LIGHTING JUSTIFICATION REPORT

for

Boggy Creek Road from Simpson Road to Narcoossee Road

Osceola County, Florida

Prepared By:

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April 2021

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This item has been digitally signed and sealed by Bahman Behzadi, PE on the date adjacent to the seal.

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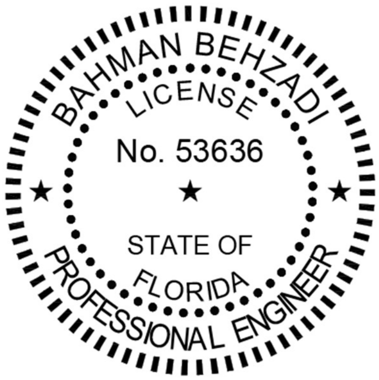

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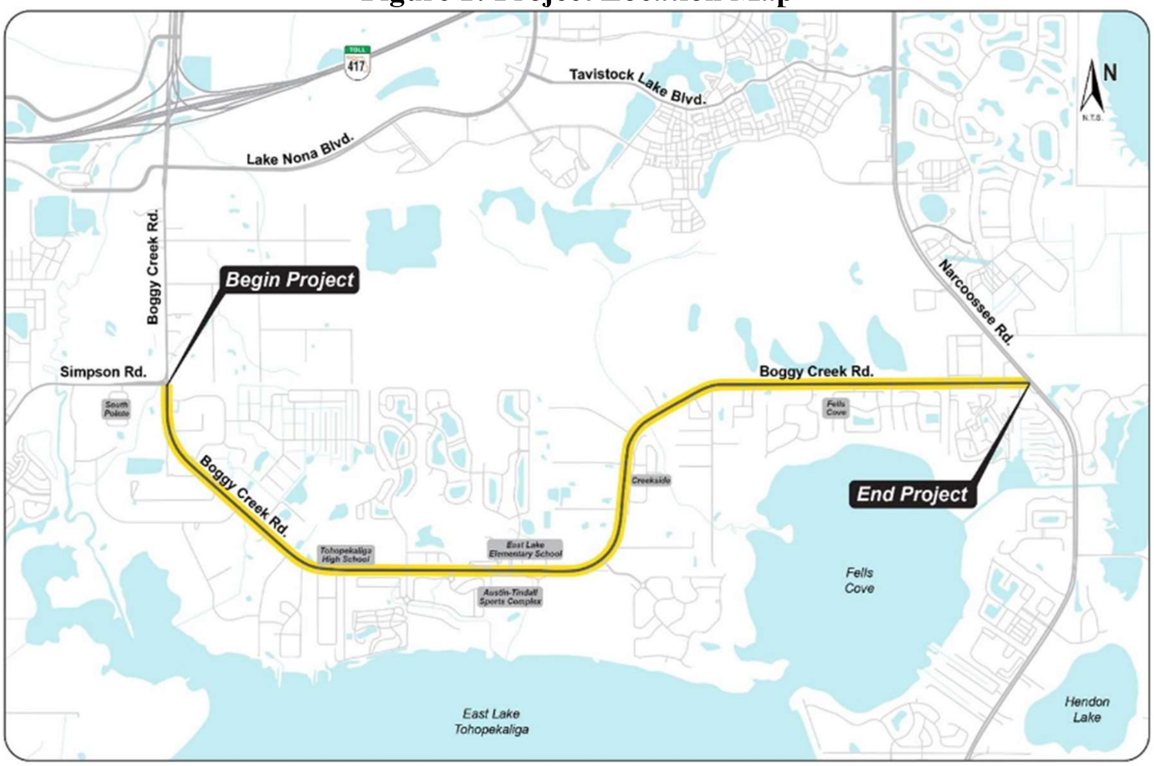
1.0 INTRODUCTION

Project Description

This lighting justification report is being conducted for Boggy Creek Road from Simpson Road to Narcoossee Road from a two-lane undivided roadway to a four-lane divided roadway. The Proposed Typical Section for this project can be found in **Appendix A**.

Per the FDOT Design Manual (FDM) Section 231.4 and Chapter 14 of the FDOT Manual on Uniform Traffic Studies (MUTS), the proposed intersections within the project limits, will be lighted and a warranting analysis will not be required. The purpose of this report is to determine whether roadway lighting between the intersections and the end project limits is warranted and justified. The project limits are shown within **Figure 1** below.

Figure 1: Project Location Map



Analysis Methodology

The analysis is based on the procedure outlined in Chapter 14 of the MUTS. The MUTS divides the procedure into two steps: Step 1 consists of determining whether or not roadway lighting is warranted by addressing the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Association of Canada (TAC) warranting systems; and Step 2 consists of determining if the roadway lighting is justified by performing a net present value (NPV) analysis to quantify the safety benefits of the lighting system versus the cost of construction, maintenance, and operation. The AASHTO Roadway Lighting Design Guide warranting system is used to evaluate freeways, bridges, and interchanges. The TAC Guide for the Design of Roadway Lighting is used to evaluate local streets, major arterials, and collectors.

2.0 LIGHTING WARRANTS

Lighting warrants assist in determining locations where lighting may be beneficial based on defined conditions. The warranting systems discussed in the MUTS are the TAC Guide for the Design of Roadway Lighting and the AASHTO Roadway Lighting Design Guide. These warranting systems are detailed below.

TAC Warranting System

The TAC Guide for the Design of Roadway Lighting warranting system is used for local streets, major arterials, and collectors. This warranting system is based upon geometric, operational, environmental, and collision factors. Since Boggy Creek Road is a major arterial, this warranting system was considered.

AASHTO Warranting System

The AASHTO Roadway Lighting Design Guide warranting system is used for freeways, bridges, and interchanges. This warranting system is based upon traffic volumes, spacing of freeway interchanges, lighting in adjacent areas, and night-to-day crash ratios. Since this project is not a freeway, bridge, or interchange, this warranting system was not considered.

The following warranting conditions described in Table 1 is used for information only and do not apply to our project.

Table 1 - Warranting Conditions for Continuous Freeway Lighting (CFL)

Case	Warranting Conditions
CFL-1	Sections in and near cities where the current average daily traffic (ADT) is 30,000 or greater.
CFL-2	Sections where three or more successive interchanges are located with an average spacing of 1.5 miles or less, and adjacent areas outside the right-of-way are substantially urban in character.
CFL-3	Sections of two miles or more passing through a substantially developed suburban or urban area in which one or more of the following conditions exist: a. Local traffic operates on a complete street grid having some form of street lighting, parts of which are visible from the freeway. b. The freeway passes through a series of developments-such as residential, commercial, industrial and civic areas, colleges, parks, terminals, etc. that include lighted roads, streets, parking areas, yards, etc. – that are lighted. c. Separate cross streets, both with and without connecting ramps, occur with an average spacing of 0.5 miles or less, some of which are lighted as part of the local street system. d. The freeway cross section elements, such as median and borders, are substantially reduced in width below desirable sections used in relatively open country.
CFL-4	Sections where the ratio of night to day crash rate is at least 2.0 times the statewide average for all unlighted similar sections, and a study indicates that lighting may be expected to result in a significant reduction in the night crash rate. Where crash data is not available, rate comparison may be used as a general guideline for crash severity.

3.0 NET PRESENT VALUE ANALYSIS

If lighting is warranted, as determined by the TAC warranting conditions, a net present value (NPV) analysis is required to determine if lighting is justified for the project. The NPV evaluates the profitability of the proposed improvement, utilizing an interest rate of 4%.

The NPV analysis is used to compare the total crash cost savings (difference between the monetary cost of crashes for unlighted conditions and lighted conditions) to the present value of the lighting project (cost of construction, maintenance, and operation). If the total crash cost savings is greater than or equal to the present value of the lighting project, then lighting is justified.

Per Chapter 14 of the MUTS, the predictive method outlined in the Highway Safety Manual (HSM) should be used for the lighting justification crash cost analysis where applicable. The HSM method is applicable for the facility and site types shown on the following page.

HSM Chapter	Undivided Roadway Segments	Divided Roadway Segments	Intersections			
			Stop Control on Minor Leg(s)		Signalized	
			3-Leg	4-Leg	3-Leg	4-Leg
10—Rural Two-Lane Roads	✓	—	✓	✓	—	✓
11—Rural Multilane Highways	✓	✓	✓	✓	—	✓
12—Urban and Suburban Arterial Highways	✓	✓	✓	✓	✓	✓

The HSM predictive method is utilized to predict the crash frequency for a roadway with and without lighting. A monetary cost of crashes is then quantified for each condition following the guidance of Section 122.6.3 of the FDM. The cost difference between the two conditions is the total crash cost savings. The NPV is then computed by comparing the crash cost savings to the present value of the project. The steps to perform a NPV computation using the HSM methodology are detailed below:

Step 1: Identify or compute crash frequencies for NO LIGHTING CONDITIONS

Step 2: Quantify monetary cost of crashes for NO LIGHTING CONDITIONS

Step 3: Identify or compute crash frequencies for LIGHTED CONDITIONS

Step 4: Quantify monetary cost of crashes for LIGHTED CONDITIONS

Step 5: Compute difference: BENEFIT = Monetary cost of crashes for NO LIGHTING CONDITIONS – Monetary cost of crashes for LIGHTED CONDITIONS

Step 6: Utilizing an interest rate of 4% and analysis period (i.e. 20 years), compute the project NPV.

The FDOT MUTS Manual spreadsheet *750-020-21b Present Worth Analysis for Rural-Multilane Roads (09/20)* was utilized for the present worth analysis and is shown in **Figure 2** on the following page. The spreadsheet is a tool derived from the predictive method outlined in Chapter 11 of the HSM; the general form of the predictive model for rural multilane highways, shown in HSM equation 11-1, is as follows:

$$N_{predicted} = N_{spf\,x} \times (CMF_{1x} \times CMF_{2x} \times \ldots \times CMF_{yx}) \times C_x$$

Where:
$N_{predicted}$ = predicted average crash frequency for a specific year on site type x;
$N_{spf\,x}$ = predicted average crash frequency determined for base conditions of the SPF developed for site type x;
CMF_{yx} = crash modification factors specific to site type x and specific geometric design and traffic control features y; and
C_x = calibration factor to adjust SPF for local conditions for site type x.

