Quality Assurance Review of Intersection Lighting Retrofits

Project No.

FDOT BDV25-977-60

Final Report

Prepared For

Florida Department of Transportation

August, 2019

CUTR CENTER FOR URBAN TRANSPORTATION RESEARCH
USF UNIVERSITY OF SOUTH FLORIDA
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Ed Cashman, P.E., Standard Plans Engineer

Prepared by

USF Center for Urban Transportation Research (CUTR)

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August, 2019

Disclaimer

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation.

Metric Conversion Chart

APPROXIMATE CONVERSIONS TO SI UNITS

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
AREA				
in^2	squareinches	645.2	square millimeters	mm^2
ft^2	squarefeet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

Technical Report Documentation Page

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16. Abstract

To effectively reduce fatal pedestrian and traffic crashes in Florida, the Florida Department of Transportation (FDOT) is taking a robust approach towards adequate lighting for pedestrians. There are more than 2,000 signalized intersection lighting retrofits currently underway. They will be completed by 2021. New and reconstructed signalized intersections with crosswalks will have vertical illumination. To successfully accomplish this goal, a quality assurance review of intersection lighting retrofits is crucial.

This project developed an innovative measurement technique to collect adequate illumination data in a safe, efficient, and high-quality way. The Center for Urban Transportation Research (CUTR) team used the system to measure both horizontal illuminance and vertical illuminance on each illuminated crosswalk at 23 signalized intersections in FDOT Districts 1, 2, 3, 4, 6, and 7. The measured illuminance values were compared to the theoretical values obtained from the design files at the same measurement points. Comparison tables and satellite maps were used to present the comparison results for verifying the lighting system design and upgrade.

The major findings include the following:

- The measured illuminance data reflect the “real” lighting patterns at signalized intersections.
- The measured illuminance values at some measurement points are significantly different from the theoretical values as a result of external factors such as shadows and external lighting resources.

17. Key Word	18. Distribution Statement
Street lighting, signalized intersections, pedestrian safety, crosswalks, horizontal illuminance, vertical illuminance, foot-candles	

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Executive Summary

Nighttime crashes are overrepresented in Florida and other states. According to Fatality Analysis Reporting System (FARS) data from the National Highway Traffic Safety Administration (NHTSA), only 21%–23% of vehicle miles traveled (VMT) occurred at night in Florida, but they accounted for about 60% of fatal crashes and at least 75% of fatal pedestrian crashes. In addition to alcohol and drug impairment of drivers and pedestrians, poor or inadequate nighttime visibility contributed significantly to these fatal crashes. Roadway illumination has become a vital component of nighttime pedestrian safety. To effectively reduce fatal pedestrian and traffic crashes in Florida, the Florida Department of Transportation (FDOT) is taking a robust approach towards lighting for pedestrians. There are more than 2,000 signalized intersection lighting retrofits currently underway. They will be completed by 2021. New and reconstructed signalized intersections with crosswalks will have vertical illumination. To successfully accomplish this goal, a quality assurance review of intersection lighting retrofits is crucial.

The purpose and objectives of the project included the following:

1. Review lighting analysis design for selected intersections.
2. Measure horizontal and vertical illumination (5 ft above surface) along the centerline of each illuminated crosswalk at three points (left edge of pavement, center of roadway, right edge of pavement). Ensure that ambient lighting will not affect measurements.
3. Compare measured illumination values to theoretical illumination values from lighting analysis design.

The research team developed an improved manual lighting measurement system to overcome the issues of the conventional method. The system consists of an Arduino microcontroller, a GPS module, an SD card, and two lighting meters. The system wirelessly connects to an Android tablet so the operator can remotely control the system. The two lighting meters are mounted on an L-shaped bracket on the top of a tripod. The horizontal meter is fixed on the highest point of the tripod (5 ft 3 in. above ground) to exclude influence from other system components. The vertical meter is mounted on the side (5 ft above ground) facing the vehicle approach direction. This installation method avoids the influence between the horizontal and vertical measurements.

