Street Light Audit

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Photo courtesy of Public Works Staff

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Energy Efficiency and Conservation Block Grant

Study and Report Completed by Jennifer Wendt

Street Light Audit – Table of Contents

1. Introduction

Street lighting can have many purposes; but most importantly it is an effective tool in helping provide a safer night driving environment. Numerous before and after nighttime crash studies have shown that roadway lighting helps prevent accidents and that the benefits far exceed the cost. It should be remembered that typically street lighting is to assist the motorist during nighttime driving and any additional area being illuminated is of secondary benefit.

The amount of street light preferred by residents can vary greatly. Some neighborhoods feel safe and semi-rural, and illumination would only serve to annoy residents unless it is imperative for driver safety. Even then, specific drop-offs or other roadside hazards might better be highlighted through use of simple reflectors rather than an elaborate street lighting program. In other cases, residents prefer having the entire neighborhood illuminated.

Often in areas that seem more crime-prone, residents want more and more lighting. In fact, uniformity is much more important than brightness. The high light level can cause glare, whereas a consistent but lesser amount of light increases perception of safety. Also the distribution of light on the surface of buildings can increase perception of safety in business districts. Research isn't definitive on whether very high levels of street lighting actually deter crime, one can find results to support either argument.

Currently University City pays approximately $650,000 annually in street light costs. These street lights account for over 2,400,000 kilowatt hours (kWh) of electricity per year. This equates to approximately 2000 metric tons of CO_2 emissions per year (Grow, 2008), driving approximately 1400 cars per year, and using 62,000 gallons of oil per year.

This street lighting study was performed for three main reasons; first to inventory all of the street lights located in University City, second to provide energy/cost saving options associated with providing street lighting, and third to develop a new street light policy for today-to better reflect the state of the art of new lighting understanding, technology and energy efficiency.

2. PROCESS OF DATA COLLECTION

- Determined a search area by Comparing historic Ameren maps with a list of current street lights provided by Ameren UE.
- Downloaded area onto a Hand Held Device and using Global Positioning System (GPS) each street light was plotted on a map.
- The streets, alleys, walkways, train tracks, and empty spaces in University City were researched.
- Data from 4060 streetlights were collected. Data collected included:

Tag Number

Street Segment ID

Height of light fixture

NEMA Tag Information

Fixture Type

Bulb Type

Pole Type

Pole Owner

"U" tags

Each Ameren owned University City light should have a NEMA tag on it. The color and number on this tag indicates the bulb type and wattage. The NEMA tag descriptions are as follows:

- Gold colored 10 = 100 watt HPS (9500 lumens)
- Gold colored 25 = 250 watt HPS (25,500 lumens)
- Gold colored 40 = 400 watt HPS (50,000 lumens)
- Gold colored 10 = 100 watt HPS (9500 lumens)
- Red colored 40 = 400 watt MH (34,000 lumens)
- Blue colored 10 = 100 watt MV (3300 lumens)
- Blue colored 17 = 175 watt MV (6800 lumens)
- Blue colored 40 = 400 watt MV (20,000 lumens)

Gold 25
NEMA TAG

3. DATA RESULTS

3.1. TOTAL INVENTORY OVERVIEW

- 4060 street lights were inventoried, including city owned, privately owned, and Ameren owned street lights.
- Approximately 470 (11%) of these are University City owned.
- Approximately 3339 (82%) of these are Ameren Owned and billed to University City and make up the vast majority of street lights and the Ameren bills.
- An additional 217 (5%) privately paid/Ameren owned lights were collected.
- Additional lights were located in inaccessible areas and data were not collected.
- 6 lights designated by Ameren have not yet been located.
- 9 extra Ameren lights were located which were not designated by Ameren.
- 75 lights inventoried did not match Ameren designated fixture type.
- 41 lights inventoried did not match Ameren designated bulb type and wattage based on the affixed NEMA tag*.
- 912 lights had no affixed NEMA tag*.
- 84 lights still have no U#### tag or have U#### tags in question.
- 44 lights are located in areas that seem to no longer be needed. These areas include: former alleys, private driveways, amongst trees on the edge of Metcalf Park, paths, etc.

Because the NEMA tag was not present on many of the street lights, and because it is unknown if the bulbs have been changed in lights with conflicting NEMA tag information, the bulb information provided by Ameren was used for calculations.

For additional individual information, see Appendix 8.1.

3.2. Inventory According to Current Policy

- There are 446 lights which are located on streets that are in excess of the current street light policy. (These 446 lights are proposed for decommissioning in Energy/Cost Saving option).These 446 lights are broken down as such:

Total Excess	Cobra	Post Top
446	341	105

Total Excess	Public	Private
446	373	73

- There are 140 areas where additional lighting may be needed to meet the current street light policy. Some of these are areas where city owned historical lights are located and additional lights are not wanted for aesthetic reasons. Some of these areas have an Ameren owned/privately paid for "Z" light splitting the distance as to meet policy requirements. Further research should be performed to determine if these areas need additional lighting.
- There are 14 intersections which do not have a light located directly at the intersections. These areas may be lit by lights located adjacent to the intersection. Further research should be performed to determine if these areas need additional lighting.

See Appendix 8.2 for information regarding spacing and intersection information

3.3. AMEREN INVENTORY

Street Light Types

There are 8 different types of light fixtures which make up 2 main groups:

- **Cobra:** 2479 cobra lights were located making up 74% of all Ameren owned street lights. There are 4 different types of Ameren owned cobra lights currently in use in University City. Cobra can include Horizontal Semi Cutoff and Horizontal Cutoff. Floodlights and Open Bottom Nema Head Fixture types are listed here for simplicity reasons. On average these lights are 25 – 30 feet tall.

Semi Cut-Off

The majority of Cobra light Fixtures are Semi Cut-off which account for 2326 of all cobra lights. The bulbs currently used in Semi Cut-off lights are either 175 or 400 Watt Mercury Vapor (MV); or 100, 250, or 400 Watt High Pressure Sodium (HPS).

Cut-Off

The Cut-off style light fixtures account for 125 of all cobra light fixtures. The bulbs currently used in Cut-off lights are either 175 Watt Mercury Vapor (MV); or 100 or 250Watt High Pressure Sodium (HPS).

Open Bottom

The Open Bottom light fixture accounts for 26 of all cobra lights. The bulbs currently used in Open Bottom lights are either 175 Watt Mercury Vapor (MV) or 100 Watt High Pressure Sodium (HPS).

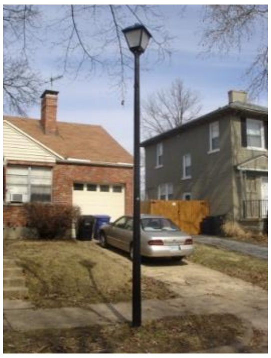
Flood

Flood light fixtures account for only 2 of all Cobra lights. Only 400 Watt Metal Halide (MH) bulbs are currently used in Flood Lights.

- **<u>Post Top</u>**: 857 post top lights were located making up 26% of all Ameren owned street lights. There are 4 different types of Ameren owned post top lights currently in use in University City. Post Top includes Colonial, Early American, Contemporary, and Aspen Post Top Fixtures. On average Post Top style lights are 14 – 16 feet tall.

Early American

Early American light fixtures account for 316 of all post top light fixtures. The bulbs used currently are either 100 or 175 Watt MV or 100 Watt HPS.



Colonial

Colonial light fixtures account for 294 of all post top light fixtures. The bulbs used currently are either 175 Watt MV or 100 Watt HPS.

Contemporary

Contemporary light fixtures account for 246 of all post top light fixtures. The bulbs used can be MV or HPS. The bulbs used currently are either 175 Watt MV or 100 Watt HPS.

Aspen

Aspen light fixtures account for 1 of all post top light fixtures. The bulb used currently is a 100 Watt HPS.

Bulb Types

Ameren owned street lights are furnished with one of three different bulb types; High Pressure Sodium (HPS), Mercury Vapor (MV), or Metal Halide (MH). The factors used to compare energy efficiency are photopic and scotopic luminous efficacy, S/P Ratio, Color Rendering Index (CRI) and bulb lifetime. These are defined as follows:

Photopic luminous efficacy: A measure of how well a light source produces visible light, "photopic" referring to bright conditions. It is measured in lumens (light output) per watt (power consumed by the source).

Scotopic luminous efficacy: A measure of how well a light source produces visible light, "scotopic" referring to dim conditions. It is measured in lumens (light output) per watt (power consumed by the source).

S/P Ratio: The ratio of scotopic light versus photopic light in a light source.

(For more information on photopic and scotopic ranges, see section 5.4)

Color Rendering Index (CRI): A measure of the light quality of a light source as compared with sunlight (which is given the maximum CRI value of 100). The closer a light-source's CRI is to 100, the better its ability to show true colors.

High Pressure Sodium (HPS) HPS bulbs are the main type of bulbs used. 100, 250, and 400 watt bulbs are used, which produce 9500, 25,500 and 50,000 lumens respectively. 2589* of all street lights are HPS.	**HPS Energy Efficiency** Photopic luminous efficacy: 80 – 150 lm/W Scotopic luminous efficacy: 30 – 60 lm/W S/P Ratio: 0.62 Bulb Lifetime: 24,000 hours or more CRI: 22 HPS have been the most cost/energy efficient bulbs for use in street lighting in recent years. (NYSERDA, 2002) (LGE Lighting, 2011) (Westside Solutions, 2011)
Mercury Vapor (MV) There are still MV bulbs used although they are being phased out. 100, 175 and 400 watt bulbs are used, which produce 3300, 6800 and 20,000 lumens, respectively. 745* of all street lights are still MV.	**MV Energy Efficiency** Photopic luminous efficacy: 25 – 60 lm/W Scotopic luminous efficacy: N/A S/P Ratio: 0.80 Bulb Lifetime: 24,000 hours or more; however, light can diminish significantly after 12,000 hours. CRI: 15 MV lamps are continuously being replaced with HPS. (NYSERDA, 2002) (Westside Solutions, 2011)
Metal Halide (MH) MH bulbs are only used in flood lights. 400 watt bulbs are used, which produce 34,000 lumens. There are 2 MH flood lights.	**MH Energy Efficiency** Photopic luminous efficacy: 60 – 110 lm/W Scotopic luminous efficacy of 80 – 150 lm/W S/P Ratio: 1.49 Bulb Lifetime: up to 20,000 hours CRI: 65 or higher Current development in MH lamps, particularly ceramic MH, has shown promise for improving lumen maintenance and lamp life; some models are surpassing HPS in luminous efficacy and lifetime. (NYSERDA, 2002) (LGE Lighting, 2011) (Westside Solutions, 2011)

**Totals do not include 3 unknown bulb types*

Inventory Results by Fixture and Bulb Type

TABLE 1: AMEREN LIGHTS FOUND IN FIELD

(Bulb Type – Lumens – Watts)									
Lights by Fixture Type	**Quantity**	**HPS - 25500 - 250**	**MV - 3300 - 100**	**HPS - 50000 - 400**	**HPS - 9500 - 100**	**MH - 34000 - 400**	**MV - 20000 - 400**	**MV - 6800 - 175**	**UNKNOWN**
ASPEN	1				1				
COLONIAL	294				194			100	
CONTEMPORARY	249				244			4	1
CUT-OFF	125	24			97			4	
EARLY AMERICAN	316		2		219			95	
FLOOD	2					2			
OPEN BOTTOM	26				20			6	
SEMI CUT-OFF	2326	527		26	1240		100	431	2
Total Lights:	3339								

STREETLIGHTSAMERENLOCATEDLIGHTS_CROSSTAB.XLS

TABLE 2: AMEREN LIGHTS IN AMEREN DATABASE

(Bulb Type – Lumens – Watts)								
Lights by Fixture Type	**Quantity**	**HPS - 25500 - 250**	**MV - 3300 - 100**	**HPS - 50000 - 400**	**HPS - 9500 - 100**	**MH - 34000 - 400**	**MV - 20000 - 400**	**MV - 6800 - 175**
ASPEN	1				1			
COLONIAL	301				196			105
CONTEMPORARY	244				241			3
CUT-OFF	101	18			81			2
EARLY AMERICAN	322		2		222			98
FLOOD	2					2		
OPEN BOTTOM	29				24			5
SEMI CUT-OFF	2337	533		25	1252		100	427
Total Lights:	3337							

STREETLIGHT COST.XLS

3.4. UNIVERSITY CITY OWNED STREET LIGHTING

University City owns approximately 470 street lights. These lights range from LED lights encased in a stainless steel wall to 30 feet tall cobra lights. There is a wide range of bulbs as well.