The $N_{spf\,x}$ for the base condition is calculated by HSM equation 11-9, shown below:

$$N_{spf\,rd} = e^{(a+b\times\ln(AADT)+\ln(L))}$$

Where:
$N_{spf\,rd}$ = base total number of roadway segment crashes per year;
$AADT$ = annual average daily traffic (vehicles/day) on roadway segment;
L = length of roadway segment (miles); and
a, b = regression coefficients (shown in HSM Table 11-5 and **Appendix B**).

The various crash modification factors applied are based on site conditions such as segment length, lane widths, shoulder width and type, median width, AADT, presence of lighting, and speed enforcement condition and are discussed and derived in the HSM. Applied CMFs are shown in **Appendix B** for each condition.

Figure 2: Present Worth Analysis Spreadsheet (Example)

Form 750-020-21b
TRAFFIC ENGINEERING
September 2020

State of Florida Department of Transportation
Present Worth Analysis
Rural Multilane Arterial
No-Build Alternative

General Information				Site Information			
Analyst:		Date:		Roadway:		Jurisdiction:	
Agency or Company:				Roadway Section:			

Manual Input from Analysis

Growth Rate =		Current Year =	0	Project Opening Year =	
Opening Year AADT =	0	Rate of Return =		Analysis Period =	
Segment Length =	0.00	Segment Type =	Undivided		
Crash Data Used =		Segment =	Undivided Multilane - U	1.25	Analyze

Default Distribution for Crash Severity Level (2010-2014 Florida HSM Crash Distribution)

Fatality =	2.9%	Possible Injury =	21.8%
Incapacitating =	11.1%	Property Damage Only =	46.0%
Non-Incapacitating =	18.2%		100.0%

	Year		$(N_{predicted})$	Annual Number of Crashes: Fatality	Incap.	Non-Inc.	Possible Injury	PDO	Annual Cost: Fatality	Incap.	Non-Inc.	Possible Injury	PDO	Total Cost	Present Value
	0	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	1	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	2	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	3	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	4	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	5	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	6	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	7	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	8	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	9	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	10	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	11	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	12	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	13	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
	14	0		0.000	0.000	0.000	0.000	0.000	$0	$0	$0	$0	$0	$0	$0
														Total Present Value	$0

Shaded cell indicates the AADT is outside the limits

Calibration Factors (Cx)

The present worth analysis requires a calibration factor (Cx) based on the roadway characteristics. The calibration factor was obtained from Table 122.6.3 in the FDM, as shown in **Figure 3**. The calibration factor (Cx) is used in the *750-020-21b Present Worth Analysis for Rural-Multilane Roads (09/20)* spreadsheet.

Figure 3: FDOT Design Manual (FDM) Calibration Factors

Table 122.6.3 HSM Calibration Factors for Florida

Type Facility		Abbreviation	Calibration Factor (Cx)
FDOT Roadway Calibration Factors			
Rural	2-lane Undivided	R2U	1.00
	4-lane Divided	R4D	0.68
Urban	2-lane Undivided	U2U	1.02
	3-lane with a Center Two-Way Left Turn Lane	U32LT	1.04
	4-lane Undivided	U4U	·073
	4-lane Divided	U4D	1.63
	5-lane with a Center Two-Way Left Turn Lane	U52LT	0.70
FDOT Intersection Calibration Factors			
Rural	2-lane 3-Leg Stop-Controlled	RTL3ST	1.27
	2-lane 4-Leg Stop-Controlled	RTL4ST	0.74
	2-lane 4-Leg Signalized	RTL4SG	0.92
	Multilane 3-Leg Stop-Controlled	RML3ST	2.20
	Multilane 4-Leg Stop-Controlled	RML4ST	1.64
	Multilane 4-Leg Signalized	RML4SG	0.45
Urban	3-Leg Stop-Controlled Intersection	USA3ST	1.14
	4-Leg Stop-Controlled Intersection	USA4ST	1.87
	3-Leg Signalized w/o Ped. CMFs	USA3SG w/o Ped.	2.58
	3-Leg Signalized w/ Ped. CMFs	USA3SG w/ Ped.	2.50
	4-Leg Signalized	USA4SG	2.27

When calculating present worth of crashes, it is recommended the subject corridor be analyzed as one segment and lighting is automatically justified at all signalized intersections within the project limits. Therefore, the entire project was analyzed as one segment.

It should be noted that the crashes predicted using HSM methodologies are not nighttime-only crashes, but rather a compilation of all day and night crashes. However, when modifying the lighting parameter within the present worth analysis spreadsheet (present/not present), the calculation automatically adjusts to show the impact of lighting to nighttime crashes only.

The total present worth of crashes is determined by the cumulative present values over 14 years, from Opening Year (2025) to Design Year (2039), and is based on the following equation:

$$Present\ Value = {}^{Future\ Value}\!/_{(1+i)^n}$$

Where:
i = required rate of return; and
n = number of years.

The total present worth of crashes calculations for each condition are detailed in **Appendix B**.

Tables 2 and **3** below illustrate the predicted total present values for the no-build (unlighted) and build (lighted) conditions, respectively, with crash cost summarized in

Table 4. A detailed analysis of the total crash cost for each condition is shown in **Appendix B**.

Table 2 – Alt #1 (No-Build) Summary of Total Present Value

SUMMARY OF TOTAL PRESENT VALUE Alternative #1 (No-Build)							
Segment Site	**Beginning Year**			**End Year**			**Total Present Value**
	Year	**AADT**	**N expected**	**Year**	**AADT**	**N expected**	
Mainline	2025	20,000	19.2	2039	34,634	32.9	$57,597,385
						TOTAL No-Build	$57,597,385

Table 3 –Alt #2 (Full Lighting) Summary of Total Present Value

SUMMARY OF TOTAL PRESENT VALUE Alternative #2 (Full Lighting)							
Segment Site	**Beginning Year**			**End Year**			**Total Present Value**
	Year	**AADT**	**N expected**	**Year**	**AADT**	**N expected**	
Mainline	2025	20,000	17.5	2039	47,615	30.6	$53,676,507
						TOTAL Full Lighting	$53,676,507

Table 4 – Crash Cost Analysis

From Simpson Road to Narcoossee Road	
Scenario	**Total Present Worth**
No Lighting Condition	$57,597,385
Lighted Condition	$53,676,507
Crash Cost Savings for Lighted Condition	$3,920,878

Present Value of Lighting Project – Including Installation, Operation, and Maintenance costs

The present value of the lighting project was calculated by determining the installation, maintenance, and energy costs associated with the installation of proposed lighting. The cost savings determined by the analysis previously stated is **$3,920,878**. To estimate the installation cost, a typical section photometric analysis has been performed using Lighting Analyst, Inc.'s AGi32 software version 19.10 to determine the pole spacing required to meet the lighting criteria outlined in Section 231 of the FDM. The analysis resulted in a pole spacing of 265 feet. This equates to approximately 118 proposed poles along the roadway segment. The results of the typical section photometric analysis are detailed in **Appendix C** and summarized in **Table 5** below:

Input Data

Luminaire:	Lumec RoadFocus LED Cobra Head Luminaire (Catalog No. RFL-241W112LED4K-G2-R2M-HS
Lamp:	243-watt LED
Distribution:	Type II medium distribution (B4-U2-G4)
Mounting Height:	45 feet
Arm Length:	15 feet
Pole Configuration:	Staggered Across
Pole Spacing:	265 feet

Table 5 – Photometric Results

	Average/Min Ratio	**Max/Min Ratio**	**Average Illuminance (H.F.C.)**	**Veiling Luminance Ratio**
FDM Table 231.2.1 Criteria	4:1 or Less	10:1 or Less	1.5	0.3:1 or Less
Proposed Photometric Results	2.85:1	7.09:1	1.51	0.28:1

Estimates for the installation, maintenance, and energy costs based on the calculated pole spacing are summarized below. The detailed calculation used to determine the estimated installation cost is provided in **Appendix E**.

Installation Cost (IC) = $1,616,495.95
(Based on the latest FDOT Historical Costs)
Present Value of Annual Maintenance Cost (PVMC) = $472,000.00
($200 per fixture per year)
Present Value of Annual Energy Cost (PVEC) = $260,748.00
(Based on Florida Average of 11.42¢ per kWh)

The crash cost savings and the total lighting project costs have been compared to determine the NPV of the lighting project, utilizing the service life for a lighting project. The results are shown in **Table 6** below:

Table 6 – Net Present Value Analysis

From South of US 17/92 to Ronald Reagan Pkwy	Total Present Value
Crash Cost Savings for Lighted Condition	$3,223,451.00
Total Lighting Project Costs	$2,349,243.95
Net Present Value (NPV)	$874,207.05

The total project cost to light Boggy Creek Road within the project limits was less than the monetary crash savings and resulted in NPV of $874,207.05.

4.0 BENEFIT-COST ANALYSIS

The purpose of performing a benefit-cost analysis is to determine if the project is justified based on its benefit-cost ratio. If the benefit-cost ratio is equal to 1.0 or more, then lighting is justified for high crash locations, as identified by the State Safety office. At other locations, the benefit-cost ratio should be 2.0 or greater. The B/C ratio was calculated using the following equation:

$$\mathrm{B/C} = \frac{\text{Crash Cost Savings}}{\text{Improvement Cost}} = \mathrm{X.XX}$$

Since there is no existing lighting, the system has been analyzed using the installation of lighting as the improvement cost. The results of the benefit-cost analysis are summarized in **Table 7** below.

Table 7 – Benefit-Cost Ratio Summary

Alternative #2 Full Lighting	
Crash Cost Savings	$3,223,451.00
Improvement Cost	$2,349,243.95
B / C	1.37

Based on the Benefit-Cost analysis, the lighting would provide a significant return on investment. Therefore, it is justified to install lighting along the proposed segment of Boggy Creek Road in accordance with current lighting standards.

