Delaware Municipal Electric Corporation (DEMEC)

LED Street Lighting Conversion Project

2016 M&V Report

Prepared for: Delaware Municipal Electric Corporation (DEMEC)

Submitted by: Vermont Energy Investment Corporation (VEIC)

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Vermont Energy Investment Corporation

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veic.org

Tel: (802) 658-6060
Toll-free: (800) 639-6069

VEIC Headquarters:
128 Lakeside Avenue, Suite 401
Burlington, VT USA 05401

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1. Executive Summary

The following report provides a comprehensive overview of the evaluation services provided by the Vermont Energy Investment Corporation (VEIC) to the Delaware Municipal Electric Corporation (DEMEC) of the LED Streetlight Conversion Project installed in 2016. This project was initiated in 2014 by DEMEC to help provide member communities with an opportunity to purchase LED street lighting fixtures at a group discounted price. In early 2015 DEMEC issued a public request for proposal (RFP) and conducted an evaluation of bidder submissions—ultimately selecting Rumsey Electric of Coshocton, PA to be the group lighting supplier. DEMEC did not require municipalities to purchase lights directly from Rumsey Electric, nor did they require any specific lighting fixtures or provide guidelines for the project. Rather any qualifying[1] LED luminaire purchase was permissible to be installed by the participating municipality.

Following the installation of fixtures across a total of five municipalities in 2016, this follow up evaluation provides a review and back-check of the installed equipment, project economics and overall energy savings achieved at the following five cities and towns in Delaware: Lewes, Newark, Seaford, Smyrna, and Dover. It also summarizes specific lessons learned related to the project process as well as opportunities for improvement should this project be considered for wider application.

Per DEMEC's request the following report provides numeric outputs and supporting narrative of the project's impact and cost-effectiveness. While in-depth analysis and details regarding the specific calculations and methodologies used to support the results can be found in subsequent sections of this report, Table 1.1 provides a high level overview of the total impact delivered by the installation of LED streetlights through conversion projects at the five aforementioned locations:

Total Project Impact	
Total Annual Energy Savings (kWh)[2]	1,093,329
Total Lifetime Energy Savings (kWh)[3]	19,679,913
Annual Avoided Energy Costs[4]	$75,013
Operations & Maintenance (O&M) Savings[5]	$1,785,156
Total Project Cost[6]	$818,418
Total Project Lifetime Benefit[7]	$3,135,395

[1] All LED street light fixtures used in this project were qualified products as listed by the DesignLights Consortium (DLC) http://staging.designlights.org/content/about.

[2] The total annual energy savings is calculated as the sum of claimable savings as a result of the lighting upgrades made in Lewes, Seaford, Smyrna, Dover, and Newark in 2016.

[3] The total lifetime savings is the total annual energy savings for the anticipated life of the new fixture--18 years.

[4] The annual avoided energy cost is the total annual kWh savings multiplied by the avoided costs for the residential sector as specified in the 3 February 2017 memorandum from Optimal Energy to the EEAC and subsequently approved at the February Council meeting--which is $68.61 per MWh for 2016

[5] Lifetime O&M savings is calculated based on the knowledge that if not for this project, the municipalities would have continued their current practice of replacing lamps and ballasts and fixtures as they failed. Therefore, the O&M savings calculation uses a deemed per fixture per year amount of $41.

[6] The total project costs include the material cost of the fixtures and photo cells, the cost of in-house labor to install the fixtures, and the cost incurred by DEMEC ($13,500) for the engineering and consulting work completed by DEDC in support of this project.

[7] The total lifetime benefit is the avoided energy cost for the life of the project plus the lifetime O&M savings using current (2016) rates and costs.

Total Resource Benefit (TRB)[8]	$1,237,032
Net Present Value (NPV)[9]	$1,835,894
Simple Payback (SPB) without O&M[10]	10.9 years
Simple Payback (SPB) with O&M	4.7 years
Benefit to Cost Ratio (BCR)[11]	3.8:1

Table 1.1 Total Project Impact

It is important to note that the total project cost illustrated in Table 1.1 above also includes the cost incurred by DEMEC ($13,500) for the engineering and consulting work completed by DEDC LLC in support of the LED Streetlight conversion project. For individual communities the total project cost would reflect a proportional share ($1,500) of this value.

Finally, in addition to the above cost-effectiveness analysis, the evaluation of the project's total societal impact/benefits—calculated as a Greenhouse Gas benefits—was determined to equal the avoidance of 768 metric tons of CO_2 emissions annually[12] for the State of Delaware.

Considerations for Future Project Application and Impact:

The following report has been developed with the expectation that it will provide DEMEC a solid foundation for establishing a state-compliant savings record of the LED street-lighting conversion project. The evaluation methodology used in this report follows the International Performance Measurement and Verification Protocol (IPMVP®) which defines standard terms and suggests best practice for quantifying the results of energy efficiency investments and increase investment in energy and water efficiency, demand management and renewable energy projects. The Protocol has become the national measurement and verification standard in the United States and many other countries and, as one of the most widely recognized and independent verification set of standards, it has helped to increase certainty and reliability for project measurement and evaluation (M&V). Specifically, the measurement and evaluation protocol recommends that all savings claims be verified in an un-ambiguous way either through direct observation and measurement or through a thorough and rigorous review of the documents that clearly demonstrate that the described implementation of energy conservation measures (ECMs) has happened.

For this project, the removal of existing fixtures or the installation of the new fixtures was not directly observed. Instead, the documentation provided by each municipality was used, followed by a site visit to confirm the veracity of the documentation and to spot-check installation and fixture counts. In some cases, inconsistencies were found between the various documents provided, and in other cases, clarifying statements made during the site visits contradicted the documents provided. Where

[8] The total resource benefit is the present value of electric, fuel, and water savings over the lifetime of the measures based on avoided costs. The calculation uses standard Excel PV functions and represent the lifetime energy cost savings of the project.

[9] Net Present Value (NPV) is the net of benefits minus costs; it includes not only TRB but also the measure cost and the value of Operation and Maintenance (O&M) savings. Discounting techniques for both NPV and O&M use standard Excel functions.

[10] Simple Payback (SPB) is the amount of time that must pass until the energy savings alone has paid for the cost of the project (SPB=implementation cost/annual avoided cost).

[11] The Benefit-Cost Ratio (BCR) is an indicator that attempts to summarize the overall value for money of the project. The ratio of the benefits of a project is expressed in monetary terms, relative to its costs. BCR takes into account the amount of monetary gain realized over the life of the project by performing a project versus the amount it costs to execute the project calculation. The higher the BCR the better the investment.

[12] Source: https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references.

ambiguities remained, conservative assumptions were made, or those parts of the project were omitted completely. While this report's scope did not include a calculation of the associated impact that resulted from these inconsistencies, it is a defensible notion that this type of an approach—the use of the most conservative assumptions—likely resulted in a reduction of the total savings being claimed.

Moving forward, in accordance with the IPMVP® since complete and accurate documentation of project details is key to supporting the M&V process, it is recommended that DEMEC provide its member communities with standardized project implementation forms to help facilitate document consistency in all future projects. Further, while this report looks to provide the most robust, defensible and locally relevant sources to support its calculations, it is arguable that by basing the realization of kWh savings claimed for this project on deemed operating hours and not actual known operating hours has resulted in a significant reduction in claimable kWh[13]. Specifically, while the current interpretation of the Mid Atlantic Technical Reference Manual (TRM)[14] deemed savings inputs for exterior LED lighting hours of operation suggests using the deemed savings value in lieu of any site-specific data, it is generally acknowledged by other utility efficiency programs that the general dawn-to-dusk operation hours of street light LEDs controlled by photo cells is considerably greater than 3,338. Again, to ensure future savings claims for this project are accurately recorded, it is strongly recommended that municipalities be encouraged to monitor or meter site specific LED operating hours so that these actual (known) input values be used instead of deemed value as provided by the TRM.

[13] The use of 3,338 operating hours per year for this project versus the >4,000<4,300 operating hours per year value specified by NYSERDA, PG&E, GMP and Efficiency VT ISO-NE results produce a significant reduction (approximately 24%) in claimable kWh savings.

[14] The Mid Atlantic TRM v.7 dated May 2017 used as the basis for energy savings calculations in this report states that "if annual operating hours are unknown, assume 3,338. Otherwise, use site specific annual operating hour information." This is often interpreted to mean that site specific monitoring and/or metering is required to justify the use of a value other than 3,338 and that is how it is applied here.

2. Introduction and Purpose of the Study

In 2014 the Delaware Municipal Electric Corporation (DEMEC) initiated a LED streetlight conversion project to provide its member communities with an opportunity to purchase LED street lighting fixtures at a group discounted price. Supported by DEDC LLC—a multi-disciplinary engineering and design firm located at 315 South Chapel St., Newark, DE—DEMEC issued a public request for proposal (RFP) in early 2015 aimed at identifying a lighting company to support this effort.

The RFP documents provided lighting specification requirements alongside an inventory of existing luminaires from all nine DEMEC municipalities to indicate the potential size of purchases needed to support the LED conversion project. The recommended fixtures submitted for this project included the Phillips RoadFocus Luminaire and the Acuity Autobahn Luminaire[15]; and all of the LED fixtures subsequently installed as part of this project met the Design Lights Consortium (DLC) specification standards.

Following a full review of all RFP responses, Rumsey Electric of Coshocton, PA, was selected as the winning bidder and subsequent fixture orders were placed beginning in the fall of 2015[16]. Installations occurred in 2016, after which the Vermont Energy Investment Corporation (VEIC) was hired in 2017 to perform an overall evaluation of the LED street lighting conversion project, including verification of installations, fixture performance, project economics and overall energy savings achieved. To successfully complete this effort, Tim Stearns of VEIC worked alongside Scott Lynch and Shannon Maner of DEMEC to inspect sites and verify that fixtures were installed, and that these fixtures matched the invoices and other supporting data to be used in the savings calculations.

During each site visit, a brief interview was conducted with the local participants in the LED street lighting installations and overall project. The purpose of the interview was to confirm that the street lighting documents provided were accurate and installations had been completed, and to determine the best means to verify the fixture counts during the following field visits. In all cases, the local representative responsible for the installations was able to provide secondary information (handwritten notes or other) which corroborated, clarified, and confirmed purchase orders and other data previously supplied.

In all municipalities (with the exception of Newark), Mr. Stearns accompanied the local representative responsible for the installations on a guided tour of the streets where fixtures had been installed. In Newark, Mr. Stearns was supplied with a copy of a worksheet which was generated in real-time by the actual installing service technicians that documented LED fixture locations using GPS technology and included the date of installation and fixture type. Mr. Stearns then spot-checked several streets in Newark to confirm fixture installations.

Actual site inspections occurred on June 27th, 28th, and 29th, and the following report includes individual site visit notes and pictures, as well as supporting equipment invoices and data. The product specifications cut sheets that were used to determine input wattage, rated life, and to confirm warranty

[15] DEDC LLC did not recommend the Leotek fixture (as submitted by Rumsey Electric Company) stating that the photo metrics did not meet all of the RFP requirements.

[16] The City of Dover had previously purchased 18-Holophane post top fixtures from Wesco Distribution and also installed 16-SAT-S cobra head fixtures. These fixtures while not listed under the RFP specifications were included in the subsequent project evaluation.

of each fixture used are also attached. Existing fixture wattage was assumed based on industry accepted deemed values since the fixtures had already been removed from service prior to this evaluation process. Additional specific project details, data and other supporting documentation used to support this evaluation was provided by Mr. Lynch and as requested, this effort was carried out in compliance with energy efficiency evaluation standards established by the State of Delaware.

There were no significant challenges or roadblocks experience in performing this evaluation and the following section outlines the key analysis requested by DEMEC.

3. Analysis

Evaluation of Fixture Selection, Installation and Performance:
All of the street light fixtures used in this project were qualified products as listed by the DesignLights Consortium[17] (DLC) and installed in 2016. The total number of installed products noted in the five municipalities reviewed are shown below in Table 3.1.

Total Fixture Quantities Installed by Community				
CITY	100 watt equivalent LED	150 watt equivalent LED	250 watt equivalent LED	400 watt equivalent LED
Lewes	25	75	-	-
Newark	-	802	862	239
Seaford	-	283	-	-
Smyrna	-	-	-	133
Dover	-	-	18	20

Table 3.1 Installed Fixtures by Community

The wattage of the existing fixtures and their corresponding replacement LED fixtures is shown in Table 3.2 and includes new fixture costs (including the new photocell[18]).

Fixture type	Fixture Model #		LED wattage	HPS replacement	HPS fixture wattage incl. ballast*
100 watt equivalent-Philips Lumec LED	RFM-72w32LED4K-T-R3M-UNIV-DMG-R-CD-W		73	100	130
	fixture+photocell cost	$234			
	fixture+photocell+installation cost	$309			
150 watt equivalent-Philips Lumec LED	RFM-108W32LED4K-t-R3M-UNIV-DMG-RCD		108	150	190
	fixture+photocell cost	$248			
	fixture+photocell+installation cost	$323			
400 watt equivalent-	RFL-241W112LED4k-T-R3M-UNIV-DMG		244	400	465
	fixture+photocell cost	$471			
	fixture+photocell+installation cost	$546			

[17] The DesignLights Consortium™ (DLC) is a project of Northeast Energy Efficiency Partnerships (NEEP), a regional non-profit founded in 1996 whose mission is to serve the Northeast and Mid-Atlantic to accelerate energy efficiency in the building sector through public policy, program strategies and education. Over its 14 year history the DLC program has driven the lighting market towards innovation by providing information, education, tools and technical expertise for cutting edge technologies. Since 2010, the DLC has administered the Qualified Products List (QPL), a leading resource that distinguishes quality, high efficiency LED products for the commercial sector. Today, the QPL sets the bar for efficiency program incentives across the U.S. and Canada while informing manufacturer product development.

[18] Photo cell (sometimes termed, photo control device) costs vary based on the fixture paring, quantity purchased, and make and model of the device; for this calculation, we used the approximate cost of the photo cells purchased by the City of Newark per invoice #S4749990.003 dated 11/04/15 from Rumsey Electric--$20 each.

Philips Lumec LED					
400 watt equivalent-Philips Lumec LED	RFL-215W96LED4k-T-R3M-UNIV-DMG		207	400	465
	fixture+photocell cost	$436			
	fixture+photocell+installation cost	$511			
150 watt equivalent-Leotech LED	GCJ2-20G-MV-NW-2-GY-1A		74	150	190
	fixture+photocell cost	$174			
	fixture+photocell+installation cost	$249			
250 watt equivalent-Leotech LED	GCM2-40F-MV-NW-2-GY-1A		138	250	295
	fixture+photocell cost	$235			
	fixture+photocell+installation cost	$310			
400 watt equivalent-Leotech LED	GC1-80F-MV-NW-2-GY-700		180	400	465
	fixture+photocell cost	$370			
	fixture+photocell+installation cost	$445			
250 watt equivalent-Holophane Postlite	WCFL2070HO4KASBKL4SHAOPCS		95	250	295
	fixture+photocell cost	$1,360			
	fixture+photocell+installation cost	$1,435			
400 watt equivalent-Roadwaylighting SAT-S LED	SAT-96M		200	400	465
	fixture+photocell cost	$645			
	fixture+photocell+installation cost	$720			
400 watt equivalent RAB FXLED Flood	FXLED150SF		150	400	465
	fixture+photocell cost	$495			
	fixture+photocell+installation cost	$570			

Table 3.2 LED Fixture Replacement Types

* Existing HPS fixture wattage are deemed values based on the Northeast Energy Efficiency Partnerships report published in January 2015 http://www.neep.org/led-street-lighting-assessment-and-strategies-northeast-and-mid-atlantic

Based on the installations recorded in Table 3.1 and above LED fixture replacements details in Table 3.2, the annual energy savings that will result from the lighting upgrade can be calculated for each community as illustrated in Table 3.3 with the supporting algorithm and specified assumptions outlined as follows.

Annual Energy Savings (kWh) savings by new LED Fixture Type and City					
CITY	100 watt equivalent LED	150 watt equivalent LED	250 watt equivalent LED	400 watt equivalent LED	Total kWh savings
Lewes	4,757	20,529	-	-	25,285
Newark	-	149,916	451,745	227,368	829,029

Seaford	-	110,525	-	-	110,525
Smyrna	-	-	-	98,114	98,114
Dover	-	-	12,017	18,359	30,376
			Total kWh savings all cities		1,093,329

Table 3.3 Annual Energy Savings (kWh) by Community

The kWh savings calculation is as follows:

> KWh savings = (Existing fixture wattage - new fixture wattage)/1,000 X annual operating hours X total number of fixtures,
>
> Where existing fixture wattage is the sum of lamp wattage and ballast wattage operating as a system in the field and,
>
> Where new fixture wattage is the actual LED fixture wattage as specified from manufacturer's cut sheet data and,
>
> Where annual burn hours for photo cell controlled street lighting fixtures in the absence of other data is deemed to be 3,338 hours annually, unless actual site-specific operating hours are known[19].

The kWh savings assumptions are as follows:

> It is assumed that the efficient outdoor area lighting, when functioning properly, will never result in coincident peak demand (kW) savings since these fixtures operate exclusively at off-peak hours i.e. at night.
>
> It is assumed that while these LED fixtures should function properly for the next 22 years based on the 100,000 hour rated life of the fixtures, excepting any un-foreseen mechanical or catastrophic failure. For the purposes of this report the calculations will use the Mid Atlantic TRM prescribed deemed measure life value of 18 years[20].
>
> Based on this 18-year measure life assumption, the lifetime and annual savings (avoided costs) of the LED fixtures is calculated as the total annual kWh savings multiplied by the avoided costs for the residential sector as specified in the 3 February 2017 memorandum from Optimal Energy to the EM&V subcommittee of the Delaware Energy Efficiency Advisory Council (EEAC) and subsequently approved at the February 2018 Council meeting--which is $68.61 per MWh for 2016.

[19] In lieu of available metered information the deemed annual operating hours from the Mid Atlantic TRM v.7.0 May 2017 is 3338 hrs. That being said, as noted, in other utility efficiency programs it is common to use a higher value, even when a known value is not available. As such, it is recommended that all communities install metering of streetlights to ensure more a robust and accurate characterization of kWh savings moving forward.

[20] The average rated lifetime for applicable products on the Design Lights Consortium Qualified Products List – Updated 11/21/2012 <http://www.designlights.org/solidstate.about.QualifiedProductsList_Publicv2.php> is approximately 70,000 hours. For the purposes of this characterization, it is assumed the typical equipment will operate for 60,000 hours. Assuming average annual operating hours of 3,338 (Efficiency Vermont Technical Reference Manual 2009-55, December 2008; based on 5 years of metering on 235 outdoor circuits in New Jersey), the estimated measure life is 18 years.

Taking into account these assumptions the following total annual and lifetime savings (in kWh and $) of this project are illustrated in Table 3.4 below.

Energy Only - Annual and Lifetime Savings in 2016 Dollars				
CITY	Annual kWh savings	Avoided Energy Cost Only	TRM lifetime kWh savings	TRM lifetime $ savings
Lewes	25,285	$1,735	455,136	$31,227
Newark	829,029	$56,880	14,922,522	$1,023,834
Seaford	110,525	$7,583	1,989,441	$136,496
Smyrna	98,114	$6,732	1,766,049	$121,169
Dover	30,376	$2,084	546,764	$37,514
Total	1,093,329	$75,013	19,679,913	$1,350,239

Table 3.4 Annual and Lifetime kWh and Dollar Savings

Evaluation of Project Economics

The cost-effectiveness of the LED street lighting conversion project can be readily provided by calculating the Simple Payback (SPB) terms and a Benefit to Cost Ratio (BCR) of the project.

SPB terms for this project can be calculated by dividing the total project cost by the annual dollar savings from energy. The result is expressed in years. This is the amount of time it will take to recover the project cost with the energy savings. The SPB for this project at each city when only considering the fixture cost is shown in Table 3.5. This table also shows the BCR that is expressed as a ratio of the project's monetary benefits to its monetary costs. A higher BCR indicates a better investment. For this calculation, the BCR represents the total value of the benefits[21] divided by the total value of the costs over the 18-year lifetime of the project.

