

WSDOT LED Adaptive Roadway Lighting & Illumination Reform

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**Western States Rural Transportation Technology Implementers Forum
June 17-19, 2014
Yreka, CA**

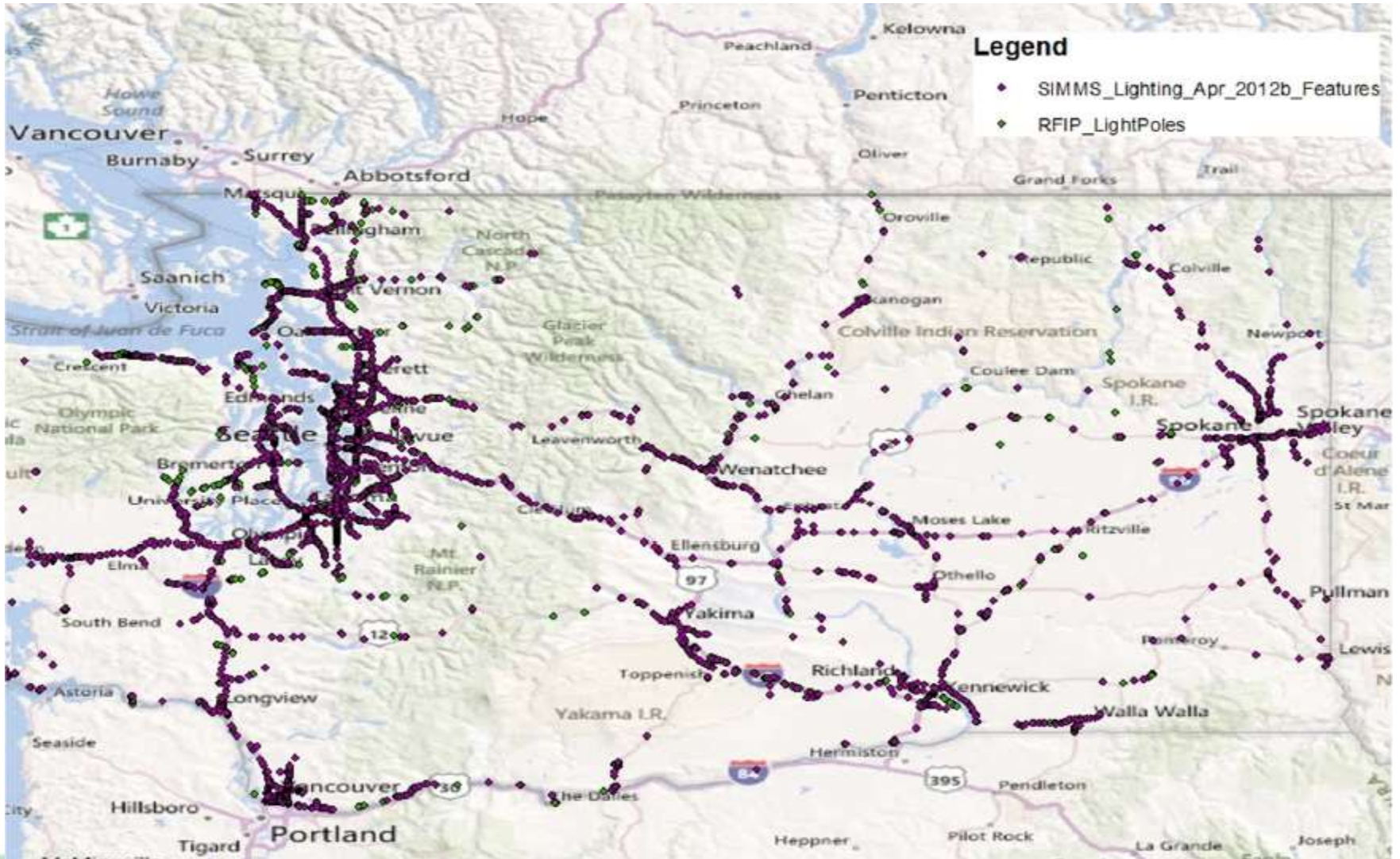
Each year WSDOT spends millions of dollars on illumination system repairs, preventative maintenance and utility costs. In addition, the ongoing preservation funding needed to perform life cycle replacement of these systems far surpasses current and projected funding. With thousands of miles of state owned roadways and intersections with and without illumination a more strategic approach to when, where and why to provide roadway illumination is needed.

WSDOT Illumination Inventory

- Total Illumination Systems = 3,100 (*400 installed since 2005*)
 - Total Individual Light Fixtures = 60,000
 - Cobra Heads = 47.5%
 - Sign Lights = 2.5%
 - Pole Top = 3%
 - Underdeck = 14%
 - Wall Mount = 2%
 - Shoe Box = 4%
 - High Mast = 3%
 - Tunnel = 24%
- 100%

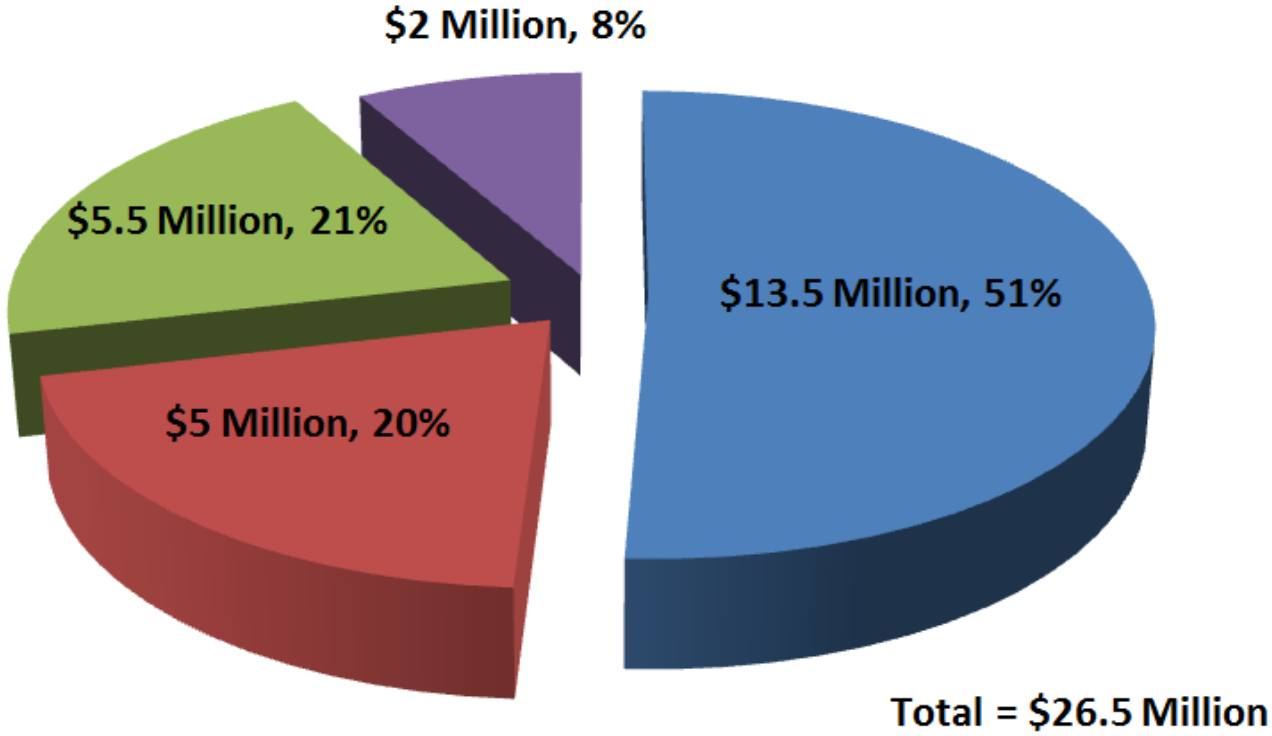
These are estimates based on extrapolations from existing inventory data