TABLE 3: UNIVERSITY CITY OWNED STREET LIGHTING

quantity of poles	quantity of lights	watts	bulb type	description	location	Comments
35	72	175	MH	C1 - C29 Double Pedestrian Lights around City Hall, C31 (double light - not including attached spotlight), C32 (double light - not including attached spotlight), C30 (5 light pole), C33 (5 light pole)	Around City Hall	
4	4	500	Halogen	C31 spotlight, C32 spotlight, C34 spotlight, C35 spotlight	Around City Hall	
3	3			City Hall Parking Lot Lights	City Hall West Lot	
0	5			City Hall Lawn Flood Lights	City Hall Lawn flood lights; 4 on entrance lions, 1 on flag	
12	12	50	MH	L1 - L2 Lion Lights	Lion Pillars Trinity and Delmar	
36	36	100	HPS	H1 - H37 Historical lights	Washington, Kingsbury, Waterman, Pershing, and Vassar west of Big Bend; Linden Ave; Washington Ave East of Big Bend	
41	41	70 or 100	HPS	A1 - A45 Ackert Walkway Pedestrian Lights Vernon thru bus stop	Ackert Walkway Vernon thru Bus Stop (Vernon to Lot 3: 41 black contemporary post top 100 watt HPS)	(4 lights originally in A1 - A45 are no longer located, hence 41 lights total).
7	7	70	MH	A46 - A52 Ackert Walkway Green Pedestrian Lights bus stop thru Delmar	Ackert Walkway Bus Stop thru Delmar (Lot 3 to Delmar: 7 green 70 watt MH)	
2	2	100	HPS	Post top lights at All Saints Plaza	All Saints Plaza	
121	121	70	HPS	Pedestrian Lights - Olive	Olive	Counted by number of poles, not individual lights because in process of changing double lights to single lights. Current lights are 100 w HPS - medium base.
91	91	50	HPS	Pedestrian Lights - Delmar	Delmar	
4	4	100	MH	Market in the Loop lights	Market in the Loop	
4	4		unknown	Purdue Walk Lights	Purdue and Midland	Currently shut off.
7	7	400	HPS	XU2, XU3, XU8, XU11, XU12, XU13, XU9Millbrook at Pershing	Millbrook blvd at Pershing; Forest Park Pkway	
10	16	400 or 250	HPS	P1 - P10 Parking lot lights	Parking lot behind businesses between Leland Ave, Loop North, Kingsland	There is an additional light NOT counted: There is a large orb light located in a corner of the parking lot that is not functional.
16	16	70	MH	Pedestrian Lights - Melville	Pedestrian Lights on Melville between Delmar and Kingsbury	Melville, from Delmar to Kingsbury: 16 green 70 watt MH

Continued…

TABLE CONTINUED: UNIVERSITY CITY OWNED STREET LIGHTING

0	---		LED	Decorative Light Show Walls	North Side of Delmar at Melville	The total number of LEDs is not listed here because they would overinflate the total number of City Owned Lights
0	16	70	HPS	Wellesley Underpass (14 lights located in underpass, 1 at each entrance/exit)	Wellesley and Forest Park Parkway	Public works maintains these lights but the ownership is still in question as of 4/14/11
393	**Total Poles**			**457**	**Total City Owned Street Lights***	

***In addition to the above street/parking lot lights, the following lights are also owned and maintained by U City:**

4 lights attached to the garage

4 lights above the Gas Pumps

3 traffic lights; 1 at Jackson school, 1 at Asbury and Forsyth, and 1 at Pershing just before Midvale

1 cobra light on a wood pole at 8373 Elmore (owned and maintained by Ameren, paid for by Public Works)

150 watt HPS bulbs used in sign making machine (Soon to be discontinued)

Ruth Park, Heman Park, and Centennial Commons athletic field lighting

Various other sign and parks lighting; Billboard, Pavilions, etc.

UCITYOWNEDSTREETLIGHTS.XLS

See Appendix 8.3 for pictures of University City owned lights.

4. ENERGY/COST SAVING OPTIONS

Street lighting consumes a great deal of energy. The energy consumption per year of the street lights located in University City is approximately 2.5 million kilowatt hours. This is the same as running 1400 cars on the road. It equals approximately 2000 tons of CO_2 and approximately 62,000 gallons of oil per year. Therefore, a change in energy use is warranted.

CITY OWNED LIGHTS

University City owned street lights are generally energy efficient and cost effective. Research on retrofitting is being done, particularly for the cobra lights located in The Loop parking lot and at Pershing/Forest Park Parkway. Currently University City is retrofitting pedestrian lights along Olive. Where there are currently a double fixture light with two 100 watt HPS lamps, there will be a single fixture with one 70 watt HPS lamp. This will reduce the energy consumption for these 121 lights by 59%. There are also proposed changes for the lights located around City Hall, and the lights located in parking lots behind The Loop. Retrofit options include LED, Ceramic Metal Halide, and Induction.

City Hall Lights

There are 72 175 watt Metal Halide bulbs in lights located along Trinity and Delmar around City Hall. Options below are listed for retrofitting, although these lights will not be changed until there are specific plans in place for The Loop Trolley. The lights are not slated for removal, but until the plans are finalized, no changes for these lights will take place. Below indicates the possible energy savings*:

72 175 watt MH bulbs = 12600 watts --→ 72 55 watt LED retrofits = 3960 watts

This results in a 69% savings in the energy used for these lights. This is only one of many options that are being explored.

Parking Lot 3 Lights

A pilot project is being proposed for Parking Lot 3. There are 4 250 watt HPS bulbs in lights located in parking lot 3. The retrofit options for these lights include LED and Ceramic Metal Halide. The three main options include:

120 watt Holophane LEDgend (LED) which equals a 52% energy savings* for these lights
140 watt Holophane Estilo (CMH) which equals a 44% energy savings* for these lights
130 watt Philips Roadstar (LED) which equals a 48% energy savings* for these lights

*The energy savings only take into account the energy of the bulbs, and not the energy use of the driver/ballast. If the total rated wattage were used, the % energy savings would increase.

See Appendix 8.13 for preliminary photometric information on Parking Lot 3 options.

Other City Owned Retrofit Options

There are other retrofit options being explored for the lights owned by University City including but not limited to the Wellesley Tunnel, parking garage lights, and parking lot 4 lights.

University City owned lights only account for 1% of the total lighting energy use. The Ameren owned lights, which account for 99% of lighting energy use and costs are the lights focused on for energy reduction in this report.

AMEREN OWNED LIGHTS

Many options were researched for energy and cost savings. Retrofitting the lights to LED, Induction, Ceramic Metal Halide, Metal Halide, or lower wattage HPS were explored. However, these options are currently not applicable to the Ameren owned lights. Ameren has many restrictions regarding bulb types, fixture types, etc. Options to reduce energy and costs of Ameren owned lights are very limited. Decommissioning lights and retrofitting bulbs are the main options outside of the acquisition of the entire Ameren lighting system.

See Section 6 – Understanding the Ameren Bills – for a breakdown of charges.

The following options for energy and cost savings associated with the Ameren owned lights are as follows:

1. **RETROFIT:** Retrofit bulbs which are currently MV to an equivalent HPS bulb and retrofit a portion of higher wattage HPS bulbs to lower wattage HPS bulbs.
2. **DECOMMISSION (300 ft)**: Decommission lights that are in excess of University City's current policy; 300' spacing between residential street lights (post top or cobra), 200' between non-residential street lights.
3. **DECOMMISSION (300/200 ft)**: Decommission lights that are in excess of University City's current policy; 300' spacing between residential street lights (post top or cobra), 200' between non-residential street lights, except using 200' as the maximum spacing between post top style lights due to lower height of pole equalling lower light output.
4. **DECOMMISSION UNWARRANTED**: Decommission lights which are no longer warranted; former alleys, private driveways, hidden by trees, etc.
5. **TRANSFER PRIVATE COSTS (ALL)**: Transfer ALL costs of private neighbourhood lights currently paid for by University City to the private neighbourhoods in which they are located.
6. **TRANSFER PRIVATE COSTS (300 ft)**: Transfer only the costs of private neighbourhood lights in excess of University City's current policy, 300' spacing between residential street lights.
7. **TRANSFER PRIVATE COSTS (300/200 ft)**: Transfer only the costs of private neighbourhood lights which are in excess of University City's current policy, 300' spacing between residential street lights, but using 200' maximum spacing between lights which are post top style.
8. **TRANSFER WASH U COSTS (ALL)**: Transfer ALL costs of lights located around Washington University owned property currently paid for by University City to Washington University.
9. **TRANSFER WASH U COSTS (300 ft)**: Transfer only the costs of lights located around Washington University owned properties which are in excess of University City's current policy; 300' spacing between residential street lights, 200' between non-residential street lights.
10. **ACQUISITION OF LIGHTS**: Purchase Ameren owned Lights from Ameren.

The following table summarizes the cost and energy savings of each option:

TABLE 4: SUMMARY OF ENERGY/COST SAVINGS

OPTION	% POTENTIAL ENERGY SAVINGS	POTENTIAL ANNUAL SAVINGS	COST ASSOCIATED	PAY BACK (YEARS)
RETROFIT	23	$22,566	$106,600	4.7
DECOMMISSION (300 ft)	14	$71,319	$44,700	0.6*
DECOMMISSION (300/200 ft)	12	$52,917	$36,200	0.7*
DECOMMISSION UNWARRANTED	1	$6,650	$4,400	0.7*
TRANSFER PRIVATE COSTS (ALL)	0	$82,162	$0	N/A
TRANSFER PRIVATE COSTS (300 ft)	0	$16,929	$0	N/A
TRANSFER PRIVATE COSTS (300/200 ft)	0	$7,674	$0	N/A
TRANSFER WASH U (ALL)	0	$14,485	$0	N/A
TRANSFER WASH U (300 ft)	0	$5,284	$0	N/A
**ACQUISITION OF AMEREN LIGHTS	Immeasurable	Ranges from $136,000 to $527,000	Ranges from $401,000 to $3,669,000	Ranges from 2.0 to 12.3

*University City does not have a current contract with Ameren. An Ameren representative indicated that because of this, there would be no cost associated with decommissioning lights. If University City has a current contract, the cost for each light decommissioned would be $100 each. It behooves the City to act now to decommission these fixtures.
**An agreement for the acquisition of Ameren lights must be established with Ameren. At this time Ameren has not provided adequate information regarding the purchase of their lights. $467 per light is an adjusted amount based on the cost Clayton paid for the acquisition of lights in 1987. $100 per light is an amount given by an Ameren representative to O'Fallon. It is unknown if Ameren requires the lighting system to be metered for purchase. $100 per light is added to this amount for estimated metering costs.

See the following table for a breakdown of the option Acquisition of Ameren Lights.

TABLE 5: SUMMARY OF ENERGY/COST SAVINGS ACQUISITION OF AMEREN LIGHTS

OPTION	% POTENTIAL ENERGY SAVINGS	POTENTIAL SAVINGS per YEAR	COST ASSOCIATED	PAY BACK (YEARS)
ACQUISITION OF ALL AMEREN LIGHTS Clayton as an Example: $1,558,000 to meter the system and to purchase the lights (at $467 per light) METERED 6M Rate	Immeasurable	$284,693	$1,558,000	5
ACQUISITION OF ALL AMEREN LIGHTS UNMETERED 6M Energy Only Rate + Contracted Maintenance (at $280,000 per year) at purchase price of $467 per light	Immeasurable	$310,346	$1,558,000	5
ACQUISITION OF ALL AMEREN LIGHTS UNMETERED 6M Energy Only Rate + Contracted Maintenance (at $280,000 per year) at purchase price of $1100 per light	Immeasurable	$310,346	$3,669,000	12
ACQUISITION OF ALL AMEREN LIGHTS UNMETERED 6M Energy and Maintenance at purchase price of $467 per light	Immeasurable	$527,090	$1,558,000	3
ACQUISITION OF ALL AMEREN LIGHTS UNMETERED 6M Energy and Maintenance at purchase price of $1100 per light	Immeasurable	$527,090	$3,669,000	7
ACQUISITION OF ALL AMEREN LIGHTS METERED 6M Energy Rate + Contracted Maintenance (at $280,000 per year) at purchase/meter price of $467 per light	Immeasurable	$299,166	$1,558,000	5
ACQUISITION OF ALL AMEREN LIGHTS METERED 6M Energy Rate + Contracted Maintenance (at $280,000 per year) at purchase/meter price of $1100 per light	Immeasurable	$299,166	$3,669,000	12
ACQUISITION OF AMEREN POST TOP LIGHTS ONLY UNMETERED 6M Energy Only Rate + Contracted Maintenance (at $73,000 per year) at a purchase cost of $467 per light	Immeasurable	$140,922	$401,620	3
ACQUISITION OF AMEREN POST TOP LIGHTS ONLY UNMETERED 6M Energy Only Rate + Contracted Maintenance (at $73,000 per year) at a purchase cost of $1100 per light	Immeasurable	$140,922	$946,000	7
ACQUISITION OF AMEREN POST TOP LIGHTS ONLY UNMETERED 6M Energy and Maintenance Rate at a purchase cost of $467 per light	Immeasurable	$197,311	$401,620	2
ACQUISITION OF AMEREN POST TOP LIGHTS ONLY UNMETERED 6M Energy and Maintenance Rate at a purchase cost of $1100 per light	Immeasurable	$197,311	$946,000	5
ACQUISITION OF AMEREN POST TOP LIGHTS ONLY METERED 6M Energy Only Rate + Contracted Maintenance (at $73,000 per year) at a purchase/meter cost of $467 per light	Immeasurable	$136,236	$401,620	3
ACQUISITION OF AMEREN POST TOP LIGHTS ONLY METERED 6M Energy Only Rate + Contracted Maintenance (at $73,000 per year) at a purchase/meter cost of $1100 per light	Immeasurable	$136,236	$946,000	7
An agreement for the acquisition of Ameren lights must be established with Ameren. At this time Ameren has not provided adequate information regarding the purchase of their lights. $467 per light is an adjusted amount based on the cost Clayton paid for the acquisition of lights in 1987. The cost of each light at $1000 per light is an amount given by an Ameren representative to another municipality. $100 per light is added to this amount for estimated metering costs.				
It is also important to note that it may be more cost effective to hire and employee for in-house maintenance and repairs instead of contracting maintenance.				