Total Annual and Lifetime Savings with Simple Payback and Benefit Cost Ratio--Fixture Cost Only								
Muni	Annual Savings (kwh)	Annual Avoided Energy ($)	Annual Avoided O&M ($)	Total Annual Savings ($)	Lifetime Savings ($)	Fixture Only Cost ($)	SPB-Fixtures Only (yrs)	BCR-Fixtures Only
Lewes	25,285	$ 1,735	$ 4,100	$ 5,835	$ 105,026	$ 24,450	4.2	4.3 : 1
Newark	829,029	$ 56,880	$ 78,023	$ 134,903	$ 2,428,248	$ 430,548	3.2	5.6 : 1
Seaford	110,525	$ 7,583	$ 11,603	$ 19,186	$ 345,350	$ 66,222	3.5	5.2 : 1
Smyrna	98,114	$ 6,732	$ 5,453	$ 12,185	$ 219,323	$ 62,643	5.1	3.5 : 1
Dover	30,376	$ 2,084	$ 1,558	$ 3,642	$ 65,558	$ 36,780	10.1	1.7 : 1
Total	1,093,329	$ 75,013	$100,737	$ 175,750	$ 3,163,505	$ 620,643	5.2	5.1 : 1

Table 3.5 Simple Payback and Benefit Cost Analysis by Community Using Fixture Cost Only

[21] The total energy and O&M savings over the 18 years. The savings does not exclude the cost to replace fixtures in Dover in year 15.

If the cost to install these fixtures is also included in the calculation, the SPB term increases but the results still demonstrates a cost effective project since the useful life of the fixture (18 years) is well beyond the time it takes to recover the total installed cost. Table 3.6 illustrates the SPB and BCR terms for each community with installation costs included[22, 23, 26].

Total Annual and Lifetime Savings with Simple Payback and Benefit Cost Ratio								
Muni	Annual Savings (kwh)	Annual Avoided Energy ($)	Annual Avoided O&M ($)	Total Annual Savings ($)	Lifetime Savings ($)	Total Project Cost ($)	SPB (yrs)	BCR
Lewes	25,285	$ 1,735	$ 4,100	$ 5,835	$ 105,026	$ 33,450	5.73	3.1 : 1
Newark	829,029	$ 56,880	$ 78,023	$ 134,903	$ 2,428,248	$ 574,773	4.26	4.2 : 1
Seaford	110,525	$ 7,583	$ 11,603	$ 19,186	$ 345,350	$ 88,947	4.64	3.8 : 1
Smyrna	98,114	$ 6,732	$ 5,453	$ 12,185	$ 219,323	$ 74,118	6.08	2.9 : 1
Dover	30,376	$ 2,084	$ 1,558	$ 3,642	$ 65,558	$ 41,130	11.29	1.6 : 1
Total	1,093,329	$ 75,013	$100,737	$ 175,750	$ 3,163,505	812,418	4.62	3.8 : 1

Table 3.6 Simple Payback and Benefit Cost Analysis by Community

This project also results in operational and maintenance (O&M) savings that is a coincident result of the assumed longer life of the new LED fixtures vs. the existing HPS fixtures. For all of the municipalities save Newark, the common practice has been to replace the entire lighting fixture at reported failure[24]. Using the assumption that the most likely cause of fixture failure is the result of a burned-out HPS lamp, which has an average rated life of 24,000+ hours[25] and knowing that the LED replacement fixture has a rated life of 100,000 hours, it can be reasonably asserted that O&M costs would be reduced by approximately 75% over the lifetime of the LED fixture. For purposes of quantifying the O&M savings over the project's 18-year lifetime, this same assumption is applied given that the municipalities could have continued to replace their existing street lighting at fixture failure one-for-one using similar HPS technology.

Following, by using the NEEP LED Street Lighting Assessment and Strategies for the Northeast and Mid-Atlantic[2627] as the source for determining O&M savings, the O&M savings per fixture is calculated as $41/year, taking into consideration a cost-adjustment factor for Delaware of 82% compared with California (which is the location of the original source data that calls out an annual $50/fixture saving).

By applying this average O&M cost of $41/year per fixture for Delaware the analysis also produced a total estimate of O&M savings over the 18-year life of the new fixtures. While there is no certainty when the existing fixture would have failed, this assumption allows for the avoided cost of future lamp and

[22] Incremental costs assumptions used in this calculation ($41/fixture) are supported by the (May 10, 2017) NEEP incremental cost recommendation memo to the MidAtlantic TRM v7.0 regarding commercial LED lighting http://www.neep.org/mid-atlantic-technical-reference-manual-v7..

[23] Total project costs include the proportional share if the $13,500 consulting cost incurred by DEMEC for this project and not the entire fee.

[24] For Newark, Mr. Stearns was told that at reported outage, service technicians would replace the lamp and photo cell on the fixture as the 1st response and then replace the ballast as a 2nd response and only replace the entire fixture if response 1 and 2 failed to correct the outage. For all other municipalities, the service technicians would replace the entire fixture at reported outage.

[25] Rated lamp life is based on 50% survival http://www.americanelectriclighting.com/Library/Literature/PDFs/HPS%20Servicing%20Guide.pdf.

[26] The lifetime saving total does not exclude the cost to replace fixtures in Dover in year 15.

[27] http://www.neep.org/led-street-lighting-assessment-and-strategies-northeast-and-mid-atlantic. Incremental costs assumptions used in this calculation ($41/fixture) are also supported by the (May 10, 2017) NEEP incremental cost recommendation memo to the MidAtlantic TRM v7.0 regarding commercial LED lighting http://www.neep.org/mid-atlantic-technical-reference-manual-v7.

ballast replacements (O&M costs) to be spread more accurately through the 18 year project period. Taking into account these O&M savings, the total project financial impacts are calculated and show in Table 3.7. These calculations also include the following assumption that some of the LED fixtures installed in Dover would need to be replaced in year 15 based on the 50,000 hour rated lifespan.[28]

MEASURE IMPACTS						
Year	Maintenance and Fixture Costs for Baseline Equipment	Maintenance and Fixture Costs for Efficient Equipment	Net Operation & Maintenance Savings (Costs)	Annual Avoided Costs	Net Annual Cash Flow	Net Cumulative Cash Flow
0					$(818,418)	$(818,418)
1	$100,737		$100,737	$75,013	$175,750	$(642,668)
2	$100,737		$100,737	$75,013	$175,750	$(466,918)
3	$100,737		$100,737	$75,013	$175,750	$(291,168)
4	$100,737		$100,737	$75,013	$175,750	$(115,418)
5	$100,737		$100,737	$75,013	$175,750	$60,332
6	$100,737		$100,737	$75,013	$175,750	$236,082
7	$100,737		$100,737	$75,013	$175,750	$411,832
8	$100,737		$100,737	$75,013	$175,750	$587,582
9	$100,737		$100,737	$75,013	$175,750	$763,332
10	$100,737		$100,737	$75,013	$175,750	$939,082
11	$100,737		$100,737	$75,013	$175,750	$1,114,832
12	$100,737		$100,737	$75,013	$175,750	$1,290,582
13	$100,737		$100,737	$75,013	$175,750	$1,466,332
14	$100,737		$100,737	$75,013	$175,750	$1,642,082
15	$100,737	$28,110	$72,627	$75,013	$147,640	$1,789,722
16	$100,737		$100,737	$75,013	$175,750	$1,965,472
17	$100,737		$100,737	$75,013	$175,750	$2,141,222
18	$100,737		$100,737	$75,013	$175,750	$2,316,972
		TOTAL	$1,785,156	$1,350,234		

Table 3.7 Total Project Financial Cash Flow

In addition to the above cost-effectiveness calculations the LED streetlight conversion project can also be expressed in terms of the project's Return on Investment (ROI) and IRR (internal rate of return). Calculating these ratios that show the community's ability to translate sales dollars into profits, can also illustrates the overall impact of the project in terms of generating returns (capital or resources) that could be re-invested or re-allocated elsewhere in the future.

[28] While the Mid Atlantic TRM v.7.0 specifies 18 years for LED Outdoor Pole/Arm- or Wall-Mounted Area and Roadway Lighting, given the different fixture installations in Dover (post-top LED fixtures and Kirkwood BB court flood lights have a manufacturers rated life of only 50,000 hours) as compared to the other municipalities it was agreed that is not sufficient to assume one number for all LED street lighting applications and as such a separate value based on the manufacturer's specifications be used in this instance.

As a simple gauge of a project's viability the ROI can help illustrate the investment profitability. This can be calculated by essentially dividing the benefit "gain from investment less the cost" by the total cost of the investment[29]. Following this rudimentary approach, the project ROI can be calculated as outlined here:

Return On Investment (ROI) calculation:

$$\frac{\text{(Gain from investment-cost of investment)}}{\text{Cost of investment}}$$

Where: Gain from investment refers to the total lifetime benefit of the investment
Cost refers to the total cost of the project

Using this approach the project ROI is 283%. For the individual communities the ROI is shown in Table 3.8 below:

CITY	Return on Investment (ROI)
Lewes	229%
Newark	324%
Seaford	295%
Smyrna	202%
Dover	65%

Table 3.8 Return on Investment by Community

In general a higher ROI indicates a better investment. However, given an ROI calculation does not account for the amount of time over which an investment is taking place, it is also important to consider the IRR as this calculation accounts for the differences in the value of money over time and as such provides a more realistic representation of a community's ability to measure the overall efficiency of a project in terms of generating returns based on its investment. In more specific details, the IRR on an investment illustrates the "annualized effective compounded return rate" or rate of return that sets the net present value of all cash flows (both positive and negative) from the investment equal to zero. Given this fact, and based on the assumed time and cash flow calculations of this project, the calculated internal rate of return for this project is 21%.

Further project savings are also achieved when taking into consideration the avoided costs of energy production and delivery. The avoidable marginal cost to supply electric energy or fuel to a utility customer can also be reflected as the electric energy and fuel costs typically reflect by the utility's service rate to its customers. Additional transmission and distribution (T&D) avoided costs are represented by the avoided infrastructure costs due to postponement and/or reductions in the size of new capital projects that have to be built, as a result of a reduced electric demand that needs to be delivered. The calculation

[29] Note for a more accurate ROI it is important to use inputs that incorporate all costs over the investment time period.

of annual avoided energy costs as explained here were based on values from the Maryland Avoided Energy (MEA) Costs Study[30] (inflated to 2016 dollars) that are used by the DPL in their Maryland service territory[31]. In addition to the reported MEA avoided costs values this calculation also includes a component for demand-reduction price effects (DRIPE); and the avoided cost of Renewable Energy Credits (RECs) and Solar Renewable Energy Credits (SRECs)[32] that assuming a conservative $75 fixed price per SREC and $15 fixed price per REC. To simplify the electrical energy avoided cost into a single set of projections, the typical load shapes for residential and commercial and industrial (C&I) measures were also used.

Based on these assumptions, Table 3.9 illustrates the Net Present Value (NPV) of the project by fixture type[33].

Street Lighting Project Totals by Measure						
Measure Location	Annual Energy Savings (kWh/Yr)	Measure Cost ($)	Annual Avoided Cost ($/Yr)	Annual O&M Savings ($)	Total Resource Benefits ($)	Net Present Value ($)
Totals	**1,093,329**	**$818,418**	**$75,013**	**$100,737**	**$1,237,032**	**$1,835,894**
Lewes 100 watt equivalent LUMEC	4,757	$10,400	$326	$1,025	$5,382	$9,380
Lewes 150 watt equivalent LUMEC	20,529	$24,600	$1,408	$3,075	$23,227	$41,894
Seaford 150 watt equivalent LUMEC	110,525	$88,662	$7,583	$11,603	$125,052	$199,494
Smyrna 400 watt equivalent LUMEC	98,114	$73,283	$6,732	$5,453	$111,010	$114,122
Dover 250 watt equivalent post top	12,017	$25,920	$824	$738	$13,596	$(2,163)
Dover 400 watt equivalent SAT-S	14,153	$11,600	$971	$656	$16,013	$13,573

[30] Exeter Associates, 2014

[31] DPS's service territory in Maryland and Delaware together compose a single zone as defined by PJM, the regional operator.

[32] RECs and SCRECs are defined by 26 Del. C. §§352(18) and (25). Specifically, in 26 Del. C. §354(a) the requirement to acquire RECs and SRECs is tied to total state electric sales, reductions in sales from efficiency programs reduce the need to acquire RECs/SRECs

[33]Total resource benefits is the present value of electric, fuel, and water savings over the lifetime of the measures based on DEMEC avoided costs. Net Present Value is also a present value but is the net of benefits minus costs, so it includes not only TRB but also the measure cost and the value of operation and maintenance savings.

Dover 400 watt equivalent Kirkwood BB court	4,206	$2,300	$289	$164	$4,759	$4,755
Newark 150 watt equivalent LEOTEK	149,916	$203,235	$10,286	$32,882	$169,621	$429,720
Newark 250 watt equivalent LEOTEK	451,745	$270,688	$30,994	$35,342	$511,121	$737,867
Newark 400 watt equivalent LEOTEK	$227,368	$107,550	$15,600	$9,799	$257,252	$287,254

Table 3.9 Total Resource Benefits by Measure

These performance metrics can also be calculated in a similar fashion for the individual communities as illustrated in Table 3.10 below:

Street Lighting Project Totals by Community						
Municipality	Annual Energy Savings (kWh/yr.)	Project Cost ($)	Annual Avoided Energy Cost ($)	Annual O&M savings ($)	Total Resource Benefits ($)	Net Present Value ($)
Lewes	25,285	33,000	1,735	4,100	28,609	51,273
Seaford	110,525	88,862	7,583	11,603	125,052	199,494
Smyrna	98,114	73,283	6,732	5,453	111,010	114,122
Dover	30,376	39,283	2,084	1,558*	34,368	16,165
Newark	829,029	581,453	56,880	78,023	937,994	1,454,840
totals	1,093,329	818,418	75,013	100,737	1,237,032	1,835,894

Table 3.10 Total Resource Benefits by Community

**The annual O&M savings for City of Dover does not include the allowance for the replacement of some fixtures in year 15.*

Evaluation of Additional Societal Benefits

Additional benefits associated with the LED lighting project include greenhouse gas avoidance. A greenhouse gas (GHG) is any gas in the atmosphere that absorbs and emits radiation within the thermal

infrared range. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Human activities since the beginning of the Industrial Revolution (taken as the year 1750) have produced a 40% increase in the atmospheric concentration of carbon dioxide, from 280 ppm in 1750 to 406 ppm in early 2017.[34]

The calculated annual CO_2 emissions avoided as a result of this project are measured at 768 metric tons. This is calculated by converting the reductions of electrical reductions (kWh) into avoided units of CO_2 by using the EPA greenhouse gas equivalency calculator[35].Similarly, the sum of the greenhouse gas emissions saved can also be reviewed as a Carbon Dioxide Equivalent (CO_2e) of the following GHG emissions[36]:

- 162 passenger vehicles driven for one year or 1,841,507 miles driven, or
- 34 garbage trucks of waste or 244 tons recycled instead of landfilled.

Or the CO_2e from:

- 86,459 gallons of gasoline consumed, or
- 1,779 barrels of oil consumed, or
- 819,919 pounds of coal burned, or
- 113 homes' electricity use for one year.

It can also be expressed as the equivalent to the carbon sequestered by:

- 727 acres of U.S. forests in one year.

[34] Source: https://www.esrl.noaa.gov/gmd/ccgg/trends/global.html

[35] This value is calculated using the following Emission Factor 7.03 x 10^{-4} metric tons $C0_2$/kWh as found on the EPA greenhouse gas equivalencies website https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

[36] The following equivalent units reported are calculated using the EPA greenhouse gas equivalencies calculator that supports the conversion of greenhouse gas emissions numbers into different types of units: https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

4. Site Visit Reports

4.1 Lewes

Lewes is an incorporated city on the Delaware Bay in eastern Sussex County, Delaware. According to the 2010 census, the population is 2,747.

The site visit was conducted on June 27, 2017. Tim Stearns, Scott Lynch and Shannon Maner met with Lewes BPW General Manager, Darrin Gordon, and Electric Department supervisor Bob Barnes.

Bob Barnes confirmed that he personally supervised the installation of the 100 fixtures, and that these amounted to the only remaining non-LED or induction lights on "beach side" of town (beach side refers to all streets between the canal and the beachfront).

He also stated that the 100-watt equivalent fixtures were installed on "side-streets" and cul-de-sacs in this neighborhood (25 fixtures in total), while the 150-watt equivalent LEDs were installed along Bay Ave. and Cedar St. (75 fixtures in total). He also confirmed that the existing fixtures were 100-watt and 150-watt HPS respectively and were replaced one-for-one.

It was also confirmed that existing maintenance/repair was conducted by replacing the entire cobra-head HPS fixture with a new Cobra-head HPS fixture, and this was done in approximately 15 minutes with two employees and a bucket truck.

Bob escorted Tim on a tour of this "neighborhood" which consisted of the following streets:

- Savannah
- Cedar St.
- Iowa
- Bay Ave.
- N. Washington
- Illinois
- Ohio
- Massachusetts
- West Canal
- East Canal
- O St.
- Oregon
- Newark
- Houston
- Delmar
- Indiana

Tim made a physical count of the fixtures along Bay Ave. and Cedar St., and confirmed that 75 fixtures were installed. Based on that physical count, it was concluded that all 100 fixtures have been installed.

https://www.mapquest.com/us/de/lewes-282038662

Figure 4.1.1 Map of canal/beachfront area where LED fixtures were installed.

Figure 4.1.2 Fixture mounted along poles on Bay Ave. (typical)

Figure 4.1.3 Fixture mounted along poles on Cedar Rd. (typical)

4.2 Seaford

Seaford is a city located along the Nanticoke River in Sussex County, Delaware. According to the 2010 Census, the population of the city is 6,928.

The site visit was conducted on June 27, 2017. Tim Stearns, Scott Lynch and Shannon Maner met with The City of Seaford Electrical Engineer, Rick Garner, PE and Superintendent of Electric, Bill Bennett.

Bill Bennet confirmed that he personally supervised the installation of the 408 fixtures and that these constituted the first two phases of a three-phase installation project that would convert the entire town to LED streetlights. Bill confirmed that 34 400-watt equivalent LED streetlights were installed on Nylon St. and that all of the remaining LEDs were 150-watt equivalents installed as one-for-one replacement of existing HPS cobra heads. [37]

He also confirmed that existing maintenance and repair was conducted by replacing the entire cobra-head HPS fixture with a new cobra-head HPS fixture and this was done in approxamitly15 minutes with two employees and a bucket truck.

Bill provided the following worksheet which lists the streets where the streetlights were installed:

[37] Some LED fixtures (including the 400-watt equivalent LED fixtures on Nylon St.) were installed in 2015, and are not included in this project count.

