
A WRCOG Report

# Results of Regional Streetlight Program Demonstration Area

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# Introduction

Updating conventional street lighting systems to light-emitting diode (LED) lights has become one of the most popular municipal projects today. The primary reason is that, if designed correctly, LED lighting systems save enough utility, energy, and maintenance costs to pay for the upgrade. Jurisdictions all around the world are undertaking LED projects to capitalize on the savings. As part of the Regional Streetlight Program, WRCOG is assisting member jurisdictions identify the feasibility of, and supporting through, the acquisition process to acquire the streetlights within their jurisdictional boundaries from Southern California Edison (SCE) and then helping them to make the conversion to cost-effective, energy efficient LED technologies.

LED lighting is different from older light sources. Older sources employ bulbous high intensity discharge (HID) lamps that require large reflectors, lenses, and heavy auxiliary electrical devices called ballasts. HID lamps are design large in size for purposes of housing the high wattage bulbs. They also have long warm up times as well as a long restart times if power is interrupted. Most of the HID lighting in Riverside County is either low pressure sodium (LPS), which exhibits a pure yellow light, or high pressure sodium (HPS), a yellow-pinkish light. All HID lamps burn out and need replacing every 2-4 years.

LED lighting, on the other hand, consists of several small, bright light emitting diodes working together to provide as much light as a single conventional HID lamp. Light is distributed differently with the potential to provide better lighting with less energy and less wasted light. The most obvious difference between HID lamps and LED is the light color. The LED color can be chosen to suit the application; for example, a warm white light could be used in residential and commercial areas, and an amber colored light in environmentally sensitive areas. Some WRCOG communities will choose one, the other or both.

There are less obvious but extremely important advantages of LED lighting. LED lighting can be switched on to full brightness instantaneously, and requires no restart time delay. LED lighting can also be dimmed to better match the specific application, which saves energy. Moreover, LED lighting can operate for over 15 years with no need for replacement or maintenance, other than cleaning.

The idea of a LED Streetlights demonstration area was created over two years ago, to provide communities the opportunity to see what they might expect from LED lighting in real-life situations. It also serves as a learning tool to teach community leaders, planners, engineers, and the public the fine points and considerations of LED lighting.

## Design and Implementation

The City of Hemet was selected both because of willingness to host the LED Streetlight Demonstration Area, and because the city owns and operates a large number of light poles. The consulting team worked with the City's Facilities Manager to select streets and intersections that represented typical lighting applications that the consulting team felt were common throughout Riverside County. The selected streetscapes included residential streets, collectors and arterials streets and intersections.

Sample lamps were requested from all interested lighting manufacturers, and the team received over 150 lamps from twelve different manufacturers. The manufacturers included the major lighting companies in the USA, as well as, several local manufacturers and smaller companies. The City of Hemet installed the demonstration lamps per plans produced by the consulting team. An identifying pole tag was attached to each light pole equipped with a test lamp, with a scan-able QR code to centralize data gathering.

For the purposes of studying community responses, eight specific LED "scenes" were developed to allow for the side-by-side comparison and evaluation of existing fixtures to LED by community stakeholders, as well as lighting engineers and experts. Scenes were selected to be representative of the types of streets, roads and intersections found throughout western Riverside County communities.

The eight scenes included residential streets, collector streets, and arterial roadways. Some of the scenes were intersections; others were a stretch of roadway where several LED lamps were installed in a line of existing lighting to illustrate the difference. Two scenes involved a cluster of LED luminaires in a neighborhood. One major intersection was completely re-lit with LED lamps. Two of the scenes demonstrated amber LED's to gauge community reaction. Scenes involved streets posted at 30 MPH or lessor at 45 MPH.

Five docent-guided bus tours were organized and over 120 members of city governments and the public provided detailed reviews and comments to all eight scenes. Each participant was asked five questions during evaluation of each scene, using a sliding scale for which 1 means 'disagree strongly', 2 means 'disagree', 3 means 'neutral', 4 means 'agree', and 5 means 'agree strongly':

Q1 The amount of light is just right.