As the system measures horizontal illuminance at the height of 5 ft 3 in., it is necessary to convert the measured illuminance values to FDOT standard horizontal illuminance measures (6 in. above ground). The research team conducted a calibration experiment to set up the conversion between measured horizontal illuminance (5 ft 3 in.) and standard horizontal illuminance (6 in.) and obtained the following conversion equation:

$$y = 0.0041 \cdot x^3 + 0.0701 \cdot x^2 + 1.1037 \cdot x + 0.2122$$

where y is the converted horizontal illuminance at 6 in. and x is the measured horizontal illuminance at 5 ft 3 in.

The research team developed a standard lighting measurement and analysis procedure that operators can follow for field measurement to ensure data accuracy, operation efficiency, and

operator safety. The procedure included determining measurement points by reviewing lighting design files, scheduling data collection times, filing data collection using the developed system, processing data (including horizontal illuminance conversion), comparing measured data and theoretical data, and presenting comparison results in tables and satellite maps.

The data collection was conducted at 23 signalized intersections in six FDOT Districts (1, 2, 3, 4, 6, and 7), following the data collection procedure. All data collection was conducted at 12:00 midnight and avoided adverse weather conditions to exclude the influence from external factors (e.g., headlights, rain, etc.). In total, 50 samples (horizontal and vertical illuminance pairs) were collected at each measurement point on crosswalks at an intersection. The means of the samples were compared to the theoretical values to verify the street lighting design and upgrade. The assurance review results (the difference between measured and theoretical illuminance) are given in the table below.

FDOT District	Intersection	Horizontal Illuminance Difference (%)		Vertical Illuminance Difference (%)	
		Measured ≥ Theoretical	Measured < 1.5 fc	Measured ≥ Theoretical	Measured < 1.5 fc
1	1st St and Fowler St	86%	0%	13%	53%
	Tamiami Tr and Pondella Rd	79%	46%	13%	49%
	McGregor Blvd and Colonial Blvd	74%	0%	43%	19%
	McGregor Blvd and College Pkwy	37%	33%	54%	46%
2	Collins Blvd and SR-21	94%	19%	100%	42%
	Jammes Rd and SR-128	72%	61%		75%
	Wesconnett Blvd and SR-134	39%	53%	75%	75%
	Youngerman Cr and SR-21	69%	36%	50%	75%
3	Lillian Hwy and 57th Ave	75%	0%		8%
	Lillian Hwy and 65th Ave	72%	56%		25%
	Lillian Hwy and 69th Ave	56%	3%		8%
4	Commercial Blvd and 6th Ave	33%	78%	25%	78%
	Glades Rd and SR-7	8%	14%	75%	17%
	Sunrise Blvd and Sunset Strip	0%	78%		74%
	Sunset Strip and University Dr	25%	72%		83%
6	1st St and 22nd Ave	44%	25%	43%	58%
	SW 8th Ave and SW 6th St	6%	42%	43%	42%
	NW 17th St and NW 27th Ave	48%	11%		26%
	W Flagler St and W 25th Ave	39%	25%	50%	36%
7	Busch Blvd and N 30th St	86%	22%	50%	47%
	Busch Blvd and Nebraska Ave	33%	17%	100%	33%
	Hillsborough Ave and N 15th St	39%	0%	63%	22%
	Hillsborough Ave and N 40th St	47%	14%	100%	75%

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1 Introduction

1.1 Background

Nighttime crashes are overrepresented in Florida and other states. According to the Fatality Analysis Reporting System (FARS) data from the National Highway Traffic Safety Administration (NHTSA), only 21%–23% of vehicle miles traveled (VMT) occurred at night in Florida, but they accounted for about 60% of fatal crashes and at least 75% of fatal pedestrian crashes. In addition to alcohol and drug impairment of drivers and pedestrians, poor or inadequate nighttime visibility contributed significantly to these fatal crashes. Roadway illumination has become a vital component of nighttime pedestrian safety. To effectively reduce fatal pedestrian and traffic crashes in Florida, the Florida Department of Transportation (FDOT) is taking a very robust approach towards lighting for pedestrians. There are more than 2,000 signalized intersection lighting retrofits currently underway. They will be completed by 2021. New and reconstructed signalized intersections with crosswalks will have vertical illumination. To successfully accomplish this goal, a quality assurance review of intersection lighting retrofits is crucial.