Phase 1	ordered	installed	date installed
North St from Water to Eskridge Hwy	**18**	**16**	**12/7/2015**
Arch St from High St to Stein Hwy	**13**	**13**	**12/9-12/10**
Pine St from High St to Stein Hwy	**14**	**14**	**12/10/2015**
Bradford St from Del Ave to Stein	**14**	**14**	**1/4/2016**
Hall St from dead end to Stien Hwy	**15**	**15**	**1/5/2016**
Porter St from Harrington to Stein	**14**	**14**	**1/4/2016**
E King St from Cedar to Poplar	**12**	**12**	**1/13/2016**
Conwell ST from river to Spruce	**10**	**10**	**12/31/2015**
Cannon St from river to Poplar	**9**	**9**	**12/11/2015**
Locust St from De Ave to Sussex	**17**	**17**	**1/13/2016**
Market St from High to Virginia Ave	**24**	**24**	**12/8-12/9**
Nylon Blvd	**34**	**34**	**11/20/2015**
Pearl Alley		**2**	**12/31/2015**
New ST	**2**	**4**	**1/4/2016**
Church St	**2**	**2**	**12/11/2015**
Spares	3	1	
	201	**200**	
Bold print is done			

Tim Stearns:
We only counted fixtures confirmed to be installed in 2016 and excluded all others from this Project, including the 1 spare

Phase 2	
Pearl St	7
Spruce St from Cedar to Pine	4
Chandler St from Eskridge to Third	9
Purnell St & Thomas St	3
Third St from Pine to the east end	12
Liberty St	4
Thompson Ct	3
Woolford St	4
Clarence St	6
Collins Ave	4
Lincoln St	2
Grant St , 3 are in Fred Douglas parking lot	5
Douglas St	3
Griffin St	1
Perkins St	4
Pond ST	2
Nutter Lane	3
Dutton Ave.	11
Locust from cedar to Pine	3
Poplar St from Cedar Ave to Middleford Rd	18
New St & Arcadia	6
fourth, fifith, sixth	10
Pennsylvania Ave from Nylon Blvd to Shipley St	4

Wahington Ave from school lane to hockey field	5
Linden St & State ST	3
School Lane	10
State St from Pine to Market	3
Washington St from Pine to Market	5
Dover St	5
Spruce St from De Ave to Golf Course	7
Poplar St from De Ave to Nylon Blvd	7
Holly St from Shipley to Nylon Blvd	3
Elm ST, S Phillips, S Willey, Alley	4
Juniper, Phillips & Alleys	10
Delaware Ave, Williams and Holly	18
	208

Table 4.2.1 Fixture Counts by Street

Bill escorted Tim on a tour of the streets where LEDs were installed. Tim counted fixtures on Pearl St., Hall St., and Nylon St. to confirm the counts and locations. Based on that representative physical count, it was concluded that all 283 fixtures were installed in 2016.[38]

[38] There have been additional LED streetlights installed in Seaford both before and since 2016—these were not counted as part of this project.

https://www.mapquest.com/us/de/seaford-282033251

Figure 4.2.1 Map of south side of town where Phase 1&2 fixtures were installed

Figure 4.2.2 Fixtures installed on Hall St. (typical)

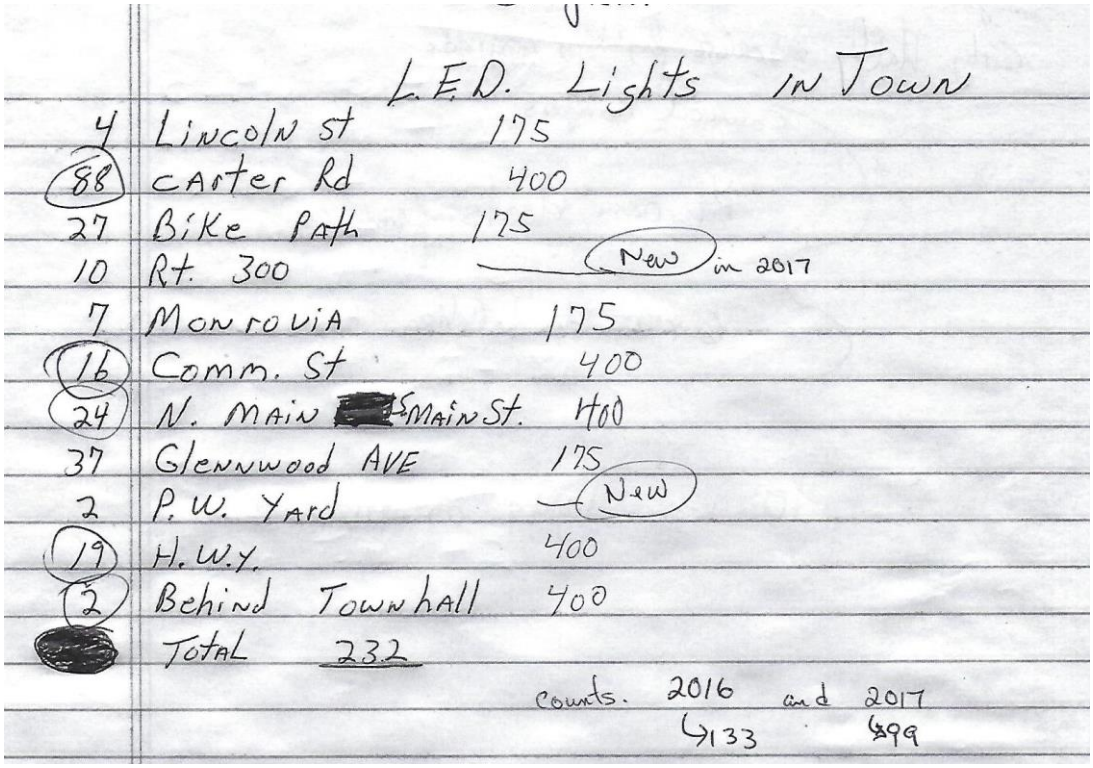
Figure 4.2.3 Fixtures installed on Pearl St. (typical)

4.3 Smyrna

Smyrna is a town in Kent and New Castle counties in Delaware. It is part of the Dover, Delaware Metropolitan Statistical Area. According to 2010 Census, the population of the town is 10,023.

The site visit was conducted on June 28, 2017. Tim Stearns, Scott Lynch, and Shannon Maner met with The City of Smyrna Electric Department Operations Manager, Buck Smith and Director of Public Works & Electric Director, Bill Evans.

Buck Smith provided Tim with a handwritten copy of his working list of streets where LED fixtures have been installed. The list contains street names of installations for both 2016 and 2017, and includes streets where no streetlights previously existed but now have LED streetlights. All of these LED fixtures were 400-watt HPS equivalents, although some of the streets previously have 175-watt HPS (See Figure 4.3.1 below).



L.E.D. Lights in Town

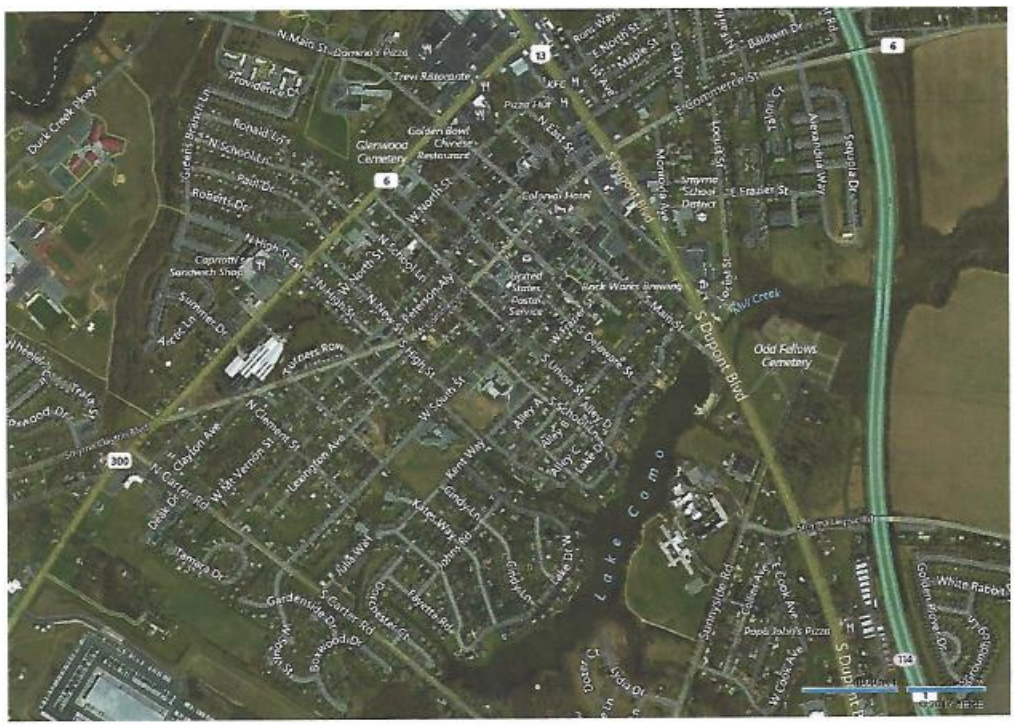
4	Lincoln st	175
88	carter Rd	400
27	Bike Path	175
10	Rt. 300	New in 2017
7	Monrovia	175
16	Comm. St	400
24	N. Main [redacted] Main St.	400
37	Glenwood AVE	175
2	P.W. Yard	New
19	H.W.Y.	400
2	Behind Town hall	400
[redacted]	Total 232	

counts. 2016 and 2017
133 99

Figure 4.3.1 Fixture Counts by Street Location

Buck clarified that they initially concentrated on replacing the 400-watt HPS lights in 2016, and that at least 149 fixtures were installed to replace 400-watt HPS on Carter Rd., Commerce St., North and South Main St.; and along Highway 13. Invoices submitted as part of this project indicate that 133 fixtures were shipped to Smyrna in late 2015 and 2016. Based on these invoices, savings will only be claimed for 133 fixtures.

Tim confirmed the quantity of installed fixtures on Carter Rd., Commerce Rd., and along North and South Main St.; and along Highway 13.



https://www.bing.com/maps?&ty=18&q=Smyrna%2c%20DE&vdpid=5490454192206118913&m... 7/10/2017

Figure 4.3.2 Map of the center of the Town of Smyrna

Figure 4.3.3 LED fixtures on Carter St.

Figure 4.3.4 LED fixtures on S. Main St.

Figure 4.3.5 LED fixtures along Hwy 13.

4.4 Dover

Dover is the capital and second-largest city in Delaware. It is the principal city of the Dover, DE, Metropolitan Statistical Area. According to the 2010 Census, the city had a population of 36,047.

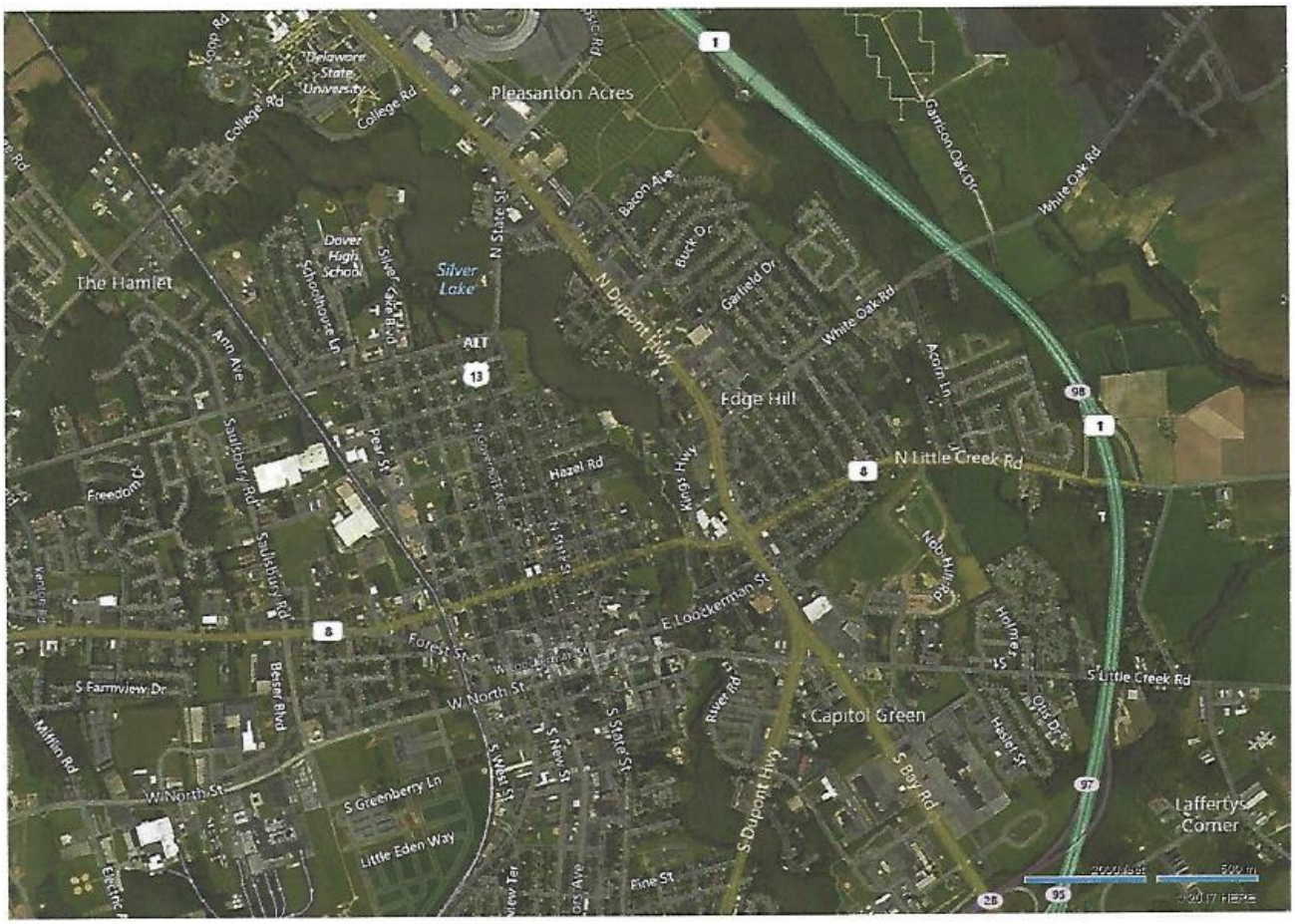
The site visit was conducted on June 28, 2017. Tim Stearns, Scott Lynch, and Shannon Maner met with The City of Dover Electric Engineering Services and System Operations Superintendent, Paul Waddell, and Plant Operations Manager, Daniel Corrigan.

Paul previously provided information on its streetlights to Scott via e-mail on May 25, 2017, and this e-mail was reviewed to clarify and confirm the information.

Paul confirmed the following:

- Existing HPS cobra head streetlights were replaced whenever an outage was reported. The cost of the HPS fixture (materials only) was $152.90.
- Cost (materials only) for the new LED flood lights at the basketball courts was confirmed to be $495.
- Existing fixtures at the basketball courts were 400-watt HPS flood lights
- The 95-watt LED post top fixtures were replacing 18 of the existing 250-watt HPS
- Replacement 200-watt LEDs (along RT. 13-Dupont Hwy) were replacing 400-watt HPS

Paul stated that he confirmed the installation of all fixtures with site visits to all locations. He provided Tim with a guided tour to the locations where fixtures were installed.



https://www.bing.com/maps?&ty=18&q=Smyrna%2c%20DE&vdpid=5490454192206118913&m... 7/10/2017

Figure 4.4.1 Map of the center of the City of Dover

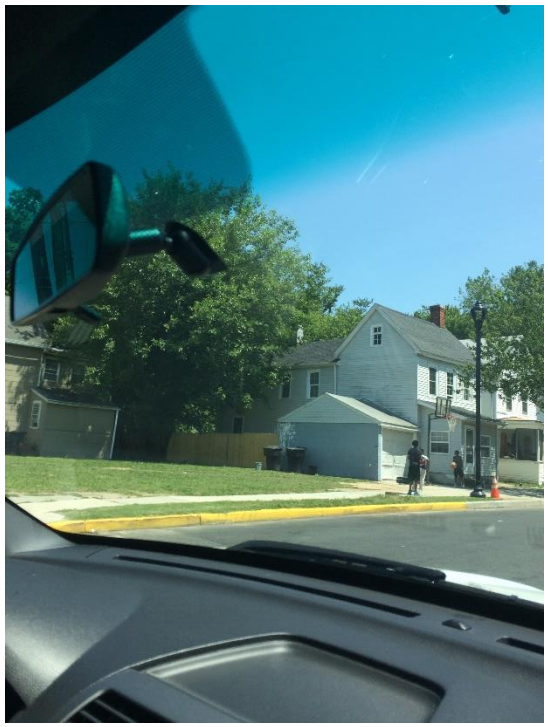


Figure 4.4.2 Post Top LED fixtures on S. New St.

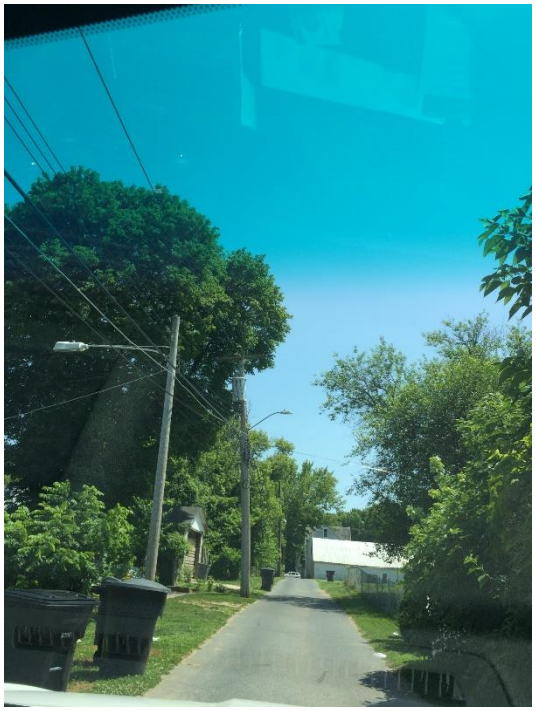


Figure 4.4.3 LED fixture in alley near S. New St.

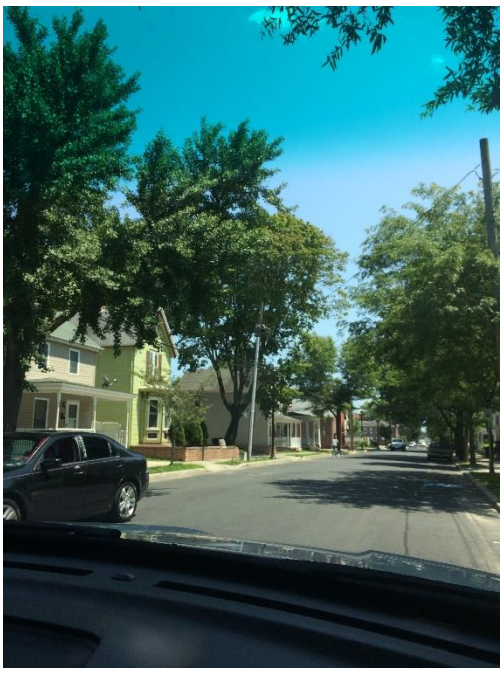


Figure 4.4.4 LED fixture on street near S. New St.

Figure 4.4.5 LED fixture along Rt. 13

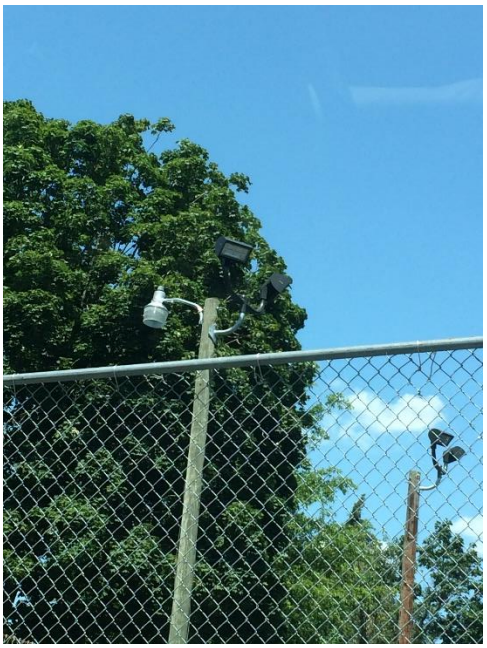


Figure 4.4.6 Flood light LED fixture at Kirkwood basketball courts

4.5 Newark

Newark is a city in New Castle County, Delaware. According to the 2010 Census, the population of the city is 31,454.