Q2 I feel safe/visible with this light.

Q3 The light is better than what we have now.

Q4 I want this light in my community.

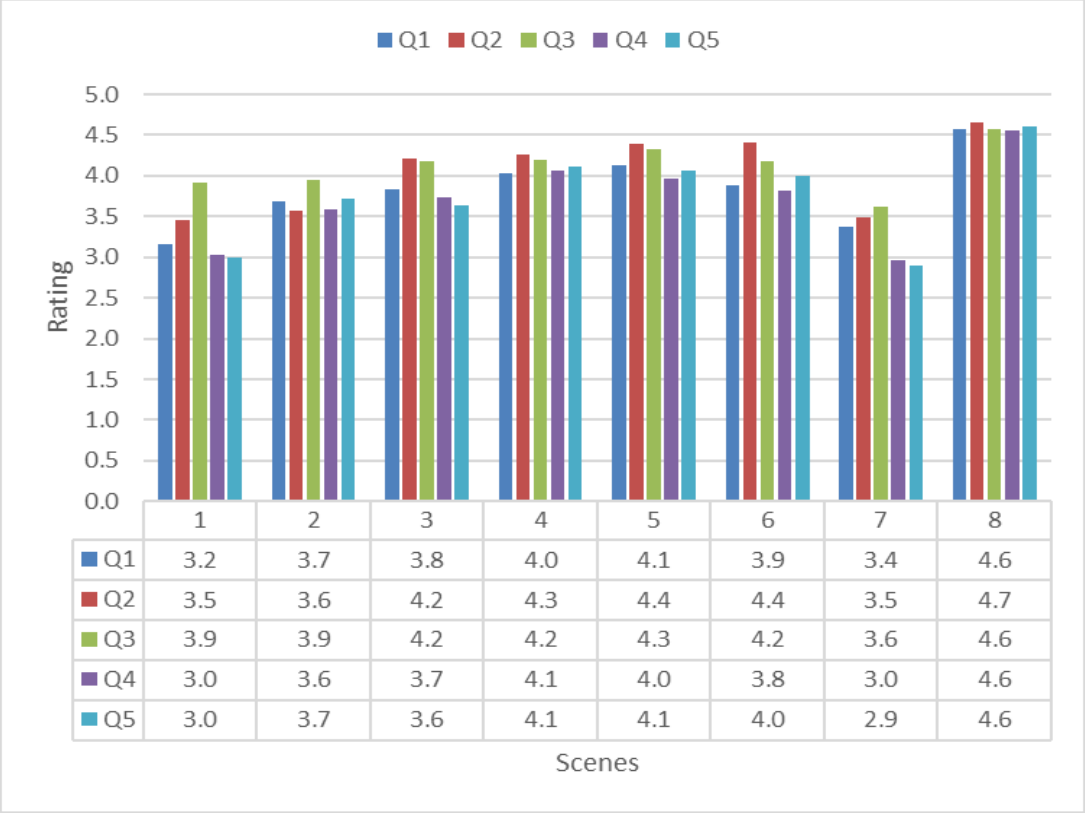
Q5 I like the color of this light.

An important part of the Demonstration Area surveys were that neither energy nor cost assessments were included in the surveys. The surveys were meant to assess the value of the lights on a qualitative basis.

## Results

Using data extracted from the Demonstration Area Tour surveys and data received from stakeholders that participated in the electronic survey using QR codes attached to Demonstration Area participating streetlight, WRCOG compiled the data (below).

Overall, the average score indicated a generally positive acceptance of the lighting demonstrated in the Demonstration Area. Only one scene received a negative average score for one question (Scene #7, Question #5 – I like the color of this light); three scenes received neutral scores; and the remaining 36 scores were positive.