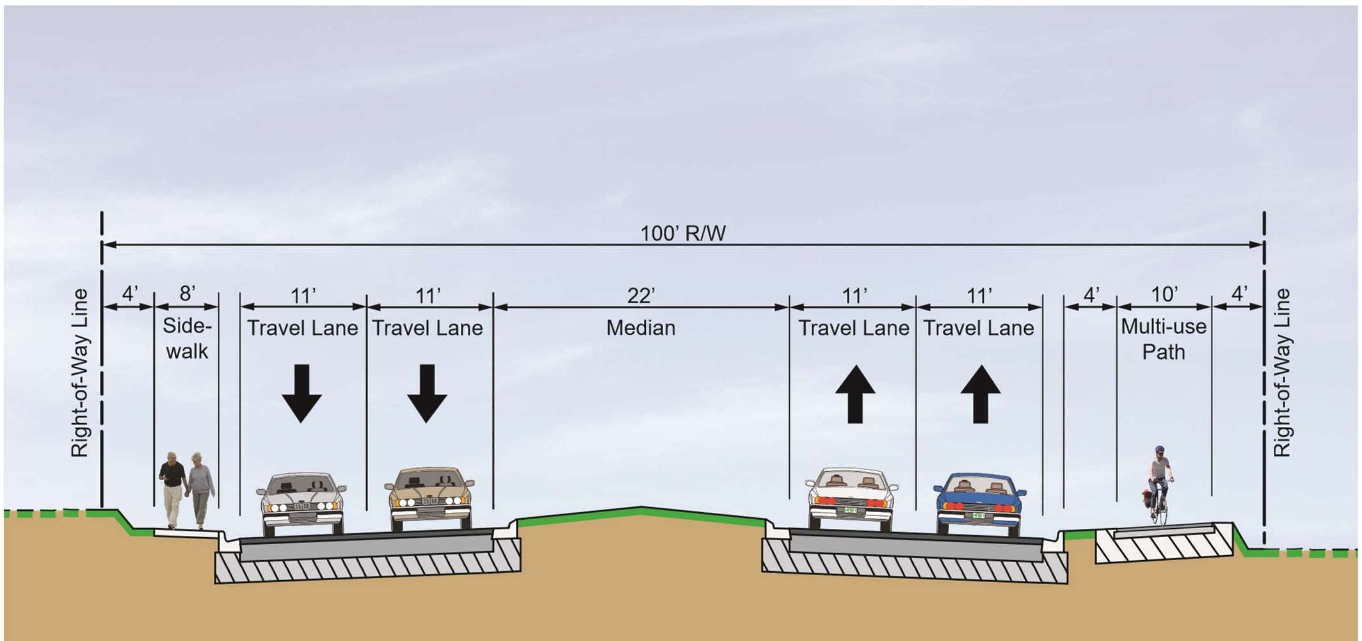
5.0 CONCLUSION

The TAC warrant system was used to determine if lighting was warranted for the project area. The AASHTO warrant system was not utilized considering the project area is not a freeway, bridge, or interchange. Based on the TAC warranting system, proposed lighting was determined to be warranted along Boggy Creek Road within the project limits.

According to the findings outlined in this report including the results of the NPV calculations and benefit-cost analysis, it is recommended to install proposed continuous lighting along Boggy Creek Road corridor within the project limits.

<u>Appendix A</u>

Typical Section



Typical Section 2

4 Lane Roadway with 22' Median, Multi-use Path, 8' Sidewalk

Appendix B

Present Worth Analysis

Alternative #1
(No-Build – No Lighting Installed)

Worksheet 1A -- General Information and Input Data for Rural Multilane Roadway Segments

General Information		Location Information	
Analyst	B. Behzadi	Roadway	Boggy Creek Road
Agency or Company	Dewberry Engineers, Inc.	Roadway Section	From Simpson Road to Narcoossee Road
Date Performed	03/31/21	Jurisdiction	Osceola County
		Analysis Year	2025

Input Data		Base Conditions	Site Conditions	
Roadway type (divided / undivided)		Undivided	Divided	
Length of segment, L (mi)		--	5.9	
AADT (veh/day)	$AADT_{MAX}$ = 89,300 (veh/day)	--	20,000	AADT OK
Lane width (ft.)		12	11	
Shoulder width (ft.) - right shoulder width for divided [if differ for directions of travel, use average width]		8	0	
Shoulder type - right shoulder type for divided		Paved	Paved	
Median width (ft.) - for divided only		30	20	
Side Slopes - for undivided only		1:7 or flatter		
Lighting (present/not present)		Not Present	Not Present	
Auto speed enforcement (present/not present)		Not Present	Not Present	
Calibration Factor, Cr		1.00	0.68	

Tables Affiliated with CMFs for Specific Segment AADT values:

Table 11-16: CMF for Lane Width on Divided Roadway Segments (CMF_{RA})

Lane Width (ft.)	AADT (veh/day) < 400	AADT (veh/day) 400 to 2000	AADT (veh/day) > 2000
9	1.03	3.73	1.25
9.5	1.02	3.23	1.20
10	1.01	2.73	1.15
10.5	1.01	1.99	1.09
11	1.01	1.26	1.03
11.5	1.01	1.13	1.02
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include run-off-the-road, head-on crashes, and sideswipes.

Worksheet 1B (a) -- Crash Modification Factors for Rural Multilane Divided Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)
CMF for Lane Width	CMF for Right Shoulder Width	CMF for Median Width	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1rd	*CMF 2rd*	*CMF 3rd*	*CMF 4rd*	*CMF 5rd*	*CMF comb*
from Equation 11-16	from Table 11-17	from Table 11-18	from Equation 11-17	from Section 11.7.2	(1)*(2)*(3)*(4)*(5)
1.02	1.18	1.02	1.00	1.00	1.22

Worksheet 1C (a) -- Roadway Segment Crashes for Rural Multilane Divided Roadway Segments

(1)	(2)			(3)	(4)	(5)	(6)	(7)
Crash Severity Level	**SPF Coefficients** from Table 11-5			**N spf rd**	**Overdispersion Parameter, k**	**Combined CMFs** (6) from Worksheet 1B (a)	**Calibration Factor, Cr**	**Predicted average crash frequency, $N_{predicted\ rs(d)}$**
	a	b	c	from Equation 11-9	from Equation 11-10			(3)*(5)*(6)
Total	-9.025	1.049	1.549	23.074	0.036	1.22	0.68	19.168
Fatal and Injury (FI)	-8.837	0.958	1.687	11.308	0.031	1.22	0.68	9.394
Fatal and Injury[a] (FI[a])	-8.505	0.874	1.740	6.859	0.030	1.22	0.68	5.698
Property Damage Only (PDO)	--	--	--	--	--	--	--	$(7)_{TOTAL} - (7)_{FI}$ 9.775

NOTE: [a] Using the KABCO scale, these include only KAB crashes. Crashes with severity level C (possible injury) are not included.

Worksheet 1D (a) -- Crashes by Severity Level and Collision Type for Rural Multilane Divided Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Collision Type	**Proportion of Collision $Type_{(TOTAL)}$**	**$N_{predicted\ rs(d)\ (TOTAL)}$ (crashes/year)**	**Proportion of Collision Type(FI)**	**$N_{predicted\ rs(d)\ (FI)}$ (crashes/year)**	**Proportion of Collision Type (FI[a])**	**N *predicted rs* (FI[a]) (crashes/year)**	**Proportion of Collision Type (PDO)**	**$N_{predicted\ rs(d)\ (PDO)}$ (crashes/year)**
	from Table 11-6	$(7)_{TOTAL}$ from Worksheet 1C (a)	from Table 11-6	$(7)_{FI}$ from Worksheet 1C (a)	from Table 11-6	$(7)_{FI}^{a}$ from Worksheet 1C (a)	from Table 11-6	$(7)_{PDO}$ from Worksheet 1C (a)
Total	1.000	19.168	1.000	9.394	1.000	5.698	1.000	9.775
		$(2)*(3)_{TOTAL}$		$(4)x(5)_{FI}$		$(6)*(7)_{FI}^{a}$		$(8)*(9)_{PDO}$
Head-on collision	0.006	0.115	0.013	0.122	0.018	0.103	0.002	0.020
Sideswipe collision	0.043	0.824	0.027	0.254	0.022	0.125	0.053	0.518
Rear-end collision	0.116	2.224	0.163	1.531	0.114	0.650	0.088	0.860
Angle collision	0.043	0.824	0.048	0.451	0.045	0.256	0.041	0.401
Single-vehicle collision	0.768	14.721	0.727	6.829	0.778	4.433	0.792	7.741
Other collision	0.024	0.460	0.022	0.207	0.023	0.131	0.024	0.235

NOTE: [a] Using the KABCO scale, these include only KAB crashes. Crashes with severity level C (possible injury) are not included.

Worksheet 1E -- Summary Results for Rural Multilane Roadway Segments

(1)	(2)	(3)	(4)
Crash severity level	**Predicted average crash frequency (crashes/year)**	**Roadway segment length (mi)**	**Crash rate (crashes/mi/year)**
	(7) from Worksheet 1C (a) or (b)		(2)/(3)
Total	19.2	5.9	3.2
Fatal and Injury (FI)	9.4	5.9	1.6
Fatal and Injury[a] (FI[a])	5.7	5.9	1.0
Property Damage Only (PDO)	9.8	5.9	1.7

NOTE: [a] Using the KABCO scale, these include only KAB crashes. Crashes with severity level C (possible injury) are not included.

Worksheet 4A -- Predicted and Observed Crashes by Severity and Site Type Using the Project-Level EB Method

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Site type	**Predicted average crash frequency (crashes/year)**			**Observed crashes,**	**Overdispersion Parameter, k**	N_{w0}	N_{w1}	W_0	N_0	w_1	N_1	$N_{p/comb}$
	$N_{predicted}$ (TOTAL)	$N_{predicted}$ (FI)	$N_{predicted}$ (PDO)	$N_{observed}$ (crashes/year)		Equation A-8 $(6)*(2)^2$	Equation A-9 sqrt((6)*(2))	Equation A-10	Equation A-11	Equation A-12	Equation A-13	Equation A-14
ROADWAY SEGMENTS												
Segment 1 (Divided)	19.168	9.394	9.775	--	0.036	13.231	0.831	--	--	--	--	--
Segment 2 (Undivided)	#REF!	#REF!	#REF!	--	#REF!	#REF!	#REF!	--	--	--	--	--
Segment 3				--				--	--	--	--	--
Segment 4				--				--	--	--	--	--
Segment 5				--				--	--	--	--	--
Segment 6				--				--	--	--	--	--
Segment 7				--				--	--	--	--	--
Segment 8				--				--	--	--	--	--
INTERSECTIONS												
Intersection 1	#REF!	#REF!	#REF!	--	#REF!	#REF!	#REF!	--	--	--	--	--
Intersection 2				--				--	--	--	--	--
Intersection 3				--				--	--	--	--	--
Intersection 4				--				--	--	--	--	--
Intersection 5				--				--	--	--	--	--
Intersection 6				--				--	--	--	--	--
Intersection 7				--				--	--	--	--	--
Intersection 8				--				--	--	--	--	--
COMBINED (sum of column)	#REF!	#REF!	#REF!		--	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!

