.91 | 0.92 |
| 0.78 | 0.8  | 0.98 | 1.25 | 1.39 | 1.97 | 1.94 | 1.84 | 1.48 | 1.17 | 0.96 | 0.9  | 0.87 |
| 0.71 | 0.78 | 0.84 | 1.04 | 1.16 | 1.38 | 1.27 | 1.25 | 1.1  | 0.96 | 0.84 | 0.81 | 0.79 |
| 0.63 | 0.7  | 0.75 | 0.82 | 0.85 | 0.81 | 0.78 | 0.8  | 0.74 | 0.73 | 0.71 | 0.72 | 0.69 |
| 0.59 | 0.6  | 0.72 | 0.68 | 0.64 | 0.6  | 0.52 | 0.56 | 0.54 | 0.54 | 0.57 | 0.61 | 0.62 |
| 0.29 | 0.28 | 0.26 | 0.23 | 0.17 | 0.15 | 0.06 | 0.11 | 0.12 | 0.14 | 0.18 | 0.21 | 0.24 |

Cur  
b

Cur  
b

Vendor 4 – Median



|      |      |      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.32 | 0.32 | 0.49 | 0.64 | 0.99 | 2.25 | 2.34 | 2.38 | 1.26 | 0.83 | 0.65 | 0.4  | 0.38 |
| 0.38 | 0.39 | 0.62 | 0.84 | 1.44 | 2.23 | 1.74 | 2.16 | 1.52 | 0.97 | 0.68 | 0.49 | 0.46 |
| 0.43 | 0.43 | 0.63 | 0.85 | 1.53 | 1.71 | 1.75 | 1.66 | 1.62 | 0.96 | 0.68 | 0.51 | 0.48 |
| 0.46 | 0.45 | 0.61 | 0.85 | 1.42 | 1.35 | 1.51 | 1.27 | 1.3  | 0.86 | 0.75 | 0.52 | 0.52 |
| 0.48 | 0.48 | 0.68 | 0.82 | 1.06 | 1.1  | 1.17 | 1.12 | 1.16 | 0.87 | 0.82 | 0.57 | 0.55 |
| 0.5  | 0.52 | 0.69 | 0.87 | 1.18 | 1.33 | 1.44 | 1.29 | 1.25 | 0.98 | 0.69 | 0.57 | 0.55 |
| 0.5  | 0.52 | 0.6  | 0.87 | 1.08 | 1.18 | 1.47 | 1.38 | 1.15 | 0.88 | 0.64 | 0.58 | 0.56 |
| 0.38 | 0.42 | 0.46 | 0.55 | 0.64 | 0.65 | 0.62 | 0.58 | 0.55 | 0.49 | 0.42 | 0.43 | 0.37 |

Cur  
b

Cur  
b

| Min  | Max  | Avg  | Uniformity |
|------|------|------|------------|
| 0.32 | 2.38 | 0.89 | 2.79       |

# Comparison



Median

Vendor 1

Cur  
b

10' from  
Curb

|      |      |      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.57 | 0.58 | 0.66 | 0.9  | 1.48 | 2.04 | 1.95 | 2.13 | 1.65 | 0.96 | 0.75 | 0.65 | 0.59 |
| 0.72 | 0.69 | 0.77 | 0.83 | 1.39 | 1.87 | 1.93 | 1.96 | 1.57 | 1    | 0.94 | 0.76 | 0.72 |
| 0.89 | 0.83 | 0.79 | 1    | 1.26 | 1.67 | 1.86 | 1.34 | 1.45 | 1    | 1.04 | 0.99 | 0.82 |
| 1.02 | 0.89 | 0.81 | 0.95 | 1.2  | 1.41 | 1.75 | 1.54 | 1.37 | 1.02 | 1.07 | 1.02 | 0.92 |
| 0.9  | 0.85 | 0.81 | 0.85 | 0.99 | 1.14 | 1.18 | 1.1  | 1.29 | 0.91 | 0.83 | 0.85 | 0.84 |
| 0.67 | 0.65 | 0.54 | 0.61 | 0.64 | 0.64 | 0.69 | 0.69 | 0.65 | 0.65 | 0.66 | 0.74 | 0.72 |
| 0.5  | 0.47 | 0.49 | 0.44 | 0.48 | 0.43 | 0.43 | 0.41 | 0.44 | 0.47 | 0.55 | 0.63 | 0.6  |
| 0.14 | 0.17 | 0.15 | 0.17 | 0.14 | 0.16 | 0.16 | 0.17 | 0.15 | 0.23 | 0.24 | 0.27 | 0.27 |