When calculating energy/cost savings, the values for individual cost, power, and energy use (In kilowatt hours, kWh) are those listed in the Ameren 5M tariff, applying to Missouri Service Area and titled “Service Classification No. 5M Street and Outdoor Area Lighting – Company-Owned”. The following table provides the cost and energy use information.

TABLE 6: 5M RATE COST AND ENERGY USAGE FOR EACH LIGHT TYPE

Bulb and Fixture Type	Cost Each	Energy use each (WATTS)	Lumen Output
100 WATT HPS Cobra Lights	$10.15	120	9500
100 WATT HPS Open Bottom Lights	$8.98	120	9500
100 WATT HPS Post Top Lights	$18.81	120	9500
100 WATT MV Post Top Lights	$17.78	127	3300
175 WATT MV Cobra Lights	$10.15	207	6800
175 WATT MV Open Bottom	$8.98	207	6800
175 WATT MV -Post Top Lights	$18.81	207	6800
250 WATT HPS Cobra Lights	$14.67	307	25500
400 WATT HPS Cobra Lights	$26.15	482	50000
400 WATT MH Flood Lights	$15.75	450	34000
400 WATT MV Cobra Lights	$14.67	455	20000

*Notice the actual power in watts is higher than the wattage of the bulb alone (i.e. a 250 watt bulb = 307 watts). This accounts for the ballast wattage as well.

See Appendix 8.4 for the Ameren 5M tariff

4.1. RETROFIT BULBS

The majority of street lights are owned by Ameren and retrofitting these light bulbs is restricted by the bulbs offered by Ameren. If this was not the case, a bulb with a better scotopic rating/lower energy consumption would be suggested. The most energy efficient light bulb that Ameren currently offers for the majority of applications is a 100 Watt 9500 bulb. Despite these limitations, there are higher wattage bulbs which can be replaced with lower wattage bulbs.

TABLE 7: RETROFIT ENERGY ANALYSIS

Current Bulb Type	Current Quantity	Current KWH per year (4000 burning hours per year)	Proposed Bulb Type	Proposed Quantity	Proposed KWH per year (4000 burning hours per year)
400 WATT MH Flood Lights	2	3600	*no change*		3600
100 WATT MV Post Top lights	2	1016	*no change*		1016
175 WATT MV Open Bottom lights	6	4968	**100 WATT HPS**	6	2880
100 WATT HPS Open Bottom lights	20	9600	*no change*		9600
400 WATT HPS Cobra lights	26	50128	**250 WATT HPS**	26	31928
400 WATT MV Cobra lights	100	182000	**100 WATT HPS**	50	24000
			250 WATT HPS	50	61400
175 WATT MV Post Top lights	199	164772	**100 WATT HPS**	199	95520
175 WATT MV Cobra lights	435	360180	**100 WATT HPS**	435	208800
250 WATT HPS Cobra lights	551	676628	**250 WATT HPS**	251	308228
			100 WATT HPS	300	144000
100 WATT HPS Post Top lights	658	315840	*no change*		315840
100 WATT HPS Cobra lights	1337	641760	*no change*		641760
Totals*:	**3336**	**2410492**		**3336**	**1848572**

*Totals do not include 3 lights with unknown bulb type

% reduced energy usage in KWH:	**23%**

TABLE 8: RETROFIT COST ANALYSIS

Current Light/Bulb Type	Current Quantity	Current Totals $	Proposed Bulb Type	Proposed Quantity	Proposed Totals $
400 WATT MH Flood Lights	2	$37.24	*no change*		$37.24
100 WATT MV Post Top lights	2	$35.56	*no change*		$35.56
175 WATT MV Open Bottom lights	6	$53.88	**100 WATT HPS**	6	$53.88
100 WATT HPS Open Bottom lights	20	$179.60	*no change*		$179.60
400 WATT HPS Cobra lights	26	$679.90	**250 WATT HPS**	26	$381.42
400 WATT MV Cobra lights	100	$1,467.00	**100 WATT HPS**	50	$507.50
			250 WATT HPS	50	$733.50
175 WATT MV Post Top lights	199	$3,743.19	**100 WATT HPS**	199	$3,743.19
175 WATT MV Cobra lights	435	$4,415.25	**100 WATT HPS**	435	$4,415.25
250 WATT HPS Cobra lights	551	$8,083.17	**250 WATT HPS**	251	$3,682.17
			100 WATT HPS	300	$3,045.00
100 WATT HPS Post Top lights	658	$12,376.98	*no change*		$12,376.98
100 WATT HPS Cobra lights	1337	$13,570.55	*no change*		$13,570.55
Totals*:	**3336**	**$44,642.32**		**3336**	**$42,761.84**

*Totals do not include 3 lights with unknown bulb type

% reduced cost of lighting charges:	**4%**	**$ saved per month**	**$ saved per year**	**$ saved per 5 years**	**$ saved per 10 years**
		$1,880.48	**$22,565.76**	**$112,828.80**	**$225,657.60**

cost of changing:	**1066**	**bulbs @ $100/bulb =**	**$106,600.00**
Years until payoff:			**4.7 years**

4.2. DECOMMISSION (300 FT)

Decommission lights based on current policy: 300' spacing for residential (all fixture types), 200' spacing for non-residential

The option of decommissioning will provide less light for residents; therefore residents need to be involved and aware of the situation. The City of Lewiston, Maine performed a reduction in street lighting by decommissioning in 2009 successfully. This city can be used as a model if this option is viable.

See Appendix 8.5 for Correspondence, policy information, and decommissioning procedures from Lewiston, Maine.

TABLE 9 DECOMMISSION (300 FT) ENERGY ANALYSIS

Current Bulb Type	Current Quantity	Current KWH per year (4000 burning hours per year)	Proposed Quantity	Proposed KWH per year (4000 burning hours per year)
400 WATT MH Flood Lights	2	3600	2	3600
100 WATT MV Post Top lights	2	1016	1	508
175 WATT MV Open Bottom lights	6	4968	5	4140
100 WATT HPS Open Bottom lights	20	9600	16	7680
400 WATT HPS Cobra lights	26	50128	23	44344
400 WATT MV Cobra lights	100	182000	90	163800
175 WATT MV Post Top lights	199	164772	175	144900
175 WATT MV Cobra lights	435	360180	365	302220
250 WATT HPS Cobra lights	551	676628	464	569792
100 WATT HPS Post Top lights	658	315840	579	277920
100 WATT HPS Cobra lights	1337	641760	1172	562560
Totals*:	**3336**	**2410492**	**2892**	**2081464**

*Totals do not include 3 lights with unknown bulb type

% reduced energy usage in KWH:	**14%**

TABLE 10 DECOMMISSION (300 FT) COST ANALYSIS

Current Bulb Type	Current Quantity	Subtotal $	Proposed Quantity	Subtotal $
400 WATT MH Flood Lights	2	37.24	2	37.24
100 WATT MV Post Top lights	2	35.56	1	17.78
175 WATT MV Open Bottom lights	6	53.88	5	44.90
100 WATT HPS Open Bottom lights	20	179.60	16	143.68
400 WATT HPS Cobra lights	26	679.90	23	601.45
400 WATT MV Cobra lights	100	1,467.00	90	1320.30
175 WATT MV Post Top lights	199	3,743.19	175	3291.75
175 WATT MV Cobra lights	435	4,415.25	365	3704.75
250 WATT HPS Cobra lights	551	8,083.17	464	6806.88
100 WATT HPS Post Top lights	658	12,376.98	576	10834.56
100 WATT HPS Cobra lights	1337	13,570.55	1172	11895.80
Totals*:	**3336**	**$44,642.32**	**2889**	**$38,699.09**

*Totals do not include 3 lights with unknown bulb type

% street light reduction:	***13%***				
% reduced cost of lighting charges:	**13.31%**	**$ saved per month**	**$ saved per year**	**$ saved per 5 years**	**$ saved per 10 years**
		$5,943.23	**$71,318.76**	**$356,593.80**	**$713,187.60**

cost of decommissioning: 447 bulbs @ $100/bulb =	**$44,700.00**
Years until payoff:	**0.6 years**

At this time University City does not have a current contract with Ameren. If there is no current contract, Ameren does not charge for decommissioning lights. If there is a current contract, Ameren charges $100/light to decommission. It behooves the City to act now to decommission these fixtures.

4.3. DECOMMISSION LIGHTS (300/200 FT)

Decommission lights based on current policy except using 200' maximum spacing for post top style

TABLE 11 DECOMMISSION LIGHTS (300/200 FT) ENERGY ANALYSIS

Current Bulb Type	Current Quantity	Current KWH per year (4000 burning hours per year)	Proposed Quantity	Proposed KWH per year (4000 burning hours per year)
400 WATT MH Flood Lights	2	3600	2	3600
100 WATT MV Post Top lights	2	1016	2	1016
175 WATT MV Open Bottom lights	6	4968	5	4140
100 WATT HPS Open Bottom lights	20	9600	16	7680
400 WATT HPS Cobra lights	26	50128	23	44344
400 WATT MV Cobra lights	100	182000	90	163800
175 WATT MV Post Top lights	199	164772	194	160632
175 WATT MV Cobra lights	435	360180	367	303876
250 WATT HPS Cobra lights	551	676628	467	573476
100 WATT HPS Post Top lights	658	314400	632	303360
100 WATT HPS Cobra lights	1337	641760	1176	564480
Totals*:	**3336**	**2409052**	**2974**	**2130404**

*Totals do not include 3 lights with unknown bulb type

% reduced energy usage in KWH:	**12%**

TABLE 12 DECOMMISSION (300/200 FT) - COST ANALYSIS

Current Bulb Type	Current Quantity	Subtotal $	Proposed Quantity	Subtotal $
400 WATT MH Flood Lights	2	37.24	2	37.24
100 WATT MV Post Top lights	2	35.56	2	35.56
175 WATT MV Open Bottom lights	6	53.88	5	44.90
100 WATT HPS Open Bottom lights	20	179.60	16	143.68
400 WATT HPS Cobra lights	26	679.90	23	601.45
400 WATT MV Cobra lights	100	1,467.00	90	1320.30
175 WATT MV Post Top lights	199	3,743.19	194	3649.14
175 WATT MV Cobra lights	435	4,415.25	367	3725.05
250 WATT HPS Cobra lights	551	8,083.17	467	6850.89
100 WATT HPS Post Top lights	658	12,376.98	632	11887.92
100 WATT HPS Cobra lights	1337	13,570.55	1176	11936.40
Totals*:	**3336**	**$44,642.32**	**2974**	**$40,232.53**

*Totals do not include 3 lights with unknown bulb type

% street light reduction:	***11%***				
% reduced cost of lighting charges:	**9.88%**	**$ saved per month**	**$ saved per year**	**$ saved per 5 years**	**$ saved per 10 years**
		$4,409.79	**$52,917.48**	**$264,587.40**	**$529,174.80**

cost of decommissioning:	**362**	**bulbs**	**@**	**$100/bulb =**	**$36,200.00**
Years until payoff:					**0.7 years**

At this time University City does not have a current contract with Ameren. If there is no current contract, Ameren does not charge for decommissioning lights. If there is a current contract, Ameren charges $100/light to decommission. It behooves the City to act now to decommission these fixtures.

4.4. DECOMMISSION UNWARRANTED LIGHTS

This option may not be a major energy/cost savings, but these lights proposed for decommissioning are no longer needed, and in some cases have been reported as nuisances by the residents. Therefore, saving a marginal amount of energy and almost $500 per month is a rational choice.