WSDOT Illumination System Inventory



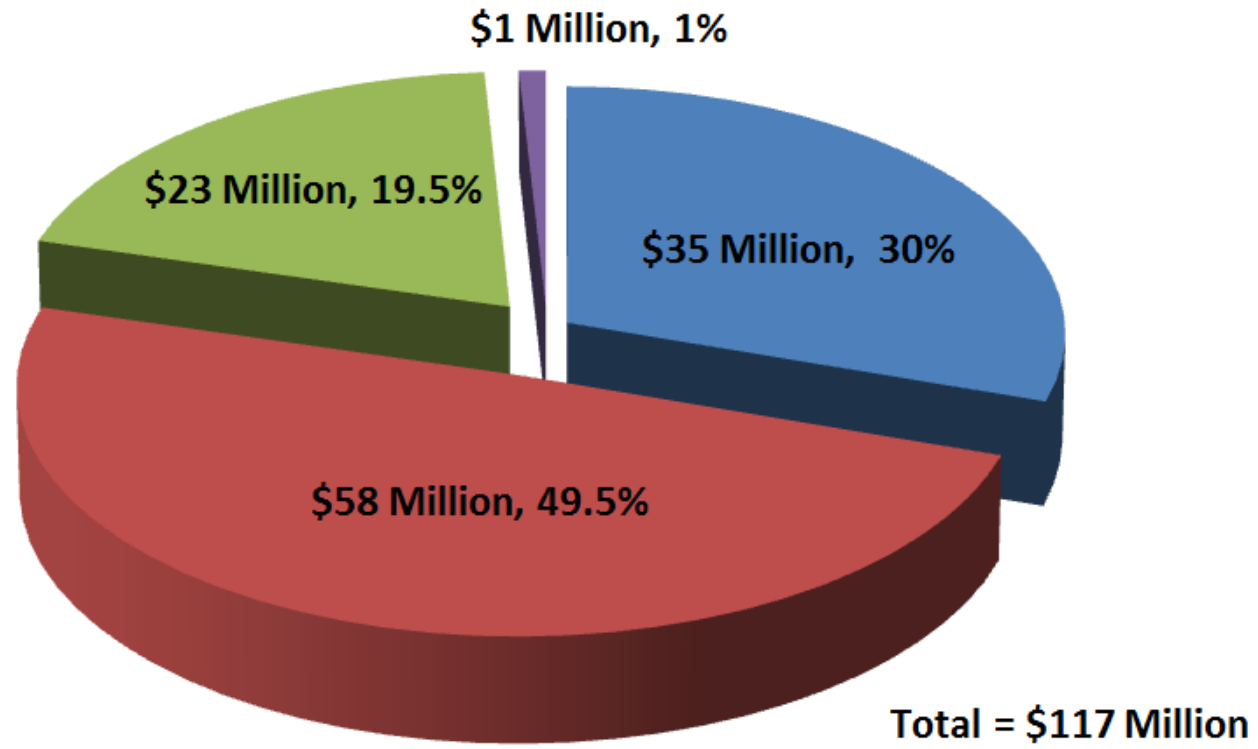
Data from SiMMS and Roadside Features inventory Database

WSDOT - Preventative Maintenance Expenditures Traffic Signals, Illumination and ITS (12 year total)



- Signal, Ramp Meter, Flashing Beacon Systems
- Illumination System
- ITS System (CCTV, VMS, HAR, RWIS, Radio, Phone, HUBS, Exp Ln Gates, WIM)
- Electrical Services

WSDOT – Repair, Non-Preventative Maintenance & Electricity Traffic Signals, Illumination and ITS (12 year total)



- Signal, Ramp Meter, Flashing Beacon Systems
- Illumination System
- ITS System (CCTV, VMS, HAR, RWIS, Radio, Phone, HUBS, Exp Ln Gates, WIM)
- Electrical Services

WSDOT Illumination System

- Life Cycle Cost Analysis

Assumptions

- 3,100 Existing Illumination Systems
- 50yr Life Cycle
- Average System Cost = \$125k
- All Existing Systems need to be replaced in kind

Rough Approximations

- Replacement Cost for 3,100 Systems
= **\$400 Million** or **\$8 Million / Year**

Current Backlog ??

WSDOT Annualized Illumination System - Life Cycle Cost

- Repair & Non-Preventative Maintenance = \$1.0 Million
- Preventative Maintenance = \$0.5 Million
- Electricity = \$4.0 Million
- Annual Replacement Cost to maintain existing inventory on a 50yr Life Cycle = \$8.0 Million

2015 - 2021

\$13.5 Million / Year

Current Project Funding to Replace Existing Illumination Systems

\$16 Million or \$2.7 Million / year

(Need is \$8.0 Million / Year)

30% is Electricity

It is clear revenues will not meet our needs so we have to rethink how we do the things.

One of the things we wanted to explore was ways that we could reduce our electricity consumption and maintenance costs for our illumination systems.

WSDOT started evaluating Light Emitting Diode (LED) lighting products several years ago. In the beginning there was not an established way to compare LED luminaire fixtures to our standard High Pressure Sodium (HPS) luminaires because they were so new to the industry. WSDOT received LED submittals from a multitude of manufacturers, both new to the lighting industry and also very established lighting manufacturers. With the number of requests and the varying types of fixtures it became clear that WSDOT needed a set evaluation process.

WSDOT created an evaluation process that was a multi-step approach to use and approval. First the manufacturers had to submit the product technical information to the HQ Traffic office for review. If they passed this initial stage the manufacturer was required to provide the photometric data file for computer evaluation. After passing these two stages the manufacturer was invited to a hands on demonstration with their fixture, maintenance personnel, materials lab personnel, lighting designers, and HQ Traffic personnel. If the manufacturer passed the three previous stages then their product was approved for field testing and evaluation.

Out of the 75+ fixtures we evaluated, only 4 manufacturers fixtures met the lighting requirements and were ready for field testing and evaluation.

The next step was selecting an appropriate interchange where we could do field testing.

LED Adaptive Lighting - Project Overview

US 101 and Black Lake Boulevard Interchange - Olympia



Interchange Characteristics

- The project is 1.2 miles on US101, a limited access control facility, with 60 MPH speed limit located near the state capitol.
- This is a Single Point Urban Interchange, with two mainline lanes in each direction.
- The Westbound Off-ramp and Eastbound On-ramp are double lane ramps.
- The Westbound On-ramp and Eastbound Off-ramp are single lane ramps.
- All illumination is shoulder mounted 40' metal poles with 16' mast arms, with the poles located 16' from the fog stripe.
- All existing luminaires are 310W High Pressure Sodium Luminaires.
- Only the luminaire fixtures are to be changed. No new poles are to be added.
- System required to meet or exceed existing light levels.

The current lighting requirements for this section of roadway would be:

Average-0.6fc

Minimum-0.2fc

Uniformity-4:1 Max

The existing 310watt HPS luminaires generated light levels ranging from:

EB Mainline

Average-0.82fc

Minimum-0.1fc

Uniformity-8.20:1

WB Off Ramp

Average-1.24fc

Minimum-0.4fc

Uniformity-3.10:1

We broke the interchange up into four quadrants and placed each manufacturer in a separate quadrant.

Two manufacturers had 21 fixtures and the other two had 23 fixtures.

The request was made to make the evaluation project an adaptive system that could have dimming capabilities and also be programmable and controllable by time of night.

We evaluated the accident history for the entire interchange.

We paid particular attention to the two ramps with the highest volumes.

We checked the traffic volumes to identify times of night when the lights were not needed.