1.2 Research Objectives

The purpose and objective(s) of the project include the following:

1. Review lighting analysis design for selected intersections.
2. Measure horizontal and vertical illumination (5 ft above the surface) along the centerline of each illuminated crosswalk at three points (left edge of pavement, center of roadway, right edge of pavement). Ensure that ambient lighting will not affect measurements.
3. Compare measured illumination values to theoretical illumination values from lighting analysis design.

1.3 Support Tasks

To achieve the research objectives, the research team completed the following tasks:

- *Task 1: Preparation and Calibration of Intersection Lighting Measurement System* – CUTR developed an innovative measurement device to collect adequate illumination data in a safe, efficient, and high-quality way. Before field data collection, CUTR took some sample data to assess impacts of external lighting resources (oncoming vehicle headlights, property lighting, and traffic signals). Based on the testing experiences, CUTR developed a lighting measurement procedure and guidelines and trained operators to conduct intersection lighting data collection.
- *Task 2: Illumination Data Collection* – CUTR collected data at 23 signalized intersections randomly selected by FDOT from six FDOT Districts. The collected data was processed and a dataset was generated with at a correct format for further analysis.

- *Task 3: Data Analysis* – The collected lighting data were compared with theoretical illumination values provided by FDOT at 23 intersections. The relative difference between the field measurement and theoretical calculation was computed to assist FDOT for verifying the lighting system design.

1.4 Organization of Report

The report is organized as follows: Chapter 2 describes the developed lighting measurement device and the data collection procedure, and Chapter 3 illustrates the lighting data measurement activities and results. Data analysis is presented in Chapter 4, and Chapter 5 summarizes the findings obtained from this study.

2 Lighting Measurement Method

The research team developed and calibrated a lighting measurement system that would help the research team to quickly, accurately, and safely collect lighting measures at signalized intersections. A standard operating procedure was produced to guide data collection operators using the system for collecting in the field. In addition, pre-tests were conducted to assess the impacts of external lighting sources (e.g., traffic signals) and train operators.

2.1 Development of Lighting Measurement System

The conventional method for measuring horizontal roadway illumination involves spot-checking along a grid set up in the selected intersection. Measurements are taken using a light meter placed 6 in. above the ground (for horizontal measurement) or 5 ft above the ground (for vertical measurement). The operator sets up the light meter, stands back, and triggers a measurement manually. The light meter is then moved to the next point on the grid, and the process is repeated. This method, which is both time-consuming and dangerous, is lengthy and leaves the operator and the testing equipment vulnerable to roadway dangers for prolonged periods. This danger can be avoided with lane closures and police presence, but doing so adds cost to the measurement process. Thus, it is necessary to use an advanced method to measure lighting data efficiently, accurately, and safely.

The research team developed an improved manual lighting measurement system to overcome the issues of the conventional method. As shown in Figure 1, the system consists of an Arduino microcontroller (*1*), a GPS module, an SD card, and two lighting meters. All these modules are assembled and mounted on a tripod (Figure 2). The system wirelessly connects to an Android tablet so the operator can remotely control the system. The two lighting (*2*) meters are mounted on an "L" shaped bracket on the top of the tripod, as shown in Figure 2. The horizontal meter is fixed on the highest point of the tripod (5 ft 3 in. above ground) to exclude influence from other system components. The vertical meter is mounted on the side (5 ft above ground) facing the vehicle approach direction. This installation method avoids the influence between the horizontal and vertical measurements.

Compared to the conventional measurement method, this new lighting system has several advantages:

- The system allows the operator to trigger the measurement activities remotely, such that he/she can stay in a safe place (such as a sidewalk) and avoid exposure to traffic.
- The operator triggering the system can read horizontal and vertical illuminance values simultaneously 10 times. This is beneficial for collecting enough samples in a short time (for example, a gap between two approaching vehicles). Measurement time can also be significantly reduced using the system.
- In conventional measurement, it is difficult to control the accurate position of lighting meters manually. Affixing the meters on a tripod excludes the influence of unstable lighting meter position during measurement.