TABLE 13 DECOMMISSION UNWARRANTED LIGHTS ENERGY ANALYSIS

Current Bulb Type	Current Quantity	Current KWH per year (4000 burning hours per year)	Proposed Quantity	Proposed KWH per year (4000 burning hours per year)
400 WATT MH Flood Lights	2	3600	2	3600
100 WATT MV Post Top lights	2	1016	2	1016
175 WATT MV Open Bottom lights	6	4968	3	2484
100 WATT HPS Open Bottom lights	20	9600	11	5280
400 WATT HPS Cobra lights	26	50128	26	50128
400 WATT MV Cobra lights	100	182000	100	182000
175 WATT MV Post Top lights	199	164772	195	161460
175 WATT MV Cobra lights	435	360180	430	356040
250 WATT HPS Cobra lights	551	676628	549	674172
100 WATT HPS Post Top lights	658	315840	649	311520
100 WATT HPS Cobra lights	1337	641760	1325	636000
Totals*:	**3336**	**2410492**	**3292**	**2383700**

*Totals do not include 3 lights with unknown bulb type

% reduced energy usage in KWH:	**1%**

TABLE 14 DECOMMISSION UNWARRANTED LIGHTS COST ANALYSES

Current Bulb Type	Current Quantity	Subtotal $	Proposed Quantity	Subtotal $
400 WATT MH Flood Lights	2	37.24	2	37.24
100 WATT MV Post Top lights	2	35.56	2	35.56
175 WATT MV Open Bottom lights	6	53.88	3	26.94
100 WATT HPS Open Bottom lights	20	179.60	11	98.78
400 WATT HPS Cobra lights	26	679.90	26	679.90
400 WATT MV Cobra lights	100	1,467.00	100	1467.00
175 WATT MV Post Top lights	199	3,743.19	195	3667.95
175 WATT MV Cobra lights	435	4,415.25	430	4364.50
250 WATT HPS Cobra lights	551	8,083.17	549	8053.83
100 WATT HPS Post Top lights	658	12,376.98	649	12207.69
100 WATT HPS Cobra lights	1337	13,570.55	1325	13448.75
Totals*:	**3336**	**$44,642.32**	**3292**	**$44,088.14**

*Totals do not include 3 lights with unknown bulb type

% street light reduction:	**1%**				
% reduced cost of lighting charges:	**1%**	**$ saved per month**	**$ saved per year**	**$ saved per 5 years**	**$ saved per 10 years**
		$554.18	**$6,650.16**	**$33,250.80**	**$66,501.60**

cost of decommissioning:	**44**	**bulbs**	**@**	**$100/bulb =**	**$4,400.00**
Years until payoff:					**0.66 years**

4.5. TRANSFER COSTS OF "PRIVATE" LIGHTS

Currently some street lights located in private neighbourhoods are paid for by University City and some are paid for by the neighbourhoods in which they are located. 364 lights, approximately 11%, paid for by University City are "private" lights. Because the lights in private neighbourhoods are almost exclusively post top fixtures, the cost of $18.81 per 100 watt post top light was used.

Energy Reduction analyses were not performed due to no overall energy reduction.

Below are three scenarios; the first scenario transfers all of the costs of the private lights to the private neighbourhoods in which they are located.

TABLE 15 TRANSFER PRIVATE LIGHTS ALL COST ANALYSES

	monthly	yearly	5 years	10 years	20 years
Savings of transferring **ALL** 364 "private" street lights	$6,846.84	$82,162.08	$410,810.40	$821,620.80	$1,643,241.60
estimated % savings:	18%	approximate reduction in lighting cost			

The second scenario transfers only the costs of street lights which are in excess of the current street policy to the private neighborhoods.

TABLE 16 TRANSFER PRIVATE LIGHT (300 FT) COST ANALYSIS

	monthly	yearly	5 years	10 years	20 years
savings of transferring 75 "private" street lights based on U City lighting policy - 300' maximum spacing for any light type	$1,410.75	$16,929.00	$84,645.00	$169,290.00	$338,580.00
estimated % savings:	4%	approximate reduction in lighting cost			

The third scenario transfers only the costs of street lights which are in excess of 300' spacing requirements for cobra style lights, and 200' spacing requirements for post top style lights.

TABLE 17 TRANSFER PRIVATE LIGHT OPTION (300/200 FT) COST ANALYSIS

	monthly	yearly	5 years	10 years	20 years
savings of transferring 34 "private" street lights based on a maximum of 200' spacing for post top type lights	$639.54	$7,674.48	$38,372.40	$76,744.80	$153,489.60
estimated % savings:	2%	approximate reduction in lighting cost			

4.6. TRANSFER COST OF LIGHTS LOCATED ADJACENT TO WASHINGTON UNIVERSITY PROPERTY

Currently 132 street lights are located adjacent to property owned by Washington University. The next two scenarios propose transferring the costs of these lights to Washington University, similar to the “Private” option.

See Appendix 8.6 for map of Washington University owned property

Energy Reduction analyses not performed due to no overall energy reduction.

The first scenario proposes transferring all costs of lights located around Washington University to Washington University.

TABLE 18 TRANSFER WASH U ALL COST ANALYSIS

	monthly	yearly	5 years	10 years	20 years
Savings of transferring all 132 "Wash U" streetlights at $18.81 per post top light and 10.15 per cobra light	$1,207.08	$14,484.96	$72,424.80	$144,849.60	$289,699.20
estimated % savings:	3%	approximate reduction in lighting cost			

The second scenario proposes transferring the costs of only the lights which are *in excess* of the current street light policy to Washington University.

TABLE 19 TRANSFER WASH U (300 FT) COST ANALYSIS

	monthly	yearly	5 years	10 years	20 years
savings of transferring 47 "private" streetlights proposed for reduction based on U City lighting policy - 300' max distance at $18.81 per cobra and $10.15 per post top	$440.33	$5,283.96	$26,419.80	$52,839.60	$105,679.20
estimated % savings:	1%	approximate reduction in lighting cost			

Savings are negligible for the 200’ post top option because only 5 of the “Wash U” lights are post top.

4.7. ACQUISITION OF LIGHTS FROM AMEREN

Purchasing the lights from Ameren is a long term energy and cost savings option. The energy cost for street lighting would be drastically reduced even without changing the bulbs/fixtures because the lights would fall under Ameren 6M* tariff instead of the 5M tariff. Not only would the Ameren bill be drastically reduced, it would give University City the option of using more energy efficient lighting than that currently offered by Ameren. Currently the most energy efficient bulb type that is offered by Ameren is a 100 watt 9500 lumen HPS. Ameren has not provided enough information to completely analyze the option of purchasing the lighting systems. Other municipalities, including Ballwin and O'Fallon, have also researched this option but have not had success in getting the necessary information from Ameren regarding the purchase. One of the municipalities received a cost from an Ameren representative of **$1000** per light. This cost seems excessive since the pole and fixture may be decades in age, particularly for the cobra lights that University City has been paying pole fees for decades.

It is important to note that the Public Service Commission (PSC) has just approved a 15.4% increase in the 5M tariff cost per light, increasing the bill by $6,900 per month. Along with this, the PSC has required Ameren to remove the monthly pole costs from the 5M bill, which should reduce the bill by approximately $14,000 per month. At this time Ameren has agreed to remove *only half* of the pole charges from the 5M bill, and has agreed to remove the other half in the future. The below "Additional Charges" associated with the 5M bill will include half the pole charges, totaling approximately $7,000. To see the itemized 5M bill and a comparison of the old and new rates, see section 6.

**See Appendix 8.7 for the Ameren 6M tariff*

Clayton's Annual Street Light Budget as an example

Clayton owns approximately 2400 luminaries. Although the exact numbers are currently unknown, the approximate cost for Clayton was $360,000 to purchase the lights and approximately $200,000 to meter they system. Despite these costs, the payoff was abundant. In 2010 Clayton paid approximately $95,000 for lighting charges; and approximately $290,000 overall for street lighting. This $290,000 includes two full-time electricians-benefits and overtime, maintenance, energy, parts, and traffic signals. This does not include vehicles. In 2010 University City paid $640,000 in street lighting costs alone.

If these costs were amortized to today's prices, the costs are estimated as such:

It cost Clayton approximately $560,000 in 1987. $360,000 to purchase, $200,000 to meter.
Clayton has approximately 2400 lights
This would equal approximate $233 per light
Adjusted to today prices would equal approximately $467 per light
University City has approximately 3340 lights

This would total approximately $1,558,000 for University City to purchase the lights and meter the system.

TABLE 20 ACQUISITION OF LIGHTS: CLAYTON BUDGET AS AN EXAMPLE, METERED 6M RATE

U City Annual 5M street light bill:	$688,276.56
Clayton total Annual lighting Budget, 2009:	$290,000.00
Adjusted Estimated U City Annual lighting Budget:	$403,583.33
Estimated Cost to purchase system using Clayton as an example:	$1,558,666.67
Annual Lighting budget savings:	$284,693.23
PAYBACK IN YEARS:	**5**

See Appendix 8.8 for Clayton's street lighting budget.

Contracting maintenance

In order for University City to own and maintain all the Ameren owned lights, a contractor would presumably be necessary for the maintenance of the lights. The following contractor was referred by Gary Scheipeter, Superintendent of Streets, Clayton, MO.

K&F I ELECTRIC, INC
13545 Barrett Parkway Drive Suite 200
St. Louis, MO 63021
Phone: 314.822.2217
Fax: 866.248.7894
Cell 314.550.9657

The following contractor also provides these services and has been used by University City Public Works on various projects. This company provides all of the maintenance and repair of the majority of street lights in Kansas City Missouri so they are familiar with this situation.

Andy Boyer
Project Manager
Black & McDonald Limited
314-280-1015 cell
636-376-4833 office
636-376-4611 fax

Andy Boyer gave an estimate of $7 per light for maintenance. This includes maintenance and replacement of the fixture, bulb and ballast (This does not include replacing/repairing poles or maintenance of the wiring). This total would be $23,373 in maintenance costs for the Ameren owned lights per month.

6M Rate Comparison Costs

The 6M rate, which is based on customer owned lighting, offers several options. Unmetered energy only, unmetered energy and maintenance, and metered energy only. The 6M tariff price of energy and energy/maintenance varies greatly from the 5M rate. The following table demonstrates the difference in cost in the 5M and the 6M rates.

TABLE 21 5M RATE VS 6M RATE

6M rate UNMETERED Energy and Maintenance		6M rate UNMETERED Energy Only (estimated rate increase based on 10.3% increase for 6M Energy and Maintenance)		6M rate METERED Energy Only	
Energy only per month:	$12,727.07	Energy only per month:	$7,455.75	Energy only per month:	$7,814.00
additional monthly charges:	$5.17	additional monthly charges:	$5.17	additional monthly charge per meter:	$576.00
Rider/FAC adjustment:	$700.00	Estimated Rider/FAC adjustment:	$700.00	Estimated Rider/FAC adjustment:	$700.00
Approximate Total per month:	$13,432.24	Approximate Total per month:	$8,160.92	Approximate Total per month:	$9,090.00
Approximate Total per year including addn charges:	**$161,186.88**	Approximate Total per year including addn charges:	**$97,931.05**	Approximate Total per year including addn charges:	**$109,079.98**
23%	**of 5M charges**	**14%**	**of 5M charges**	**16%**	**of 5M charges**
PARTIAL MAINTENANCE INCLUDED		**MAINTENANCE NOT INCLUDED**		**MAINTENANCE NOT INCLUDED**	

Because the actual cost of purchasing the system has not been provided by Ameren, two calculations will be included below to estimate the costs associated and payback for the purchase of the lights. The first will again use the adjusted Clayton cost of $1,558,000 to purchase and meter the system, **equaling $467 per light**. The second will use the higher cost of $1,000 per light that had been given by Ameren to various municipalities, plus a high-end estimate of $100 per light to meter, **equaling $1,100 per light**, totaling $3,669,600.

The cost of maintaining the system is a strong variable in the decision of purchasing the system. The estimated cost of $280,000 for maintaining the lights will be used from the previous section for the options where maintenance is not included. **Pole maintenance and wiring repairs do not seem to be included in the Black and McDonald maintenance costs or the Ameren 6M Unmetered Energy and Maintenance option**. If purchasing the system is a viable option, historical information on repairs of the current Ameren owned light poles and wiring would be necessary.

TABLE 22 ACQUISITION OF ALL LIGHTS: COST AND PAYBACK 6M RATE

Rate Type	Annual Lighting Cost	Annual maintenance cost	Annual Lighting and Maintenance Cost	Annual Savings	Payback in Years at $467 per light	Payback in Years at $1,100 per light
6M UNMETERED Energy Only	$97,931.05	$280,000.00	$377,931.05	**$310,345.51**	5.0	11.8
6M UNMETERED Energy and Maintenance	$161,186.88	included	$161,186.88	**$527,089.68**	3.0	7.0
Annual 6M METERED Energy	$109,079.98	$280,000.00	$389,079.98	**$299,196.58**	5.2	12.3

Acquisition of Post Top style lights Only

Another option for consideration is the purchase of only Post Top style lights. The Ameren costs for post top style lights are significantly higher than the costs for the cobra style lights. The reason for this was explained by an Ameren representative as such: The cost of each post top light includes the cost of maintenance and replacement of the poles as well. The difference in costs for the same types of bulbs in post top lights versus cobra lights is as follows:

TABLE 23 POST TOP VS. COBRA AMEREN COSTS

Bulb Type	**5M rate Post Top**	5M rate Cobra: Enclosed	5M rate Cobra: Open Bottom	6M rate 9500 HPS
100 watt HPS	**$18.81**	$10.15	$8.98	$1.49

Not only are the costs important to note in this option, but currently University City already owns and maintains many of the exact same or very similar lights as the Ameren owned post tops. The staff is knowledgeable regarding maintenance of these lights. Below are calculations for the same options as above, except purchasing only (approximately) 860 post top lights and continuing to pay the 5M rates for the cobra lights. The same three scenarios are calculated as above. Purchasing and metering 860 post top lights at $467 per light would equal $401,620. Purchasing and metering 860 post top lights at $1,100 per light would equal $946,000. It is important to note that *if* all of the pole charges are removed as indicated in the beginning of this section, the yearly annual cobra light cost would reduce by approximately $84,000 per year making the acquirement of the post top lights only a much more practical option.