Worksheet 4B -- Project-Level EB Method Summary Results

(1)	(2)	(3)
Crash severity level	$N_{predicted}$	$N_{expected}$
Total	$(2)_{COMB}$ from Worksheet 4A	$(13)_{COMB}$ from Worksheet 4A
	#REF!	#REF!
Fatal and injury (FI)	$(3)_{COMB}$ from Worksheet 4A	$(3)_{TOTAL} * (2)_{FI} / (2)_{TOTAL}$
	#REF!	#REF!
Property damage only (PDO)	$(4)_{COMB}$ from Worksheet 4A	$(3)_{TOTAL} * (2)_{PDO} / (2)_{TOTAL}$
	#REF!	#REF!

State of Florida Department of Transportation

Present Worth Analysis
Rural Multilane Arterial
No-Build Alternative

General Information						Site Information			
Analyst:	B. Behzadi	Date:	3/31/2021			Roadway:	Boggy Creek Road	Jurisdiction:	Osceola County
Agency or Company:	Dewberry Engineers, Inc.					Roadway Section:	From Simpson Road to Narcoossee Road		
Manual Input from Analysis									
Growth Rate =	4.0%	Current Year =	2025	Project Opening Year =	2025	Default Distribution for Crash Severity Level (2010-2014 Florida HSM Crash Distribution)			
Opening Year AADT =	20,000	Rate of Return =	4.0%	Analysis Period =	15	Fatality =	1.6%	Possible Injury =	41.6%
Segment Length =	5.90	Segment Type =	Divided	E		Incapacitating =	0.0%	Property Damage Only =	56.8%
Crash Data Used =	Yes	Segment =	Divided Multilane - DSeg1	1.153881642		Non-Incapacitating =	0.0%		100.0%

	Year	AADT	Annual Number of Crashes						Annual Cost						
			Site Specific ($N_{predicted / expected}$)	Fatality	Incap.	Non-Inc.	Possible Injury	PDO	Fatality	Incap.	Non-Inc.	Possible Injury	PDO	Total Cost	Present Value
1	2025	20,000	19.2	0.307	0.000	0.000	7.987	10.906	$3,142,656	$0	$0	$779,950	$82,883	$4,005,489	$3,851,431
2	2026	20,800	19.9	0.318	0.000	0.000	11.303	11.303	$3,257,232	$0	$0	$1,103,757	$85,904	$4,446,894	$4,111,403
3	2027	21,632	20.6	0.330	0.000	0.000	8.570	11.701	$3,371,808	$0	$0	$836,821	$88,926	$4,297,556	$3,820,511
4	2028	22,497	21.4	0.342	0.000	0.000	8.902	12.155	$3,502,752	$0	$0	$869,319	$92,380	$4,464,451	$3,816,231
5	2029	23,397	22.2	0.355	0.000	0.000	9.235	12.610	$3,633,696	$0	$0	$901,817	$95,833	$4,631,346	$3,806,629
6	2030	24,333	23.1	0.370	0.000	0.000	9.610	13.121	$3,781,008	$0	$0	$938,377	$99,718	$4,819,104	$3,808,608
7	2031	25,306	24.1	0.386	0.000	0.000	10.026	13.689	$3,944,688	$0	$0	$979,000	$104,035	$5,027,723	$3,820,656
8	2032	26,319	25.1	0.402	0.000	0.000	10.442	14.257	$4,108,368	$0	$0	$1,019,622	$108,352	$5,236,342	$3,826,144
9	2033	27,371	26.1	0.418	0.000	0.000	10.858	14.825	$4,272,048	$0	$0	$1,060,245	$112,668	$5,444,961	$3,825,557
10	2034	28,466	27.1	0.434	0.000	0.000	11.274	15.393	$4,435,728	$0	$0	$1,100,867	$116,985	$5,653,580	$3,819,356
11	2035	29,605	28.2	0.451	0.000	0.000	11.731	16.018	$4,615,776	$0	$0	$1,145,552	$121,734	$5,883,061	$3,821,525
12	2036	30,789	29.3	0.469	0.000	0.000	12.189	16.642	$4,795,824	$0	$0	$1,190,236	$126,482	$6,112,543	$3,817,876
13	2037	32,021	30.5	0.488	0.000	0.000	12.688	17.324	$4,992,240	$0	$0	$1,238,983	$131,662	$6,362,886	$3,821,384
14	2038	33,301	31.7	0.507	0.000	0.000	13.187	18.006	$5,188,656	$0	$0	$1,287,730	$136,843	$6,613,229	$3,818,975
15	2039	34,634	32.9	0.526	0.000	0.000	13.686	18.687	$5,385,072	$0	$0	$1,336,477	$142,023	$6,863,572	$3,811,098

Shaded cell indicates the AADT is outside the limits

Total Present Value **$57,597,385**

NOTES:

1. Present Value = Future Cash Flow / (1 + Required Rate of Return)$^{\text{Number of Years You Have To Wait For The Cash Flow}}$
2. Traffic Growth Rate = $[((ADT_f / ADT_i)^{(1/(F-I))})-1] \times 100$

where ADT_f = Average Daily Traffic for Future Year

ADT_i = Average Daily Traffic for Initial Year

I = Initial Year for ADT

F = Future Year for ADT

SUMMARY OF TOTAL PRESENT VALUE FOR SEGMENTS

Segment Site	Beginning Year			End Year			Total Present Value
	Year	AADT	$N_{predicted-rs}$	Year	AADT	$N_{predicted-rs}$	
DSeg1	2027	21,632	20.6	2036	30,789	29.3	$57,597,385
DSeg2	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
COMBINED							#REF!

Alternative #2
(Build – Install Lighting)

Worksheet 1A -- General Information and Input Data for Rural Multilane Roadway Segments

General Information		Location Information	
Analyst	B.Behzadi	Roadway	Boggy Creek Road
Agency or Company	Dewberry Engineers, Inc.	Roadway Section	From Simpson Road to Narcoossee Road
Date Performed	03/31/21	Jurisdiction	Osceola County
		Analysis Year	2025

Input Data		Base Conditions	Site Conditions	
Roadway type (divided / undivided)		Undivided	Divided	
Length of segment, L (mi)		--	5.9	
AADT (veh/day)	$AADT_{MAX}$ = 89,300 (veh/day)	--	20,000	AADT OK
Lane width (ft.)		12	11	
Shoulder width (ft.) - right shoulder width for divided [if differ for directions of travel, use average width]		8	0	
Shoulder type - right shoulder type for divided		Paved	paved	
Median width (ft.) - for divided only		30	20	
Side Slopes - for undivided only		1:7 or flatter		
Lighting (present/not present)		Not Present	Present	
Auto speed enforcement (present/not present)		Not Present	Not Present	
Calibration Factor, Cr		1.00	0.68	

Tables Affiliated with CMFs for Specific Segment AADT values:

Table 11-16: CMF for Lane Width on Divided Roadway Segments (CMF_{RA})

Lane Width (ft.)	AADT (veh/day) < 400	AADT (veh/day) 400 to 2000	AADT (veh/day) > 2000
9	1.03	3.73	1.25
9.5	1.02	3.23	1.20
10	1.01	2.73	1.15
10.5	1.01	1.99	1.09
11	1.01	1.26	1.03
11.5	1.01	1.13	1.02
12	1.00	1.00	1.00

Note: The collision types related to lane width to which this CMF applies include run-off-the-road, head-on crashes, and sideswipes.

Worksheet 1B (a) -- Crash Modification Factors for Rural Multilane Divided Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)
CMF for Lane Width	CMF for Right Shoulder Width	CMF for Median Width	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1rd	*CMF 2rd*	*CMF 3rd*	*CMF 4rd*	*CMF 5rd*	*CMF comb*
from Equation 11-16	from Table 11-17	from Table 11-18	from Equation 11-17	from Section 11.7.2	(1)*(2)*(3)*(4)*(5)
1.02	1.18	1.02	0.91	1.00	1.11

Worksheet 1C (a) -- Roadway Segment Crashes for Rural Multilane Divided Roadway Segments

(1)	(2)			(3)	(4)	(5)	(6)	(7)
Crash Severity Level	**SPF Coefficients** from Table 11-5			**N spf rd**	**Overdispersion Parameter, k**	**Combined CMFs** (6) from Worksheet 1B (a)	**Calibration Factor, Cr**	**Predicted average crash frequency, $N_{predicted\ rs(d)}$**
	a	b	c	from Equation 11-9	from Equation 11-10			(3)*(5)*(6)
Total	-9.025	1.049	1.549	23.074	0.036	1.11	0.68	17.490
Fatal and Injury (FI)	-8.837	0.958	1.687	11.308	0.031	1.11	0.68	8.571
Fatal and Injury[a] (FI[a])	-8.505	0.874	1.740	6.859	0.030	1.11	0.68	5.199
Property Damage Only (PDO)	--	--	--	--	--	--	--	$(7)_{TOTAL} - (7)_{FI}$ 8.919

NOTE: [a] Using the KABCO scale, these include only KAB crashes. Crashes with severity level C (possible injury) are not included.