Vendor 2

|      |      |      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.66 | 0.65 | 0.63 | 0.82 | 1.07 | 1.44 | 1.84 | 1.65 | 1.34 | 1.34 | 0.99 | 0.75 | 0.53 |
| 0.71 | 0.66 | 0.65 | 0.71 | 0.89 | 1.08 | 1.34 | 1.18 | 1.1  | 1.1  | 0.94 | 0.8  | 0.6  |
| 0.74 | 0.71 | 0.61 | 0.71 | 0.87 | 1.01 | 1.17 | 1.14 | 1.04 | 1.04 | 0.83 | 0.79 | 0.68 |
| 0.72 | 0.7  | 0.65 | 0.72 | 0.81 | 0.96 | 1.03 | 1.04 | 1.03 | 1.03 | 0.88 | 0.76 | 0.68 |
| 0.76 | 0.68 | 0.64 | 0.7  | 0.74 | 0.82 | 0.9  | 0.96 | 0.92 | 0.92 | 0.84 | 0.85 | 0.7  |
| 0.8  | 0.75 | 0.71 | 0.62 | 0.67 | 0.76 | 0.83 | 0.83 | 0.82 | 0.82 | 0.87 | 0.92 | 0.75 |
| 0.85 | 0.77 | 0.87 | 0.66 | 0.66 | 0.75 | 0.82 | 0.8  | 0.74 | 0.74 | 0.99 | 0.93 | 0.82 |
| 0.74 | 0.73 | 0.57 | 0.48 | 0.51 | 0.6  | 0.66 | 0.57 | 0.43 | 0.43 | 0.54 | 0.6  | 0.62 |

Vendor 3

|      |      |      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.75 | 0.79 | 0.99 | 1.52 | 2.68 | 3.96 | 4.03 | 3.79 | 2.57 | 1.52 | 1.06 | 0.88 | 0.87 |
| 0.75 | 0.8  | 1.03 | 1.5  | 2.28 | 3.11 | 3.4  | 2.97 | 2.14 | 1.44 | 1.08 | 0.91 | 0.93 |
| 0.77 | 0.84 | 1.03 | 1.49 | 1.93 | 2.46 | 2.51 | 2.38 | 1.85 | 1.35 | 1.03 | 0.91 | 0.92 |
| 0.78 | 0.8  | 0.98 | 1.25 | 1.39 | 1.97 | 1.94 | 1.84 | 1.48 | 1.17 | 0.96 | 0.9  | 0.87 |
| 0.71 | 0.78 | 0.84 | 1.04 | 1.16 | 1.38 | 1.27 | 1.25 | 1.1  | 0.96 | 0.84 | 0.81 | 0.79 |
| 0.63 | 0.7  | 0.75 | 0.82 | 0.85 | 0.81 | 0.78 | 0.8  | 0.74 | 0.73 | 0.71 | 0.72 | 0.69 |
| 0.59 | 0.6  | 0.72 | 0.68 | 0.64 | 0.6  | 0.52 | 0.56 | 0.54 | 0.54 | 0.57 | 0.61 | 0.62 |
| 0.29 | 0.28 | 0.26 | 0.23 | 0.17 | 0.15 | 0.06 | 0.11 | 0.12 | 0.14 | 0.18 | 0.21 | 0.24 |