TABLE 24 ACQUISITION OF POST TOP ONLY

Rate Type (All scenarios include 5M rate for cobras)	Annual Cobra Light Cost	Annual Post Top Cost (6M Rate)	Annual additional maintenance cost* - Post Top Lights	Total Annual Lighting and Maintenance Cost	Annual Savings	Payback in Years at $467 per light	Payback in Years at $1,100 per light
6M UNMETERED Energy Only for Post Top, Contracted Maintenance	$456,696.84	$18,416.86	$72,240.00	$547,353.70	$140,922.86	2.8	6.7
6M UNMETERED Energy and Maintenance	$456,696.84	$34,268.88	included	$490,965.72	$197,310.84	2.0	4.8
6M METERED Energy Only, Contracted Maintenance	$456,696.84	$23,104.48	$72,240.00	$552,041.32	$136,235.24	2.9	6.9

*****It is important to note that the cost of outside maintenance may be in excess of using in-house resources. Using in-house resources or hiring an electrician may be more cost effective.

5. STREET LIGHT POLICY

There is much information available regarding various street light policies. While some policies are very basic, some policies are very in-depth. Policies may only address height, spacing, and lumen output, or may address data such as street width, light depreciation, vision ranges, roadway classifications, pedestrian traffic, pavement types, etc.

Roadway guidelines and recommendations are numerous; however, the decision of a final policy is dependent on municipality economics, aesthetics, and other local conditions.

5.1. UNIVERSITY CITY STREET LIGHT POLICY

The current University City street light policy for placement and lumen output is as follows:

- Residential:

Minimum 9500 lumens
300' maximum distance between lights
Light at intersections

- Non-residential:

Minimum 25,500 lumens
200' maximum distance between lights

See Appendix 8.9 for the full University City Street Light Policy

5.2. COMPARISON POLICIES, MO-DOT, RP-8-00

Many cities do not have a formal policy, while some cities have policies that are precise down to the individual streets themselves. Many local municipalities were contacted and most of them did not have policies. Clayton, Ladue, Olivette, Richmond Heights, Maplewood, Creve Coeur, and even St. Louis City do not have particular policies and determine lighting on a case by case basis. Crestwood and Kirkwood both specify 300 feet spacing between lights, intersection lights, and lights on sharp curves, but do not specify lighting levels, heights, types, etc.

Comparison Policies

The following table shows various street light policies that do exist.

TABLE 25 COMPARISON POLICIES

Residential:

City	Population	Lumen/watt Requirement	Height Requirement	Spacing Requirement
University City	36,262	9500 Lumens	None average 15' for post top, 26' for cobra	300 ft.
St. Louis County - unincorporated	322,085	6800 Lumens	16 ft.	minor streets: 325 ft.
				collector streets: 250 ft.
				arterial streets: 200 ft.
Ballwin, MO	30,095	6800 Lumens or 175 watt	16 ft.	250 ft.
Fort Worth, TX	534,694	100 watt	25 ft. is standard but post top may be allowed for complete neighborhoods	300 ft.
				city parks: 200 ft.
				post top: 150 ft.
Minneapolis, MN	382,618	100 watt, 150 watt for intersections	none, but fixture style is cobra	200 ft.
Lisbon, ME	9,077	*at most* 150 watt, at most 250 watt for intersections	25 - 35 ft.	220 ft. (intersections and midblock)
				street segments < 350', at intersections and dead ends
				minor: 440 ft.
				arterial: 440 ft.
San Diego, CA	1,223,400	150 watt, 100 watt in alleys	none listed	150 ft. staggered near transit stops/high-crime areas
				200 ' cul-de sacs if greater than 200' and less than 300'
				else, 300 '
Lewiston, ME	35,690	***at most*** 150 watt, at most 250 watt HPS for intersections and crosswalks	none listed	150 - 220' for highest population density areas
				220' for medium population density, principal and minor arterial streets
				440' for medium population density and street segments >1000'
				660' for medium population density and street segments >2000'
				440' for low population density areas
Vacaville CA	88,625	70 watt	none listed	250' if cobra, staggered
				170' if post top, staggered
St. George, UT	49,663	150 watt for 16' poles 220 - 250' distance (street width 25 - 50')		
		250 watt for 35' poles, 300 - 350' distance (street width 25 - 50')		
		250 watt for 40' poles, 250 - 300' distance (street width 51 - 62')		
		400 watt for 40' poles, 250 - 300' distance (street width 63 - 72')		
Loveland, CO	50,608	70 watt for 15' poles, 160 - 200' distance (street width 28 - 44')		250 watt for 32' poles, 150 - 175' distance (street width 38 - 75')

TABLE 25 COMPARISON POLICIES CONTINUED

Non-Residential:

City	Population	Lumen Requirement	Height Requirement	Spacing Requirement
University City	36,262	25500	none, average 15' for post top, 26' for cobra	200 ft.
St. Louis County - unincorporated	322,085	6800	16 ft.	minor streets: 325 ft.
				collector streets: 250 ft.
				arterial streets: 200 ft.
Ballwin, MO	30,095	6800 or 175 watt	16 ft.	250 ft.
Fort Worth TX	534,694	200 watt (~ 20000)	collector streets: 30 ft.	collector streets: 300 ft.
			arterial streets: 38 ft.	arterial streets: 200 ft.
Minneapolis, MN	382,618	100 watt (~9500); 150 watt (~15000) for intersections	none, but fixture style is cobra	200 ft.
Lisbon, ME	9,077	70 - 100 watt (~6800 to 9500); 250 watt (~25000) for intersections	25 - 35 ft.	220 ft.
				minor: 440 ft.
				arterial: 440 ft.
San Diego, CA	1,223,400	250 watt (~25,500)	none listed	150 ft. staggered near transit stops/high-crime areas
				else, 300 ft.
Lewiston, ME	35,690	***at most*** 150 watt; at most 250 watt HPS at intersections, crosswalk	none listed	150 - 220' for highest population density areas
				220' for medium population density principal and minor arterial streets
				440' for medium population density and street segments >1000'
				660' for medium population density and street segments >2000'
				440' for low population density areas
Vacaville CA	88,625	100 watt for Collector and Industrial; 200 watt for Arterial	none listed	190' staggered if post top on collector
				150' staggered if post top on Arterial (64' wide)
				125' staggered if post top on Arterial (80' wide) OR if cobra on Arterial
St. George, UT	49,663	150 watt for 16' poles 220 - 250' distance (street width 25 - 50')		
		250 watt for 35' poles, 300 - 350' distance (street width 25 - 50')		
		250 watt for 40' poles, 250 - 300' distance (street width 51 - 62')		
		400 watt for 40' poles, 250 - 300' distance (street width 63 - 72')		
Loveland, CO	50,608	250 watt for 32' poles, 150 - 175' distance (street width 38 - 75')		400 watt for 38' poles, 120 - 150' distance (street width 60 - 90')

Mo-DOT Engineering Policy Guide (MoDOT, 2011)

Although the MoDOT Engineering Policy Guide refers mostly to freeways, much information can be used for the development of a new street light policy. Some of which includes:

- HPS lamps are used for fixed source lighting of roadways and underpasses. 150-watt lamps are rated at 16,000 lumens, 250-watt lamps are rated at 27,500 lumens, and 400-watt lamps are rated at 50,000 lumens.
- Continuous lighting installations along freeways, urban arterials, expressways and ramp connections thereto must provide an average maintained intensity of 0.6 fc (6.5 lux) and a minimum intensity of 0.2 fc (2.2 lux). Continuous lighting installations on existing roadways, not including freeways, urban arterials, expressways or ramp connections thereto must provide an average maintained intensity of 0.4 fc (4.3 lux) and a minimum intensity of 0.2 fc (2.2 lux).
- Basic lighting at intersections, including ramp terminals at crossroads, is to provide an average maintained intensity of 0.6 fc (6.5 lux) and a minimum intensity of 0.2 fc (2.2 lux) within the limits of the intersection.
- Luminaires are to be positioned within 3 ft. at the 30-ft. mounting height and 5 ft. at the 45-ft. mounting height from the edge of the nearest traffic lane. This applies to either continuous or intersection lighting.
- The following calculation is given to determine footcandles/spacing for luminaires:

$$\text{Avg} = \frac{LampLumens \times Utiliz.Coef. \times Maint.Factor}{Spacing \times Width}$$

Where:
Avg. = Average footcandles or Average lux
Lamp Lumens = Initial lamp lumen rating
Utiliz. Coef. = Coefficient of Utilization
Maint. Factor = 0.70
Spacing = either ft. (for fc) or m (for lux)
Width = Roadway width, either ft. (for fc) or m (for lux)

The table below lists typical continuous lighting designs for different roadway width, luminaire and mounting height combinations. Various brands of luminaires perform slightly different; therefore, this table is to be used as a guide.

TABLE 26 MO-DOT LIGHTING CONFIGURATIONS

VARIOUS CONTINUOUS LIGHTING CONFIGURATIONS					
Roadway Width (ft.)	Luminaire	Type	Mounting Height (ft.)	Arrangement	Maximum Spacing (ft.)
24	100 Watt HPS 9,500 Lumens	II	30	One Side Staggered	150 160
24	250 Watt MV 11,000 Lumens	II	30	One Side Staggered	160 170
24	150 Watt HPS 16,000 Lumens	II	30	One Side Staggered	200 220
36	150 Watt HPS 16,000 Lumens	II	30	Staggered	200
36	400 Watt MV 21,000 Lumens	II	30	One Side	200
36	200 Watt HPS 22,000 Lumens	II	30	One Side	220
36	250 Watt HPS 27,500 Lumens	II	40	One Side Staggered	260 280
36	250 Watt HPS 27,500 Lumens	II	45	One Side Staggered	270 300
48	250 Watt HPS 27,500 Lumens	II	40	Staggered One Side	250 240
48	400 Watt MV 21,000 Lumens	II	45	Staggered	210
48	200 Watt HPS 22,000 Lumens	II	45	Staggered	230
48	250 Watt HPS 27,500 Lumens	II	45	Staggered	250
60	150 Watt HPS 16,000 Lumens	III	30	Staggered Opposite	100 225
60	250 Watt HPS 27,500 Lumens	II	40	Staggered One Side	220 210
60	250 Watt HPS 27,500 Lumens	II	45	Staggered	220
60	400 Watt HPS 50,000 Lumens	II	45	Staggered Opposite	240 250

RP-8-00 IES Roadway Lighting (IESNA, 2005)

The (ANSI/IESNA RP-8-00) guidelines are intended for designing new construction and not intended to be applied to existing lighting systems. In this case these guidelines are intended to aid in the development of a new street light policy for University City.

Lighting levels for roadway street lighting aimed at promoting efficient traffic movement is generally based on Illuminating Engineering Society of North America (IES) recommendations contained in IES publication RP-8-00 Roadway Lighting. IES guidelines are based on geometric, operational, and environmental factors and suggest average roadway luminance and uniformity ratios to reduce traffic accidents. Although the IES standards are desirable to attain for roadways with high traffic volumes, the IES standard do not easily translate to rural and residential roadway lighting applications where promoting traffic flow and traffic speed are not the primary concern. (Lewiston, 2009)

Three different methods can be used in continuous lighting design; illuminance, luminance, and STV. Illuminance refers to the amount of light incident on the roadway surface from the roadway lighting system and is measured in footcandles or Lux. Luminance refers to the amount of light reflected from the pavement in the direction of the driver and is measured in cd/m^2. STV refers to the visibility level of an array of targets on the roadway. Illuminance, measured in footcandles or lux, is the method that is used to help aid in the development of a new street light policy.

The following tables show recommended footcandle levels for various situations. These factors will be discussed more in detail in the next section.

TABLE 27 IESNA RECOMMENDED FOOTCANDLES ON ROADWAYS

Road	Example Roadways	Pedestrian Conflict Area	Recommended Average footcandles
Major	Olive, Delmar, Forsyth, Big Bend	High	1.7
		Medium	1.3
		Low	0.9
Collector	Pershing, Canton, Old Bonhomme	High	1.2
		Medium	0.9
		Low	0.6
Local	Amherst, Mount Olive, Westover	High	0.9
		Medium	0.7
		Low	0.4

TABLE 28 IESNA RECOMMENDED FOOTCANDLES AT INTERSECTIONS

Roadway Classification	Example Intersections	Pedestrian Area Classification		
		High	Medium	Low
Major/Major	Olive/Hanley	3.4	2.6	1.8
Major/Collector	Delmar/Kingsland	2.9	2.2	1.5
Major/Local	Big Bend/Kingsbury	2.6	2	1.3
Collector/Collector	North and South/Canton	2.4	1.8	1.2
Collector/Local	Old Bonhomme/Teasdale	2.1	1.6	1
Local/Local	Gay/Amherst	1.8	1.4	0.8

Average Illuminance at Pavement in footcandles

5.3. STREET LIGHT POLICY FORMATIVE FACTORS

There are many different factors that can determine where a street light is placed. Many of these factors listed are specific to certain areas and not specific to others. Therefore, these factors are important in final decisions of street light placement but cannot be individualized in a general street light policy. These factors are as follows:

- Roadway Classification
- Pedestrian Traffic
- Light Loss
- Scotopic, Mesopic, and Photopic Ranges
- Lighting Configuration
- Lateral Light Distributions
- Fixture Type
- Mounting Height
- Bulb Type
- Lumen Output
- Light Pollution: Sky Glow/Light Trespass/Glare

Roadway Classification

Roadway classification is an important factor in determining a street light policy. The current street light policy classifies roadways into two categories; residential and non-residential. In general, roadways are divided into the following three categories (IESNA, 2005).