Worksheet 1D (a) -- Crashes by Severity Level and Collision Type for Rural Multilane Divided Roadway Segments

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Collision Type	**Proportion of Collision $Type_{(TOTAL)}$**	**$N_{predicted\ rs(d)\ (TOTAL)}$ (crashes/year)**	**Proportion of Collision Type(FI)**	**$N_{predicted\ rs(d)\ (FI)}$ (crashes/year)**	**Proportion of Collision Type (FI[a])**	**N *predicted rs* (FI[a]) (crashes/year)**	**Proportion of Collision Type (PDO)**	**$N_{predicted\ rs(d)\ (PDO)}$ (crashes/year)**
	from Table 11-6	$(7)_{TOTAL}$ from Worksheet 1C (a)	from Table 11-6	$(7)_{FI}$ from Worksheet 1C (a)	from Table 11-6	$(7)_{FI}^{a}$ from Worksheet 1C (a)	from Table 11-6	$(7)_{PDO}$ from Worksheet 1C (a)
Total	1.000	17.490	1.000	8.571	1.000	5.199	1.000	8.919
		$(2)*(3)_{TOTAL}$		$(4)x(5)_{FI}$		$(6)*(7)_{FI}^{a}$		$(8)*(9)_{PDO}$
Head-on collision	0.006	0.105	0.013	0.111	0.018	0.094	0.002	0.018
Sideswipe collision	0.043	0.752	0.027	0.231	0.022	0.114	0.053	0.473
Rear-end collision	0.116	2.029	0.163	1.397	0.114	0.593	0.088	0.785
Angle collision	0.043	0.752	0.048	0.411	0.045	0.234	0.041	0.366
Single-vehicle collision	0.768	13.432	0.727	6.231	0.778	4.045	0.792	7.064
Other collision	0.024	0.420	0.022	0.189	0.023	0.120	0.024	0.214

NOTE: [a] Using the KABCO scale, these include only KAB crashes. Crashes with severity level C (possible injury) are not included.

Worksheet 1E -- Summary Results for Rural Multilane Roadway Segments

(1)	(2)	(3)	(4)
Crash severity level	**Predicted average crash frequency (crashes/year)**	**Roadway segment length (mi)**	**Crash rate (crashes/mi/year)**
	(7) from Worksheet 1C (a) or (b)		(2)/(3)
Total	17.5	5.9	3.0
Fatal and Injury (FI)	8.6	5.9	1.5
Fatal and Injury[a] (FI[a])	5.2	5.9	0.9
Property Damage Only (PDO)	8.9	5.9	1.5

NOTE: [a] Using the KABCO scale, these include only KAB crashes. Crashes with severity level C (possible injury) are not included.

Worksheet 4A -- Predicted and Observed Crashes by Severity and Site Type Using the Project-Level EB Method

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Site type	**Predicted average crash frequency (crashes/year)**			**Observed crashes,**	**Overdispersion Parameter, k**	**N_{w0}**	**N_{w1}**	**W_0**	**N_0**	**w_1**	**N_1**	**$N_{p/comb}$**
	$N_{predicted}$ (TOTAL)	$N_{predicted}$ (FI)	$N_{predicted}$ (PDO)	$N_{observed}$ (crashes/year)		Equation A-8 $(6)*(2)^2$	Equation A-9 sqrt((6)*(2))	Equation A-10	Equation A-11	Equation A-12	Equation A-13	Equation A-14
ROADWAY SEGMENTS												
Segment 1 (Divided)	17.490	8.571	8.919	--	0.036	11.015	0.794	--	--	--	--	--
Segment 2 (Undivided)	#NUM!	#NUM!	#NUM!	--	#NUM!	#NUM!	#NUM!	--	--	--	--	--
Segment 3				--				--	--	--	--	--
Segment 4				--				--	--	--	--	--
Segment 5				--				--	--	--	--	--
Segment 6				--				--	--	--	--	--
Segment 7				--				--	--	--	--	--
Segment 8				--				--	--	--	--	--
INTERSECTIONS												
Intersection 1	#NUM!	#NUM!	#NUM!	--	0.277	#NUM!	#NUM!	--	--	--	--	--
Intersection 2				--				--	--	--	--	--
Intersection 3				--				--	--	--	--	--
Intersection 4				--				--	--	--	--	--
Intersection 5				--				--	--	--	--	--
Intersection 6				--				--	--	--	--	--
Intersection 7				--				--	--	--	--	--
Intersection 8				--				--	--	--	--	--
COMBINED (sum of column)	#NUM!	#NUM!	#NUM!		--	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

Worksheet 4B -- Project-Level EB Method Summary Results

(1)	(2)	(3)
Crash severity level	$N_{predicted}$	$N_{expected}$
Total	$(2)_{COMB}$ from Worksheet 4A	$(13)_{COMB}$ from Worksheet 4A
	#NUM!	#NUM!
Fatal and injury (FI)	$(3)_{COMB}$ from Worksheet 4A	$(3)_{TOTAL} * (2)_{FI} / (2)_{TOTAL}$
	#NUM!	#NUM!
Property damage only (PDO)	$(4)_{COMB}$ from Worksheet 4A	$(3)_{TOTAL} * (2)_{PDO} / (2)_{TOTAL}$
	#NUM!	#NUM!

State of Florida Department of Transportation

Present Worth Analysis
Rural Multilane Arterial
Build Alternative

General Information				Site Information			
Analyst:		Date:		Roadway:		Jurisdiction:	
Agency or Company:				Roadway Section:			

Manual Input from Analysis

						Default Distribution for Crash Severity Level (2010-2014 Florida HSM Crash Distribution)			
Growth Rate =	4.0%	Current Year =	2025	Project Opening Year =	2025				
Opening Year AADT =	20,000	Rate of Return =	4.0%	Analysis Period =	15	Fatality =	1.6%	Possible Injury =	41.6%
Segment Length =	5.90	Segment Type =	Divided	P		Incapacitating =	0.0%	Property Damage Only =	56.8%
Crash Data Used =	Yes	Segment =	Divided Multilane - DSeg2	1.25		Non-Incapacitating =	0.0%		100.0%

	Year	AADT	Annual Number of Crashes						Annual Cost						
			Site Specific ($N_{predicted / expected}$)	Fatality	Incap.	Non-Inc.	Possible Injury	PDO	Fatality	Incap.	Non-Inc.	Possible Injury	PDO	Total Cost	Present Value
1	2025	20,000	17.5	0.280	0.000	0.000	7.280	9.940	$2,864,400	$0	$0	$710,892	$75,544	$3,650,836	$3,510,419
2	2026	20,800	18.2	0.291	0.000	0.000	7.571	10.338	$2,978,976	$0	$0	$739,328	$78,566	$3,796,869	$3,510,419
3	2027	21,632	19.6	0.314	0.000	0.000	8.154	11.133	$3,208,128	$0	$0	$796,199	$84,609	$4,088,936	$3,635,049
4	2028	22,497	20.3	0.325	0.000	0.000	8.445	11.530	$3,322,704	$0	$0	$824,635	$87,631	$4,234,970	$3,620,070
5	2029	23,397	21.1	0.338	0.000	0.000	8.778	11.985	$3,453,648	$0	$0	$857,133	$91,084	$4,401,865	$3,618,012
6	2030	24,333	21.9	0.350	0.000	0.000	9.110	12.439	$3,584,592	$0	$0	$889,631	$94,538	$4,568,760	$3,610,758
7	2031	25,306	22.7	0.363	0.000	0.000	9.443	12.894	$3,715,536	$0	$0	$922,128	$97,991	$4,735,656	$3,598,709
8	2032	26,319	23.6	0.378	0.000	0.000	9.818	13.405	$3,862,848	$0	$0	$958,689	$101,876	$4,923,413	$3,597,490
9	2033	27,371	24.5	0.392	0.000	0.000	10.192	13.916	$4,010,160	$0	$0	$995,249	$105,762	$5,111,170	$3,591,041
10	2034	28,466	25.4	0.406	0.000	0.000	10.566	14.427	$4,157,472	$0	$0	$1,031,809	$109,647	$5,298,928	$3,579,766
11	2035	29,605	26.4	0.422	0.000	0.000	10.982	14.995	$4,321,152	$0	$0	$1,072,431	$113,964	$5,507,547	$3,577,597
12	2036	30,789	27.4	0.438	0.000	0.000	11.398	15.563	$4,484,832	$0	$0	$1,113,054	$118,280	$5,716,166	$3,570,300
13	2037	32,021	28.4	0.454	0.000	0.000	11.814	16.131	$4,648,512	$0	$0	$1,153,676	$122,597	$5,924,785	$3,558,273
14	2038	33,301	29.5	0.472	0.000	0.000	12.272	16.756	$4,828,560	$0	$0	$1,198,361	$127,346	$6,154,266	$3,553,935
15	2039	34,634	30.6	0.490	0.000	0.000	12.730	17.381	$5,008,608	$0	$0	$1,243,045	$132,094	$6,383,748	$3,544,668

Shaded cell indicates the AADT is outside the limits

Total Present Value **$53,676,507**

NOTES:

1. Present Value = Future Cash Flow / (1 + Required Rate of Return)$^{\text{Number of Years You Have To Wait For The Cash Flow}}$
2. Traffic Growth Rate = $[((ADT_f / ADT_i)^{(1/(F-I))})-1] \times 100$

where ADT_f = Average Daily Traffic for Future Year

ADT_i = Average Daily Traffic for Initial Year

I = Initial Year for ADT

F = Future Year for ADT

SUMMARY OF TOTAL PRESENT VALUE FOR SEGMENTS

Segment Site	Beginning Year			End Year			Total Present Value
	Year	AADT	$N_{predicted-rs}$	Year	AADT	$N_{predicted-rs}$	
DSeg1	2027	20,000	0.0	2036	20,000	0.0	$0
DSeg2	2031	25,306	22.7	2038	33,301	29.5	$53,676,507
COMBINED							$53,676,507

Appendix C

Roadway Optimizer Layout

Roadway Optimizer - Layout 1

General:

4 LANE RDWY W 22' MEDIAN

Roadway Standard: IES RP-8-14
R-Table: R3 (Slightly Specular), Q0=0.07   Actual QO Value: 0.07

Roadway Layout:

Layout Type: Two Rows, Staggered, With Median; 2R_STG_w/M
Roadway Width: 44 ft
Median Width: 22 ft
Lanes In Direction Of Travel: 2
Driver's Side Of Roadway: Right

Luminaire Information:

RFL-241W112LED4K-G2-R2M-HS
Description: RFL-241W112LED4K-G2-R2M-HS
File Name: RFL-241W112LED4K-G2-R2M-HS.ies
Lumens Per Lamp: N.A.
Number Of Lamps: 1
Total Lamp Lumens: N.A.
Luminaire Lumens: 25225
Luminaire Watts: 243
Efficiency (%): N.A.
S/P Ratio: 1.00
Total Light Loss Factor: 1.000
Luminaire Arrangement: SINGLE
Arm Length: 15.667 ft
Offset: 0 ft