Vendor 4

|      |      |      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.32 | 0.32 | 0.49 | 0.64 | 0.99 | 2.25 | 2.34 | 2.38 | 1.26 | 0.83 | 0.65 | 0.4  | 0.38 |
| 0.38 | 0.39 | 0.62 | 0.84 | 1.44 | 2.23 | 1.74 | 2.16 | 1.52 | 0.97 | 0.68 | 0.49 | 0.46 |
| 0.43 | 0.43 | 0.63 | 0.85 | 1.53 | 1.71 | 1.75 | 1.66 | 1.62 | 0.96 | 0.68 | 0.51 | 0.48 |
| 0.46 | 0.45 | 0.61 | 0.85 | 1.42 | 1.35 | 1.51 | 1.27 | 1.3  | 0.86 | 0.75 | 0.52 | 0.52 |
| 0.48 | 0.48 | 0.68 | 0.82 | 1.06 | 1.1  | 1.17 | 1.12 | 1.16 | 0.87 | 0.82 | 0.57 | 0.55 |
| 0.5  | 0.52 | 0.69 | 0.87 | 1.18 | 1.33 | 1.44 | 1.29 | 1.25 | 0.98 | 0.69 | 0.57 | 0.55 |
| 0.5  | 0.52 | 0.6  | 0.87 | 1.08 | 1.18 | 1.47 | 1.38 | 1.15 | 0.88 | 0.64 | 0.58 | 0.56 |
| 0.38 | 0.42 | 0.46 | 0.55 | 0.64 | 0.65 | 0.62 | 0.58 | 0.55 | 0.49 | 0.42 | 0.43 | 0.37 |



LEE ENGINEERING



# LIGHT LEVEL MEASUREMENT COMPARISON

Measurement Area Includes – 10' beyond curb

|            | <b>MH<br/>295W</b> | <b>Vendor 1<br/>190W</b> | <b>Vendor 2<br/>95W</b> | <b>Vendor 3<br/>142W</b> | <b>Vendor 4<br/>120W</b> |
|------------|--------------------|--------------------------|-------------------------|--------------------------|--------------------------|
| Min        | 0.16               | 0.14                     | 0.43                    | 0.06                     | 0.32                     |
| Max        | 2.68               | 1.96                     | 1.84                    | 4.03                     | 2.38                     |
| Avg        | 0.71               | 0.82                     | 0.83                    | 1.12                     | 0.95                     |
| Uniformity | 4.45               | 5.88                     | 1.93                    | 18.66                    | 2.97                     |

Measurement Area - Only Pavement

|            | <b>MH<br/>295W</b> | <b>Vendor 1<br/>190W</b> | <b>Vendor 2<br/>95W</b> | <b>Vendor 3<br/>142W</b> | <b>Vendor 4<br/>120W</b> |
|------------|--------------------|--------------------------|-------------------------|--------------------------|--------------------------|
| Min        | 0.28               | 0.41                     | 0.53                    | 0.52                     | 0.32                     |
| Max        | 2.68               | 2.13                     | 1.84                    | 4.03                     | 2.38                     |
| Avg        | 0.77               | 0.96                     | 0.87                    | 1.25                     | 0.95                     |
| Uniformity | 2.76               | 2.34                     | 1.63                    | 2.41                     | 2.97                     |