The site visit was conducted on June 29, 2017. Tim Stearns, Scott Lynch, and Shannon Maner met with The City of Newark's Director of Electric, Rick Vitelli, and Assistant Electric Utilities Director, Sam P. E. Sneeringer. Sam confirmed that repair and replacement of existing HPS cobra heads was conducted as follows:

1. In response to first call of streetlight outage: replace lamp and Photo cell. Estimate material cost was $16
2. In response to second call of streetlight outage: replace lamp and ballast
3. In response to third call of streetlight outage: replace entire cobra head. Current material cost was $90-$140

He stated that replacing the entire fixture was rarely done.

Sam confirmed the repair or replace values he originally provided to Scott on May 23, 2017. The average time to repair/replace a fixture was 45 minutes for two employees, and the cost was calculated to be $60 for in-house labor. This did not include the cost of the truck or overhead. The 45 minutes included travel time to and from the fixture location. For consistency with the other municipalities, this travel time was not included in maintenance savings calculations.

Sam confirmed that the intent of the project was to finalize the conversion of all of the city's streetlights to LEDs. The city had some LED streetlights installed already, but it was not clear how many of these there were.

Sam also stated in an e-mail on May 25, 2017 to Scott that there had only been 11 customer complaints from residents regarding the new lights being too bright. These were in neighborhoods where 100-Watt lights were upgraded to 150-watt LED equivalents. The lights were replaced with 100-watt equivalents or a field side shield was installed.

The city provided a link to a Google Earth LED Fixture Locations Map. kmz file, which showed where each LED fixture was located. The map was created with GPS tracking of all LED fixtures and was plotted in real time during the installation of these LED fixtures. A Screenshot of the map is shown below.

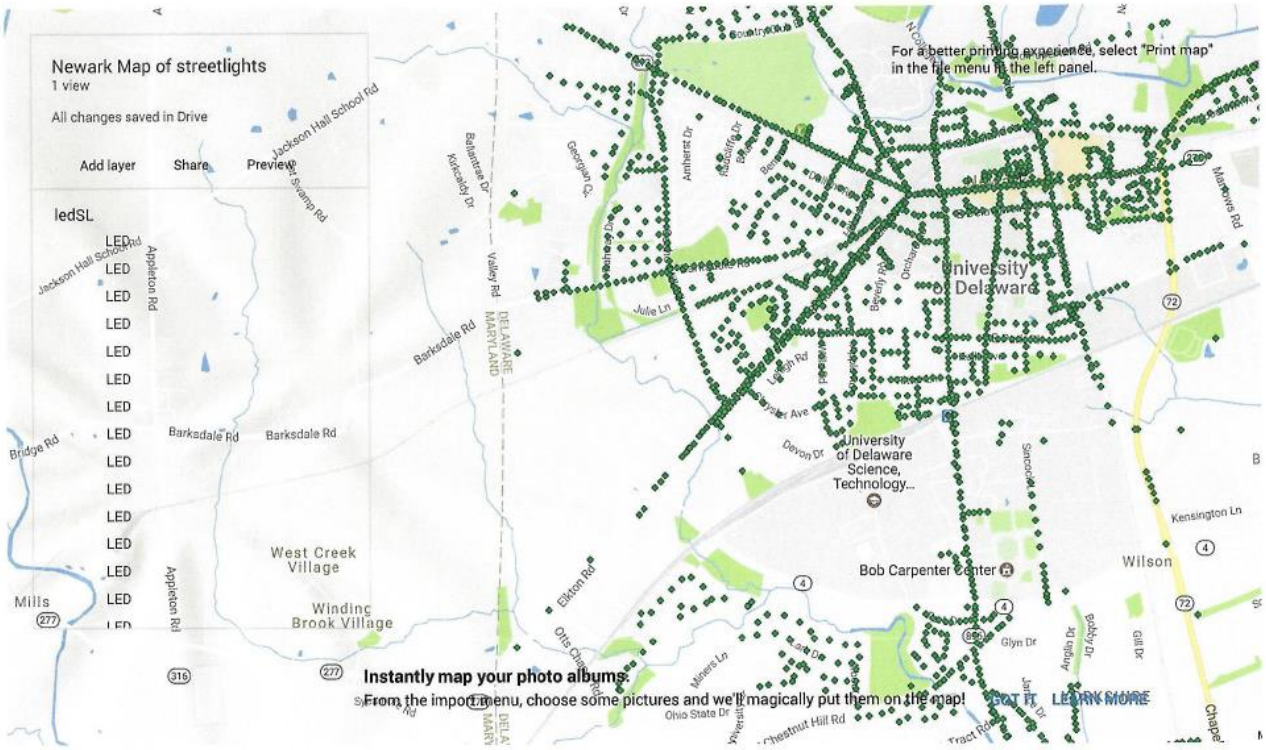


Figure 4.5.1 Map Locations of Installed LED Fixtures

During the site visit, Anthony Hanna from the Newark Electric Department accessed the excel file that was created during this mapping process and shared it with Tim via e-mail. That worksheet lists a total of 1,977 LED fixtures installed. Using that worksheet, and listed by LED replacement, reveals the following:

- 802 LED fixtures were installed replacing 150-watt HPS fixtures
- 936 LED fixtures were installed replacing 250-watt HPS fixtures
- 239 LED fixtures were installed replacing 400-watt HPS fixtures

Tim confirmed with Anthony via e-mail that this map and worksheet represents the LED fixtures that were installed in 2016. Anthony further clarified that 74 of the 250-watt equivalent LED fixtures were installed in 2015 or earlier. These 74 were not counted in the 2016 savings totals.

Tim also confirmed with Anthony that the city did not specifically count the number of 100-watt HPS fixtures compared to the 150-watt HPS fixtures that were replaced with 150-watt equivalent LED fixtures. Anthony stated that "most" of the existing fixtures were 100-watt HPS, but there was no way to be certain how many of each fixture type was replaced with 150-watt LED equivalents. Due to this, a conservative savings calculation was made based on the assumption that all 150-watt LED equivalents replaced 100-watt HPS fixtures.

Newark provided an order acknowledgement for 1,450 fixtures and also an invoice for 506 more fixtures (the order acknowledgement and invoice were created using different customer numbers, which presumable indicates that these are not duplicate orders). It is presumed that other invoices exist, but these were not provided.

Based on order acknowledgement and invoice documents, it was noted that the wattages of the new LED fixtures—as input into the GPS mapping software and imported into the excel worksheet—did not match the cut sheet data. The discrepancy is noted below:

- 862 138-watt LED fixtures replacing 250-watt HPS fixtures were listed as 137-watt in the worksheet, and 74 were listed as 143-watts
- 180-watt LED fixtures replacing 400-watt HPS were listed as 183-watt in worksheet.

Figure 4.5.2 LED fixture at Library and Main St.

Figure 4.5.3 LED fixture on Veterans Lane

Figure 4.5.4 LED fixtures along S. Main St.

Figure 4.5.5 LED fixtures along S. Main St.

Figure 4.5.6 LED fixtures in Municipal building parking lot

5. Purchase Orders and Documentation of Installed Fixtures

5.1 Lewes

RUMSEY
Quality & Service - Since 1895

** INVOICE **

35208 HUDSON WAY
REHOBOTH BEACH, DE 19971-4419
Phone: 302-644-1900 Fax: 302-644-0292

Phone: 610-832-9097
Fax : 610-941-8183

APPROVED BY:
APPROVED BY:

INVOICE DATE	INVOICE NUMBER
10/28/15	S4697261.001

REMIT TO:
RUMSEY - REHOBOTH
P.O. BOX 824429
PHILADELPHIA, PA 19182-4429

PAGE NO.
1 of 1

BILL TO:
LEWES BOARD OF PUBLIC WORK
107 FRANKLIN AVE
LEWES, DE 19958-1413

SHIP TO:
LEWES BOARD OF PUBLIC WORKS BLDG
216 SCHLEY AVENUE
ATTN: BOB BARNES
LEWES, DE 19958-1400

CUSTOMER NUMBER	CUSTOMER ORDER NUMBER	RELEASE NUMBER	SALESPERSON	
10548	181			
WRITER	**SHIP VIA**	**TERMS**	**SHIP DATE**	**ORDER DATE**
MICHAEL DECK	BW - BEST WAY	Net 30 Days	10/28/15	08/06/15

LN	DESCRIPTION	ORDER QTY	SHIP QTY	NET UNIT PRICE	NET AMOUNT
1	LUMEC RFM-72W32LED4K-T-R3M-UNIV-DMG-RCD-W C10-GY3 **NS**	25	25	214.00ea	5350.00
2	LUMEC RFM-108W32LED4K-T-R3M-UNIV-DMG-RCD- WC10-GY3 **NS**	75	75	228.00ea	17100.00

RECEIVED
NOV 02 2015
BY:.....

Subtotal	22450.00
S&H CHGS	0.00
Sales Tax	0.00
Amount Due	22450.00

S4697261.001

Payment is due by 11/27/15
Refer to www.Rumsey.com/contactus/creditapp for Terms and Conditions
Past due accounts are subject to a 1.5% per month service charge.

5.2 Seaford

RUMSEY
Quality & Service - Since 1895

** INVOICE **

35208 HUDSON WAY
REHOBOTH BEACH, DE 19971-4419
Phone: 302-644-1900 Fax: 302-644-0292

Phone: 610-832-9097
Fax : 610-941-8183

INVOICE DATE	INVOICE NUMBER
11/06/15	S4707428.002

REMIT TO:
RUMSEY - REHOBOTH
P.O. BOX #24429
PHILADELPHIA, PA 19182-4429

PAGE NO.
1 of 1

BILL TO:
CITY OF SEAFORD
414 HIGH STREET
PO BOX 1100
SEAFORD, DE 19973-3914

SHIP TO:
CITY OF SEAFORD
8000 HERRING RUN ROAD
MUST CALL 302-629-9841 24HRS PRIOR
SEAFORD, DE 19973-5753

CUSTOMER NUMBER	CUSTOMER ORDER NUMBER	RELEASE NUMBER	SALESPERSON	
3797	16-00516		RICK GARNER	
WRITER	**SHIP VIA**	**TERMS**	**SHIP DATE**	**ORDER DATE**
MICHAEL DECK	BW - BEST WAY	Net 30 Days	11/06/15	08/21/15

LN	DESCRIPTION	ORDER QTY	SHIP QTY	NET UNIT PRICE	NET AMOUNT
1	LUMEC RFL-215W96LED4K-T-R3M-HVU-DMG-R CD-P H9-WC10-GY3 **NS**	35	35	416.00ea	14560.00

Subtotal	14560.00
S&H CHGS	0.00
Sales Tax	0.00
Amount Due	14560.00

Payment is due by 12/06/15
Refer to www.Rumsey.com/contactus/creditapp for Terms and Conditions
Past due accounts are subject to a 1.5% per month service charge.

S4707428.002

RUMSEY
Quality & Service - Since 1895

** INVOICE **

35208 HUDSON WAY
REHOBOTH BEACH, DE 19971-4419
Phone: 302-644-1900 Fax: 302-644-0292

Phone: 610-832-9097
Fax : 610-941-8183

INVOICE DATE	INVOICE NUMBER
11/23/15	S4707428.004

REMIT TO:
RUMSEY - REHOBOTH
P.O. BOX 824429
PHILADELPHIA, PA 19182-4429

PAGE NO.: 1 of 1

BILL TO:
CITY OF SEAFORD
414 HIGH STREET
PO BOX 1100
SEAFORD, DE 19973-3914

SHIP TO:
CITY OF SEAFORD
8000 HERRING RUN ROAD
MUST CALL 302-629-9841 24HRS PRIOR
SEAFORD, DE 19973-5753

CUSTOMER NUMBER	CUSTOMER ORDER NUMBER	RELEASE NUMBER	SALESPERSON	
3797	16-00516		RICK GARNER	
WRITER	**SHIP VIA**	**TERMS**	**SHIP DATE**	**ORDER DATE**
MICHAEL DECK	BW - BEST WAY	Net 30 Days	11/23/15	08/21/15

LN	DESCRIPTION	ORDER QTY	SHIP QTY	NET UNIT PRICE	NET AMOUNT
1	LUMEC RFM-72W32LED4K-T-R3M-UNIV-DMG-RCD-W C10-GY3 **NS**	166	166	214.00ea	35524.00

Subtotal	35524.00
S&H CHGS	0.00
Sales Tax	0.00
Amount Due	35524.00

S4707428.004

Payment is due by 12/23/15

Refer to www.Rumsey.com/contactus/creditapp for Terms and Conditions
Past due accounts are subject to a 1.5% per month service charge.

5.3 Smyrna

RUMSEY
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** INVOICE **

1251 COLLEGE PARK DRIVE
DOVER, DE 19904-8713
Phone: 302-735-3300 Fax: 302-735-3303

Phone: 610-832-9097
Fax : 610-941-8183

INVOICE DATE	INVOICE NUMBER
09/30/16	S4956746.001

REMIT TO:
RUMSEY - DOVER BRANCH
P.O. BOX 824429
PHILADELPHIA, PA 19182-4429

PAGE NO.
1 of 1

TOWN OF SMYRNA
OCT 3 -2016
RECEIVED

BILL TO:
TOWN OF SMYRNA
220 ARTISAN DRIVE
PO BOX 307
SMYRNA, DE 19977-3715

SHIP TO:
TOWN OF SMYRNA
220 ARTISAN DRIVE
PO BOX 307
SMYRNA, DE 19977-3715

CUSTOMER NUMBER	CUSTOMER ORDER NUMBER	RELEASE NUMBER	SALESPERSON
7696	PER BILL EVANS		BILL EVANS

WRITER	SHIP VIA	TERMS	SHIP DATE	ORDER DATE
MICHAEL DECK	BW - BEST WAY	Net 10 Days	09/30/16	09/06/16

LN	DESCRIPTION	ORDER QTY	SHIP QTY	NET UNIT PRICE	NET AMOUNT
1	LUMEC RFL-241W112LED4K-T-R3M-UNIV-DMG -RCD -WC10-GY3 **NS**	38	38	451.00ea	17138.00

TOWN OF SMYRNA
APPROVED FOR PAYMENT

VENDOR NO: _____

ACCOUNT NO:	AMOUNT

Exp Code
021-1500-631.74-13
Revenue code
021-0000-344-30.08

Green Energy fund

Subtotal	17138.00
S&H CHGS	0.00
Sales Tax	0.00
Amount Due	17138.00

S4956746.001

Payment is due by 10/10/16
Refer to www.Rumsey.com/contactus/creditapp for Terms and Conditions
Past due accounts are subject to a 1.5% per month service charge.

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** INVOICE **

1251 COLLEGE PARK DRIVE
DOVER, DE 19904-8713
Phone: 302-735-3300 Fax: 302-735-3303

Phone: 610-832-9097
Fax : 610-941-8183

INVOICE DATE	INVOICE NUMBER
12/14/15	S4725337.005

REMIT TO:
RUMSEY - DOVER BRANCH
P.O. BOX 824429
PHILADELPHIA, PA 19182-4429

PAGE NO.: 1 of 1

TOWN OF SMYRNA
DEC 16 2015
RECEIVED

BILL TO:
TOWN OF SMYRNA
220 ARTISAN DRIVE
PO BOX 307
SMYRNA, DE 19977-3715

SHIP TO:
TOWN OF SMYRNA
220 ARTISAN DRIVE
PO BOX 307
SMYRNA, DE 19977-3715

CUSTOMER NUMBER	CUSTOMER ORDER NUMBER	RELEASE NUMBER	SALESPERSON	
7696	email bill		bill evans	
WRITER	**SHIP VIA**	**TERMS**	**SHIP DATE**	**ORDER DATE**
ROBERT JARRE	BW - BEST WAY	Net 10 Days	12/14/15	10/06/15

LN	DESCRIPTION	ORDER QTY	SHIP QTY	NET UNIT PRICE	NET AMOUNT
1	LUMEC RFL-241W112LED4K-T-R3M-UNIV-DMG -RCD -WC10-GY3 **NS**	15	15	451.00ea	6765.00

TOWN OF SMYRNA
APPROVED FOR PAYMENT
12/16/15 43
VENDOR NO: 6942
ACCOUNT NO: AMOUNT
021 1520 63 7413 $6765.00

Subtotal	6765.00
S&H CHGS	0.00
Sales Tax	0.00
Amount Due	6765.00

S4725337.005

Payment is due by 12/24/15

Refer to www.Rumsey.com/contactus/creditapp for Terms and Conditions
Past due accounts are subject to a 1.5% per month service charge.

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** INVOICE **

1251 COLLEGE PARK DRIVE
DOVER, DE 19904-8713
Phone: 302-735-3300 Fax: 302-735-3303

Phone: 610-832-9097
Fax : 610-941-8183

INVOICE DATE	INVOICE NUMBER
12/10/15	S4725337.003

REMIT TO:
RUMSEY - DOVER BRANCH
P.O. BOX 824429
PHILADELPHIA, PA 19182-4429

PAGE NO.
1 of 1

TOWN OF SMYRNA
DEC 14 2015
RECEIVED

BILL TO:
TOWN OF SMYRNA
220 ARTISAN DRIVE
PO BOX 307
SMYRNA, DE 19977-3715

SHIP TO:
TOWN OF SMYRNA
220 ARTISAN DRIVE
PO BOX 307
SMYRNA, DE 19977-3715

CUSTOMER NUMBER	CUSTOMER ORDER NUMBER	RELEASE NUMBER	SALESPERSON	
7696	email bill 4953		bill evans	
WRITER	**SHIP VIA**	**TERMS**	**SHIP DATE**	**ORDER DATE**
ROBERT JARRE	BW - BEST WAY	Net 10 Days	12/10/15	10/06/15

LN	DESCRIPTION	ORDER QTY	SHIP QTY	NET UNIT PRICE	NET AMOUNT
1	LUMEC RFL-241W112LED4K-T-R3M-UNIV-DMG -RCD -WC10-GY3 **NS**	84	69	451.00ea	31119.00

TOWN OF SMYRNA
APPROVED FOR PAYMENT 43
12.15.15
VENDOR NO 6942
ACCOUNT NO AMOUNT
02115026631 74173 $31,119.00

Lights - Money from DEMAC

Subtotal	31119.00
S&H CHGS	0.00
Sales Tax	0.00
Amount Due	31119.00

S4725337.003

Payment is due by 12/20/15

Refer to www.Rumsey.com/contactus/creditapp for Terms and Conditions
Past due accounts are subject to a 1.5% per month service charge.

RUMSEY
Quality & Service - Since 1895

** INVOICE **

1251 COLLEGE PARK DRIVE
DOVER, DE 19904-8713
Phone: 302-735-3300 Fax: 302-735-3303

Phone: 610-832-9097
Fax : 610-941-8183

INVOICE DATE	INVOICE NUMBER
12/09/15	S4725337.001

REMIT TO:
RUMSEY - DOVER BRANCH
P.O. BOX 824429
PHILADELPHIA, PA 19182-4429

PAGE NO.: 1 of 1

TOWN OF SMYRNA
DEC 11 2015
RECEIVED

BILL TO:
TOWN OF SMYRNA
220 ARTISAN DRIVE
PO BOX 307
SMYRNA, DE 19977-3715

SHIP TO:
TOWN OF SMYRNA
220 ARTISAN DRIVE
PO BOX 307
SMYRNA, DE 19977-3715

CUSTOMER NUMBER	CUSTOMER ORDER NUMBER	RELEASE NUMBER	SALESPERSON	
7696	email bill		bill evans	
WRITER	**SHIP VIA**	**TERMS**	**SHIP DATE**	**ORDER DATE**
ROBERT JARRE	BW - BEST WAY	Net 10 Days	12/09/15	10/06/15

LN	DESCRIPTION	ORDER QTY	SHIP QTY	NET UNIT PRICE	NET AMOUNT
1	LUMEC RFL-241W112LED4K-T-R3M-UNIV-DMG -RCD -WC10-GY3 **NS**	95	11	451.00ea	4961.00
	** Reprint ** Reprint ** Reprint				

Subtotal	4961.00
S&H CHGS	0.00
Sales Tax	0.00
Amount Due	4961.00

S4725337.001

Payment is due by 12/19/15

Refer to www.Rumsey.com/contactus/creditapp for Terms and Conditions
Past due accounts are subject to a 1.5% per month service charge.