Luminaire Location Summary:
Coordinates in ft

Spacing - Row 1: 265
Spacing - Row 2: 265

Label	X-Coord	Y-Coord	Z-Coord	Orient	Tilt	Spin
RFL-241W112LED4K-G2...	795	-15	45	90	0	0
RFL-241W112LED4K-G2...	530	-15	45	90	0	0
RFL-241W112LED4K-G2...	265	-15	45	90	0	0
RFL-241W112LED4K-G2...	0	-15	45	90	0	0

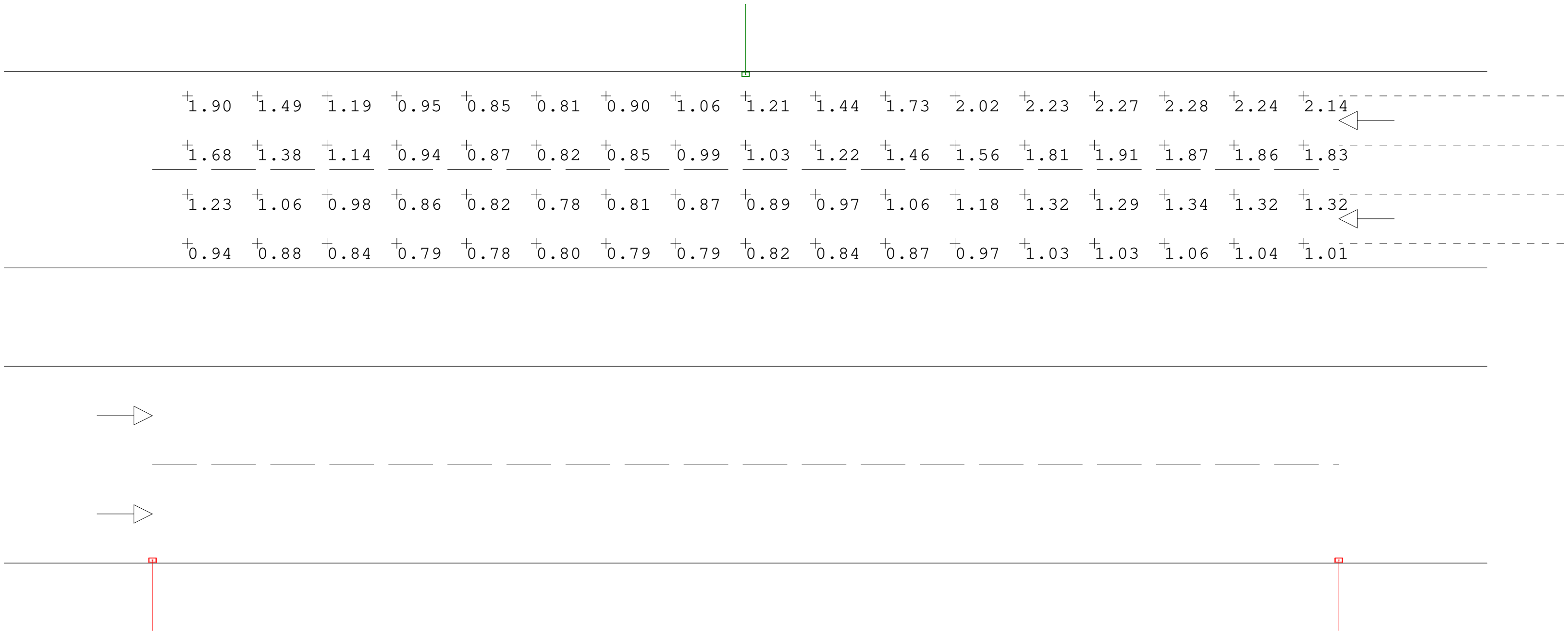
Luminaire Location Summary:
Coordinates in ft

RFL-241W112LED4K-G2...	-265	-15	45	90	0	0
RFL-241W112LED4K-G2...	-530	-15	45	90	0	0
RFL-241W112LED4K-G2...	-795	-15	45	90	0	0
RFL-241W112LED4K-G2...	662.5	125	45	270	0	0
RFL-241W112LED4K-G2...	397.5	125	45	270	0	0
RFL-241W112LED4K-G2...	132.5	125	45	270	0	0
RFL-241W112LED4K-G2...	-132.5	125	45	270	0	0
RFL-241W112LED4K-G2...	-397.5	125	45	270	0	0
RFL-241W112LED4K-G2...	-662.5	125	45	270	0	0

Total Number of locations: 13

Roadway Optimizer - Layout 1

RoadOpt_1_Luminance

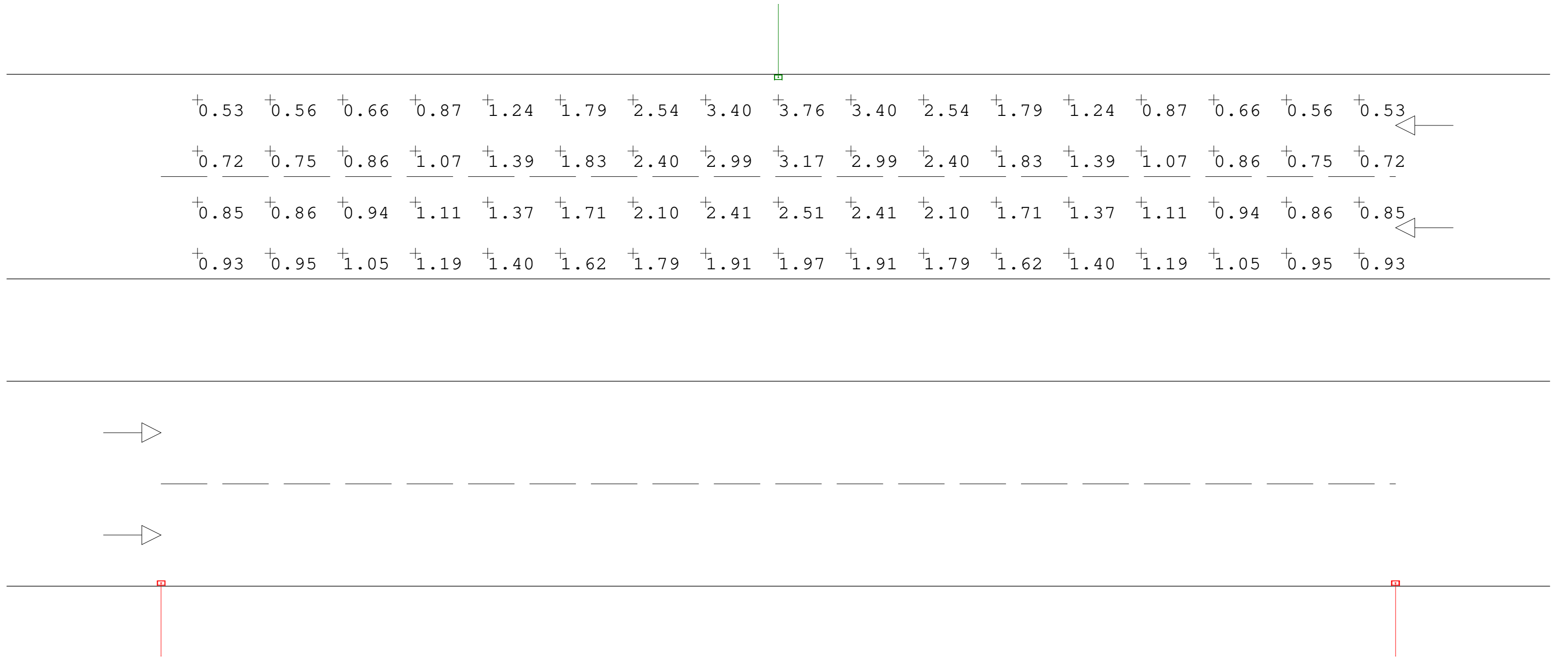


Luminance (Cd/SqM)
Average = 1.23
Maximum = 2.28
Minimum = 0.78
Avg/Min Ratio = 1.58
Max/Min Ratio = 2.92
Max/Avg Ratio = 1.85

3

Roadway Optimizer - Layout 1

RoadOpt_1_Illum



0.53	0.56	0.66	0.87	1.24	1.79	2.54	3.40	3.76	3.40	2.54	1.79	1.24	0.87	0.66	0.56	0.53
0.72	0.75	0.86	1.07	1.39	1.83	2.40	2.99	3.17	2.99	2.40	1.83	1.39	1.07	0.86	0.75	0.72
0.85	0.86	0.94	1.11	1.37	1.71	2.10	2.41	2.51	2.41	2.10	1.71	1.37	1.11	0.94	0.86	0.85
0.93	0.95	1.05	1.19	1.40	1.62	1.79	1.91	1.97	1.91	1.79	1.62	1.40	1.19	1.05	0.95	0.93

Illuminance (Fc)
Average = 1.51
Maximum = 3.76
Minimum = 0.53
Avg/Min Ratio = 2.85
Max/Min Ratio = 7.09
Max/Avg Ratio = 2.49