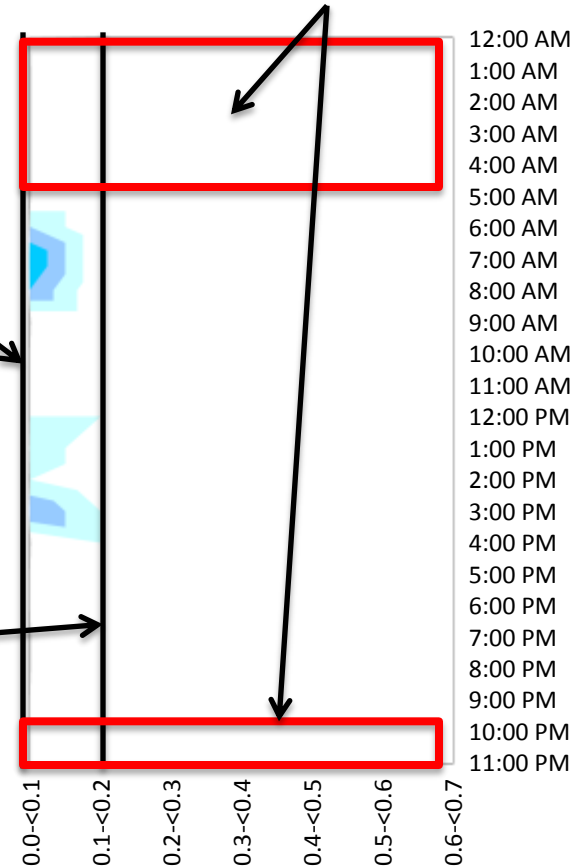
Collision Analysis – Black Lake Blvd **EB** on Ramp to US 101



US 101 On-Ramp from Black Lake Blvd to US 101 Increasing Direction
Q1 36591 for Aug 2008-Jul 2013

Heatmap: All Collisions by Hour

No Collisions from 11pm to 5am in past 5 years



Milepost

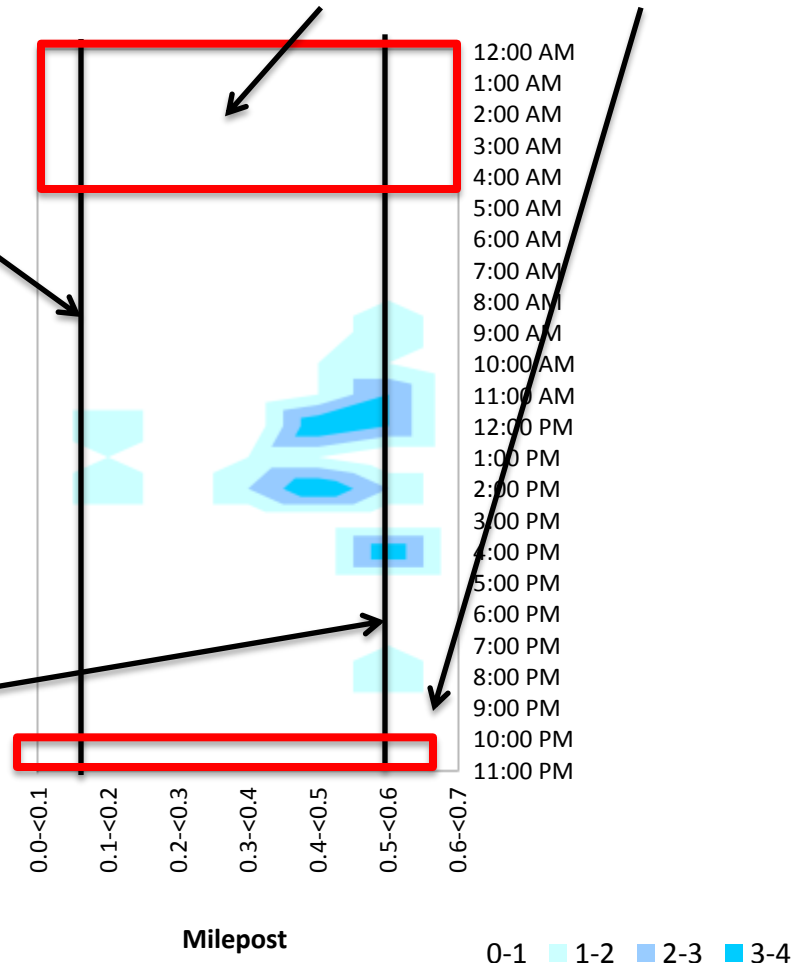
0-1 1-2 2-3 3-4

Collision Analysis – US 101 **WB** Off Ramp to Black Lake Blvd



US 101 Off-Ramp to Blacklake Blvd from US 101 Decreasing Direction
R1 36598 for Aug 2008-Jul 2013
Heatmap: All Collisions by Hour

No Collisions from 11pm to 5am in past 5 years



Given the time constraints WSDOT opted to go with a Lighting Control manufacturer with an established history.

After looking at what was available on the market and what other agencies selected we chose Acuity Brands ROAM lighting control system.

Some of the reasons WSDOT selected ROAM was:

- Time constraints looking at all manufacturers.
- ROAM is a manufacturing partner to one of the fixtures selected.
- ROAM was a “proven” commodity to WSDOT considering California and Union Station installations.
- The programming and controlling options in ROAM.
- Options available in ROAM gave WSDOT a way to keep track of the luminaire installation information and operating characteristics of each luminaire, unlike when we dig our signal system changeover to LED.
- Tracks the “operational health” of the system through System Diagnostics; Voltage and Power usage history per light
- Provides secure remote access for WSDOT Traffic Management Center for emergency

We went back to the four selected manufacturers and gave them our new requirements:

- 480V system.
- The luminaire had to be compatible with the ROAM system.
- Everything would be controlled off of one master photocell.
- All control and transformer equipment needed was required to be installed inside the luminaire fixture.
- Fixture and components required to have a warranty period of 10 years since our payback period was calculated at 12 years.

- Two of the manufacturers dropped out because they were unable to supply a 480V fixture and have the control and transformer equipment inside the luminaire fixture.
- After delaying the ordering process the third manufacturer backed out at the last minute for various reasons.
- This left WSDOT with one fixture: The American Electric Autobahn 2 fixture.

American Electric - Autobahn ATB2 LED Fixture



**1 Dimming
Control
Module (DCM)**

2 LED Drivers

➤ **Installed 88 Lights on Existing Poles**

LED Fixture and Node Installation



Remote Operating Asset Management (ROAM) Gateway Installation



Before / After Calculated Light Levels (Fc)

Objective: Average > 0.6 Fc; Minimum > 0.2Fc; Uniformity < 4:1

Westbound Off Ramp			Eastbound Off Ramp				
	310W HPS	185W LED		310W HPS	185W LED		
Priority Ramp	Average	1.24	0.84	Average	1.23	0.86	
	Maximum	2.4	1.6	Maximum	2.5	1.7	
	Minimum	0.4	0.3	Minimum	0.3	0.2	
Avg/Min (Uniformity Ratio)		3.10 : 1	2.80 : 1	Avg/Min (Uniformity Ratio)		4.10 : 1	4.30 : 1
Westbound Mainline			Eastbound Mainline				
	310W HPS	185W LED		310W HPS	185W LED		
Average	0.85	0.6	Average	0.82	0.6		
Maximum	2.7	2	Maximum	2.7	1.8		
Minimum	0.1	0.1	Minimum	0.1	0.1		
Avg/Min (Uniformity Ratio)		8.50 : 1	6.00 : 1	Avg/Min (Uniformity Ratio)		8.20 : 1	6.00 : 1
West Bound On Ramp			Eastbound On Ramp				
	310W HPS	185W LED		310W HPS	185W LED		
Average	1.1	0.79	Priority Ramp	Average	1.21	0.82	
Maximum	2.6	1.8		Maximum	2.4	1.6	
Minimum	0.2	0.2		Minimum	0.2	0.2	
Avg/Min (Uniformity Ratio)		5.50 : 1	3.95 : 1	Avg/Min (Uniformity Ratio)		6.05 : 1	4.10 : 1