5.4 Dover

3235

WESCO DISTRIBUTION
2802 N Blvd
Richmond VA 23230

ORIGINAL

CUSTOMER NUMBER	INVOICE DATE	PACKING SLIP NO.	INVOICE NUMBE
20032-00	07/07/2016	76165801	787174
BRANCH CODE	CUSTOMER ORDER NUMBER		PAGE
1763	AREN WRIGHT 5/11/16		1 of 1

REMIT TO:
WESCO RECEIVABLES CORP.
LOCKBOX #771751
1751 SOLUTIONS CENTER DR
CHICAGO IL 60677-1007

S. New St

SOLD TO:
3777 1 MB 0 419 EC315X I0568 D1794601121 S2 P3388279 0001:0001
CITY OF DOVER
ELECTRICAL DEPT
860 BUTTNER PL
DOVER DE 19904-2405

SHIP TO:
CITY OF DOVER
ELECTRICAL DEPT.
860 BUTTNER PLACE
DOVER, DE 19904

INVOICE SHIPPING DATE & ROUTING	FOB	***INVOICE*** SHIPPING TERMS	***INVOICE*** NO. OF INVOICES	B/L	***INVOICE*** INV. REQ.	RETURN MATERIAL WILL NOT BE ACCEPTED WITHOUT AUTHORIZATION
06/30/2016 BEST WAY	P/S	PREPAID-NO CHARGE	1	N	Y	

LINE NO.	CATALOG NUMBER AND DESCRIPTION	I.D. NUMBER	QUANTITY SHIPPED	BALANCE DUE	UNIT PRICE	U/M	SELLING PRICE DISCOUNT TRADE	SELLING PRICE DISCOUNT CASH	EXTENSION
010	HOLOPHAN***WFCL2 070HO 4K AS BK L4 S H AO PCS	783519	18	0	1,340.430	E	0.00	0.00	24,127.
	SUB TOTAL								24,127.

S New St Lights EE1652

[redacted]

UNLESS THERE ARE DIFFERENT OR ADDITIONAL TERMS AND CONDITIONS CONTAINED IN A MASTER AGREEMENT THAT MODIFY WESCO'S STANDARD TERMS, BUYER AGREES THAT THE ACKNOWLEDGEMENT AND ACCEPTANCE OF THIS INVOICE WILL BE GOVERNED BY WESCO'S TERMS AND CONDITIONS AVAILABLE AT HTTP://WWW.WESCO.COM/TERMS AND CONDITIONS_OF_SALE.PDF, AS SUCH TERMS MAY BE UPDATED FROM TIME TO TIME, WHICH ARE INCORPORATED HEREIN BY REFERENCE AND MADE PART HEREOF. PLEASE CONTACT THE SELLER IDENTIFIED ON THIS INVOICE IF YOU REQUIRE A PRINTED COPY

TERMS	YOU MAY DEDUCT IF PAID WITHIN 10 DAYS - NET 30 DAYS >	0.00	TOTAL >	24,127.

PAST DUE ACCOUNTS SUBJECT TO CHARGE OF 1.5% OR MAXIMUM PERMITTED BY LAW

Kirkwood Court

RUMSEY
Quality & Service - Since 1895

** INVOICE **

1251 COLLEGE PARK DRIVE
DOVER, DE 19904-8713
Phone: 302-735-3300 Fax: 302-735-3303

Phone: 610-832-9097
Fax : 610-941-8183

INVOICE DATE	INVOICE NUMBER
02/03/16	S4741589.001

REMIT TO:
RUMSEY DOVER BRANCH
P.O. BOX 824429
PHILADELPHIA, PA 19182-4429

PAGE NO.
1 of 1

BILL TO:
CITY OF DOVER ELECTRICAL DEPT
860 BUTNER PLACE
DOVER, DE 19904

SHIP TO:
CITY OF DOVER ELECTRICAL DEPT
860 BUTNER PLACE
DOVER, DE 19904

CUSTOMER NUMBER	CUSTOMER ORDER NUMBER	RELEASE NUMBER	SALESPERSON	
68192	KIRKWOOD BALL COURT	STEVE MOXLEY	STEVE MOXLEY	
WRITER	**SHIP VIA**	**TERMS**	**SHIP DATE**	**ORDER DATE**
BRYAN SMITH	WC - WILL CALL	Net 30 Days	02/03/16	01/28/16

LN	DESCRIPTION	ORDER QTY	SHIP QTY	NET UNIT PRICE	NET AMOUNT
1	RAB FXLED150SF **NS**	4	4	475.00ea	1900.00
2	RAB GDFXLED78W WIRE GUARD FXLED78 WITH STAINLESS STEEL SCREWS **NS**	4	4	22.00ea	88.00
3	RAB GDFXLED78P POLYCARBONATE SHIELD FXLED78 GUARD W SS SCREWS **NS**	4	4	22.00ea	88.00
4	RAB BULL2 BRACKET BULLHORN TWO LIGHT **NS**	2	2	92.00ea	184.00
5	RAB BWC12 **NS**	2	2	75.00ea	150.00

City of Dover
Approved
[redacted]
Signature Date
Police
Acct [redacted]
JFC Funding Grant

$3216.05
Total

Subtotal	2410.00
S&H CHGS	0.00
Sales Tax	0.00
Amount Due	2410.00

S4741589.001

Payment is due by 03/04/16

Refer to www.Rumsey.com/contactus/creditapp for Terms and Conditions
Past due accounts are subject to a 1.5% per month service charge.

5.5 Newark

** ACKNOWLEDGEMENT **

RUMSEY
www.rumsey.com

QUALITY & SERVICE - SINCE 1895

ORDER DATE	ORDER NUMBER
11/11/15	S4763788

ORDERED FROM:
RUMSEY - DOVER BRANCH
1251 COLLEGE PARK DRIVE
DOVER, DE 19904-8713

Phone: 302-735-3300
Fax: 302-735-3303

Pg 1 of 1

SOLD TO:
DELAWARE MUNICIPAL ELECTRIC CORP.
22 ARTISAN DRIVE
SMYRNA, DE 19977-3711

SHIP TO:
DELAWARE MUNICIPAL ELECTRIC CO
CITY OF NEWARK
CENTRAL STORES, 406 PHILLIPS A
NEWARK, DE 19701

CUSTOMER NUMBER	CUSTOMER ORDER NUMBER	RELEASE #/JOB NAME	SALESPERSON	ORDERED BY
77812	HOLD FOR RELEASE		MMONTELL	
INSIDE SALES	**SHIP VIA**	**TERMS**	**SHIP DATE**	**FREIGHT ALLOWED**
RJARRELL	BW - BEST WAY	Net 30 Days	12/11/15	Yes

LN	ORDER QTY	DESCRIPTION	UNIT PRICE	NET AMOUNT
		***** HOLD FOR RELEASE ORDER ONLY ***** DO NOT SHIP UNTIL WRITTEN CONFIRMATION OF RELEASE FROM MIKE MONTELLA OR ROB JARRELL ONLY *****		
1	738ea	LEOTEK GCM2-40F-MV-NW-2-GY-1A 250W EQUIVALENT LED COBRAHEAD STREET LIGHT.		
2	472ea	LEOTEK GCJ2-20G-MV-NW-2-GY-1A ROADWAY FIXTURE, 150W EQUIV LED COBRAHEAD W/ PE RECEPT **NS**		
3	240ea	LEOTEK GC1-80F-MV-NW-2-GY-700 LED COBRAHEAD 400W EQUIV. **NS**		
4	1400ea	LITHONIA DLL127F1.5CULJ50 DARK TO LIGHT PHOTOCONTROL 50 PACK BUT UNIT PRICING **NS**		
5	48ea	LITHONIA DLL127F1.5CULJ12 DARK TO LIGHT PHOTOCONTROL 12 PACK BUT UNIT PRICING. **NS**		
			Subtotal	348394.00
			S&H CHGS	0.00
			Sales Tax	0.00
			Amount Due	348394.00

RUMSEY
Quality & Service - Since 1895

** INVOICE **

1251 COLLEGE PARK DRIVE
DOVER, DE 19904-8713
Phone: 302-735-3300 Fax: 302-735-3303

Phone: 610-832-9097
Fax : 610-941-8183

INVOICE DATE	INVOICE NUMBER
11/30/15	S4749990.005

REMIT TO:
RUMSEY - DOVER BRANCH
P.O. BOX 824629
PHILADELPHIA, PA 19182-4629

PAGE NO.
1 of 1

BILL TO:
CITY OF NEWARK
220 ELKTON ROAD
NEWARK, DE 19711-4594

SHIP TO:
CITY OF NEWARK
406 PHILLIPS AVENUE
NEWARK, DE 19711-5165

CUSTOMER NUMBER	CUSTOMER ORDER NUMBER	RELEASE NUMBER	SALESPERSON	
2509	20150980-00	REQ 00014591-00		
WRITER	**SHIP VIA**	**TERMS**	**SHIP DATE**	**ORDER DATE**
ROBERT JARRE	BW - BEST WAY	Net 30 Days	11/30/15	10/26/15

LN	DESCRIPTION	ORDER QTY	SHIP QTY	NET UNIT PRICE	NET AMOUNT
1	LEOTEK GCJ2-20G-MV-NW-2-GY-1A ROADWAY FIXTURE, 150W EQUIV LED COBRAHEAD W/ PE RECEPT **NS**	371	371	154.00ea	57134.00
2	LEOTEK GCM2-40F-MV-NW-2-GY-1A 250W EQUIVALENT LED COBRAHEAD STREET LIGHT. **NS**	110	110	215.00ea	23650.00
3	LEOTEK GC1-80F-MV-NW-2-GY-700 LED COBRAHEAD 400W EQUIV. **NS**	25	25	370.00ea	9250.00

20150980
CT
90,034.00

Subtotal	90034.00
S&H CHGS	0.00
Sales Tax	0.00
Amount Due	90034.00

Payment is due by 12/30/15

Refer to www.Rumsey.com/contactus/creditapp for Terms and Conditions
Past due accounts are subject to a 1.5% per month service charge.

S4749990.005

6. Energy Savings Calculation Tables

The following is the calculation methodology used to calculate kWh savings. Methodology is prescribed per the MID-ATLANTIC TECHNICAL REFERENCE MANUAL VERSION 7.0/May 2017. LED Outdoor Pole/Arm- or Wall-Mounted Area and Roadway Lighting

Effective Date: June 2017

Measure Description

This measure relates to the installation of an LED outdoor pole/arm- or wall-mounted luminaire for parking lot, street, or general area illumination in place of a high-intensity discharge light source. Eligible applications include new construction and time of sale applications.

Definition of Baseline Condition

The baseline condition is defined as an outdoor pole/arm- or wall-mounted luminaire with a high intensity discharge light-source. Typical baseline technologies include metal halide (MH) and high pressure sodium (HPS) lamps. For the purposes of this characterization, standard metal halide fixtures are the assumed baseline technology.

Definition of Efficient Condition

The efficient condition is defined as an LED outdoor pole/arm- or wall-mounted luminaire. Eligible fixtures must be listed on the DesignLights Consortium Qualified Products List.

Annual Energy Savings Algorithm

ΔkWh = ((WattsBASE - WattsEE) / 1000) * HOURS

Where:

WattsBASE = Actual Connected load of baseline fixture

WattsEE = Actual Connected load of the LED fixture

HOURS = Average hours of use per year

Summer Coincident Peak kW Savings Algorithm

ΔkW = ((WattsBASE - WattsEE) / 1000) * CF

Where:

CF = Summer Peak Coincidence Factor for measure

= 0[39]

Measure Life

[39] It is assumed that efficient outdoor area lighting, when functioning properly, will never result in coincident peak demand savings.

The measure life is assumed to be 18 years.

Operation and Maintenance Impacts.

Due to differences in costs and lifetimes of fixture components between the efficient and baseline cases, there are significant operation and maintenance impacts associated with this measure. Estimated O&M savings and the component cost and lifetime assumptions are presented in the table below.[40]

Lewes

KWH savings calculation is (existing wattage - new wattage)/1000 X annual burn hours X total number of fixtures

Fixture type	Fixture Model #	LED wattage	HPS replaceme	HPS fixture wattage incl.
100 watt equal Philips Lumec LED	RFM-72w32LED4K-T-R3M-UNIV-DMG-R-CD-W	73	100	130
	fixture cost is $234			
150 watt equal Philips Lumec LED	RFM-108W32LED4K-t-R3M-UNIV-DMG-RCD	108	150	190
	fixture cost is $248			

Lighting Installed			annual kWh savings
	Item	count	
	100wHPS	25	6,242
	150wHPS	75	26,937
			33,179

light fixture costs				
item	count	material cost	labor	total
100 watt equa	25	$5,850	$ 1,875	$7,725
150 watt equa	75	$18,600	$ 5,625	$24,225
	total	$24,450	$ 7,500	$31,950

Table 6.1 Lewes- Energy Savings

[40] Net present value calculation is based on avoided costs methodology as recommended in the Memorandum the Delaware EEAC from Optimal Energy, EEAC Consultant, dated January 10, 2017. Subject: Avoided costs for use in cost-effectiveness analysis

Seaford

KWH savings calculation is (existing wattage - new wattage)/1000 X annual burn hours X total number of fixtures

Fixture type	Fixture Model #	LED wattage	HPS replacem	HPS fixture wattage incl.
100 watt equal Philips Lumec LED	RFM-~~72w~~32LED4K-T-R3M-UNIV-DMG-R-CD-W	73	150	190
	fixture cost is $234			

Tim Stearns:
while this fixture is generally thought of as a 100 watt HPS equivolent, Seaford installed these to replace 150 watt HPS

Lighting Installed			annual kWh savings
	Item	count	
	150wHPS	283	145,026
		283	145,026

light fixture costs				
item	count	Fixture cost	labor	total
100 watt equal Phi	283	$66,222	$ 21,225	$87,447
	total	$66,222	$ 21,225	$87,447

Table 6.2 Seaford- Energy Savings

Smyrna

KWH savings calculation is (existing wattage - new wattage)/1000 X annual burn hours X total number of fixtures

Fixture type	Fixture Model #	LED wattage	HPS replaceme	HPS fixture wattage
400 watt equal Philips Lumec LED	RFL-241W112LED4k-T-R3M-UNIV-DMG	244	400	465
	fixture cost is $471			

Lighting Installed			annual kWh savings
	Item	count	
	400wHPS	15	14,520
	400wHPS	69	66,791
	400wHPS	38	36,783
	400wHPS	11	10,648
		133	128,741

light fixture costs				
item	count	Fixture Cost	Labor	Total
400 watt equal Philip	133	$62,643	$ 9,975	$72,618
	total	$62,643	$ 9,975	$72,618

Table 6.3 Smyrna- Energy Savings

Dover

KWH savings calculation is (existing wattage - new wattage)/1000 X annual burn hours X total number of fixtures

Fixture type	Fixture Model #			LED wattage	HPS replacement	HPS fixture wattage incl.
Holophane washington Postlite	WCFL2070HO4KASBKL4SHAOPCS			95	250	295
	fixture cost is		$1,360			
LED Roadwaylighting SAT-S	SAT-96M			200	400	465
	fixture cost is		$645			
RAB FXLED Flood	FXLED150SF			150	400	465
	fixture cost is		$495			

Lighting Installed			annual kWh
	Item	count	savings
	250w HPS	18	15,768
	400HPS	16	18,571
	400wHPS	4	5,519
		38	39,858

light fixture costs				
item	count	Fixture Cost	Labor	Total
Holophane washin	18	$24,480	$ 1,350	$25,830
LED Roadwaylight	16	$10,320	$ 1,200	$11,520
RAB FXLED Flood	4	$1,980	$ 300	$2,280
	total	$36,780	$ 2,850	$39,630

Table 6.4 Dover- Energy Savings

Newark

KWH savings calculation is (existing wattage - new wattage)/1000 X annual burn hours X total number of fixtures

Fixture type	Fixture Model #	LED wattage	HPS replaceme	HPS fixture wattage incl.
150 watt equal Leotech LED	GCJ2-20G-MV-NW-2-GY-1A	74	100	130
	fixture cost is $174			
250 watt equal Leotech LED	GCM2-40F-MV-NW-2-GY-1A	138	250	295
	fixture cost is $235			
400 watt equal Leotech LED	GC1-80F-MV-NW-2-GY-700	180	400	465
	fixture cost is $370			

Tim Stearns:
we are using 100 watt HPS as the baseline fixture since we can't determine for sure how many were 100 watt HPS and how many were 150w HPS

Lighting Installed			annual kWh
	Item	count	savings
	100wHPS	802	196,715
	250 wHPS	862	592,763
	400wHPS	239	298,344
		1903	1,087,821

light fixture costs				
item	count	cost	labor	total
150 watt equa	802	$139,548	$ 60,150	$199,698
250 watt equa	862	$202,570	$ 64,650	$267,220
400 watt equa	239	$88,430	$ 17,925	$106,355
	total	$430,548	$ 142,725	$573,273

Tim Stearns:
fixture counts are from the GPS tracking worksheet. We are excluding for this project (74) of the 143 watt LEDs included on that worksheet as we believe that these were installed outside of this project.

Table 6.5 Newark- Energy Savings

7. Fixture Specifications and Cut Sheet Data

PHILIPS
LUMEC

Roadway

RoadFocus

72, 108 and 160W RFM

Project:
Location:
Cat.No:
Type:
Lamps: Qty:
Notes:

The Philips Lumec RoadFocus LED Cobra Head luminaires feature a sleek design that provides seamless replacement of existing HID luminaires. RoadFocus is available in three sizes, offers multiple lumen packages, and a complete array of optical distributions, making it an outstanding solution for all types of roadway applications.

Ordering guide

Example: RFM-72W32LED4K-T-R2S-UNIV-DMG-AST-FAWS-RCD-SP2-WC10-GY3

Luminaire	LED Module	Optical System	Voltage	Driver and Dimming	Wattage Switch	Twist-Lock Receptacle	Surge Protection	Warranty	Finish
RFM								WC10	
RFM RoadFocus Medium	**72W32LED4K-T** or **108W32LED4K-T**[3,4] or **108W48LED4K-T** or **160W48LED4K-T**[3,4]	**R2S** Type II Short **R2M** Type II Medium **R3S** Type III Short **R3M** Type III Medium **5** Type V	**UNIV** 120-277VAC **HVU** 347-480VAC	*Standard:* **DMG**[1,8] Dimmable driver 0-10V *Optional:* **AMPD**[2,4,5,8] Amplight Dimming DynaDimmer Economy Profile **CDMGE25**[2,4,5,8] **CDMGE50**[2,4,5,8] **CDMGE75**[2,4,5,8] DynaDimmer Median Profile **CDMGM25**[2,4,5,8] **CDMGM50**[2,4,5,8] **CDMGM75**[2,4,5,8] DynaDimmer Safety Profile **CDMGS25**[2,4,5,8] **CDMGS50**[2,4,5,8] **CDMGS75**[2,4,5,8] **DALI**[2,4,5,8] Digitally Adressable Lighting Interface **DMG-AST***[2,4] Adjustable Startup Time **DMG-CLO***[2,4,5] Constant Light Output **DMG-OTL***[2,4] Over The Life *Includes 0-10v Dimming	**FAWS**[5] Field Adjustable Wattage Selector (optional)	*Standard:* **RCD**[1,6,7] Receptacle for twist-lock photocell or shorting cap, 5-pin (standard) *Optional:* **RCD7**[6,7] Receptacle for twist-lock photocell or shorting cap, 7-pin (optional)	**SP2**[8] 20kV / 20kA Surge Protector (optional)	**WC10**[1] 10-year limited warranty (standard)	**BK** Black Finish **BR** Bronze Finish **GY3** Gray Finish **WH** White Finish

1. Please note these integrated features come standard with RoadFocus luminaires.
2. Denotes programmable driver option. Not available with HVU (347-480volt). Not available with 1050 mA versions (108W32LED, 160W48LED).
3. Use of photoelectric cell or shorting cap is required to ensure proper illumination.
4. Not available with HVU (347-480volt).
5. FAWS not available with AMPD, CDMG options, DALI or CLO.
6. Dimming choices: Select either DMG or AMPD or one of the CDMG options or DALI.
7. When RDC7 option is selected you will get 7-pin instead of standard RCD 5-pin.
8. When SP2 option is selected you will get SP2 instead of standard SP1.