# ENERGY SAVINGS

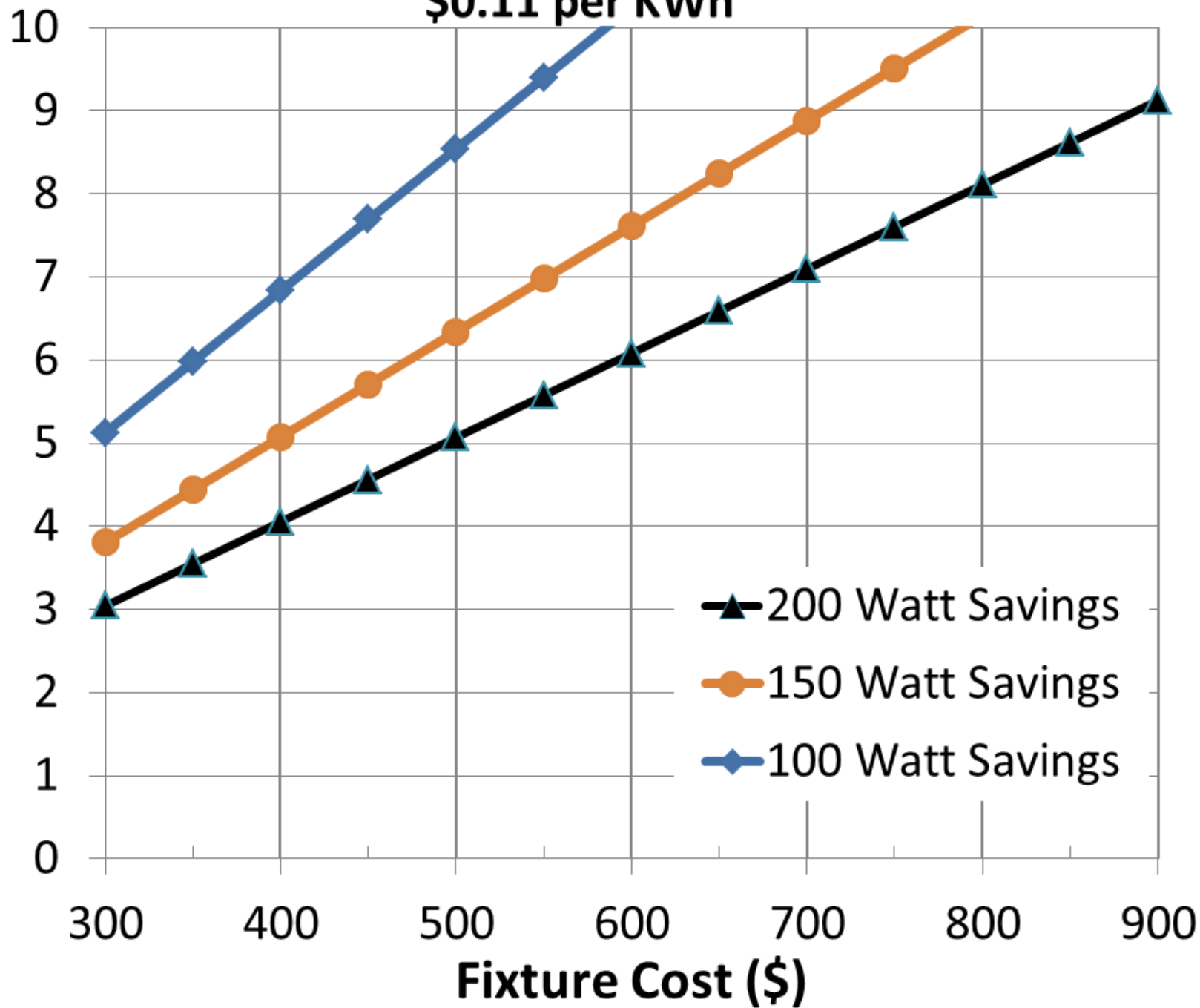
| Existing MH    | Vendor 1 | Vendor 2 | Vendor 3 | Vendor 4 |
|----------------|----------|----------|----------|----------|
| 295W           | 190W     | 95W      | 142W     | 119W     |
| Energy Savings | 36%      | 67%      | 52%      | 60%      |

# PAYBACK ANALYSIS

|                                    | Existing<br>MH  | Vendo<br>r 1 | Vendo<br>r 2 | Vendo<br>r 3 | Vendor<br>4    |
|------------------------------------|-----------------|--------------|--------------|--------------|----------------|
| Initial Purchase                   | -               | \$600        | \$450        | \$700        | \$600          |
| Yearly Energy<br>Cost @<br>0.11kWh | <b>\$124.36</b> | <b>\$80</b>  | <b>\$40</b>  | <b>\$60</b>  | <b>\$50.25</b> |
| Yearly Maint.<br>Cost              | \$17.78         | \$3.5        | \$3.5        | \$3.5        | \$3.5          |
| 5 Yr.<br>Cumulative<br>Cost        | \$711           | \$997        | \$667        | \$1001       | \$855          |
| 10 Yr.<br>Cumulative               | \$1421          | \$1262       | \$885        | \$1333       | \$1138         |