Project Installation and Cost Overview

- **88 Lights**, American Electric Autobahn Series ATB2
Luminaires: \$90k
Installation: \$15k
\$105k
- Remote Operations Asset Management (**ROAM**)
Materials, Installation, 1st Year Contract: **\$25k**
Ongoing Service Contract after 1st year: **\$2,400**
- **LED install:** 2 different 2 person Crews with a Bucket Truck, 4 days
- **ROAM Nodes / Asset Management Data Capture:**
2 different 2 person Crews with a Bucket Truck, 4 days
- **ROAM Operations and Installation Training:** 1 day in shop + 1 Day Field Engineer Support

Existing HPS - looking East



Existing HPS - looking West



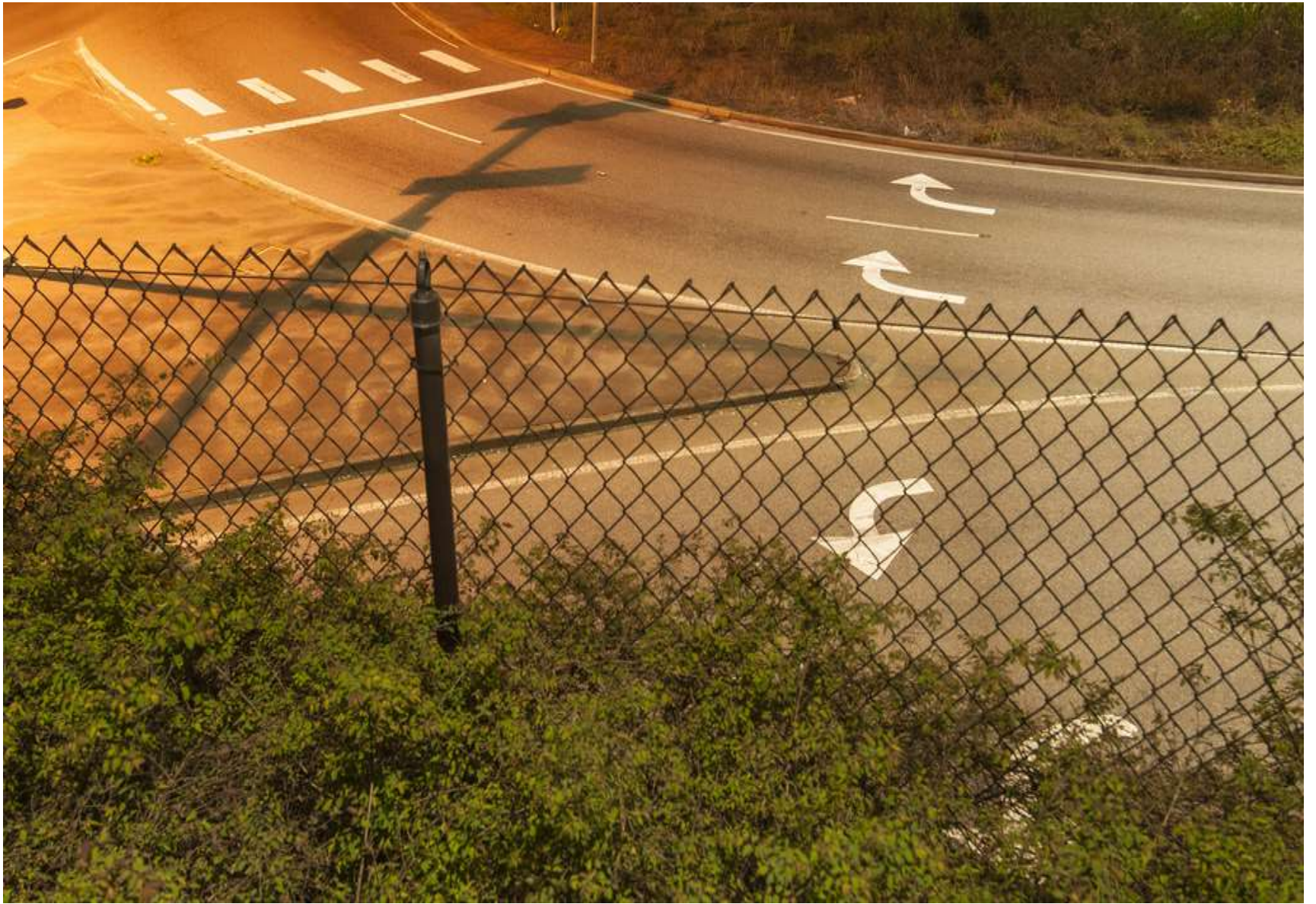
After LED Install – Looking East



After LED Install – Looking West









ROAM Adaptive Lighting Overview

US 101 Black lake Blvd LED Adaptive Lighting Pilot Project

 **Basic Illumination** - Lights are on all night from dusk until dawn (24 lights total)

 **Additional Illumination** - Lights are turned off from 11pm to 5am (64 lights total)

➤ **TMC can turn lights on remotely**

— **100% Lumen output = 187 watts**

— **During all hours of operation, all lights are dimmed to 70% lumen output (137 watts), which aligns with the "end of life" design standard. Each year the lumen output will increase by 2% (Year 1 = 70%, Year 2 = 72%, etc.) in order to ensure design standards are met throughout the life of the LED lights.**

— **At 10:59 pm, the 64 Additional Illumination Lights being turned off at 11pm will be dimmed to 15% lumen output (50watts) for 1 minute to ease the transition to turning off.**

➤ **Installed 88 Lights on Existing Poles**

BL Blvd - Calculated Power Savings

HPS (Before Condition)Power Consumption

$$88_{\text{Lights}} \times 387_{\text{Watts/light}} / 1000_{\text{Watts/KWH}} \times 13_{\text{Hours/day}} \times \$0.10_{\text{/KWH}} = \$44.27/\text{day}$$

$$\text{Total} = \$44.27/\text{day or } \$16,158.55/\text{year}$$

LED (After Condition) Power Consumption

$$26_{\text{Lights}} \times 138_{\text{Watts/Light}} / 1,000_{\text{Watts/KWH}} \times 13_{\text{hours/day}} \times \$0.10_{\text{/KWH}} = \$4.66/\text{day}$$

$$62_{\text{Lights}} \times 138_{\text{Watts/Light}} / 1,000_{\text{Watts/KWH}} \times 7_{\text{hours/day}} \times \$0.10_{\text{/KWH}} = \$5.99/\text{day}$$

Gateway Power Consumption

$$1_{\text{gateway}} \times 10_{\text{Watts/gateway}} / 1000_{\text{Watts/KWH}} \times 24_{\text{hours/day}} \times \$0.10_{\text{/KWH}} = \$0.02/\text{day}$$