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Q1 | 3.2 | 3.7 | 3.8 | 4.0 | 4.1 | 3.9 | 3.4 | 4.6 |
| Q2 | 3.5 | 3.6 | 4.2 | 4.3 | 4.4 | 4.4 | 3.5 | 4.7 |
| Q3 | 3.9 | 3.9 | 4.2 | 4.2 | 4.3 | 4.2 | 3.6 | 4.6 |
| Q4 | 3.0 | 3.6 | 3.7 | 4.1 | 4.0 | 3.8 | 3.0 | 4.6 |
| Q5 | 3.0 | 3.7 | 3.6 | 4.1 | 4.1 | 4.0 | 2.9 | 4.6 |

*Table 1: Results of five docent-moderated tours of the eight Demonstration Area scenes. The five questions (Q1-Q5) asked reviewers to rate the lighting on a scale of 1 to 5, where 3 is neutral, 1 is negative and 5 is positive. Scene 8 was the most universally well liked, a collector-to-arterial intersection on South Sanderson at Wentworth, near the Hemet-Ryan airport. Scenes 1 and 7, the least well liked, were amber LED and yellow filtered LED.*

## Analysis

From the docent-guided tours, enough data was gathered to permit drawing conclusions. The consulting team reached the following preliminary conclusions after analyzing the result of the surveys compiled at each of the eight LED scenes. The statements assessed included:

Q1 The amount of light is just right.

Q2 I feel safe/visible with this light.

Q3 The light is better than what we have now.

Q4 I want this light in my community.

Q5 I like the color of this light.

Preliminary conclusion included:

1. The warm white (2700K) color was most preferred. It is a white light rendering all colors, but the same as the soft warm light used by most household LED lamps.
2. Filtered LED and amber LED fixtures were liked better than the existing sodium-based lamps and were appreciated by astronomers and environmentalists, but they were not preferred by most of the tour participants.
3. The Demonstration Area intersection on South Sanderson (scene eight) was noticeably better lighted than the major intersections along Florida Street (California 74) already lighted with LED's by Caltrans, and it was the most preferred scene of all.
4. Almost a third of the tested lamps have excessive backlight (over 25% backlight), which wastes energy and exacerbates complaints from light trespass. Lighting for residential streets and collectors should have better house-side shielding than some of the Demonstration Area lamps. Only a few lamps perform well without an additional shield.
5. For residential streets and cul-de-sacs, luminaires under 20 watts provide adequate light and can save considerable energy (more than 60%) compared to the existing lighting.
6. For major collectors and arterials, LED lamps can save at least 50-60% of the energy use of existing lighting and still produce acceptable results.

The consulting team then reviewed all of the survey comments for additional detailed information. Data was compiled, sorted, and analyzed by a number of categories: average scores by scene, question type, technology, color temperature (Kelvin) and participant classification were all factored. Participant classifications are as follows:

- Leadership – City Council members, elected officials, planning commissioners
- City Management – City Managers and Directors
- City Staff
- Public Safety – Police, Fire, and public safety officials

- Astronomer – amateur and professional astronomers, advocates of the dark sky.
- Resident – participating members of the public

The consulting team reached the following general conclusions on each of the Demonstration Area scenes. All scenes consisted of 2700K or 3000K white LED fixtures except as noted.

**Scene 1** - Poles 196, 197, 198, on South Sanderson near West Valley High School (South of Mustang Way, on S. Sanderson).

- Type III
- 10,000 lumen
- 3000 Kelvin (K).

Average Score: 3.3. Overall the scene was slightly preferred. Astronomers and Leadership showed a moderate preference for this scene. Public Safety and City Staff showed exhibited a slight preference. Residents and City Management were neutral.

**Scene 2** - Poles 117,118, 119 on California just north of West Florida and due east of Four Seasons (Collector)

- Type III
- 5,000 lumen
- 3000K

Average score: 3.7. Overall the scene was moderately preferred. Astronomers showed a strong preference for this scene. Leadership, City Management and City Staff showed a moderate preference for this scene. Public Safety exhibited a slight preference for this scene. Residents were neutral.