Roadway Optimizer - Layout 1

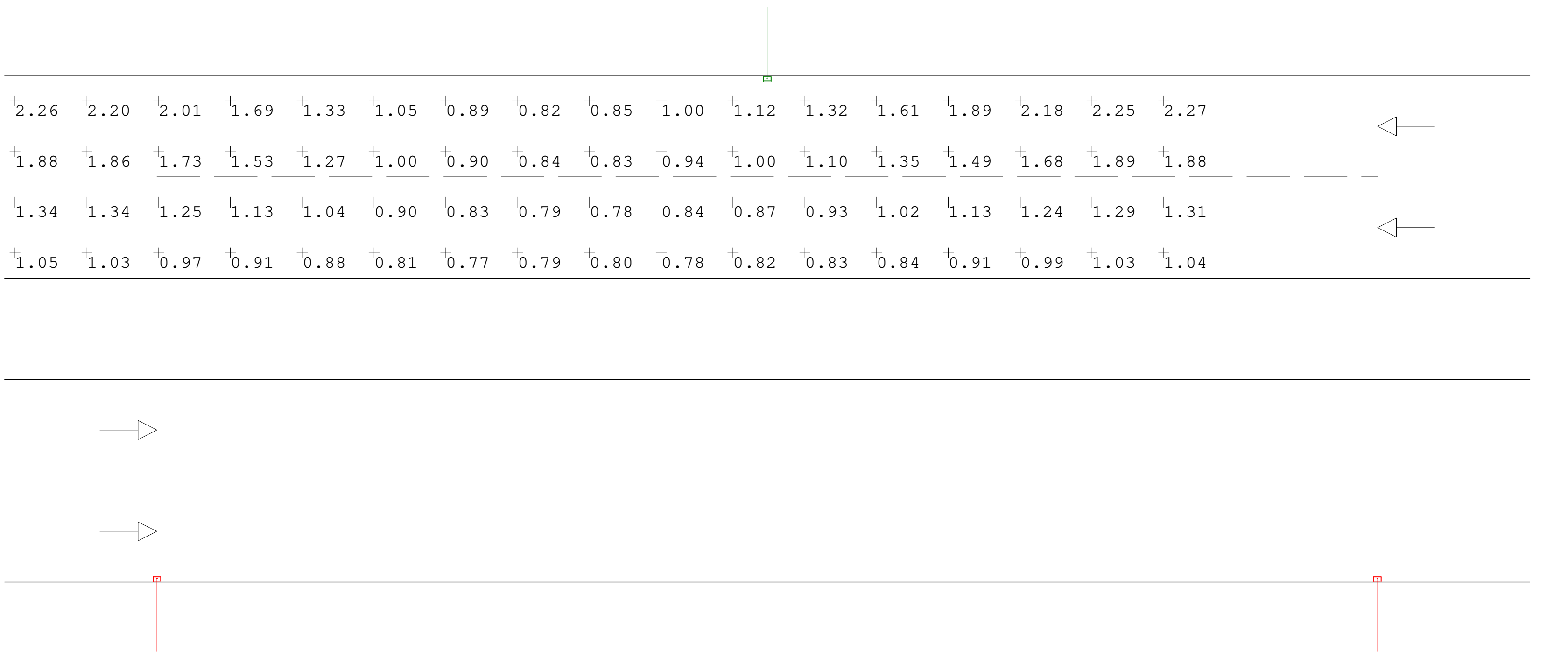
RoadOpt_1_Vis_Level

-2.43	-0.60	1.35	3.98	7.21	9.97	9.84	5.07	-5.79	-6.00	-6.20	-6.36	-6.47	-6.25	-5.82	-4.99	-3.82
0.38	1.79	3.78	6.30	8.69	10.47	9.50	4.51	-4.82	-5.03	-5.22	-5.08	-5.12	-4.59	-3.56	-2.56	-0.96
2.91	4.34	5.99	7.98	9.37	10.25	8.80	4.41	-2.38	-2.62	-2.69	-2.80	-2.74	-2.07	-0.92	0.49	1.81
4.49	5.70	7.11	8.59	9.37	9.22	7.54	4.60	0.81	1.19	1.16	0.88	0.74	0.82	1.26	2.15	3.39

Visibility Level
STV = 3.787871

Roadway Optimizer - Layout 1

RoadOpt_1_Vis_Level_Bkgd_Lum

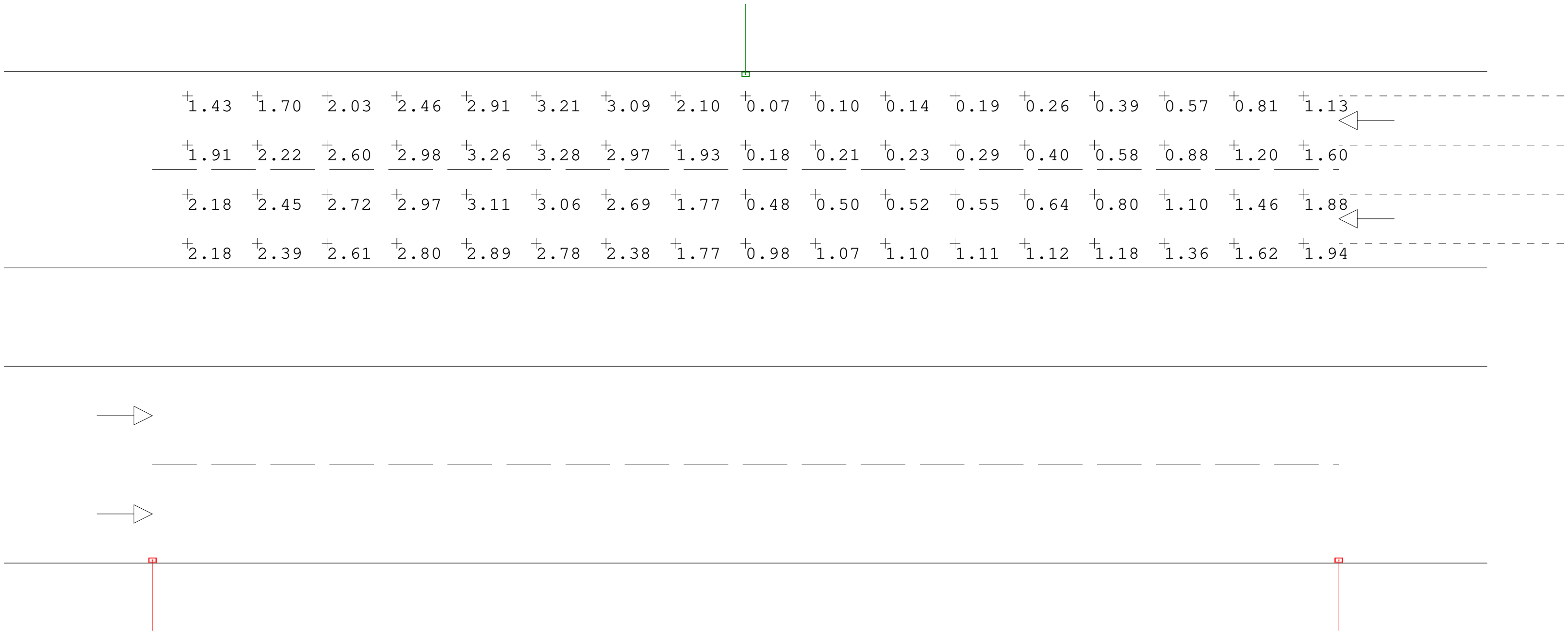


Background Luminance (Cd/SqM)
Average = 1.22
Maximum = 2.27
Minimum = 0.77
Avg/Min Ratio = 1.58
Max/Min Ratio = 2.95
Max/Avg Ratio = 1.86

6

Roadway Optimizer - Layout 1

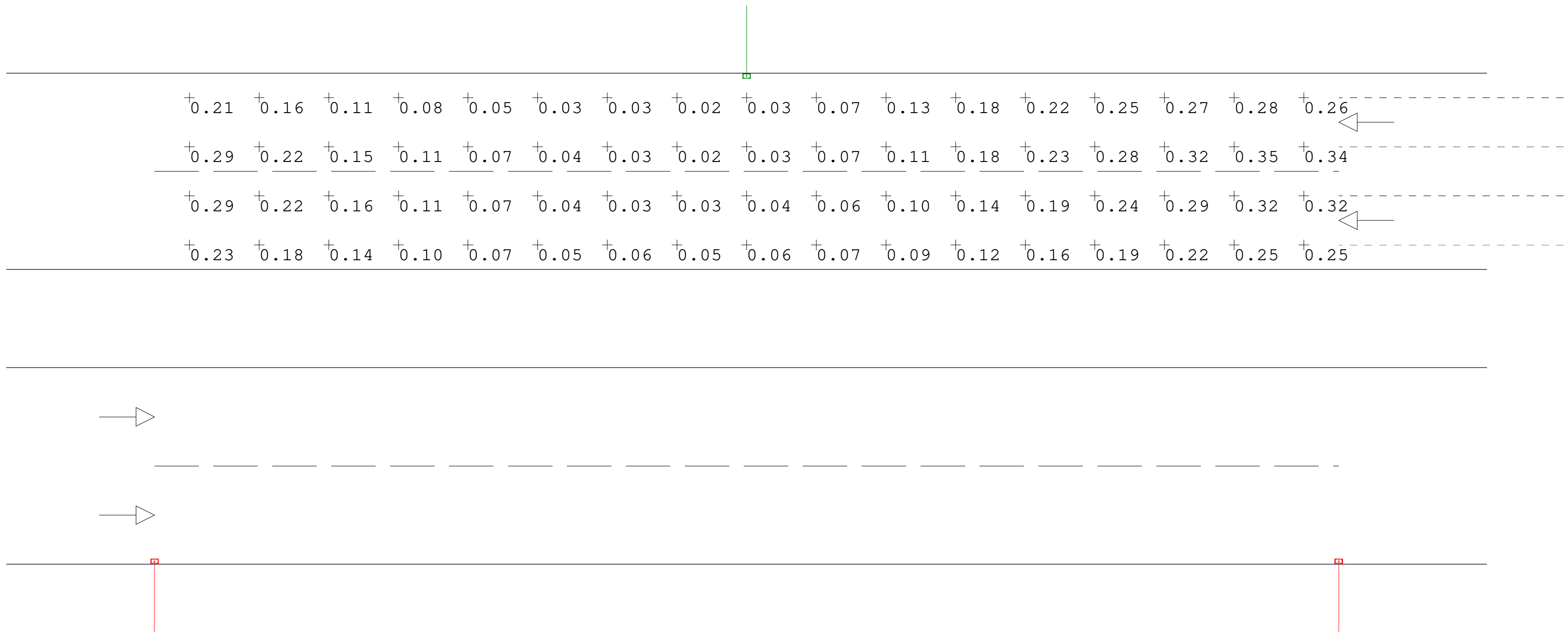
RoadOpt_1_Vis_Level_Target_Lum



Target Luminance (Cd/SqM)
Average = 1.61
Maximum = 3.28
Minimum = 0.07
Avg/Min Ratio = 23
Max/Min Ratio = 46.86
Max/Avg Ratio = 2.04