Nodes and Dimming Control Modules Power consumption

$$26_{\text{Nodes}} \times 2_{\text{Watts/Node}} / 1,000_{\text{Watts/KWH}} \times 13_{\text{hours/day}} \times \$0.10_{\text{/KWH}} = \$0.07/\text{day}$$

$$62_{\text{Nodes}} \times 2_{\text{Watts/Node}} / 1,000_{\text{Watts/KWH}} \times 7_{\text{hours/day}} \times \$0.10_{\text{/KWH}} = \$0.09/\text{day}$$

$$\text{Total} = \$10.83/\text{day or } \$3,952.95/\text{year}$$

75.5% Reduction ~ \$12,205.60/year

Actual Power Savings

After HPS to LED Conversion

51.5%

After Dimming and On / Off Operation by Time of Day

73.9%

Projected 15 year Maintenance and Operations Life Cycle Cost Savings

Save > \$75,000 Maintenance & Ops

Save 1.7 million kwh of electricity

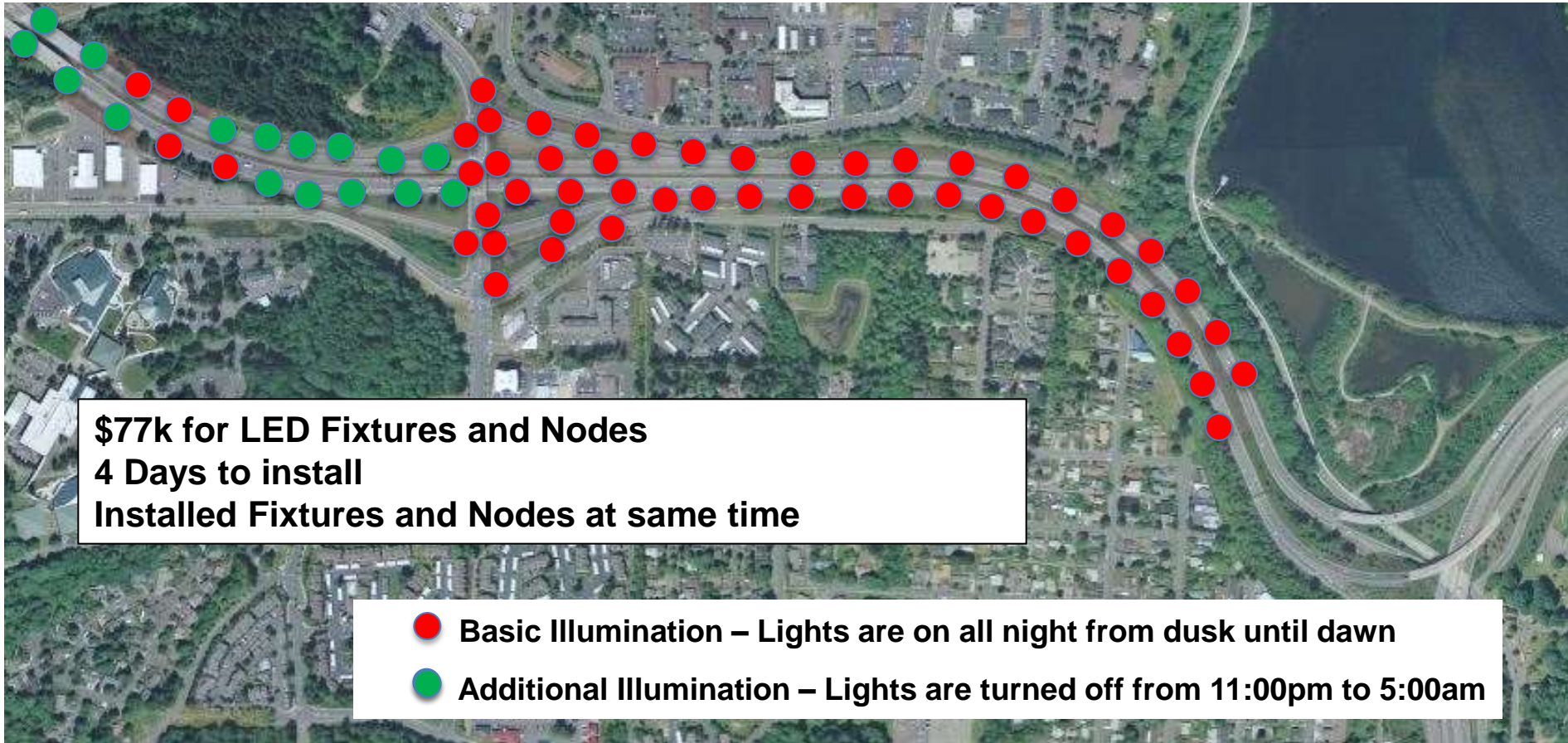
Analysis Included the following costs

- Initial Installation (Materials and Labor)
- Preventative Maintenance
 - 4 year Re-Lamp for HPS
 - Cleaning every 7.5 years for LED
- Operating Costs
 - Utility (Power) for all system components
 - Ongoing ROAM Service Agreement

Phase 2 - LED Adaptive Lighting US101 & Copper Point Rd Interchange Olympia



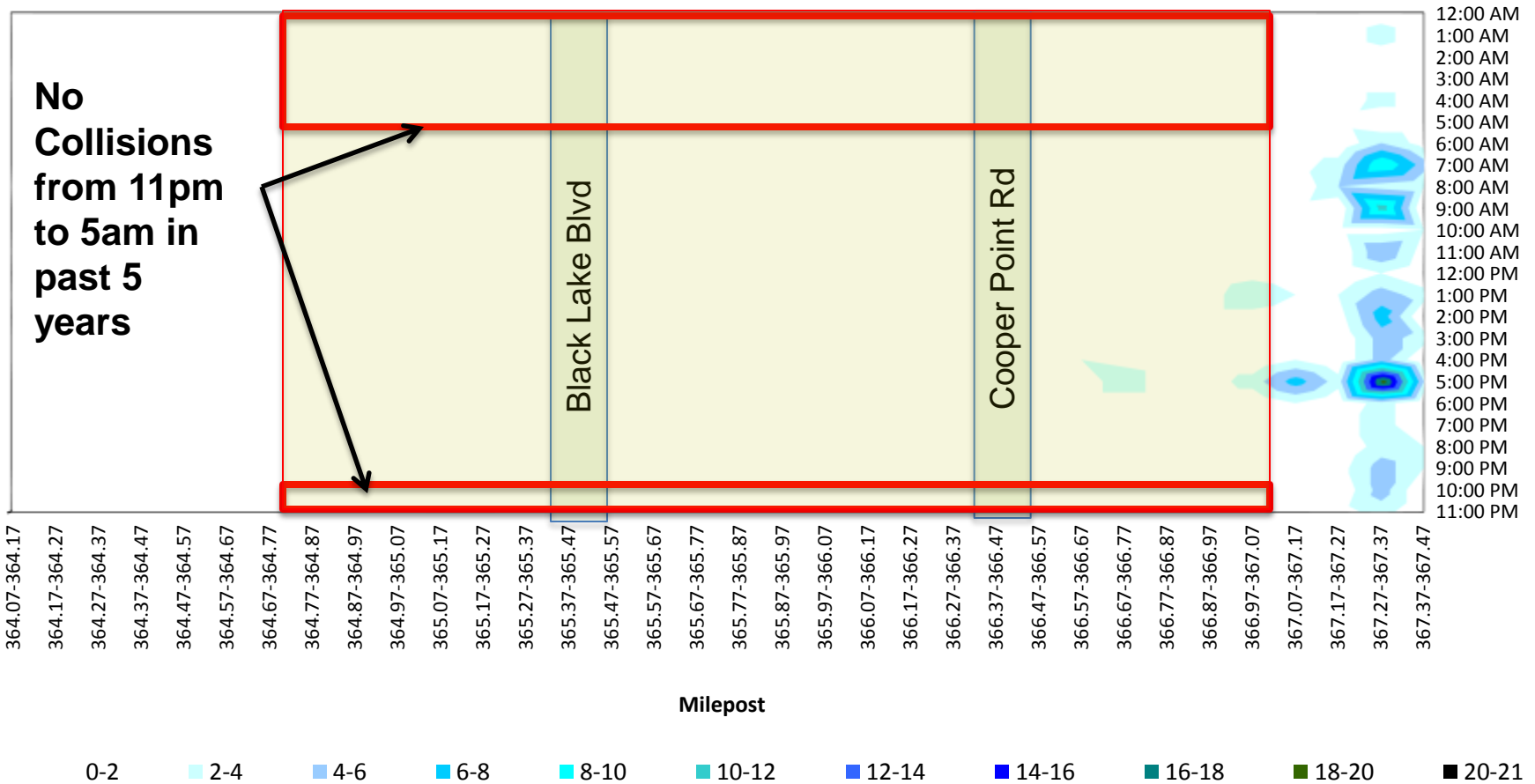
Phase 2 - LED Adaptive Lighting US101 & Copper Point Rd Interchange Olympia