**Scene 3** – Pole 38, on Will Circle (Residential cul-de-sac)

- Type II
- 1,500 lumen
- 3000K

Average score: 3.88. Overall the scene was preferred. Public Safety showed a strong preference for this scene. Leadership, City Management, Astronomers and City Staff showed a preference for this scene. Residents showed a slight preference for this scene.

**Scene 4** – Pole 34, on Gloria Drive (Residential cul-de-sac)

- Type III with house side shield
- 1,500 lumen
- 2700K

Average score: 4.10.Overall the scene was strongly preferred. Leadership, City Management, Public Safety and City Staff showed a strong preference for this scene. Astronomers and Residents showed a preference.

**Scene 5 -** Pole 78, intersection of Sherry Drive and Gloria Drive (residential)

- Type III with house side shield
- 1,500 lumen
- 3000K

Average score: 4.12. Overall the scene was strongly preferred. All reviewers strongly preferred this scene.

**Scene 6** - Poles 52, 53, intersection of Christianne Circle and Millie Drive (residential collector)

- Type II with 70 degree cutoff shield
- 1,500 lumen
- 2700 Kelvin.

Average score: 4.00. Overall the scene was strongly preferred. Leadership, City Management, City Staff and Residents showed a strong preference for this scene. Astronomers and Public Safety showed a moderate preference.

**Scene 7 -** Pole 26 on Fruitvale just west of Fruitvale Elementary School (Collector)

- Type II
- 1,500 lumen
- Filtered LED (Amber)

Average score: 3.20. Overall the scene was considered neutral. Astronomers strongly preferred this scene. City Management, City Staff and Residents slightly preferred this scene. Public Safety and Leadership disliked this scene.

**Scene 8 -** Poles 236, 237, 238, Intersection of South Sanderson and Wentworth (Arterial)

- Type IV
- 15,000 lumen &
- 2700 Kelvin.

Average score: 4.52. Overall the scene was considered very strongly preferred. All reviewers showed a strong preference for this scene.

When comparing HPS and LPS sources to LED white light, there is a significant increase in visibility and sense of security under the white light source, in addition to the gains in efficiency.

The average wattage reduction in the Demonstration Area was 65%, with a corresponding typical light level reduction of about 25%. This light level reduction did not impact the light output provided on the roadways, but rather the reduction is demonstrated by a lesser amount of backlight that illuminated properties, or residents' front yards, porches, and windows.

The results generally confirmed our preliminary conclusions with a couple of interesting details:

- Scenes 1 and 7, the two lowest scoring scenes, included amber or filtered LED (amber appearing) light sources. Public Safety definitely preferred the white light sources over amber color lights. This reinforces the recommendation of 2700K white LED for most street lighting applications.
- Astronomers tended to prefer amber lighting systems and reduced light level scenes.
- The highest scoring residential scenes (4, 5 and 6) all employed house side shields or 70 degree sharp cutoff shields, reinforcing our observation that light trespass remains a significant issue.
- Everyone found scene 8 to their liking. At the intersection on South Sanderson, it stood out as the highest scoring scene in the Demonstration Area. This was attributed to a combination of factors, including mostly dark and undeveloped or underdeveloped lots all around, use of type IV luminaires for safety lighting to improve vertical illumination, and 2700K white LED.

## Product Review

A separate analysis was performed on the photometric characteristics, efficiency, and application issues of the candidate brands of luminaires. From this analysis, the team was able to identify a number of competing brands that perform well, and were without significant comments or complaints by reviewers. The team also confirmed that reviewer complaints, especially light trespass and backlight, coincided with poor photometric qualities. The team will use these data to generate a final engineering report detailing product selections for the bidding and application phases of WRCOG projects.

## Summary

The Hemet Demonstration Area project clearly reinforced the benefits of using lower light levels, but with white light at 2700K and uniformity improvements over legacy light sources. Acceptable lighting installations must employ photometric qualities such as glare control and light trespass mitigation which will be explained in detail in the engineering report for the Demonstration Area. The use of house side shields appears to be necessary for residential streets, cul-de-sacs, residential intersections, and collectors, especially those with homes fronting onto them.