RFM_Spec 12/14 page 1 of 4

RFM RoadFocus LED Cobrahead, Medium

72, 108, and 160W

Accessories (must be ordered as separate line items - quickly and easily installed in the field)

ACC-RFS-RFM-RFL-PH9[9]
Shorting cap

ACC-RFS-RFM-RFL-HS
House side shield, 1 per 16 LED light engine.

ACC-RFS-RFM-RFL-UNIV-PH8[9]
Twist-lock Photoelectric Cell, UNIV (120-277VAC).

ACC-RFM-RFL-PH8/347[9]
Twist-lock Photoelectric Cell, HVU 347VAC.

ACC-RFM-RFL-PH8/480[9]
Twist-lock Photoelectric Cell, HVU 480VAC.

ACC-RFS-RFM-RFL-UNIV-PH8XL[9]
Twist-lock Photoelectric Cell, extended life, UNIV (120-277VAC).

ACC-RFS-RFM-RFL-UNIV-SPC[9,10]
Starsense twist-lock photoelectric cell & antenna node, UNIV (120-277VAC).

ACC-RFM-RFL-HVU-SPC[9,10]
Starsense twist-lock photoelectric cell & antenna node, HVU (347-480VAC).

ACC-RFS-RFM-RFL-UNIV-SPCD[9,10]
Starsense dimmable twist-lock photoelectric cell & antenna node, UNIV (120-277VAC).

9. Use of photoelectric cell or shorting cap is required to ensure proper illumination.
10. Please note that more hardware as well as software are required - please contact the quotations department for help with putting together the entire control system.

LED Wattage and Lumen Values

LED = Philips Lumileds LUXEON T, CRI = 70, CCT = 4000K (+/- 350K)
System (LED + driver) rated life = 100,000 hrs[11]

LED Module	Typical Delivered Lumens	Typical System Wattage (W)[12]	LED Current (mA)	Typical System Current (A) @						Efficacy (Lm/W)	BUG Rating
				120V	208V	240V	277V	347V	480V		
72W32LED4K-T-R2S	8,330	73	700	0.62	0.36	0.31	0.28	0.21	0.15	114	B2-U0-G1
72W32LED4K-T-R2M	8,140	73	700	0.62	0.36	0.31	0.28	0.21	0.15	112	B2-U0-G2
72W32LED4K-T-R3S	8,085	73	700	0.62	0.36	0.31	0.28	0.21	0.15	111	B1-U0-G2
72W32LED4K-T-R3M	8,178	73	700	0.62	0.36	0.31	0.28	0.21	0.15	112	B2-U0-G2
108W32LED4K-T-R2S	11,169	108	1050	0.91	0.53	0.47	0.41	N/A		103	B2-U0-G2
108W32LED4K-T-R2M	10,914	108	1050	0.91	0.53	0.47	0.41			101	B2-U0-G2
108W32LED4K-T-R3S	10,841	108	1050	0.91	0.53	0.47	0.41			100	B1-U0-G1
108W32LED4K-T-R3M	10,965	108	1050	0.91	0.53	0.47	0.41			102	B2-U0-G2
108W48LED4K-T-R2S	12,507	106	700	0.93	0.53	0.46	0.40	0.32	0.23	118	B3-U0-G2
108W48LED4K-T-R2M	12,222	106	700	0.93	0.53	0.46	0.40	0.32	0.23	115	B2-U0-G2
108W48LED4K-T-R3S	12,140	106	700	0.93	0.53	0.46	0.40	0.32	0.23	115	B2-U0-G2
108W48LED4K-T-R3M	12,279	106	700	0.93	0.53	0.46	0.40	0.32	0.23	116	B2-U0-G2
160W48LED4K-T-R2S	16,778	161	1050	1.34	0.76	0.66	0.58	N/A		104	B3-U0-G2
160W48LED4K-T-R2M	16,396	161	1050	1.34	0.76	0.66	0.58			102	B3-U0-G3
160W48LED4K-T-R3S	16,285	161	1050	1.34	0.76	0.66	0.58			101	B2-U0-G3
160W48LED4K-T-R3M	16,472	161	1050	1.34	0.76	0.66	0.58			102	B3-U0-G3
Type V (5) IES files for all LED modules pending.											

11. L_{70} >100,000 hrs (at ambient temperature = 25°C).
12. System wattage or total luminaire wattage includes the LED module and the LED driver.
Note: Due to rapid and continuous advances in LED technology, LED luminaire data is subject to change without notice and at the discretion of Philips.

PHILIPS
LUMEC

Roadway

RoadFocus

145, 180, 215 and 241W RFL

Project:

Location:

Cat No:

Type:

Lamps: Qty:

Notes:

The Philips Lumec RoadFocus LED Cobra Head luminaires feature a sleek design that provides seamless replacement of existing HID luminaires. RoadFocus is available in three sizes, offers multiple lumen packages, and a complete array of optical distributions, making it an outstanding solution for all types of roadway applications.

Ordering guide

Example: RFL-145W64LED4K-T-R2S-UNIV-DMG-OTL-RCD7-SP2-WC10-GY3

Luminaire	LED Module	Optical System	Voltage	Driver and Dimming	Wattage Switch	Twist-Lock Receptacle	Surge Protection	Warranty	Finish
RFL								WC10	
RFL RoadFocus Large	**145W64LED4K-T** or **180W80LED4K-T** or **215W96LED4K-T** or **241W112LED4K-T**	**R2S** Type II Short **R2M** Type II Medium **R3S** Type III Short **R3M** Type III Medium **5** Type V	**UNIV** 120-277VAC **HVU** 347-480VAC	Standard: **DMG**[1,6] Dimmable driver 0-10V Optional: **AMPD**[2,4,5,6] Amplight Dimming DynaDimmer Economy Profile **CDMGE25**[2,4,5,6] **CDMGE50**[2,4,5,6] **CDMGE75**[2,4,5,6] DynaDimmer Median Profile **CDMGM25**[2,4,5,6] **CDMGM50**[2,4,5,6] **CDMGM75**[2,4,5,6] DynaDimmer Safety Profile **CDMGS25**[2,4,5,6] **CDMGS50**[2,4,5,6] **CDMGS75**[2,4,5,6] **DALI**[2,4,5,6] Digitally Adressable Lighting Interface **DMG-AST***[2,6] Adjustable Startup Time **DMG-CLO***[2,4,5] Constant Light Output **DMG-OTL***[2,6] Over The Life *Includes 0-10v Dimming	**FAWS**[5] Field Adjustable Wattage Selector (optional)	Standard: **RCD**[3,4,7] Receptacle for twist-lock photocell or shorting cap, 5-pin (standard) Optional: **RCD7**[3,4,7] Receptacle for twist-lock photocell or shorting cap, 7-pin (optional)	**SP2**[8] 20kV / 20kA Surge Protector (optional)	**WC10**[1] 10-year limited warranty (standard)	**BK** Black Finish **BR** Bronze Finish **GY3** Gray Finish **WH** White Finish

1. Please note these integrated features come standard with RoadFocus luminaires.
2. Denotes programmable driver option. Not available with HVU (347-480volt).
3. Use of photoelectric cell or shorting cap is required to ensure proper illumination.
4. Not available with HVU (347-480volt).
5. FAWS not available with AMPD, CDMG options, DALI or CLO.
6. Dimming choices: Select either DMG or AMPD or one of the CDMG options or DALI.
7. When RDC7 option is selected you will get 7-pin instead of standard RCD 5-pin.
8. When SP2 option is selected you will get SP2 instead of standard SP1.

RFL RoadFocus LED Cobrahead, Large

145, 180, 215, and 241W

Accessories (must be ordered as separate line items - quickly and easily installed in the field)

ACC-RFS-RFM-RFL-PH9[9]
Shorting cap

ACC-RFS-RFM-RFL-HS
House side shield, 1 per 16 LED light engine.

ACC-RFS-RFM-RFL-UNIV-PH8[9]
Twist-lock Photoelectric Cell, UNIV (120-277VAC).

ACC-RFM-RFL-PH8/347[9]
Twist-lock Photoelectric Cell, HVU 347VAC.

ACC-RFM-RFL-PH8/480[9]
Twist-lock Photoelectric Cell, HVU 480VAC.

ACC-RFS-RFM-RFL-UNIV-PH8XL[9]
Twist-lock Photoelectric Cell, extended life, UNIV (120-277VAC).

ACC-RFS-RFM-RFL-UNIV-SPC[9,10]
Starsense twist-lock photoelectric cell & antenna node, UNIV (120-277VAC).

ACC-RFM-RFL-HVU-SPC[9,10]
Starsense twist-lock photoelectric cell & antenna node, HVU (347-480VAC).

ACC-RFS-RFM-RFL-UNIV-SPCD[9,10]
Starsense dimmable twist-lock photoelectric cell & antenna node, UNIV (120-277VAC).

9. Use of photoelectric cell or shorting cap is required to ensure proper illumination.
10. Please note that more hardware as well as software are required - please contact the quotations department for help with putting together the entire control system.

LED Wattage and Lumen Values

LED = Philips Lumileds LUXEON T, CRI = 70, CCT = 4000K (+/- 350K)
System (LED + driver) rated life = 100,000 hrs[11]

LED Module	Typical Delivered Lumens	Typical System Wattage (W)[12]	LED Current (mA)	Typical System Current (A) @						Efficacy (Lm/W)	BUG Rating
				120V	208V	240V	277V	347V	480V		
145W64LED4K-T-R2S	16,349	137	700	1.15	0.66	0.58	0.51	0.41	0.31	119	B3-U0-G2
145W64LED4K-T-R2M	16,046	137	700	1.15	0.66	0.58	0.51	0.41	0.31	117	B3-U0-G3
145W64LED4K-T-R3S	15,763	137	700	1.15	0.66	0.58	0.51	0.41	0.31	115	B2-U0-G3
145W64LED4K-T-R3M	15,697	137	700	1.15	0.66	0.58	0.51	0.41	0.31	115	B3-U0-G2
180W80LED4K-T-R2S	20,444	174	700	1.46	0.86	0.76	0.69	0.52	0.39	117	B3-U0-G2
180W80LED4K-T-R2M	20,065	174	700	1.46	0.86	0.76	0.69	0.52	0.39	115	B3-U0-G3
180W80LED4K-T-R3S	19,711	174	700	1.46	0.86	0.76	0.69	0.52	0.39	113	B2-U0-G3
180W80LED4K-T-R3M	19,628	174	700	1.46	0.86	0.76	0.69	0.52	0.39	113	B3-U0-G3
215W96LED4K-T-R2S	24,538	207	700	1.74	1.01	0.89	0.80	0.62	0.46	119	B3-U0-G2
215W96LED4K-T-R2M	24,084	207	700	1.74	1.01	0.89	0.80	0.62	0.46	116	B3-U0-G3
215W96LED4K-T-R3S	23,658	207	700	1.74	1.01	0.89	0.80	0.62	0.46	114	B3-U0-G4
215W96LED4K-T-R3M	23,559	207	700	1.74	1.01	0.89	0.80	0.62	0.46	114	B3-U0-G3
241W112LED4K-T-R2S	28,633	248	700	2.03	1.17	1.02	0.91	0.72	0.53	115	B4-U0-G3
241W112LED4K-T-R2M	28,102	248	700	2.03	1.17	1.02	0.91	0.72	0.53	114	B3-U0-G4
241W112LED4K-T-R3S	27,606	244	700	2.03	1.17	1.02	0.91	0.72	0.53	113	B3-U0-G4
241W112LED4K-T-R3M	27,490	244	700	2.03	1.17	1.02	0.91	0.72	0.53	113	B3-U0-G4
Type V (5) IES files for all LED modules pending.											

11. L_{70} >100,000 hrs (at ambient temperature = 25°C).
12. System wattage or total luminaire wattage includes the LED module and the LED driver.
Note: Due to rapid and continuous advances in LED technology, LED luminaire data is subject to change without notice and at the discretion of Philips.

FXLED150SF

Kirkwood Basketball Court

RAB LIGHTING

Ultra high output, high efficiency LED floodlight with wide NEMA type 6H x 6V beam spread. Patent Pending airflow technology ensures long LED and driver lifespan. Use for general and security lighting for large areas, building facades, signs and landscapes.

Color: Bronze Weight: 25.0 lbs

Project:	Type:
Prepared By:	Date:

Driver Info		LED Info	
Type:	Constant Current	Watts:	150W
120V:	1.31A	Color Temp:	5000K
208V:	0.80A	Color Accuracy:	72 CRI
240V:	0.69A	L70 Lifespan:	100000
277V:	0.60A	Lumens:	18755
Input Watts:	154W	Efficacy:	122 LPW
Efficiency:	97%		

Technical Specifications

Listings

UL Listing:

Suitable for wet locations. Suitable for ground mounting.

IESNA LM-79 & LM-80 Testing:

RAB LED luminaries have been tested by an independent laboratory in accordance with IESNA LM-79 and LM-80, and have been received the Department of Energy "Lighting Facts" label.

DLC Listed:

This product is on the Design Lights Consortium (DLC) Qualified Products List and is eligible for rebates from DLC Member Utilities.
DLC Product Code: P0000173K

LED Characteristics

Lifespan:

100,000-hour LED lifespan based on IES LM-80 results and TM-21 calculations.

LEDs:

Multip-chip, high-output, long-life LEDs

Color Consistency:

7-step MacAdam Ellipse binning to achieve consistent fixture-to-fixture color.

Color Stability:

LED color temperature is warrantied to shift no more than 200K in CCT over a 5 year period.

Color Uniformity:

RAB's range of CCT (Correlated Color Temperature) follows the guidelines of the American National Standard for Specifications for the Chromaticity of Solid State Lighting (SSL) Products, ANSI C78.377-2015.

Construction

IP Rating:

Ingress Protection rating of IP66 for dust and water

Maximum Ambient Temperature:

Suitable for use in 104° F (40°C) ambient temperatures

Effective Projected Area:

EPA = 2

Cold Weather Starting:

Minimum starting temperature is -40° F (-40° C)

Thermal Management:

Superior thermal management with external Air-Flow fins.

Housing:

Die-cast aluminum housing and door frame

Mounting:

Heavy-duty Slipfitter for 2 3/8"OD pipe.

Reflector:

Specular, vacuum-metalized polycarbonate

Gaskets:

High-temperature silicone gaskets

Finish:

Formulated for high-durability and long lasting color.

Green Technology:

Mercury and UV free. RoHS compliant components. Polyester powder coat finish formulated without the use of VOC or toxic heavy metals.

Electrical

Drivers:

Two Drivers, Constant Current, Class 2, 2000mA, 100-277V, 50-60Hz, Power Factor 99%

THD:

4.9% at 120V, 13.9% at 277V

Power Factor:

99.5% at 120V, 93.7% at 277V

Optical

NEMA Type:

NEMA Beam Spread of 6H x 6V

Replacement:

Replaces 400W Metal Halide

Sensor Characteristics

Field & Beam Angles:

Horizontal Beam Angle (50%): 91.8°, Vertical Beam Angle (50%): 73.5° Horizontal Field Angle (10%): 121.0°, Vertical Field Angle (10%): 108.0°

Other

California Title 24:

See FXLED150SF/D10, FXLED150SF/BL, FXLED105SF/PCT for a 2013 California Title 24 compliant product. Any additional component requirements will be listed in the Title 24 section under technical specifications on the product page.

FXLED150SF

Technical Specifications (continued)

Other

Warranty:

RAB warrants that our LED products will be free from defects in materials and workmanship for a period of five (5) years from the date of delivery to the end user, including coverage of light output, color stability, driver performance and fixture finish.

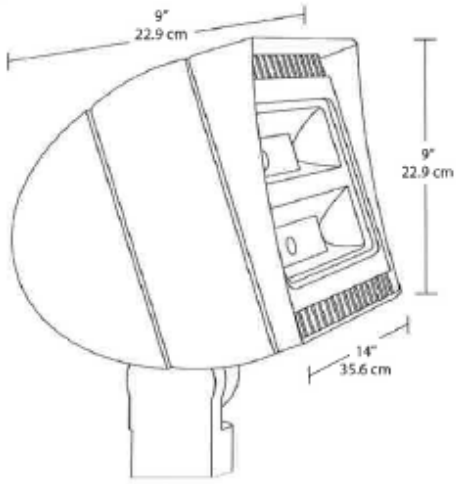
Patents:

The design of FXLED150 is protected by patents pending in US, Canada, China, Taiwan and Mexico.

American Bureau of Shipping (ABS) :

For use on Mobile Offshore Drilling Units (MODU) and shipping vessels.

Dimensions



Features

- 66% energy cost savings vs. HID
- NEMA Type - 6H x 6V
- Air-Flow technology heat dissipation
- 100,000-hour LED lifespan
- 5-year warranty

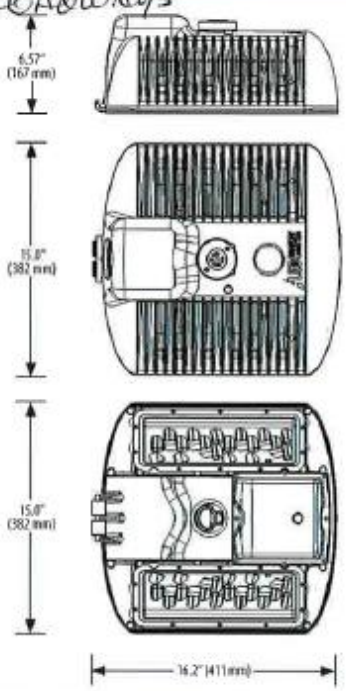
Ordering Matrix

Family	Watts	Mount	Color Temp	Finish	Dimming	Voltage	Photocell	Bi-Level
FXLED								
	150 = 150W	**T** = Trunnion **SF** = Slipfitter	**Blank** = 5000K (Cool) **Y** = 3000K (Warm) **N** = 4000K (Neutral)	**Blank** = Bronze **W** = White	**Blank** = No Dimming **/D10** = Dimmable	**Blank** = 120-277V **/480** = 480V	**Blank** = No Photocell **/PCT** = 120-277V Twistlock Photocell **/PCS** = 120V Swivel **/PCT4** = 480V Twistlock Photocell	**Blank** = No Bi-Level **/BL** = Bi-Level

SATELLITE™ SERIES: SPECIFICATIONS

SAT-S

RT. 13 ROADWAYS



Housing:	Single piece, die-cast A360 aluminum
Operating Temperature:	-40°C to +60°C (-40°F to +140°F)
Mounting:	1.625" - 2.375" (42 - 60 mm) O.D. Tenons
Weight:	18 lb (8.2 kg)
EPA Rating:	<0.509 ft² (< 0.047 m²)
Lens Material:	Acrylic
Finish:	Durable polyester powdercoat topcoat
Available Colors:	BRONZE (RAL 7022) BLACK (RAL 9005)

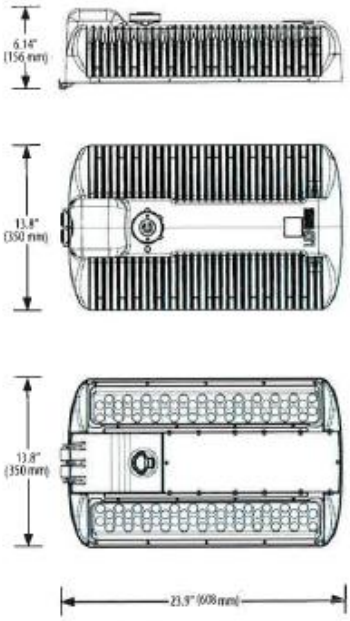
ARRA COMPLIANT

ELECTRICAL	SAT-24S (24 LEDs)					SAT-48S (48 LEDs)				
Currents (mA)	280 mA	350 mA	450 mA	525 mA	600 mA	280 mA	350 mA	450 mA	525 mA	600 mA
Power Consumption* (W)	22 W	28 W	36 W	44 W	50 W	43 W	55 W	72 W	88 W	100 W
Input Voltage* (V)	Universal Driver 120 - 240V AC, 277 - 347V AC, and 12 - 24V DC drivers available upon request.									
Surge Protection	10kV/10kA per ANSI C62.41.2-2002									
Power Factor	>0.90									
OPTICS & PERFORMANCE	**SAT-24S (24 LEDs)**					**SAT-48S (48 LEDs)**				
Photometry (Distribution Types)	Type II, Type II Medium, Type II Wide, Type II U, Type III, ANZ, EW (Type III), EN (Type II)									
Color Temperature* (CCT)	5000K (Standard), 4000K, & 4500K (Optional)									
Color Rendering Index* (CRI)	~70									
Drive Currents (mA)	280 mA	350 mA	450 mA	525 mA	600 mA	280 mA	350 mA	450 mA	525 mA	600 mA
Fixture Efficacy* (Lm/W)	102 Lm/W	96 Lm/W	93 Lm/W	90 Lm/W	86 Lm/W	99 Lm/W	95 Lm/W	93 Lm/W	88 Lm/W	84 Lm/W
Fixture Output* (Lm)	2,150 Lm	2,550 Lm	3,200 Lm	3,750 Lm	4,150 Lm	4,200 Lm	5,100 Lm	6,550 Lm	7,600 Lm	8,400 Lm
LED L70 (Hours)	> 100,000 hours (@ 350mA)									
PHOTOCELL & CONTROLS	**SAT-24S (24 LEDs)**					**SAT-48S (48 LEDs)**				
Photocell Options	20-year life photocell available.									
Control & Monitoring	LRL offers a complete range of control and monitoring solutions.									