Collision Analysis – Eastbound US 101

US 101 From Evergreen Pkwy to I-5 I/C (MP 364.07 - 367.41) for Aug 2008-Jul 2013

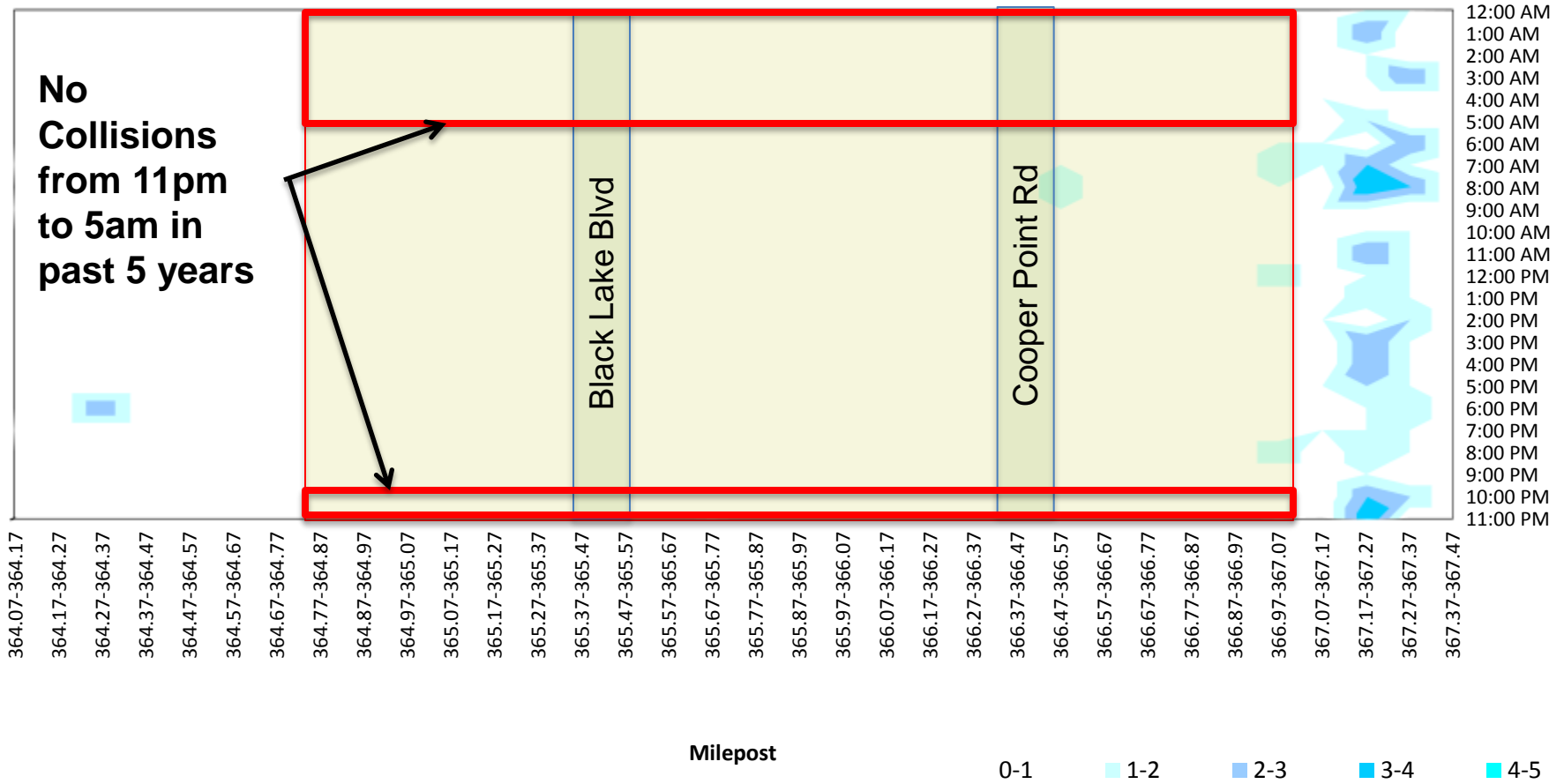
Heatmap: All Collisions, Mainline Increasing Direction by Hour



Collision Analysis – Westbound US 101

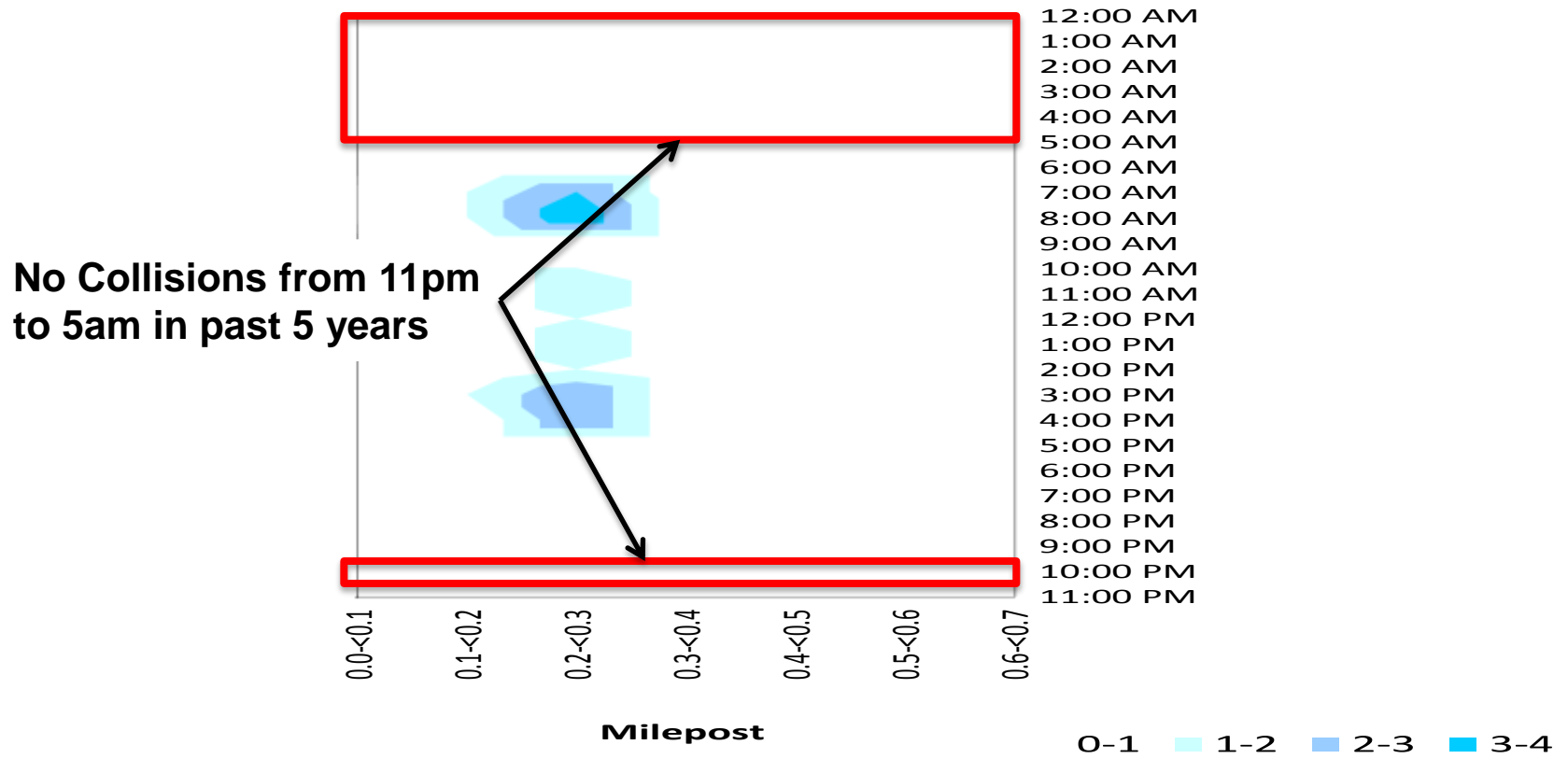
US 101 From Evergreen Pkwy to I-5 I/C (MP 364.07 - 367.41) for Aug 2008-Jul 2013