Roadway Optimizer - Layout 1

RoadOpt_1_Veil_Lum



Veiling Luminance (Cd/SqM)
Average = 0.15
Maximum = 0.35
Minimum = 0.02
Avg/Min Ratio = 7.5
Max/Min Ratio = 17.5
Max/Avg Ratio = 2.33
MaxLv Ratio = 0.28
Threshold Increment (TI) = 19.28

Roadway Optimizer - Layout Comparison

	Layout 1
Description	4 LANE RDWY W 22' MEDIAN
Roadway Standard	IES RP-8-14
R-Table	R3
Actual Q0 Value	0.07
Layout Type	2R_STG_w/M
Road Width	44
Median Width	22
Number Lanes	2
Number Lanes Opposite	0
Drivers Side	Right
Calc Area	Top
Label - Row 1	RFL-241W112LED4K -G2-R2M-HS
S/P Ratio 1	1
MH - Row 1	45
Setback - Row 1	15
+-Orient - Row 1	0
Tilt - Row 1	0
Spin - Row 1	0
Spacing - Row 1	265
Label - Row 2	RFL-241W112LED4K -G2-R2M-HS
S/P Ratio 2	1
MH - Row 2	45
Setback - Row 2	15
+-Orient - Row 2	0
Tilt - Row 2	0
Spin - Row 2	0
Spacing - Row 2	265
1_Luminance (Cd/SqM)	
Average	1.23
Maximum	2.28
Minimum	0.78

	Layout 1
Avg/Min Ratio	1.58
Max/Min Ratio	2.92
Max/Avg Ratio	1.85

1_Illum (Fc)	
Average	1.51
Maximum	3.76
Minimum	0.53
Avg/Min Ratio	2.85
Max/Min Ratio	7.09
Max/Avg Ratio	2.49

1_Vis_Level	
STV	3.79

1_Vis_Level_Bkgd_Lum (Cd/SqM)	
Average	1.22
Maximum	2.27
Minimum	0.77
Avg/Min Ratio	1.58
Max/Min Ratio	2.95
Max/Avg Ratio	1.86

1_Vis_Level_Target_Lum (Cd/SqM)	
Average	1.61
Maximum	3.28
Minimum	0.07
Avg/Min Ratio	23.00
Max/Min Ratio	46.86
Max/Avg Ratio	2.04

1_Veil_Lum (Cd/SqM)	
Average	0.15
Maximum	0.35
Minimum	0.02
Avg/Min Ratio	7.50
Max/Min Ratio	17.50

Roadway Optimizer - Layout Comparison - Cont.

	Layout 1
Max/Avg Ratio	2.33
MaxLV Ratio	0.28
Threshold Incr. (TI)	19.28

Appendix D

Net Present Value Analysis

From: Simpson Road To: Narcoossee Road

Boggy Creek Road (CR 530)

PVMC (Present Value of Annual Maintenance Cost)

The Present Value of Annual Maintenance Cost (PVMC) is calculated using the formula below:

PVMC = Number of Poles x Number of Luminaires per Pole x Annual Maintenance Cost per Luminaire x Life Span of the Project (20 years).

Annual Maintenance Cost = $200.00

PVMC = 118 * 1 * $200.00 * 20 = **$472,000.00**

PVEC (Present Value of Annual Energy Cost)

The Present Value of Annual Energy Cost (PVEC) is calculated using the following formula:

PVEC = Number of Poles x Number of Luminaires per Pole x kW per Luminaire x Cost per kWh x Usage (hours/day) x 365 days/year x Life Span of the Project (20 years).

Cost per kWh = 11.42 ¢ (Florida Average)
kW per Luminaire = Watts per Luminaire / 1000 = 269 W / 1,000 kW = 0.269
Usage = 11 hours / day

PVEC = 118 * 1 * 0.241 kW * $ 0.1142 (Florida Average) * 11 hours * 365 days * 20 = **$260,784.00**

<u>Appendix E</u>

Cost Estimate for
Installation of Proposed Lighting

Engineer's Estimate
Boggy Creek Road (CR 530) - Lighting Justification Report
Osceola County

March 30, 2021

Pay Item	Description	Unit	Quantity	Unit Cost	Cost
0630 2 11	CONDUIT, FURNISH & INSTALL, OPEN TRENCH	LF	29,152	$8.25	$240,504.00
0630 2 12	CONDUIT, FURNISH & INSTALL, DIRECTIONAL BORE	LF	2000	$25.67	$51,340.00
0635 2 11	PULL & SPLICE BOX, F&I, 13" x 24" COVER SIZE	EA	100	$765.31	$76,531.00
0635 3 13	JUNCTION BOX, FURNISH & INSTALL, EMBEDDED	EA	8	$364.48	$2,915.84
0639 1 123	ELECTRICAL POWER SERVICE, F&I, UNDERGROUND, METER FURNISHED BY POWER COMPANY	AS	3	$2,330.00	$6,990.00
0639 2 1	ELECTRICAL SERVICE WIRE FURNISH & INSTALL	LF	300	$6.55	$1,965.00
0641 2 12	PRESTRESSED CONCRETE POLE, F&I, TYPE P-II SERVICE POLE	EA	3	$1,544.28	$4,632.84
0715 1 12	LIGHTING CONDUCTORS, F&I, INSULATED, NO. 8 - 6	LF	93,456	$1.35	$126,165.60
0715 1 13	LIGHTING CONDUCTORS, F&I, INSULATED, NO. 4 TO NO 2	LF	300	$2.22	$666.00
0715 4 14	LIGHT POLE COMPLETE, FURNISH & INSTALL STANDARD POLE STANDARD FOUNDATION, 45' MOUNTING HEIGHT	EA	118	$6,034.56	$712,078.08
0715 7 11	LOAD CENTER, F&I, SECONDARY VOLTAGE	EA	3	$13,323.93	$39,971.79
0715 500 1	POLE CABLE DISTRIBUTION SYSTEM FURNISH AND INSTALL, CONVENTIONAL	EA	118	$706.81	$83,319.80
				Lighting Install Sub-Total 1	**$1,347,079.95**
0101 1	MOBILIZATION	LS		5%	$67,354.00
0102-1	MAINTENANCE OF TRAFFIC	LS		5%	$67,354.00
				Lighting Install Sub-Total 2	**$1,481,787.95**
0999 25	INITIAL CONTINGENCY	LS		5%	$67,354.00
	PRELIMINARY ENGINEERING AND CEI (PECEI)	LS		5%	$67,354.00
				Lighting Install Total	**$1,616,495.95**

Appendix F

Lighting Geometric and Operational Factors

Form 750-020-20
TRAFFIC ENGINEERING
September 2020

State of Florida Department of Transportation

LIGHTING GEOMETRIC AND OPERATIONAL FACTORS

Item No.	Classification Factor	Rating Factor "R" 1	2	3	4	5	Weight "W"	Enter "R" Here	Score "R"x"W"	
	Geometric Factors (See Note 6)									
1	Number of Lanes	≤4	5	6	7	≥8	0.15	1	0.15	
2	Lane Width (ft.)	>11.8	11.2 to 11.8	10.5 to 11.2	9.8 to 10.5	<9.8	0.35	3	1.05	
3	Median Openings/mile	<4 or 1-way	4 to 8	8 to 12	12 to 15	>15 or No Median	1.40	2	2.8	
4	Driveways and Entrances/mile	<32	32 to 64	64 to 97	97 to 129	>129	1.40	2	2.8	
5	Horizontal Curve Radius (ft.)	>1969	1476 to 1969	738 to 1476	574 to 738	<574	5.90	3	17.7	
6	Vertical Grades (%)	<3	3 to 4	4 to 5	5 to 7	>7	0.35	3	1.05	
7	Sight Distance (ft.)	>689	492 to 689	295 to 492	197 to 295	<197	0.15	4	0.6	
8	Parking	Prohibited	Loading	Off Peak	One Side	Both Sides	0.10	1	0.1	
								Subtotal Geometric Factors	26.25	G
	Operational Factors									
9	Signalized Intersections (%)	80 to 100	70 to 80	60 to 70	50 to 60	0 to 50	0.15	3	0.45	
10	Left Turn Lane	All Major Intersections or 1-way	Substantial Number of Major Intersections	Most Major Intersections	Half of the Intersections	Infrequent Number or TWTL (See Notes 1 & 3)	0.70	4	2.8	
11	Median Width (ft.)	> 32	20 to 32	10 to 20	4 to 10	0 to 4	0.35	2	0.7	
12	Operating or Posted Speed (mph) (See Note 5)	≤ 25	30	35	45	≥50	0.60	5	3	
13	Pedestrian and Bicycle Activity Level (See Note 2)			Low (< 10)	Medium (10 - 100)	High (> 100 ped)	3.15	5	15.75	
								Subtotal Environmental Factors	22.7	O
	Environmental Factors									
14	Percentage of Development Adjacent to Road (%) (See Note 4)	nil	nil to 30	30 to 60	60 to 90	>90	0.15	4	0.6	
15	Area Classification	Rural	Industrial	Residential	Commercial	Downtown	0.15	3	0.45	
16	Distance from Development to Roadway (ft) (See Note 4)	>200	150 to 200	100 to 150	50 to 100	<50	0.15	5	0.75	
17	Ambient (off Roadway) Lighting	Nil	Sparse	Moderate	Distracting	Intense	1.38	2	2.76	
18	Raised Curb Median	None	Continuous	At All Intersections (100%)	At Most Intersections (51% to 99%)	At Few Intersections (≤50%) (See Note 7)	0.35	3	1.05	
								Subtotal Environmental Factors	5.61	E
	Collision Factors									
19	Night-to-Day Collision Ratio	<1	1.0 to 1.2	1.2 to 1.5	1.5 to 2.0	>2.0 (See Note 1)	5.55	1	5.55	
								Subtotal Collision Factors	5.55	A

G + O + E + A = Total Warranting Points	60.11	
Warranting Condition	60.00	
Difference ±	0.11	D

Notes: 1 Lighting Warranted
2 Pedestrian and Bicycle Activity Level
3 Two Way Left Turn Lane
4 Development defined as Commercial, Industrial or Residential Buildings
5 85^{th} Percentile night speed should be used if available, otherwise posted Speed Limit shall be used
6 Worst case geometric factors for a segment of roadway shall apply
7 Also includes isolated medians (non-continuous) between intersections