* NOTES: VALUES SHOWN ARE SUBJECT TO ± 5% TOLERANCE. COLOR TEMPERATURE SHOWN IS ±500K. BASED ON 5000K CCT AND TYPE 3 DISTRIBUTION. ILLUSTRATED ABOVE: SAT-S IN GRAY (RAL 7035). 1. NOT ALL MODEL CONFIGURATIONS ARE DLC QUALIFIED. CONSULT FACTORY FOR DETAILS. ALL INFORMATION PROVIDED IS SUBJECT TO CHANGE WITHOUT NOTICE.

SATELLITE™ SERIES: SPECIFICATIONS

sat-m



Housing:	Single piece, die-cast A360 aluminum
Operating Temperature:	-40°C to +60°C (-40°F to +140°F)
Mounting:	1.625" - 2.375" (42 - 60 mm) O.D. Tenons
Weight:	25 lb (11.4 kg)
EPA Rating:	<0.699 ft² (< 0.065 m²)
Lens Material:	Acrylic
Finish:	Durable polyester powdercoat topcoat
Available Colors:	BRONZE (RAL 7022) BLACK (RAL 9005)

ELECTRICAL	SAT-72M (72 LEDs)					SAT-96M (96 LEDs)				
Currents (mA)	280 mA	350 mA	450 mA	525 mA	600 mA	280 mA	350 mA	450 mA	525 mA	600 mA
Power Consumption* (W)	65 W	83 W	107 W	131 W	150 W	86 W	110 W	143 W	175 W	200 W
Input Voltage* (V)	Universal Driver 120 - 240V AC, 277 - 347V AC, 480V AC, and 12 - 24V DC drivers available upon request.									
Surge Protection	10kV/10kA per ANSI C62.41.2-2002									
Power Factor	>0.90									
OPTICS & PERFORMANCE	**SAT-72M (72 LEDs)**					**SAT-96M (96 LEDs)**				
Photometry (Distribution Types)	Type II, Type II Medium, Type II Wide, Type II U, Type III, EW (Type III), EN (Type II), EL (Type II), EM (Type II)									
Color Temperature* (CCT)	5000K (Standard), 4000K, & 4500K (Optional)									
Color Rendering Index* (CRI)	~70									
Drive Currents (mA)	280 mA	350 mA	450 mA	525 mA	600 mA	280 mA	350 mA	450 mA	525 mA	600 mA
Fixture Efficacy* (Lm/W)	97 Lm/W	93 Lm/W	87 Lm/W	84 Lm/W	80 Lm/W	96 Lm/W	92 Lm/W	86 Lm/W	81 Lm/W	78 Lm/W
Fixture Output* (Lm)	6,200 Lm	7,500 Lm	9,300 Lm	10,800 Lm	11,800 Lm	8,250 Lm	10,000 Lm	12,250 Lm	14,100 Lm	15,500 Lm
LED L70 (Hours)	> 100,000 hours (@ 350mA)									
PHOTOCELL & CONTROLS	**SAT-72M (72 LEDs)**					**SAT-96M (96 LEDs)**				
Photocell Options	20-year life photocell available.									
Control & Monitoring	LRL offers a complete range of control and monitoring solutions.									

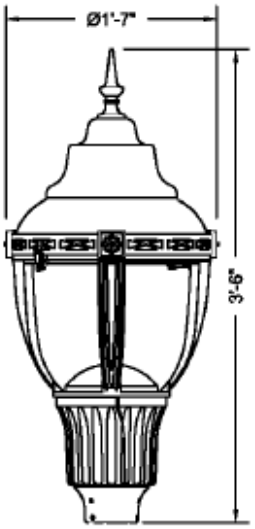
* NOTES: VALUES SHOWN ARE SUBJECT TO ±5% TOLERANCE. COLOR TEMPERATURE SHOWN IS ±500K. BASED ON 5000K CCT AND TYPE 2 DISTRIBUTION. ILLUSTRATED ABOVE: SAT-48LW (GRAY (RAL 7035)). † NOT ALL MODEL CONFIGURATIONS ARE DLC QUALIFIED. CONSULT FACTORY FOR DETAILS. ALL INFORMATION PROVIDED IS SUBJECT TO CHANGE WITHOUT NOTICE.

LED ROADWAY LIGHTING

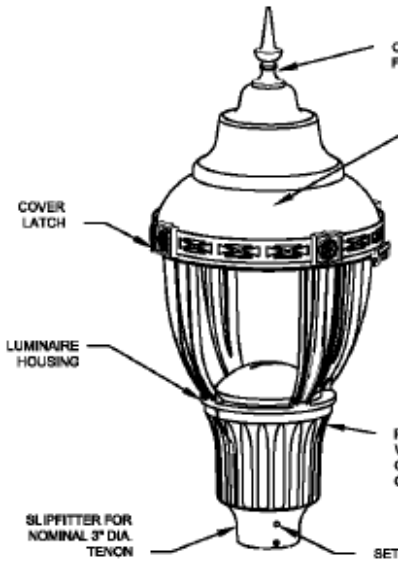
115 Chain Lake Drive, Halifax,
Nova Scotia, Canada, B3S 1B3

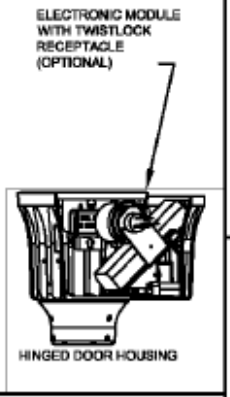
T: +1.877.533.5755
F: +1.888.533.5755

ledroadwaylighting.com
info@ledroadwaylighting.com



Maximum Effective Projected Area - 1.72 sq. ft.
Maximum Weight - 57 lbs





Utility Washington Postlite®
Series Luminaire
Full Cutoff LED 2

DECORATIVE OUTDOOR

HOLOPHANE® LEADER IN LIGHTING SOLUTIONS
An EquityBrandsCompany

EXAMPLE: WFCL2 035HO 40K AS BK L2 S

ORDERING INFORMATION:

WFCL2 [ ] [ ] [ ] [ ] [ ] [ ]

LED PERFORMANCE PACKAGE
035HO = 47W PACKAGE
053 = 70W PACKAGE[1]
053HO = 70W PACKAGE
070HO = 95W PACKAGE
105HO = 145W PACKAGE[2]

VOLTAGE
AS = AUTO-SENSING 120 - 277 V
AH = AUTO-SENSING 347 - 480 V

COLOR TEMP.
AM = TRUE AMBER[1]
30K = 3000K
40K = 4000K
50K = 5000K

COLOR
BK = BLACK
GR = GRAY
GH = GRAPHITE
GN = GREEN
PP = PRIME PAINT
WH = WHITE
BZ = BRONZE
TDC = TIGER DRYLAC COLOR (RAL***)
CMC = CUSTOM MATCH COLOR

OPTICS
L2 = TYPE 2 DISTRIBUTION, FULL CUTOFF
L3 = TYPE 3 DISTRIBUTION, FULL CUTOFF
L4 = TYPE 4 DISTRIBUTION, FULL CUTOFF
L5 = TYPE 5 DISTRIBUTION, FULL CUTOFF

FINIAL
(FACTORY INSTALLED)
B = BALL
S = SPIKE

[ ]

OPTIONS:
AO = ADJUSTABLE OUTPUT DIMMING[3, 6]
D = ROAM 0-10V DIMMING CONTROL
FPDXX = FACTORY PROGRAMMED DRIVER
H = NEMA TWISTLOCK PHOTOCONTROL RECEPTACLE ONLY
P5 = DIMMING PHOTOCONTROL RECEPTACLE - 5 PIN
P7 = DIMMING PHOTOCONTROL RECEPTACLE - 7 PIN
NL1X1 = 1"X1" ANSI WATTAGE LABEL
NL2X2 = 2"X2" ANSI WATTAGE LABEL
PCS = DTL SOLID-STATE LIGHTING PHOTOCONTROL 120-277 VOLT[4]
PCLL = DTL SOLID-STATE LONG LIFE PHOTOCONTROL 120-277 VOLT[4]
P34 = DTL TWISTLOCK PHOTOCONTROL 347 VOLT[4]
P48 = DTL TWISTLOCK PHOTOCONTROL 480 VOLT[4]
PSC = SHORTING CAP[4]
L03 = 3FT PREWIRED LEADS[5]
L10 = 10FT PREWIRED LEADS[5]
L20 = 20FT PREWIRED LEADS[5]
L25 = 25FT PREWIRED LEADS[5]
L30 = 30FT PREWIRED LEADS[5]

NOTES:
1. 053 AM IS ONLY PAIRING FOR THESE VERSIONS
2. 105HO AND OPTION "D" ARE NOT AVAILABLE TOGETHER
3. NOT AVAILABLE WITH OPTIONS "P5", "P7" OR ANY OTHER DIMMING OPTION
4. MUST BE USED WITH OPTIONS "H", "P5" OR "P7"
5. UNIT IS PROVIDED WITH 2 FEET OF PREWIRED LEADS UNLESS OTHERWISE SPECIFIED
6. FOR AO SETTINGS, REFER TO INSTRUCTIONS IM-303-D, SEE WEBSITE

ORDER #:
TYPE:
DRAWN: RAF
DATE: 11/15/2016
DWG #: LUM_WFCL2

Performance Data.

LED Package	Distribution	System Watts	3K (3000K, 70 CRI)					4K (4000K, 70 CRI)					5K (5000K, 70 CRI)				
			Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	Lumens	LPW	B	U	G
035HO	L2	47	3,705	79	1	0	1	4,163	89	1	0	1	4,287	91	1	0	1
	L3	47	3,879	83	1	0	1	4,358	93	1	0	1	4,488	95	1	0	1
	L4	47	3,804	81	1	0	1	4,274	91	1	0	1	4,402	94	1	0	1
	L5	47	4,181	89	2	0	1	4,698	100	2	0	1	4,838	103	2	0	1
053HO	L2	70	5,397	77	1	0	1	6,064	87	1	0	1	6,244	89	1	0	1
	L3	70	5,651	81	1	0	1	6,349	91	1	0	1	6,538	93	1	0	1
	L4	70	5,542	79	1	0	1	6,227	89	1	0	1	6,412	92	1	0	1
	L5	70	6,090	87	3	0	1	6,843	98	3	0	1	7,047	101	3	0	1
070HO	L2	95	6,904	73	2	0	2	7,757	82	2	0	2	7,988	84	2	0	2
	L3	95	7,229	76	2	0	2	8,122	85	2	0	2	8,364	88	2	0	2
	L4	95	7,089	75	2	0	2	7,966	84	2	0	2	8,203	86	2	0	2
	L5	95	7,791	82	3	0	2	8,754	92	3	0	2	9,015	95	3	0	2
105HO	L2	145	9,724	67	2	0	2	10,926	75	2	0	2	11,251	78	2	0	2
	L3	145	10,181	70	2	0	2	11,439	79	2	0	2	11,780	81	2	0	2
	L4	145	9,985	69	2	0	2	11,219	77	2	0	2	11,553	80	2	0	2
	L5	145	10,973	76	4	0	2	12,330	85	4	0	2	12,697	88	4	0	2

Use these factors to determine relative lumen output for average ambient temperatures from 0 - 40°C (32 - 104°F)

Average Lumen Ambient Temperature (LAT) Multipliers			
°C	°F	Lumen Multiplier	LED Packages
0	32	1.06	035HO, 053HO, 070HO, 105HO
5	41	1.05	
10	50	1.03	
15	59	1.02	
20	68	1.01	
25	77	1.00	
30	86	0.99	
35	95	0.98	
40	104	0.97	

Data references the extrapolated performance projections for the platforms noted in a 25°C ambient, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).
To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Lumen Maintenance - LLD (same for all LED packages)							
Hours	0	25,000	36,000	50,000	60,000	*75,000*	*100,000*
Factor	1	0.933	0.912	0.885	0.867	*0.84*	*0.797*

The *italicized data* is extrapolated beyond the TM-21 standard.

E=(LM)x(CU)x((LAT)x(LLD) - LM and CU are obtained from published photometry.

Utility Washington Postlite®
Series Luminaire
Full Cutoff LED 2

DECORATIVE
OUTDOOR

HOLOPHANE®
LEADER IN LIGHTING SOLUTIONS
An Acuity Brands Company

ORDER #:
TYPE:
DRAWN: RAF
DATE: 11/15/2016
DWG #: LUM_WFCL2
2 OF 4

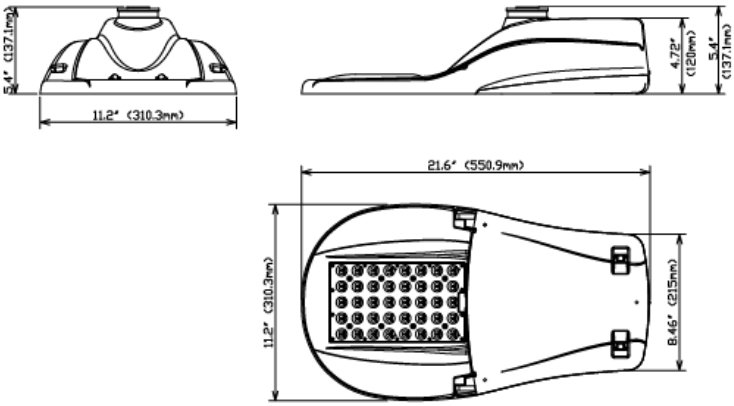
LEOTEK
LITE-ON GROUP

Project
Type
Catalog No.

GreenCobra® Midsize LED Street Light
GCM F-Series

Luminaire Data

Weight 10 lbs [4.6 kg]
EPA 0.44 ft²



Ordering Information

Sample Catalog No. GCM1 30F MV NW 2 GY 700 PCR7 WL

Product	LED No. & Type	Voltage	Color Temperature	Distribution	Finish	Drive Current[1]	Options
GCM1 30F@ 350 to 700mA	**30F**	**MV** 120-277V **HV** 347-480V	**WW** 3000K **NW** 4000K **CW** 5000K	**2** Type 2 **3** Type 3	**GY** Gray **DB** Dark Bronze **BK** Black	**350**[2] 350mA **530**[2] 530mA **700** 700mA **1A**[3] 1A	**FDC**[4] Fixed Drive Current **LPCR** Less Photocontrol Receptacle **PCR5**[5] ANSI 5-wire Photo-control Receptacle **PCR7**[5] ANSI 7-wire Photo-control Receptacle **PCR5-CR**[6] Control Ready 5-wire PC Receptacle **PCR7-CR**[6] Control Ready 7-wire PC Receptacle **WL** Utility Wattage Label **4B** 4-Bolt Mounting Bracket **DSC** Door Safety Cable **RWG** Rubber Wildlife Guard
GCM2 30F@ 700mA to 1A, 40F @ 700mA to 1A	**40F**						

Notes:

1 Factory set drive current, field adjustable standard. Refer to Performance Data Table. Consult factory if wattage limits require a special drive current.
2 350mA and 530mA drive current available with GCM1 only.
3 1A drive current available with GCM2 only.
4 Non-field adjustable, fixed drive current. Specify required drive current. Not available with PCR5-CR or PCR7-CR options.
5 Field adjustable current selector included. Wireless node dimming is disabled, field changeable connectors included to enable dimming with PCR5/7.
6 Control-ready wiring at factory for wireless node dimming. Default maximum drive current (700mA or 1A) must be specified.
7 Flush mounted house side shield. Shield cuts light off at 1/2 mounting height behind luminaire.
8 Flush mounted cul-de-sac shield. Shield cuts light off at 1/2 mounting height behind luminaire and 1-1/2 mounting height on either side of luminaire.
9 Specify Color (GY, DB, BK)
10 Specify MV (120-277V) or HV (347V-480V)

Accessories*	
HSS[7]	House Side Shield, Snap-On*
CSS[8]	Cul-De-Sac Side Shield, Snap-On*
SPB[9]	Square Pole Horizontal Arm Bracket
RPB[9]	Round Pole Horizontal Arm Bracket
PTB[9]	Pole Top Tenon Horizontal Arm Bracket
WB[9]	Wall Horizontal Arm Bracket
BSK	Bird Deterrent Spider Kit
PC[10]	Twist Lock Photocontrol
LLPC[10]	Long-Life Twist Lock Photocontrol
SC	Twist Lock Shorting Cap

*Accessories are ordered separately and not to be included in the catalog number. For factory installed HSS, CSS specify as option in luminaire catalog number.

LEOTEK
LITE-ON GROUP

GreenCobra™ Midsize LED Street Light
GCM

Luminaire Specifications

Housing
Die cast aluminum housing with universal two-bolt slip fitter mounts to 1-1/4" to 2" (1-5/8" to 2-3/8" O.D.) diameter mast arm. One-piece aluminum housing provides passive heat-sinking of the LEDs and has upper surfaces that shed precipitation. Four-bolt mounting bracket is available. Mounting provisions meet 3G vibration per ANSI C136.31-2001 Normal Application, Bridge & Overpass. Mounting has leveling adjustment from ± 5° in 2.5° steps. Electrical components are accessed without tools via a high-strength, non-conductive polycarbonate door with quick-release latches. Polycarbonate material meets UL 746C for outdoor usage. Available rubber wildlife guard (RWG option) conforms to mast arm with no gaps.

Light Emitting Diodes
Hi-flux/Hi-power white LEDs produce a minimum of 90% of initial intensity at 100,000 hours of life based on IES TM-21. LEDs are tested in accordance with IES LM-80 testing procedures. LEDS have correlated color temperature of 3000K (WW), 4000K (NW), or 5000K (CW) and 70 CRI minimum. LEDs are 100% mercury and lead free.

Optical Systems
Micro-lens optical systems produce IESNA Type 2 or Type 3 distributions and are fully sealed to maintain an IP66 rating. Luminaire produces 0% total lumens above 90° (BUG Rating, U=0). Optional house side shield cuts light off at 1/2 mounting height behind luminaire. Cul-de-sac shield provides back and side light control for end of cul-de-sac applications. Both shields are field installable without tools.