Heatmap: All Collisions, Mainline Decreasing Direction by Hour



Collision Analysis – Cooper Point Rd EB On Ramp to US 101

US 101 On-Ramp from Cooper Point Rd to US 101 Increasing Direction
Q1 36668 for Aug 2008-Jul 2013
Heatmap: All Collisions by Hour



Project Installation and Cost Overview

- **70 Lights**, American Electric Autobahn Series ATB2
Luminaires: \$72k
Installation: \$10k
\$82k
- Ongoing Service Contract after 1st year: **\$2,400**
- **LED install:** 2 different 2 person Crews with a Bucket Truck, 4 days
- **ROAM Nodes / Asset Management Data Capture:**
2 person Crew with a Bucket Truck, 4 days

CP - Calculated Power Savings

HPS (Before Condition)Power Consumption

$$68_{\text{Lights}} \times 387_{\text{Watts/light}} / 1000_{\text{Watts/KWH}} \times 13_{\text{Hours/day}} \times \$0.10_{\text{/KWH}} = \$34.21/\text{day}$$

$$\text{Total} = \$34.21/\text{day} \text{ or } \$12,486.94/\text{year}$$

LED (After Condition) Power Consumption

$$52_{\text{Lights}} \times 138_{\text{Watts/Light}} / 1,000_{\text{Watts/KWH}} \times 13_{\text{hours/day}} \times \$0.10_{\text{/KWH}} = \$9.33/\text{day}$$

$$16_{\text{Lights}} \times 138_{\text{Watts/Light}} / 1,000_{\text{Watts/KWH}} \times 7_{\text{hours/day}} \times \$0.10_{\text{/KWH}} = \$1.55/\text{day}$$

Nodes and Dimming Control Modules Power consumption

$$52_{\text{Nodes}} \times 2_{\text{Watts/Node}} / 1,000_{\text{Watts/KWH}} \times 13_{\text{hours/day}} \times \$0.10_{\text{/KWH}} = \$0.14/\text{day}$$

$$16_{\text{Nodes}} \times 2_{\text{Watts/Node}} / 1,000_{\text{Watts/KWH}} \times 7_{\text{hours/day}} \times \$0.10_{\text{/KWH}} = \$0.02/\text{day}$$

$$\text{Total} = \$11.04/\text{day} \text{ or } \$4,029.60/\text{year}$$

67.7% Reduction ~ \$8,457.34/year

Lessons Learned

Maintenance has been to the project about a dozen times trouble shooting issues.

- Approximately 12 poles repeatedly blowing fuses.
 - High inrush current > 100 AMPS, switched to 20amp slow blow fuses
- 1 transformer had to be replaced.
- 1 bad driver in a fixture, works at half power.
- 1 bad fixture, keeps shorting out & blowing fuses.
- 13 Nodes would not connect.
- Several fixtures were delivered with wiring issues
(Pinched, chaffed, bad insulation)

Lessons Learned

- Order Spares – Fixtures and Control Nodes.
- Polarity of the circuit appears to make a difference – in both the head and node.
- Use slow blow fuses due to high inrush current
- LED fixtures are evolving rapidly so expect some out of the box failures.
- Issues with using one main photocell and communication with the nodes. Also adds another step in maintenance trouble shooting the system, they have to log in to ROAM and turn all the lights on in addition to flipping the test bypass switch.
- Test to make sure your control system will work will your selected luminaire.

ROAM Operations & Asset Tracking

Manage Schedules Close

Schedules

- 70% Burn
- OFF 11PM-5AM**

Schedule Details

Schedule Name OFF 11PM-5AM Save Changes Delete Schedule

Created By OlyMaint1 on Wed Mar 27 14:20:48 PDT 2013
Changed By OlyMaint1 on Thu Apr 25 09:58:09 PDT 2013

On/Off

Weekday

- Turn Off at 23:00
- Turn Off at 00:00
- Normal Operations at 05:00

Add Action

Weekend

- Turn Off at 23:00
- Turn Off at 00:00
- Normal Operations at 05:00

Add Action

Dimming

Weekday

- Level: 15 at 22:59
- Level: 67 at 00:00

Add Action

Weekend

- Level: 15 at 22:59
- Level: 67 at 00:00

Add Action

New Schedule

Asset Info: 00161N000003E4FD Close

Choose Information Page:

Attributes

- Fixture Voltage: 240
- Latitude: 47.03702880
- Longitude: -122.95101965
- DCM ID: 00161N0000044634
- FixtureManufacturer: AEL
- Base Type: Slip
- Pole Height: 40 Feet
- Pole ID: 2
- Street: :RNUS-101/WB
- State: WA
- Zip: 98502
- Pole Type: Steel
- Lamp Type: LED
- Lamp Wattage: 183
- VoltageSystem: 480
- FixtureModelNumber: ATB2-80BLEDE70-480-R3-UPSPOM-RFD127217
- NumberOfFixtures: 1
- MastArmLength: 12 Feet

ROAM System Diagnostics

ROAM Dashboard | Maps | Reporting | History | Scheduling | Groups

Installation: WSDOT [Black Lake]

Date Range: 9/20/2013 thru 10/19/2013

Filter: 7 Consecutive Days










Work Order: Ignore

Priority Flag: Ignore

MacID / DeviceID	Location	Type	Watt	28 S	29 S	30 M	01 T	02 W	03 T	04 F	05 S	06 S	07 M	08 T	09 W	10 T	11 F	12 S	13 S	14 M	15 T	16 W	17 T	18 F	19 S
73	47.03338,-122.94197	LED	183	137	137	137	138	137	137	137	137	138	137	137	138	137	138	137	138	137	138	138	137	138	137
00181N000003E84C74	Not Addressable 47.03361,-122.94247	LED	183	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
00181N000003EA2478	Not Addressable 47.03383,-122.94293	LED	183	138	138	138	138	138	138	138	138	138	138	138	139	138	138	138	139	0	0	0	138	139	138
00181N000003EC4378	Not Addressable 47.03405,-122.94341	LED	183	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	138	138	138
00181N000003E54879	Not Addressable 47.03427,-122.94386	LED	183	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	137	138	137
00181N000003EB0B80	Not Addressable 47.03448,-122.94436	LED	183	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	139	139	139
00181N000003E77C81	Not Addressable 47.03471,-122.94482	LED	183	1	137	137	137	137	137	137	137	138	137	137	137	137	137	137	137	0	0	0	137	137	137

