THE CITY OF CALGARY
ROADS

ENERGY EFFICIENT STREET LIGHTING TECHNICAL REPORT

Attachment 1 to Cover Report

Transportation Department
The City of Calgary, Roads
Traffic Division
June 12, 2014

Michael Gray, P.Eng
Sr. Streetlight Design Engineer

Introduction

Roads Traffic Engineering continuously investigates new technologies to ensure that Calgary's street light system is efficient, effective, and sustainable from a triple-bottom-line perspective. There are almost 90,000 fixtures which make up Calgary's street light inventory and with recent advancements in technology, Roads has completed an investigation and contract award for ways to reduce operating costs related to electricity and maintenance, while improving light quality and reducing The City of Calgary's impact to the environment.

RFP Evaluation

A competitive request for proposal (RFP) was released in early 2014 for the supply of light-emitting diode (LED) luminaires and an adaptive lighting system. The main factors considered in the evaluation were the optical performance, quality and longevity, company profile & references, delivery lead time and cost. The adaptive lighting system proposals were reviewed based on similar criteria but provided inconclusive benefits.

A key consideration for LED luminaires in this project was the colour temperature; this was due to issues raised in Edmonton and Lethbridge by the public feeling the lights looked "eerie". Lower color temperatures tend to appear "warmer" while higher color temperatures tend to appear "cooler blue" looking. This colour temperature is stated in units of kelvin (K). The basic rule of thumb is the higher the temperature, the higher the visible light (lumen) output. In consultation with The City of Edmonton, and The City of Calgary consultant DMD & Associates Ltd., the design team used 4000K for local and collector roads, and 5000K for arterial roads.

In order to select the correct luminaires, the project team needed to look at the current pole spacing in each community. Some standard road cross sections were developed for each project area. This allowed for ease of fixture evaluation in the RFP to see how they compared on Calgary roads. Figure 1 was developed by the team and shows the 13 roadway cross sections for this project

Roadway	Roadway Classification M - Major, C - Collector & L - Local	Pedestrian Activity Level	Luminaire overhang (m) *	Median	Pole Height (m)	Arrangement - Staggered (S), One sided (OS)	# of lanes	Sidewalk width (m)	Sidewalk Offset from lane edge (m)	Existing HPS Wattage (W)	Pole Spacing - Full Cycle Length (m)	Weighting (1000 Total)
1	M	LOW	0	5	15	S	2 - 2	1.85	1.05	400	100	28
2	M	LOW	0	4.5	15	OS	2 - 2	1.85	2.05	400	46	37
3	M	LOW	0	0	9.1	S	2 - 2	1.85	0	400	90	43
4	M	HIGH	0	0	9.1	S	2 - 2	1.85	0	250	110	8
5	M	HIGH	0	0	15	S	2 - 2	1.85	3.9	400	106	7
6	C	LOW	-2.7	0	10.7	OS	1 - 1	1.85	2.5	200	68	49
7	C	LOW	-2.7	0	10.7	S	1 - 1	1.85	2.5	200	69	114
8	C	LOW	-2.7	0	9.1	S	1 - 1	1.85	2.5	200	120	64
9	C	LOW	0	0	9.1	OS	2 - 2	1.85	0	150	79	21
10	L	LOW	-1.5	0	10.7	OS	1 - 1	1.85	1.3	100	79	178
11	L	LOW	0	0	10.7	S	1 - 1	1.85	4.8	100	79	167
12	L	LOW	0	0	9.1	S	1 - 1	1.85	4.8	100	90	274
13	L	LOW	-3.6	3	9.1	S	1 - 1	1.85	3.4	100	86	11

Figure 1 Roadway Cross Sections

Based on these 13 roadway types, 13 discrete models were created in AGI 32 roadway lighting software. One of the key parts of the RFP was the mandatory submission of Illuminating Engineering Society (IES) electronic photometric files. These photometric files (per manufacturer) were input into the software so that the performance of each luminaire could be compared against each other, and against the Transportation Association of Canada (TAC) guidelines. The below table (figure 2) was completed by the project team for each manufacturer so a fair comparison could be made.

Roadway Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Luminaire Make and Model No.													
Light Loss Factor													
Lamp Lumen Depreciation													
Input Watts													
Driver Current													
Efficacy (lumens per watt)													
BUG Rating													
Roadway Calculation Results													
Average Luminance (cd/m²)													
Uniformity Ratio Avg / Min													
Uniformity Ratio Max / Min													
Veiling Luminance Ratio													
Sidewalk Calculation Results													
Average Horizontal Illuminance													
Uniformity Ratio Avg / Min													
Pole Spacing and UPD Results													
Pole Spacing													
Roadway UPD (W/ m²)													

Figure 2 Optical Performance of Luminaires

The critical components from figure 2 were whether a fixture could meet lighting levels and the UPD (Unit Power Density), which is defined as the power in watts (W) emitted over the area being illuminated per meter squared.

The following key items were looked at for each fixture in addition to figure 2:

- Ingress Protection (IP) Rating of Optical System
- Mean time between failure (MTBF)
- Dark Sky Compliant (yes/no)
- Luminaire weight and Effective Projected Area (EPA)

In total there were eight companies that bid on the RFP, with eight distinct products. The City shortlisted four of these vendors based on initial RFP scores (i.e. selected the highest rated proponents based on the main selection factors listed above). The shortlisted vendors were invited to provide two fixtures each so that the team could get an overall feeling of comfort with the luminaire optics, aesthetics, and product quality. With the knowledge gained from field testing the fixtures and comparison to the theoretical lighting models, The City was able to award the RFP in May 2014 to the successful product supplier(s).

Next Steps

The complete LED conversion of applicable street lights in the communities of Douglasdale, Altadore, Tuxedo Park, Brentwood and Marlborough is expected to be completed by fall 2014. The fixtures are expected to arrive before the end of July 2014 and installation is expected to begin shortly after.

The Streetlight design team recommends a City wide conversion program to mitigate the rising costs of operating Calgary's street lighting system. LED technology has reached a point of maturity where conversion will not only mean reduced maintenance and energy costs, but improved light quality. This conversion would cover all fixtures which are 400W or less since the greater wattage classes do not have the same kind of efficiency gains (lumens/watt) that are required to meet TAC lighting levels. Decorative fixtures will not be included for the time being as those types of fixtures typically do not have the same order of efficiency as replacing the high pressure sodium (HPS) cobrahead light fixtures with LED cobrahead fixtures.

The Streetlight design team also recommends that the LED conversion follow the group bulb re-lamping schedule as closely as possible to maximize the lifecycle efficiency of replacing the oldest HPS lights with the LED lights first.

Another Streetlighting opportunity is to encourage developers to use LED lighting in new subdivisions. This option requires investigation with the Urban Development (UDI) Institute to explore options on how to proceed.