- **Major Roadway**: The roadway that serves as the principal network for through-traffic flow. Also known as "arterials", "thoroughfares", or "preferentials." These roadways in University City include Olive, Delmar, Midland, Hanley, Forest Park Parkway, Forsyth, Big Bend, and McKnight.

- **Collector Roadway**: Roadways servicing traffic between major and local streets. These are streets used mainly for traffic movements within residential, commercial and industrial areas. These roadways in University City include at least sections of the following streets: Pershing, Eighty-Second St., Canton, North and South, Vernon, Pennsylvania, Kingsland, Etzel, Groby, and Old Bonhomme.

- **Local Roadway**: Local streets are used primarily for direct access to residential, commercial, industrial, or other abutting property. They make up a large percentage of the total street system, but carry a small proportion of vehicular traffic. These roadways in University City include the residential roadways.

See Appendix 8.10 for a map of University City roadway classifications

Pedestrian Traffic

The level of recommended light is dependent on how many pedestrians are present on a roadway at night. Pedestrian Traffic is usually divided into 3 categories; high, medium and low (IESNA, 2005).

- **High Pedestrian Conflict Area**: Area with significant numbers of pedestrians on sidewalks or crossing streets during darkness. Examples are The Loop, near transit terminals, or other high volume shopping/entertainment areas. (over 100 pedestrians/hour)
- **Medium Pedestrian Conflict Area:** Areas where lesser numbers of pedestrians utilize the streets at night. Typical areas include office areas, blocks with apartments or library, or neighborhood shopping. (11-100 pedestrians/hour)
- **Low Pedestrian Conflict Area:** Areas with very low volumes of night pedestrian usage. These can occur in any of the roadway classifications but are usually suburban single family streets, low density residential developments, and rural or semi-rural areas. (10 pedestrians/hour)

Street Width

Street Width is an important factor in determining street light placement. As discussed in the section on **Lateral Light Distributions**, the configuration (single-sided vs. staggered vs. opposite) can be decided upon based on street width. For wider streets, higher mounting heights are more appropriate, whereas for narrower streets, lower mounting heights are adequate.

Light Loss

Many contributing factors attribute to light loss over time and must be considered when determining spacing and light output.

TABLE 29 LIGHT LOSS FACTORS (REVIT, 2010)

Parameter	Description
Temperature Loss/Gain Factor	For fluorescent light sources, a measure of the amount of light lost or gained due to deviations above or below the ideal operating temperature. Valid values are between 0 and 2. A value of 1.0 indicates that no light is lost or gained due to temperature changes. Values greater than 1.0 indicate an increase in light. Values less than 1.0 indicate a loss of light.
Voltage Loss/Gain Factor	A measure of the amount of light lost or gained due to fluctuations in voltage delivered to the light source. Valid values are between 0 and 2. A value of 1.0 indicates that no light is lost or gained due to voltage changes. Values greater than 1.0 indicate an increase in light. Values less than 1.0 indicate a loss of light.
Ballast Loss Factor	Lamps and ballasts experience losses when operating together as a system. The Ballast Loss Factor is the percentage of a lamp's initial rated lumens that is produced by given ballast. Valid values are between 0 and 1. For example, a value of 0.95 indicates that the ballast produces 95% of its initial lumens and loses 5%.
Lamp Tilt Loss Factor	For metal halide lamps, a measure of the amount of light lost due to the position of the lamp. A decrease in light occurs when the angle of the lamp shifts the cold spot of the bulb. Values less than 1.0 indicate a loss of light.
Surface Depreciation Factor	A measure of the amount of light lost due to deterioration of the surfaces of the lighting fixture as it ages. For example, blemishes and discolored shielding materials change the amount of light emitted. Values less than 1.0 indicate a loss of light.
Lamp Lumen Depreciation	As a lamp ages, it produces decreasing amounts of light on a predictable curve. A typical strategy is to use an average Lamp Lumen Depreciation (LLD) value at 40% of its life. Valid values are between 0 and 1. For example, a compact fluorescent has an LLD factor of 0.85, indicating an average output at 85% of its initial lumens, losing an average of 15% over its life as the lamp ages.
Luminaire Dirt Depreciation	A measure of the amount of light lost due to environmental dirt and dust that is trapped by the lighting fixture. Valid values are between 0 and 1. For example, a value of 0.9 indicates that the fixture produces 90% of its initial lumens and loses 10% due to trapped dust and dirt.
Total Light Loss Factor	A measure of the amount of light produced by a lamp, taking into account various environmental factors that obscure or reduce the emitted light. When the Method is Simple, use the slider or text box to specify a value. When the Method is Advanced, this parameter displays a read-only value, which is calculated by multiplying the values of the other parameters. Valid values are between 0 (total light loss) and 4 (light gain up to 400%). A value of 1 indicates no light loss (100% of initial light intensity).

Scotopic, Mesopic, and Photopic Ranges

Humans actually have two distinct visual systems–rods and cones–that function quite differently, but work in concert to provide our vision. The rods, which are relatively uniformly distributed across the retina, contribute to our peripheral vision and are particularly effective at modest and low light levels. The rods, most sensitive to shades of gray and motion, seem to be a very old visual system in evolutionary terms, as we share it with most other animals. The second visual system consists of the cones, which allow us to see color.

These visual systems normally function seamlessly together, with the focal system directing the center of our attention and the peripheral system filling in the visual context. However, when illumination levels become too low for the cones, the rods in the peripheral system start to take over. Together, our visual systems function in three modes: photopic, mesopic and scotopic.

• *Photopic vision* is defined as vision at relatively high light levels where the cones are fully activated. It occurs at illumination levels above 3 footcandles. This is commonly called "day vision." Almost all research on visual acuity and visual preferences has occurred in the illumination ranges from 50 to 200 footcandles, to represent indoor work environments. Illumination meters are typically adjusted to the ranges of sensitivity of the eye in this range.

• *Scotopic vision* occurs at illumination levels under which the cones cease to function, at substantially less than 1 footcandle, such as those illuminances experienced on a starlit night. It is commonly called "night vision." With scotopic vision, there is no perception of color, and central, or foveal, vision is impaired.

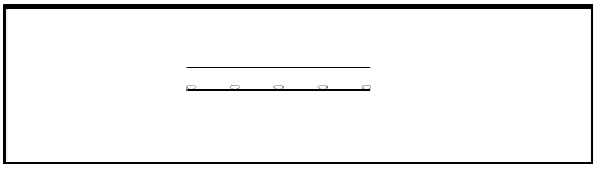
• *Mesopic vision* occurs in the state between the photopic and scotopic extremes. In this state both rods and cones are active. It is typically experienced at dusk and under a bright moonlit sky, and includes almost all outdoor lighting conditions. As illumination levels decline, focal vision decreases and color perception also declines. Similarly, there is a shift in spectral sensitivity from the yellow-green peak of the cones to the blue-green wavelength peak of the rods.

Some research suggests that this difference in visual response has implications for the specification of outdoor lighting systems at night (under 0.5 footcandles, or 5 lux). If peripheral vision, contrast detection, and sensitivity to motion are key concerns for outdoor night lighting, as they might be for security lighting or roadway vision, then using blue-rich lighting to preferentially stimulate the rods may be important. This work suggests that metal halide lamps would be a better choice for peripheral detection under street and roadway lighting than high-pressure sodium lamps because of the increased light output in the blue range of the spectrum in metal halide lamps. It is important to note that—other than color detection—central visual acuity does not differ significantly under metal halide or high pressure sodium sources at equal illumination levels. (Advanced Lighting, 2001)

Lighting Configurations

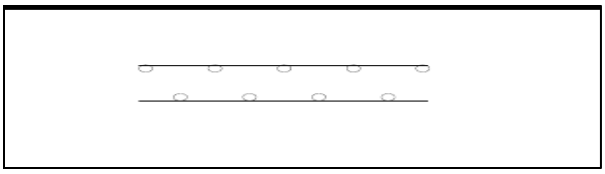
There are three basic spacing configurations; single sided, staggered, or opposite.

Single sided arrangements, in which all luminaries are located on one side of the road, should be used when the width of the road is equal to or less than the mounting height of the luminaires. (Design, 2009)



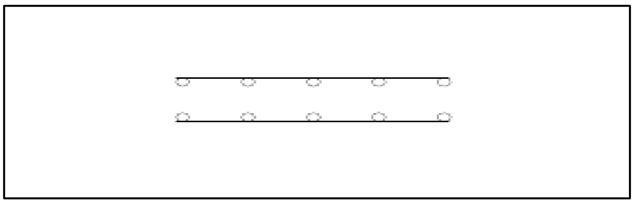
Single Sided Configuration

Staggered arrangement, in which the luminaries are located on both sides of the road in a staggered or zigzag arrangement, should be used mainly when the width of the road is between 1 to 1.5 times the mounting height of the luminaries. (Design, 2009)



Staggered Configuration

Opposite arrangement, in which the luminaries are located on both sides of the road opposite to one another, is used mainly when the width of the road is greater than 1.5 times the mounting height of the luminaries. (Design, 2009)

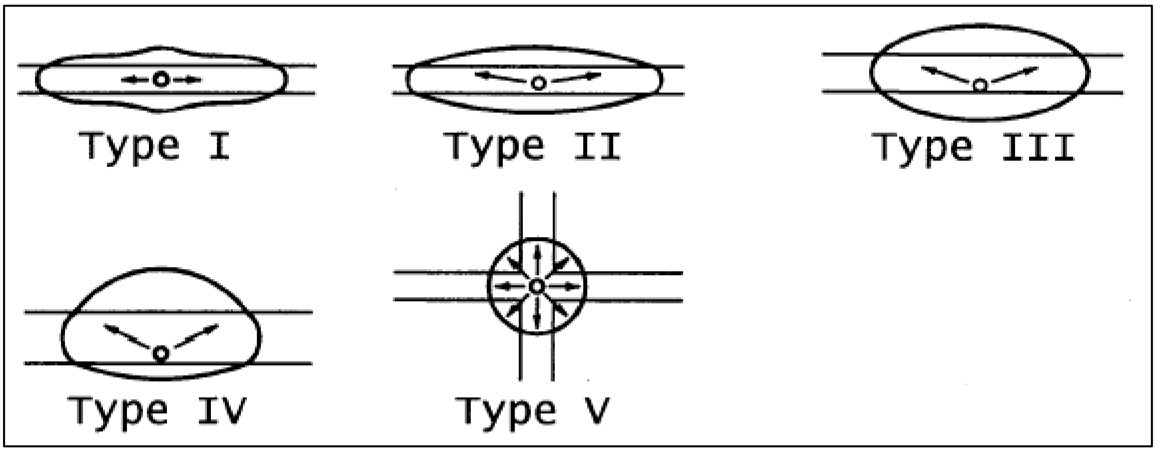


Opposite Configuration

Lateral Light Distributions

The Illuminating Engineering Society established a series of lateral distribution patterns designated as Types I, II, III, IV, and V. In general, we may describe Types I and V as luminaires mounted over the center of the area to be lighted. Type I applies to rectangular patterns on narrow streets, while Type V applies to areas where light is to be distributed evenly in all directions. Type V and a modified Type I are generally the class of luminaire applied in high mast lighting systems. Types II, III, and IV are classes of luminaires to be mounted near the edge of the area to be lighted. Type II applies to narrow streets, Type III to streets of medium width, while Type IV applies to wide street applications. (MnDOT, 2006)

TABLE 30 LATERAL LIGHT DISTRIBUTIONS



According to Ameren Outdoor Lighting General Information Distribution Construction Standards, Ameren owned post tops and Ameren owned cobras are either Type III or Type V, but approximately **90% of all Ameren lights are Type III** (Wu, 2011).

See Appendix 8.11 for Ameren Outdoor Lighting General Information

Fixture Type – Post Top/Cobra

Post Top light fixtures are generally used in residential areas for aesthetic reasons in addition to roadway and pedestrian lighting. The light output is usually a type V light distribution so the house side is lit as well as the street side of the light. Because of the height of the light and lower wattage used in post top lights, light distribution is not as wide spread.

Cobra style lights (not including flood and open bottom fixtures) are used solely for light distribution. These lights can be either semi-cutoff (dropped lens) or cutoff (flat lens). The dropped lens was developed when the lighting criteria for roadway lighting was solely based on horizontal illuminance on the roadway surface. These dropped-lens cobra heads provide the best means of meeting that criteria and maximizing spacing between poles, thus minimizing the amount of equipment required. Dropped-lens cobra heads are used at the expense of disability glare in motorists' eyes.