Views

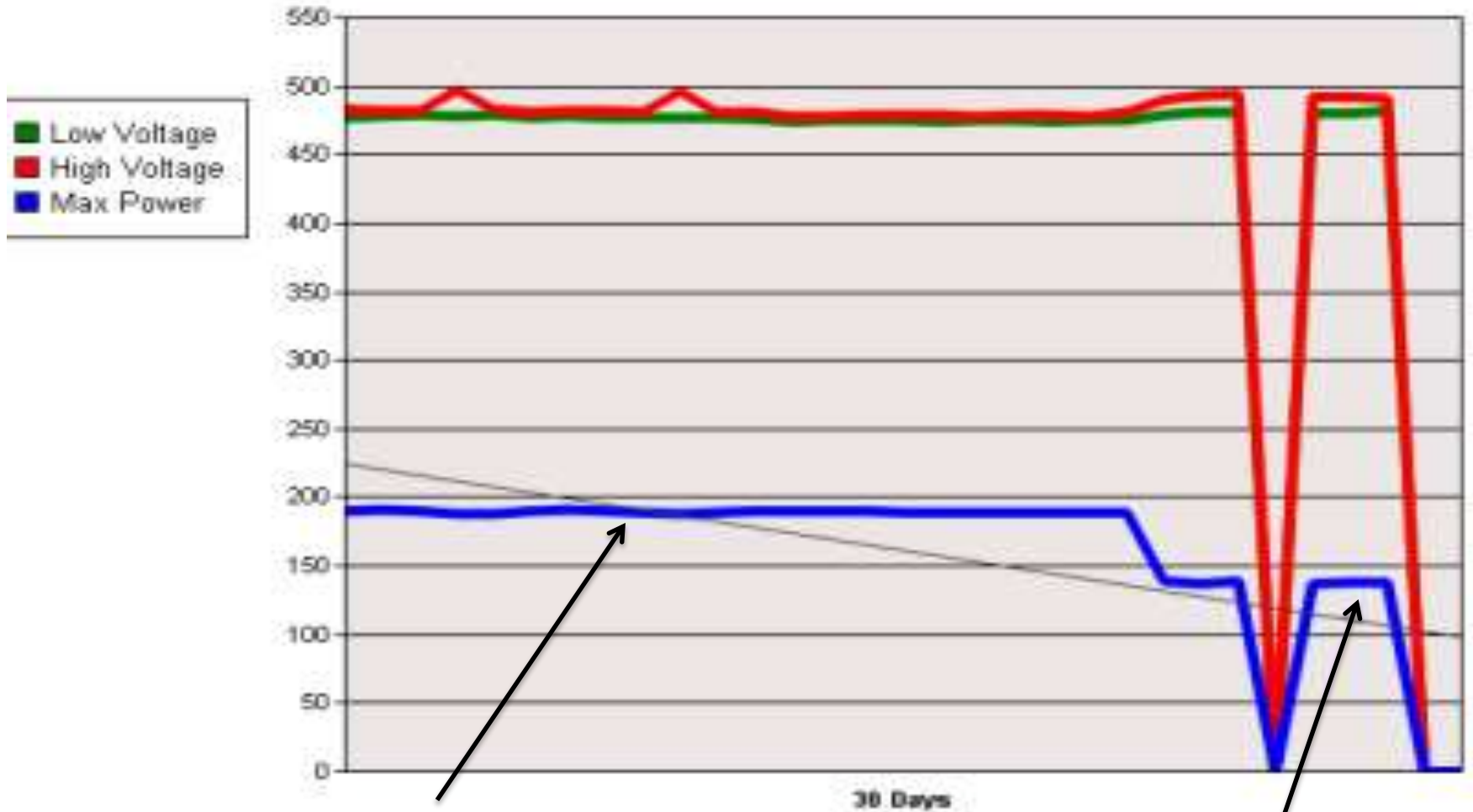
Diagnostic

-  Normal Operation
-  Operational With Issues
-  Fixture Malfunction
-  Low Wattage
-  Unspecified Malfunction
-  Not Communicating
-  Partial Report
-  Unregistered
-  No Power at Activation

Information
Current Time: 8:07:37 PM
Logged in as: HQTraffic
Current Bookmark: Site Image

Wire Theft – WB on Ramp

ROAM Power Usage History Per Light



Full Lumen Output

**Dimming
(70% Lumen Output)**

ROAM Burn Hour Report for US 101 & Black Lake

ROAM Dashboard | Maps | Reporting | History | Scheduling | Groups

WSDOT (Black Lake) | Reports | Burn Hours

ROAM Burn Hour Report for WSDOT [Black Lake]
Current Date: 10/20/2013 22:56:38
As of 10/19/2013

Page 1 of 3

Date Created	Device ID	Mac ID	DCM ID	Latitude	Longitude	Voltage	System	Pole Type	Base Type	Electrical Feed	Fixture Type	Lamp Wattage	Lamp Type	Daily Burn Hours	Daily KWH Hours	Total Burn Hours	Total KWH Hours
3/20/2013	74	00161N000003E64C	00161N000004DFCE	47.0336	-122.9425	480		Steel	Slip			183	LED	7.00	0.95	1,943.52	118.75
3/20/2013	90	00161N000003E551	00161N00000454C1	47.0376	-122.9516	480		Steel	Slip			183	LED	7.00	0.96	1,517.49	123.85
3/20/2013	1	00161N000003E5D6	00161N0000042CE2	47.0373	-122.9519	480		Steel	Slip			183	LED	7.00	0.96	1,092.50	124.36
3/20/2013	4	00161N000003E55D	00161N000003E84E	47.0364	-122.9493	480		Steel	Slip			183	LED	7.00	0.96	1,513.90	125.74
3/20/2013	10	00161N000003E78D	00161N0000047F7A	47.0343	-122.9453	480		Steel	Slip			183	LED	7.00	0.96	1,485.16	126.06
10/10/2013	37	00161N000003E7D6	00161N000004E3F6	47.0297	-122.9359	480		Steel	Slip			183	LED	13.00	2.46	85.23	13.84
3/20/2013	73	00161N000003EC44	00161N0000045481	47.0334	-122.9420	480		Steel	Slip			183	LED	7.00	0.96	1,291.68	145.78
3/20/2013	29	00161N000003E58A	00161N0000043BDC	47.0314	-122.9389	480		Steel	Slip			183	LED	7.00	0.96	1,449.05	152.14
3/20/2013	85	00161N000003E7C7	00161N00000454E2	47.0359	-122.9473	480		Steel	Slip			183	LED	7.00	0.95	1,703.00	152.38
3/20/2013	36	00161N000003E59D	00161N0000042E13	47.0299	-122.9363	480		Steel	Slip			183	LED	7.00	0.95	1,673.11	152.57
3/20/2013												183	LED	7.00	0.95	1,716.71	152.61
3/20/2013												183	LED	7.00	0.95	1,725.32	152.81
3/20/2013												183	LED	7.00	0.95	1,677.61	153.00
3/20/2013												183	LED	7.00	0.95	1,811.61	153.33
3/20/2013												183	LED	7.00	0.96	1,733.51	153.45
3/20/2013												183	LED	7.00	0.95	1,698.56	153.68
3/20/2013												183	LED	7.00	0.96	1,623.56	154.21
3/20/2013												183	LED	7.00	0.97	1,617.68	154.27
3/20/2013												183	LED	7.00	0.96	1,556.23	154.30
3/20/2013												183	LED	7.00	0.96	1,647.16	154.35
3/20/2013												183	LED	7.00	0.96	1,603.01	154.62
3/20/2013												183	LED	7.00	0.95	1,671.13	154.91
3/20/2013												183	LED	7.00	0.96	1,956.83	155.01
3/20/2013												183	LED	7.00	0.96	1,680.80	155.26
3/20/2013												183	LED	7.00	0.95	1,793.53	155.30
3/20/2013												183	LED	7.00	0.95	1,674.40	155.37

Lamp Wattage	Lamp Type	Daily Burn Hours	Daily KWH Hours	Total Burn Hours	Total KWH Hours
183	LED	7.00	0.95	1,943.52	118.75
183	LED	7.00	0.96	1,517.49	123.85
183	LED	7.00	0.96	1,092.50	124.36
183	LED	7.00	0.96	1,513.90	125.74
183	LED	7.00	0.96	1,485.16	126.06
183	LED	13.00	2.46	85.23	13.84

For more information on the
**US 101 Adaptive LED Lighting Project
and Illumination Reform**

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WSDOT Illumination Design Standards: www.wsdot.wa.gov/Design/Traffic

LED Pilot Project: www.wsdot.wa.gov/Design/Traffic/Electrical/LEDPilotProject