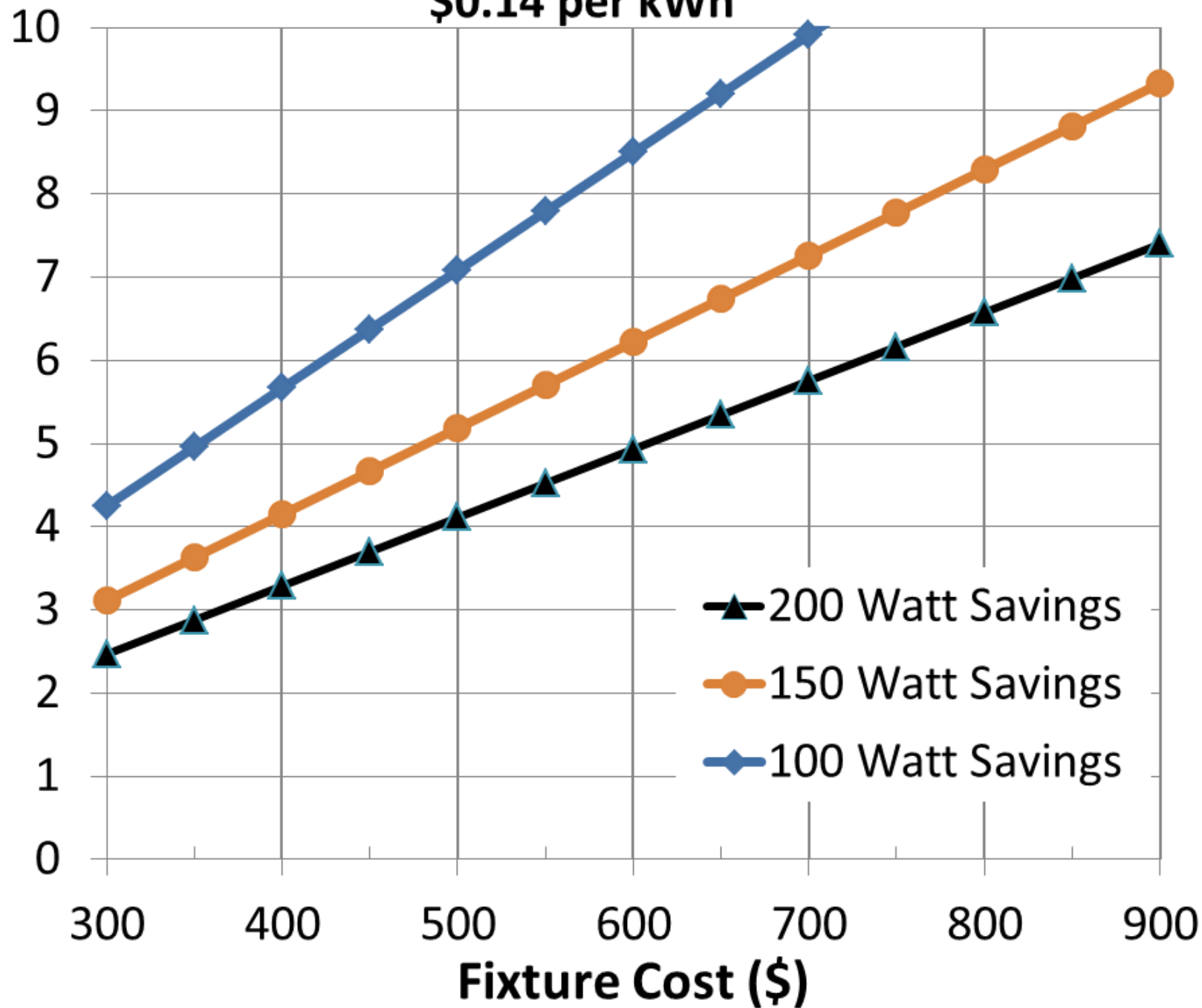
**Years to Payback**

**\$0.11 per KWh**



**\$0.14 per kWh**

**Years to Payback**



# WHAT NEXT?

- Select Vendor(s)
- LED Fixtures on New Projects
- Replacement of Existing Fixtures?
- Small Cell Installation?
- Lighting Control Systems



# QUESTIONS?

- Brian Moen, PE, City of Frisco  
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