The flat lens cobra head was developed as a response to disability glare and other environmental concerns, such as light trespass and pollution. By replacing the dropped lens with a flat lens, the glare is reduced. However, its light distribution is no longer as wide, so spacing between poles has to decrease since design criteria is normally based on horizontal illuminance. (Advanced Lighting, 2001)

Mounting Height

Although luminaire mounting heights have typically increased over the past few decades as lamp technology has allowed for higher and brighter road lights, the result is often lighting designed for the car or the parking lot, not for the person walking on the side of the street. Reducing the luminaires' height, and adjusting it to the scale of the person on the sidewalk, calls for more fixtures, which in turn leads to additional energy costs and possibly additional energy usage. (PPS, 2010)

Bulb Type

The most common bulb types used in street lighting are High Pressure Sodium (HPS), Metal Halide (MH), Mercury Vapor (MV), and fairly new to street lighting are Light Emitting Diode (LED) and Induction lighting. HPS, MH and MV were described in section 3.2. Here LED and Induction lighting are described.

- LED for general illumination is beginning to become cost effective and is getting better all of the time. Lumens per watt may increase 20% each year for at least the next five years, and pricing may come down 20% per year. The three main benefits of LEDs for street lighting are low wattage, great optical control and long life. LEDs can be aimed to provide light only where it is needed. An LED fixture, without having to replace LEDs or drivers, should last 50,000+ hours. (Walerczyk, 2010)

  Currently LED lighting may not be cost effective for two reasons; the initial costs of the fixtures and the possible failure of drivers. Keeping these factors in mind, LED technology is rapidly improving and the use of LED should be researched regularly.
- Induction provides long life, white light, and good CRI. Although the life of the lamp and generator (induction version of ballast) is typically considered as 100,000 hours, useable rated life is really more like 60-70,000 hours. Since the lamps are coated and so large, they are nothing close to being a point source, so there is very little optical control. (Walerczyk, 2010) They are of good use when optical control is not a large concern.

Lumen Output

Lumen output is obviously an important factor in light distribution. The higher the lumen rating, the more light is output from the source. Section 3.2 describes the common lumen output levels of HPS, MH, and MV lamps.

Light Pollution: Sky Glow/Light Trespass/Glare

There is a strong movement to minimize the amount of light pollution from artificial light and to create a "dark sky friendly" lighting system. Light pollution wastes energy, affects astronomers and scientists, disrupts global wildlife and ecological balance, and has been linked to negative consequences in human health.

Sky glow is a result of fixtures that emit a portion of their light directly upward into the sky where light scatters, creating an orange-yellow glow above a city or town. This light can then interfere with sensitive astronomical instruments designed to capture light from distant galaxies.

Light trespass occurs when poorly shielded or poorly aimed fixtures cast light into unwanted areas, such as an observatory, buildings, neighboring property, and homes. This light also interferes with astronomical instruments.

A dark sky friendly lighting design takes into consideration several issues:

- The selection of low glare lighting equipment is very important. With area lighting, such as for parking lots, the Illuminating Engineering Society calls for the use of full cutoff luminaires. Pedestrian and entry lighting can be accomplished with full cutoff luminaires or low wattage luminaires. Facade/architectural lighting should be aimed from the top down, if at all possible; otherwise, make certain that any uplight does not escape the lines of the building.
- Do not over light an area. Reflected light can also contribute to sky glow, so it is important to keep lighting levels low. Follow appropriate IES guidelines, targeting the lower lighting levels and better uniformity for improved safety and security lighting.
- Turn off lights when not needed. Landscape and facade lighting can easily be turned off after midnight or earlier. Many parking lot luminaires can also be turned off after hours. (IDA, 2011)

5.4. ANALYSIS OF ILLUMINANCE OF UNIVERSITY CITY ROADWAYS

Several streets were analyzed for illuminance using Visual lighting design software (Visual, 2007). These streets were also analyzed by a light meter and a GPS to compare the software calculated values with actual values, and also with IES recommended illuminance levels. The streets were chosen due to the variety of configurations, fixtures, and lumen output.

TABLE 31 UNIVERSITY CITY ROADWAYS: ILLUMINANCE ANALYSIS

STREET-->	Forsyth (Big Bend to Asbury)	Maryland (Big Bend to Asbury)	Alanson (GROBY TO GOLF COURSE LN)	Alanson (Golf Course to Balson)
Cobra/Post Top	Cobra	Post Top	cobra	cobra
Wattage/Lamp Type	250 HPS	100 HPS	100 HPS	100 HPS
Configuration	Staggered	Staggered	Single-sided	Staggered
Spacing	255 ft (AVG)	200	220	250
Mounting Height	29 ft. (AVG)	14	22	22
Roadway width	42 ft.	30	39	39
Roadway Classification	major	local	Local	local
Ped. Conflict Area	Medium	Low	Low	Low
Arm Length	6	0	6	6
Set Back	2	3	1	1
Measured Average fc	**0.8**	**0.2**	**0.2**	**0.2**
Software Produced Avg.	1.1	0.2	0.2	0.2
IES recommended Avg fc	1.4	0.4	0.4	0.4
Measured Min fc	**0.06**	**0.04**	**<0.1**	**<0.1**
Software Produced Min	0.1	0	0	0
Measured Max fc	**7.6**	**2.9**	**5.0**	**5.2**
Software Produced Max	5.3	1.5	0.7	0.8

See Appendix 8.12 for Example information regarding illumination data: Forsyth

5.5. SUGGESTED NEW UNIVERSITY CITY POLICY

The changes below have been suggested for an updated policy. This suggested policy is in now in the approval process. The main changes include an explanation for the policy, more energy efficient bulbs, and more detailed information.

STREET LIGHT POLICY

Revised July 2011

Street Light Out Notification by Residents:

- Residents should report the light(s) out, pole number(s) (if possible), and location(s) (address) to Ameren (342-1000, 24 hours a day) and the Street Division (505-8573).
- Requests and reported problems will be logged and inspected by staff for reporting to Ameren.

Street Light Out Notification by City Staff

- All City staff and other City Hall Departments should report lights out directly to the Accounts Clerk in the Street division (505-8573).
- When a street light report is made, the following action will be taken by the Street Division:
    - Record the location and pole number, if possible, or obtain it through data review or field inspection.
    - Record who made the call/report and obtain a phone number, if possible.
    - Report the light out request to Ameren.
    - Follow-up on the light out request until it is resolved.
    - Submit a monthly tracking report to the DPW.

STREET LIGHTING STANDARDS (UPGRADES/NEW INSTALLATIONS)

The Street light policy is a guideline document for the public and staff outlining the streetlight level-of-service that is intended for different parts of the City and how that service will be delivered throughout the City. It is a standard that the public and staff can fall back upon when requests are made for the installation or removal of street lights or when questions arise about the management and costs associated with street lighting.

Lighting levels for roadway street lighting are aimed at promoting efficient traffic movement, assisting in areas of high pedestrian nighttime activity, reducing light pollution, and supporting energy conservation. Street light standards are based on Illuminating Engineering Society of North America (IES) recommendations. Although IES standards are desirable to attain for roadways with high traffic volumes, these recommended standards do not easily translate to residential roadway applications where promoting traffic flow and speed are not the primary concerns.

Roadways are broken down into three main classifications; Major, Collector, Local. Major roadways may also be referred to as "Arterials". Major/Arterial roadways in University City include Olive, Delmar, Midland, Hanley, Forest Park Parkway, Forsyth, Big Bend, and McKnight. Collector Roadways in University City include (at least a part of) Pershing, Eighty-Second St., Canton, North and South, Vernon, Pennsylvania, Kingsland, Etzel, Groby, and Old Bonhomme. Local Roadways in University City include all other/residential streets.

Generally Collector and Local fall into the category of "Residential", and Major falls into the category of "Non-Residential".

RESIDENTIAL LIGHTING STANDARDS:

- Street light standards for ***residential*** districts include:
  - Each fixture should be a Post Top or Cobra style and have a bulb installed with a *maximum* *9,500 initial lumen output (or photometric equivalent) with a preferred minimum output of 120 lumens per watt. In addition new fixtures should have a preferred scotopic/photopic ratio of at least 1.3 and have a minimum lamp life of 20,000 hours.
  - Each street should have lights installed at a *maximum* spacing of 300 feet (with the intent that the street lights are at most 300 feet apart).Each street should have a light at each intersection and at low visibility curves in roadways.
  - Each street may have other lights in the middle or other sections of the block, in a staggered or single-sided fashion.

*Except when a higher or lower lumen output may be acceptable where determined necessary by the Director of Public Works.

NON-RESIDENTIAL LIGHTING STANDARDS:

- Street light standards for ***non-residential*** districts include:
  - Fixtures at intersections should have a minimum *25,500 initial lumen output (or photometric equivalent) with a preferred minimum output of 120 lumens per watt. In addition new fixtures should have a preferred scotopic/photopic ratio of at least 1.3 and have a minimum lamp life of 20,000 hours. Non-intersection fixtures should have a *minimum* of *9,500 lumens output.
  - Each fixture should generally have a *maximum spacing* of 200 feet where levels of traffic validate these guidelines (with the intent that each light at most 200 feet apart).
  - A light should be located at a low visibility curve in a roadway.
  - Each street should have a light on opposite corners of an intersection. In the case of a residential/non-residential intersection, the non-residential guidelines shall prevail.

*Except when a higher or lower lumen output may be acceptable where determined necessary by the Director of Public Works.

UPGRADES AND NEW INSTALLATIONS:

- Requests for upgrades and new installations should be made in writing to the Director of Public Works (DPW).
- The DPW will make an assessment and forward the recommendation to the City Manager (CM) for review and approval, based on the following:

- *In House Review* - Public Works will conduct a complete review of number of existing lights, types of lumen and their location relative to information available from the 1998 AmerenUE list, 2010 street light inventory, city street documentations and street light maps.
- *Field Verification* - Street lights are inspected at night to assess the necessity of the upgrade and/or new installation request.

- Department recommendation is developed by staff and sent to the DPW for review.
- If the recommendation is determined appropriate, the DPW will forward the recommendation to the CM for review and approval.
- If approved by the CM, the Street Light Upgrade/Installation Request Form will be completed and faxed to Ameren from the Director's office.
- The Street Light Upgrade/Installation Request Form will be completed by a Project Manager and faxed to Ameren after CM approval.
- All requests should remain on file in the Public Works Department; records are maintained by the Project Managers for annual reports, budgeting and billing purposes.
- A copy of each request should be forwarded to the Street division for tracking and reporting.
- The Street division will review the Ameren bill to verify that the upgrades/installations are reflected in monthly charges.

PRIVATE SUBDIVISION STREET LIGHTING:

- The City may pay the monthly electricity bill for certain standard streetlights located in private subdivisions upon approval of a *written request* by the City Manager.
- The City will only be financially responsible for the streetlights meeting the minimum standards for residential streetlights cited above and/or approved by the CM.
- In order to be considered for financial assistance, the subdivision will be required to provide the Public Works Department with the following items:
  - A map of their existing lights.
  - The pole number of each light.
  - A copy of their last bill.
- The City will notify the subdivision in writing regarding which streetlights will be paid for by the City.
- A copy shall be provided to the Public Works Director for verifying bills, budgeting, tracking, etc.
- The City will ***only pay the monthly electric lighting bill for the next billing cycle forward.***

- No refunds for previous payments will be awarded.
- The subdivision is responsible for new installations, maintenance and upgrades.
- The Public Works Department will forward the information to Ameren.
- A copy should also be sent to the Finance Department regarding the subdivision's Ameren account number, number of lights and monthly charge, and the City account number to be charged.

MISCELLANEOUS:

- It is the owner's responsibility to provide lighting in private lots and subdivisions, formerly vacated land, private walkways, or other similar privately-owned areas.
- The City does not intend to supply lighting in private lots and subdivisions, formerly vacated land, private walkways, or other similar privately-owned areas.
- City maintained street lights located in private lots and subdivisions, formerly vacated land, private walkways, or other similar privately-owned areas may be decommissioned by the City upon approval of the City Manager. Consequently, the City may transfer ownership and maintenance to private owners upon approval by the City Manager.
- City owned or paid for street lights which are deemed a nuisance, as defined by current municipal code, may be requested for decommission in writing to the Department of Public Works. The City will make the final determination to decommission.
- New lighting standards and changes to existing lighting standards shall be reviewed for design and energy efficiency by the Green Practices Committee.

6. UNDERSTANDING THE AMEREN BILLS

University City receives one 5M rate bill, as well as 30 individual bills for city owned lights. The number and types of lights found in the field are slightly different than the number and types of lights which are on the bill, and the number and types of lights listed in the recent Ameren inventory are different as well. However, these difference are slight and do not change the overall cost of lighting.

A recent Ameren rate case has resulted in a 15.4% increase in the costs per light for the 5M tariff, increasing the bill by $6,900 per month beginning 7/31/2011. Along with this, the Public Service Commission (PSC) has required Ameren to remove the monthly pole costs from the 5M bill, which should reduce the bill by approximately $14,000 per month. However, at this time Ameren has agreed to remove *only half* of the pole charges from the 5M bill, and has agreed to remove the other half at some point in the future. The charges are explained below.