Electrical
Rated life of electrical components is 100,000 hours. Uses isolated power supply that is 1-10V dimmable. Power supply is wired with quick-disconnect terminals. LED drive current can be changed in the field to adjust light output for local conditions (not available with PCR5-CR or PCR7-CR options). Power supply features a minimum power factor of .90 and <20% Total Harmonic Distortion (THD). EMC meets or exceeds FCC CFR Part 15. Terminal block accommodates 6 to 14 gauge wire. Surge protection complies with IEEE/ANSI C62.41 Category C High, 20kV/10kA.

Controls
3-Wire photocontrol receptacle is standard. ANSI C136.41 5-wire (PCR5) or 7-wire (PCR7) photocontrol receptacles are available. All photocontrol receptacles have tool-less rotatable bases. Wireless control module is provided by others.

Finish
Housing receives a durable, fade-resistant polyester powder coat finish. Finish tested to withstand 3000 hours in salt spray exposure per ASTM B117. Finish tested 500 hours in UV exposure per ASTM G154 and meets ASTM D523 gloss retention.

Listings/Ratings/Labels
Luminaires are UL listed for use in wet locations in the United States and Canada. DesignLights Consortium™ qualified 120-277V product. International Dark Sky Association listed.[2] Luminaire is qualified to operate at ambient temperatures of -40°C to 40°C. Assembled in the U.S.A.

Photometry
Luminaires photometrics are tested by certified independent testing laboratories in accordance with IES LM-79 testing procedures. IES files for all CCTs are available at leotek.com.

Warranty
10-year limited warranty is standard on luminaire and components.

Performance Data: 4000K (NW) and 5000K (CW)
All data nominal. IES files for all CCTs are available at leotek.com.

					Type 2	Type 3
No. of LEDs & Type	**Drive Current (mA)**	**System Wattage (W)**	**Delivered Lumens (Lm)**	**Efficacy (Lm/W)[1]**	**BUG Rating**	**BUG Rating**
GCM1 30F	350	36	3900	108	B1 U0 G1	B1 U0 G1
	530	53	5620	106	B1 U0 G1	B2 U0 G2
	700	69	7000	100	B2 U0 G2	B2 U0 G2
GCM2 30F	700	69	7000	100	B2 UO G2	B2 UO G2
	1000	104	9200	88	B2 UO G2	B2 UO G2
GCM2 40F	700	88	9000	102	B2 U0 G2	B2 U0 G2
	1000	138	12000	87	B2 U0 G2	B2 U0 G2

Performance Data: 3000K (WW)
All data nominal. IES files for all CCTs are available at leotek.com.

					Type 2	Type 3
No. of LEDs & Type	**Drive Current (mA)**	**System Wattage (W)**	**Delivered Lumens (Lm)**	**Efficacy (Lm/W)[1]**	**BUG Rating**	**BUG Rating**
GCM1 30F	350	36	4100	114	B1 U0 G1	B1 U0 G1
	530	53	5600	106	B1 U0 G1	B2 U0 G2
	700	69	6950	101	B2 U0 G2	B2 U0 G2
GCM2 30F	700	69	6950	101	B2 UO G2	B2 UO G2
	1000	107	9100	85	B2 UO G2	B2 UO G2
GCM2 40F	700	94	9400	100	B2 U0 G2	B2 U0 G2
	1000	137	11750	86	B2 U0 G2	B2 U0 G2

Notes:
1 Nominal lumens. Normal tolerance ± 10% due to factors including distribution type, LED bin variance, and ambient temperatures.
2 Not all versions DLC qualified. Consult qualified product list at www.designlights.org for latest product listing.

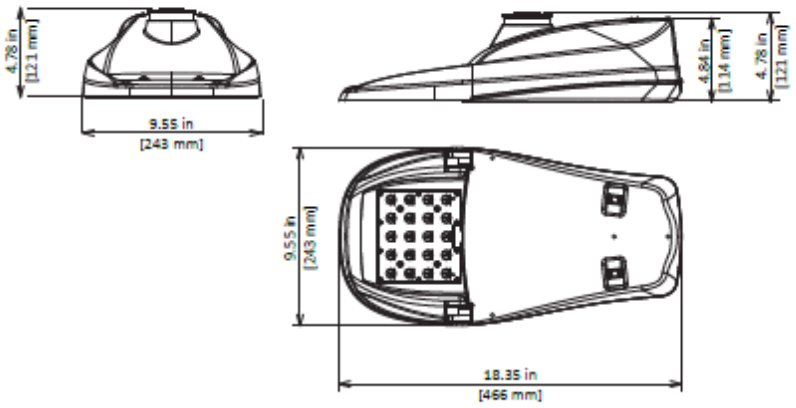
LEOTEK
LITE-ON GROUP

Project
Type
Catalog No.

GreenCobra™ Jr. LED Street Light
GCJ

Luminaire Data

Weight 7 lbs [3.2 kg]
EPA 0.59 ft²



Ordering Information

Sample Catalog No. GCJ1 20G MV NW 2 GY 5B0

Product	LED No. & Type	Voltage	Color Temperature	Distribution	Finish	Drive Current[1]	Options
GCJ1 350mA to 700mA **GCJ2** 700mA to 1A	**20G**	**MV** 120-277V	**WW** 3000K **NW** 4000K **CW** 5000K	**2** Type 2 **3** Type 3	**GY** Gray **DB** Dark Bronze **BK** Black	**350**[2] 350mA **580**[2] 580mA **700** 700mA **1A**[3] 1A	**FDC**[4] Fixed Drive Current **LPCR** Less Photocontrol Receptacle **PCR5**[5] ANSI 5-wire Photo-control Receptacle **PCR7**[5] ANSI 7-wire Photo-control Receptacle **PCR5-CR**[6] Control Ready 5-wire PC Receptacle **PCR7-CR**[6] Control Ready 7-wire PC Receptacle **WL** Utility Wattage Label **4B** 4-Bolt Mounting Bracket **DSC** Door Safety Cable **RWG** Rubber Wildlife Guard

Notes:

1 Factory set drive current, field adjustable standard. Refer to Performance Data Table. Consult factory if wattage limits require a special drive current.
2 350mA and 580mA drive current available with GCJ1 only.
3 1A drive current available with GCJ2 only.
4 Non-field adjustable, fixed drive current. Specify required drive current. Not available with PCR5-CR or PCR7-CR options.
5 Field adjustable current selector included. Wireless node dimming is disabled, field changeable connectors included to enable dimming with PCR5/7.
6 Control-ready wiring at factory for wireless node dimming. Default maximum drive current (700mA or 1A) must be specified.
7 Flush mounted house side shield. Shield cuts light off at 1/2 mounting height behind luminaire.
8 Flush mounted cul-de-sac shield. Shield cuts light off at 1/2 mounting height behind luminaire and 1-1/2 mounting height on either side of luminaire.
9 Specify Color (GY, DB, BK)

Accessories*	
HSS[7]	House Side Shield, Snap-On*
CSS[8]	Cul-De-Sac Side Shield, Snap-On*
SPB[9]	Square Pole Horizontal Arm Bracket
RPB[9]	Round Pole Horizontal Arm Bracket
PTB[9]	Pole Top Tenon Horizontal Arm Bracket
WB[9]	Wall Horizontal Arm Bracket
BSK	Bird Deterrent Spider Kit
PC	Twist Lock Photocontrol
LLPC	Long-Life Twist Lock Photocontrol
SC	Twist Lock Shorting Cap

*Accessories are ordered separately and not to be included in the catalog number. For factory installed HSS, CSS specify as option in luminaire catalog number.

GreenCobra™ Jr. LED Street Light
GCJ

Luminaire Specifications

Housing
Die cast aluminum housing with universal two-bolt slip fitter mounts to 1-1/4" to 2" (1-5/8" to 2-3/8" O.D.) diameter mast arm. One-piece aluminum housing provides passive heat-sinking of the LEDs and has upper surfaces that shed precipitation. Four-bolt mounting bracket is available. Mounting provisions meet 3G vibration per ANSI C136.31-2001 Normal Application, Bridge & Overpass. Mounting has leveling adjustment from ± 5° in 2.5° steps. Electrical components are accessed without tools via a high-strength, non-conductive polycarbonate door with quick-release latches. Polycarbonate material meets UL 746C for outdoor usage. Available rubber wildlife guard (RWG option) conforms to mast arm with no gaps.

Light Emitting Diodes
Hi-flux/Hi-power white LEDs produce a minimum of 90% of initial intensity at 100,000 hours of life based on IES TM-21. LEDs are tested in accordance with IES LM-80 testing procedures. LEDS have correlated color temperature of 3000K (WW), 4000K (NW), or 5000K (CW) and 70 CRI minimum. LEDs are 100% mercury and lead free.

Optical Systems
Micro-lens optical systems produce IESNA Type 2 or Type 3 distributions and are fully sealed to maintain an IP66 rating. Luminaire produces 0% total lumens above 90° (BUG Rating, U=0). Optional house side shield cuts light off at 1/2 mounting height behind luminaire. Cul-de-sac shield provides back and side light control for end of cul-de-sac applications. Both shields are field installable without tools.

Electrical
Rated life of electrical components is 100,000 hours. Uses isolated power supply that is 1-10V dimmable. Power supply is wired with quick-disconnect terminals. LED drive current can be changed in the field to adjust light output for local conditions (not available with PCR5-CR or PCR7-CR options). Power supply features a minimum power factor of .90 and <20% Total Harmonic Distortion (THD). EMC meets or exceeds FCC CFR Part 15. Terminal block accommodates 6 to 14 gauge wire. Surge protection complies with IEEE/ANSI C62.41 Category C High, 20kV/10kA.

Controls
3-Wire photocontrol receptacle is standard. ANSI C136.41 5-wire (PCR5) or 7-wire (PCR7) photocontrol receptacles are available. All photocontrol receptacles have tool-less rotatable bases. Wireless control module is provided by others.

Finish
Housing receives a durable, fade-resistant polyester powder coat finish. Finish tested to withstand 3000 hours in salt spray exposure per ASTM B117. Finish tested 500 hours in UV exposure per ASTM G154 and meets ASTM D523 gloss retention.

Listings/Ratings/Labels
Luminaires are UL listed for use in wet locations in the United States and Canada. DesignLights Consortium™ qualified 120-277V product.2 International Dark Sky Association listed. Luminaire is qualified to operate at ambient temperatures of -40°C to 40°C. Assembled in the U.S.A.

Photometry
Luminaires photometrics are tested by certified independent testing laboratories in accordance with IES LM-79 testing procedures. IES files for all CCTs are available at leotek.com.

Warranty
10-year limited warranty is standard on luminaire and components.

Performance Data: 4000K (NW) and 5000K (CW)

All data nominal. IES files for all CCTs are available at leotek.com.

					Type 2	Type 3
Product	Drive Current (mA)	System Wattage (W)	Delivered Lumens (Lm)[1]	Efficacy (Lm/W)	BUG Rating	BUG Rating
GCJ1	350	24	2400	100	B1 U0 G1	B1 U0 G1
	580	38	3700	97	B1 U0 G1	B1 U0 G1
	700	48	4400	92	B1 U0 G1	B1 U0 G1
GCJ2	700	48	4400	92	B1 U0 G1	B1 U0 G1
	1000	74	5900	80	B1 U0 G2	B2 U0 G2

Performance Data: 3000K (WW)

All data nominal. IES files for all CCTs are available at leotek.com.

					Type 2	Type 3
Product	Drive Current (mA)	System Wattage (W)	Delivered Lumens (Lm)[1]	Efficacy (Lm/W)	BUG Rating	BUG Rating
GCJ1	350	24	2400	100	B1 U0 G1	B1 U0 G1
	580	38	3650	96	B1 U0 G1	B1 U0 G1
	700	48	4300	90	B1 U0 G1	B1 U0 G1
GCJ2	700	48	4300	90	B1 U0 G1	B1 U0 G1
	1000	74	5700	77	B1 U0 G1	B2 U0 G2

Notes:
1 Nominal lumens. Normal tolerance ± 10% due to factors including distribution type, LED bin variance, and ambient temperatures.
2 Not all versions DLC qualified. Consult qualified product list at www.designlights.org for latest product listing.

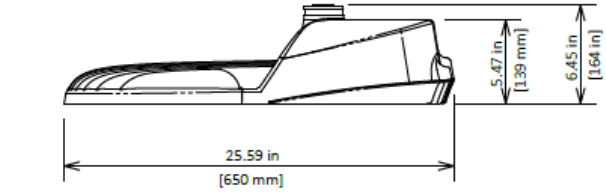
LEOTEK
LITE-ON GROUP

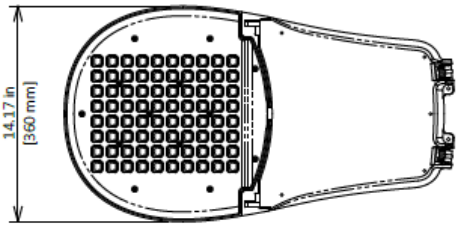
Project
Type
Catalog No.

GreenCobra™ LED Street Light
GC1

Luminaire Data

Weight 21 lbs [9.5 kg]
EPA 0.9 ft^2





Ordering Information

Sample Catalog No. GC1 60F MV NW 2 GY 350 BSK RPB FDC

Product	No. & Type of LEDs	Voltage[6]	Color Temperature	Distribution	Finish[2]	Drive Current[1]	Options
GC1	20F 30F 40F 60F 80F	MV 120-277V HV 347-480V	WW 3000K NW 4000K CW 5000K	2 Type 2 3 Type 3	GY Gray DB Dark Bronze BK Black	350 350mA 530 530mA 700 700mA 1A[3] 1A	HSS[4] House Side Shield (Factory Installed) FDC[5] Fixed Drive Current LPCR Less Photocontrol Receptacle PCR5 ANSI 5-wire Photocontrol Receptacle PCR7 ANSI 7-wire Photocontrol Receptacle PCR5-CR Control Ready 5-wire Photocontrol Receptacle PCR7-CR Control Ready 7-wire Photocontrol Receptacle SC PCR Shorting Cap WL Utility Wattage Label

Notes:

1 Factory set drive current, field adjustable standard. Refer to Performance Data Table Consult factory if wattage limits require a special drive current.
2 Gray, Black and Dark Bronze standard, consult factory for other finishes.
3 1A drive current only available with 40F.
4 Flush mounted house side shield factory installed. Shield cuts light off at 1/2 mounting height behind luminaire.
5 Non-field adjustable, fixed drive current.
6 MV is DLC qualified. HV is DLC qualified on request, consult factory.
7 Flush mounted house side shield. Shield cuts light off at 1/2 mounting height behind luminaire. Specify Model and Color.
8 Specify Color (GY, DB, BK)
9 Specify MV (120-277V) or HV (347V-480V)

Accessories*	
HSS[7]	House Side Shield
SPB[8]	Square Pole Horizontal Arm Bracket
RPB[8]	Round Pole Horizontal Arm Bracket
PTB[8]	Pole Top Tenon Horizontal Arm Bracket
WB[8]	Wall Horizontal Arm Bracket
BSK	Bird Deterrent Spider Kit
PC[9]	Twist Lock Photocontrol
LLPC[9]	Long-Life Twist Lock Photocontrol
SC	Twist Lock Shorting Cap

*Accessories are ordered separately and not to be included in the catalog number

GC1_072916. Specifications subject to change without notice.

LEOTEK
LITE-ON GROUP

GreenCobra™ LED Street Light
GC1

Luminaire Specifications

Housing
Die cast aluminum housing with universal four-bolt slip fitter mounts to 1-1/4" to 2" (1-5/8" to 2-3/8" O.D.) diameter mast arm. Aluminum housing provides passive heat-sinking of the LEDs and has upper surfaces that shed precipitation. Mounting provisions meet 3G vibration per ANSI C136.31-2001 Normal Application, Bridge & Overpass. Mounting has leveling adjustment from + 10° to -5° in 2.5° steps and integral bubble level standard. Electrical components are accessed without tools and are mounted on removable power door with stainless steel latches. Standard rubber wildlife guard conforms to mast arm with no gaps.

Light Emitting Diodes
Hi-flux/Hi-power white LEDs produce a minimum of 90% of initial intensity at 100,000 hours of life based on IES TM-21. LEDs are tested in accordance with IES LM-80 testing procedures. LEDs have correlated color temperature of 3000K (WW), 4000K (NW), or 5000K (CW) and 70 CRI minimum. LEDs are 100% mercury and lead free.

Optical Systems
Micro-lens optical systems produce IESNA Type 2 or Type 3 distributions and are fully sealed to maintain an IP66 rating. Luminaire produces 0% total lumens above 90° (BUG Rating, U=0). Optional house side shield cuts light off at 1/2 mounting height behind luminaire.

Electrical
Rated life of electrical components is 100,000 hours. Uses isolated power supply that is 1-10V dimmable. Power supply is wired with quick-disconnect terminals. LED drive current can be changed in the field to adjust light output for local conditions (not available with PCR5-CR or PCR7-CR options). Power supply features a minimum power factor of .90 and <20% Total Harmonic Distortion (THD). EMC meets or exceeds FCC CFR Part 15. Terminal block accommodates 6 to 14 gauge wire and is aligned for strait wire entry. Surge protection complies with IEEE/ANSI C62.41 Category C High, 20kV/10kA.

Controls
3-Wire photocontrol receptacle is standard. ANSI C136.41 5-wire (PCR5) or 7-wire (PCR7) photocontrol receptacles are available. All photocontrol receptacles have tool-less rotatable bases. Wireless control module is provided by others.

Finish
Housing receives a fade and abrasion resistant polyester powder coat finish. Finish tested to withstand 3000 hours in salt spray exposure per ASTM B117. Finish tested 500 hours in UV exposure per ASTM G154 and meets ASTM D523 gloss retention.

Listings/Ratings/Labels
Luminaires are UL listed for use in wet locations in the United States and Canada. DesignLights Consortium™ qualified 120-277V 4000K product. International Dark Sky Association listed. Luminaire is qualified to operate at ambient temperatures of -40°C to 40°C. Assembled in the U.S.A

Photometry
Luminaires photometrics are tested by certified independent testing laboratories in accordance with IES LM-79 testing procedures. IES files for all CCTs are available at leotek.com.

Warranty
10-year limited warranty is standard on luminaire and components.

Performance Data
All data nominal. IES files for all CCTs are available at leotek.com.

					Type 2	Type 3
No. of LEDs & Type	**Drive Current (mA)**	**System Wattage (W)**	**Delivered Lumens (Lm)[1]**	**Efficacy (Lm/W)**	**BUG Rating**	**BUG Rating**
20F	350	25	2700	108	B1 U0 G1	B1 U0 G1
	530	35	3650	104	B1 U0 G1	B1 U0 G1
	700	47	4800	102	B1 U0 G1	B1 U0 G1
30F	350	35	3800	109	B1 U0 G1	B1 U0 G1
	530	53	5400	102	B1 U0 G1	B2 U0 G1
	700	70	7000	100	B2 U0 G2	B2 U0 G2
40F	350	45	5050	112	B1 U0 G1	B2 U0 G1
	530	70	7200	103	B2 U0 G2	B2 U0 G2
	700	92	9300	101	B2 U0 G2	B2 U0 G2
	1000	132	12300	93	B3 U0 G3	B3 U0 G3
60F	350	70	7600	109	B2 U0 G2	B2 U0 G2
	530	101	10400	103	B2 U0 G2	B2 U0 G2
	700	133	13400	101	B3 U0 G3	B3 U0 G3
80F	350	85	9500	112	B2 U0 G2	B2 U0 G2
	530	133	14200	107	B3 U0 G3	B3 U0 G3
	700	180	17700	98	B3 U0 G3	B3 U0 G3

Notes:
1 All data nominal lumens for 4000K (NW) and 5000K (CW). For 3000K (WW) apply a LLF of 0.93. Normal tolerance ± 10% due to factors including distribution type, LED bin variance, and ambient temperatures.