6.1. AMEREN 5M BILL

TABLE 32 5M AMEREN BILL – COMPARISON OF NEW RATES WITH RATES PRIOR TO INCREASE

QUANTITY	LUMENS	BULB	WATTS	FIXTURE	Previous RATE ($)	Previous AMOUNT	New RATE ($)	New AMOUNT
2	34000	MH	400	DIRECT	15.75	31.5	18.62	37.24
26	50000	HPS	400	ENCLOSED	22.12	575.12	26.15	679.9
100	20000	MV	400	ENCLOSED	12.41	1241	14.67	1467
435	6800	MV	175	ENCLOSED	8.59	3736.65	10.15	4415.25
551	25500	HPS	250	ENCLOSED	12.41	6837.91	14.67	8083.17
1337	9500	HPS	100	ENCLOSED	8.59	11484.83	10.15	13570.55
6	6800	MV	175	OPEN BOTTOM	7.6	45.6	8.98	53.88
20	9500	HPS	100	OPEN BOTTOM	7.6	152	8.98	179.6
2	3300	MV	100	POST TOP	15.04	30.08	17.78	35.56
199	6800	MV	175	POST TOP	15.91	3166.09	18.81	3743.19
658	9500	HPS	100	POST TOP	15.91	10468.78	18.81	12376.98
3336	total lights				current cost of energy only:	$37,769.56	proposed cost of energy only:	$44,642.32
Additional charges; pole, wiring, span*:					+	$19,893.47	+	$12,714.06
					Previous total monthly 5M bill:	**$57,663.03**	**New 5M Rate example monthly bill:**	**$57,356.38**
					Previous yearly 5M charges:	**$691,956.36**	**New yearly 5M:**	**$688,276.56**

*Previous Rate Additional charges:		*New Rate Additional charges:	
Underground Cable/Wiring:	$4,808.83	Underground Cable/Wiring:	$4,808.83
Rider/FAC Adjustment:	$709.16	Rider/FAC Adjustment:	$709.16
Ornamental Pole Charges:	$5,403.94	Ornamental Pole Charges:	$2,701.97
Std. Overhead Span:	$16.66	Std. Overhead Span:	$16.66
Wood Pole Charges:	$8,954.88	Wood Pole Charges:	$4,477.44
Total:	**$19,893.47**		**$12,714.06**

See Appendix 8.14 for the Ameren Missouri provided Comparison rate sheets

6.2. INDIVIDUAL BILLS: CITY OWNED LIGHTS

University City has many city owned lights and matching the lights up to their corresponding bill was no slight task. Because many of the lights are unmetered, and because some accounts were set up decades ago, there are still questions about these bills. The following table links the lights to their corresponding bills. It is important to note the costs associated in table 33 are prior to the rate increase for the 2M and 6M. Table 34 shows the estimated increases in these bills. From the Ameren Missouri provided Comparison rate sheets, the rates for 6M will increase 10.3%, while the rates for 2M will increase by approximately 5%.

The following table represents the usage and costs for the lights owned by University City in March 2011. These bills total $1,711.81 per month.

TABLE 33 CITY OWNED LIGHTING BILLS: MARCH 2011

INFORMATION FROM AMEREN BILLS						LOCATED CITY OWNED LIGHTS	
account #	INVOICE ADDRESS	ADDITIONAL INVOICE INFORMATION	Rate type	kWh	cost	ACTUAL LOCATION and Number of Lights	
15410-04918	6801 Delmar	(2) 6800 MV Energy only (13) 11000 MV Energy and Maintenance	6M	1470	79.54	"XU" lights at Pershing/Forest Park Pkway	7
05410-04811	6801 Delmar	(1) 2500 inc Wood pole (8) 4000 inc wood pole (2) 6000 inc wood pole (1) 10000 inc wood pole	7M	1528	113.74	No lights associated with this bill	0
05300-99008	Olive blvd. at Sutter		2M	753	70.99	Olive pedestrian lights at Sutter	14
36070-47022	6668 Olive blvd, SS at ES Kingsland		2M	881	81.31	Olive pedestrian lights at Kingsland	16
08451-54002	6901 Olive		2M	630	61.07	Olive pedestrian lights at Advanced Automotive	12
06310-85000	Olive, Olive/Skinker		2M	856	79.29	Olive pedestrian lights at Skinker	16
16551-29006	Olive, Olive/Pennsylvania		2M	535	53.40	Olive pedestrian lights at Pennsylvania	10
60091-36011	Olive Blvd Lite, at 81st		2M	968	88.32	Olive pedestrian lights at 81st	22
13590-98002	Olive, Olive/Hanley		2M	1019	91.82	Olive pedestrian lights at Hanley	20
02990-04004	Olive, Olive/Midland		2M	670	64.29	Olive pedestrian lights at Midland	14
11950-16018	Olive, Olive/North and South		2M	1375	114.80	Olive pedestrian lights at North and South	29
10390-20049	Olive, Olive/Woodson/McKnight		2M	2751	210.44	Olive pedestrian lights at Woodson/McKnight	36
MO DOT has been paying for these lights; in process of transferring them to U City						Olive Pedestrian Lights at Ferguson	7
11490-61000	6601 Kingsbury Blvd, lighting		2M	480	50.00	PM Melville Pedestrian Lights	15
27230-72035	6801 Delmar		2M	2126	181.03	Delmar Loop Pedestrian Lights	91
18283-03114	200 Linden Rear		6M	111	10.52	"H" light located on Linden	36
09423-07110	599 Vassar		2M	212	27.35	"H" lights located on/near Vassar	
11813-08113	7066 Kingsbury		6M	541	29.27	"H" lights located on/near Kingsbury	
98823-05111	7070 Washington Rear		6M	252	16.66	"H" lights located on/near Washington	
93923-00116	7100 Waterman Rear		6M	365	21.59	"H" lights located on/near Waterman	
19683-02119	7100 Pershing Rear		6M	183	13.67	"H" lights located on/near Pershing	
54823-05114	6905 Washington Rear		6M	0	5.68	"H" lights located on/near Washington	
01231-00063	753 Westgate Ave Rear		2M	0	10.25	All Saints Plaza	2
12211-64003	341 Westgate Rear, Ackert Walkway		6M	597	31.73	Meter located; No U City lights attached to it	7
84113-02113	6655 Delmar		2M	34	13.00	Market in the Loop lights	4
02130-24163	1101 Purdue Ave. Walkway		2M	0	10.25	"PW" Purdue Walkway at Midland	4
33517-04110	8373 Elmore		5M	44	8.57	Dusk to Dawn light at Coolidge/Elmore	1
06400-03518	719 Leland Rear Alley	Paid for by Parks Dept	6M	2922	133.12	"P" Lights, parking lot #4	13
26400-03712	710 Leland Ave Rear	Paid for by Parks Dept	6M	659	34.43	"P" Lights, parking lot #3 AND Ackert Walkway	52
28400-03512	211 Westgate Rear	Paid for by Parks Dept	6M	0	5.68	Meter located; U City has NO lights attached to it	0
either 34400-03011 or 14400-03816	6801 Delmar	Paid for by thru City Hall building Account	N/A - included in City Hall building electric bill			"C" lights around City Hall	72
						"C" Spotlights in front of City Hall	4
						"L" Lion Lights on Delmar by City Hall	12
University City does not receive this bill; these lights are under Forest Park Parkway so technically County owned						Wellesley Underpass Lights	16
Total cost per month of individual bills paid for by PW or Parks:			$		1,711.81		

The following table represents the estimated bills based on the 7/31/2011 rate increase. It also indicates where individual bills have been corrected or removed throughout the inventory process. Because of this, instead of the total of all bills going up due to the rate increase, the total cost of city owned bills have gone down by $1423 per year.

TABLE 34 CITY OWNED LIGHTING BILLS: AUGUST 2011 (ESTIMATED)

INFORMATION FROM AMEREN BILLS						LOCATED CITY OWNED LIGHTS	
account #	**INVOICE ADDRESS**	**ADDITIONAL INVOICE INFORMATION**	**Rate type**	**kwh**	**cost**	**ACTUAL LOCATION**	**#of lights**
15410-04918	6801 Delmar	(2) 6800 MV Energy only (13) 11000 MV Energy and Maintenance	6M	1470	26.65	"XU" lights located at Pershing/Forest Park Pkway	7
05410-04811	6801 Delmar	(1) 2500 inc Wood pole (8) 4000 inc wood pole (2) 6000 inc wood pole (1) 10000 inc wood pole	7M	1528	0	No lights associated with this bill	0
05300-99008	Olive blvd. at Sutter		2M	753	74.54	Olive pedestrian lights at Sutter	14
36070-47022	6668 Olive blvd, SS at ES Kingsland		2M	881	85.38	Olive pedestrian lights at Kingsland	16
08451-54002	6901 Olive		2M	630	64.12	Olive pedestrian lights at Advanced Automotive	12
06310-85000	Olive, Olive/Skinker		2M	856	83.25	Olive pedestrian lights at Skinker	16
16551-29006	Olive, Olive/Pennsylvania		2M	535	56.07	Olive pedestrian lights at Pennsylvania	10
60091-36011	Olive Blvd Lite, at 81st		2M	968	92.74	Olive pedestrian lights at 81st	22
13590-98002	Olive, Olive/Hanley		2M	1019	96.41	Olive pedestrian lights at Hanley	20
02990-04004	Olive, Olive/Midland		2M	670	67.50	Olive pedestrian lights at Midland	14
11950-16018	Olive, Olive/North and South		2M	1375	120.54	Olive pedestrian lights at North and South	29
10390-20049	Olive, Olive/Woodson/McKnight		2M	2751	220.96	Olive pedestrian lights at Woodson/McKnight	36
MO DOT has been paying for these lights; in process of transferring them to U City						Olive Pedestrian Lights at Ferguson	7
11490-61000	6601 Kingsbury Blvd, lighting		2M	480	52.50	PM Melville Pedestrian Lights	15
27230-72035	6801 Delmar		2M	2126	190.08	Delmar Loop Pedestrian Lights	91
18283-03114	200 Linden Rear		6M	111	11.60	"H" light located on Linden	
09423-07110	599 Vassar		2M	212	28.72	"H" lights located on/near Vassar	
11813-08113	7066 Kingsbury		6M	541	32.28	"H" lights located on/near Kingsbury	
98823-05111	7070 Washington Rear		6M	252	18.38	"H" lights located on/near Washington	36
93923-00116	7100 Waterman Rear		6M	365	23.81	"H" lights located on/near Waterman	
19683-02119	7100 Pershing Rear		6M	183	15.08	"H" lights located on/near Pershing	
54823-05114	6905 Washington Rear		6M	0	6.27	"H" lights located on/near Washington	
01231-00063	753 Westgate Ave Rear		2M	0	10.76	All Saints Plaza	2
12211-64003	341 Westgate Rear, Ackert Walkway		6M	597	0.00	Meter located; U City has no lights attached to it	7
84113-02113	6655 Delmar		2M	34	13.65	Market in the Loop lights	4
02130-24163	1101 Purdue Ave. Walkway		2M	0	10.76	"PW" Purdue Walkway at Midland	4
33517-04110	8373 Elmore		5M	44	9.89	Dusk to Dawn light at Coolidge/Elmore	1
06400-03518	719 Leland	Paid for by Parks Dept	6M	2922	146.83	"P" Lights, parking lot #4	12

	Rear Alley						
26400-03712	710 Leland Ave Rear	Paid for by Parks Dept	6M	659	34.43	"P" Lights, parking lot #3 AND Ackert Walkway	52
28400-03512	211 Westgate Rear	Paid for by Parks Dept	6M	0	0.00	Meter located; U City has no lights attached to it	0
either 34400-03011 or 14400-03816	6801 Delmar	Paid for by thru City Hall building Account	N/A - included in City Hall building electric bill			"C" lights around City Hall	72
						"C" Spotlights in front of City Hall	4
						"L" Lion Lights on Delmar by City Hall	12
University City does not receive this bill; these lights are under Forest Park Parkway so technically County owned						Wellesley Underpass Lights	16
Total cost per month of individual bills paid for by PW or Parks:			$		**1,593.21**		

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University City Staff and the Green Practices Committee members also provided information for the Report.

8. APPENDICES

8.1. INDIVIDUAL RESULTS OF INVENTORY

8.2. SPACING AND INTERSECTION INFORMATION

8.3. PICTURES OF UNIVERSITY CITY OWNED LIGHTS

8.4. AMEREN 5M TARIFF

8.5. LEWISTON MAINE CORRESPONDENCE, POLICY, AND DECOMMISSIONING PROCEDURES

8.6. MAP OF WASHINGTON UNIVERSITY OWNED PROPERTY

8.7. AMEREN 6M TARIFF

8.8. CLAYTON, MO STREET LIGHTING BUDGET

8.9. UNIVERSITY CITY STREET LIGHT POLICY

8.10. UNIVERSITY CITY MAP: ROADWAY CLASSIFICATIONS

8.11. AMEREN OUTDOOR LIGHTING GENERAL INFORMATION

8.12. ILLUMINATION/FOOTCANDLE STUDY DATA: FORSYTH

8.13. PHOTOMETRIC INFORMATION FOR PARKING LOT 3

8.14. AMEREN RATE COMPARISON SHEET