- The system records multiple data items (horizontal/vertical illuminance, coordination, measurement point, etc.), which are stored on an SD card, thus making it easy to transfer the collected data to a computer for analysis.

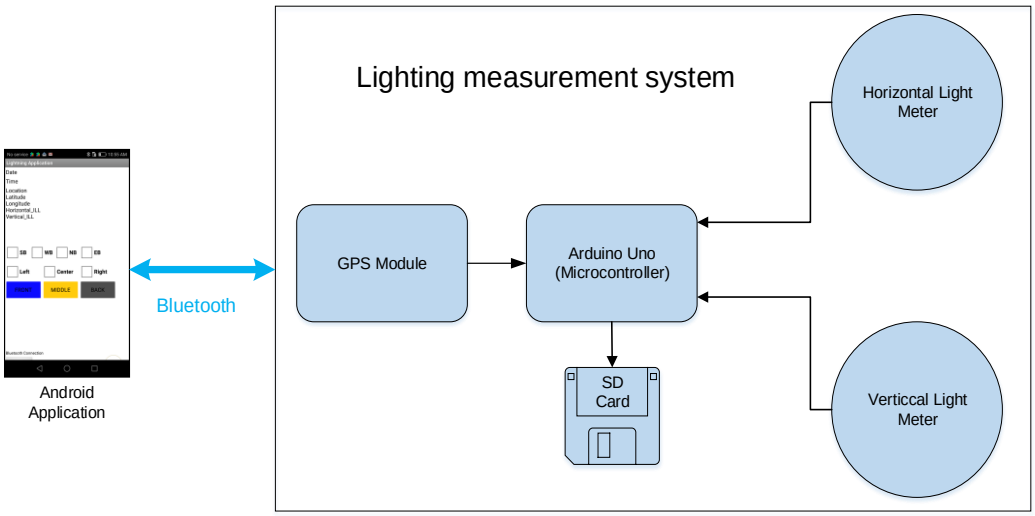

Figure 1. Lighting Measurement System

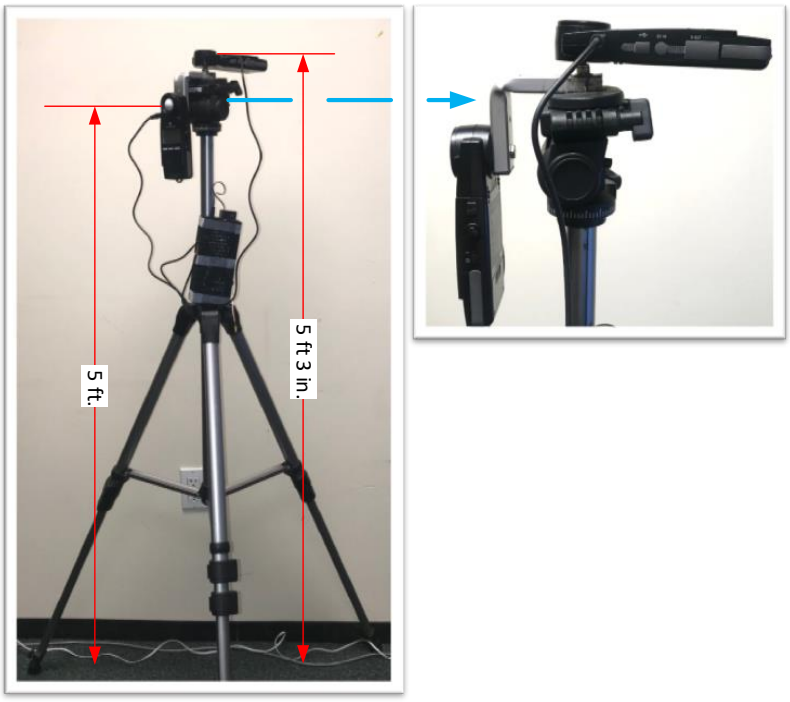

Figure 2. Lighting Measurement System Assembly and Lighting Meter Installation

2.2 Calibration

As the system measures horizontal illuminance at the height of 5 ft 3 in., it is necessary to convert the measured illuminance values to FDOT standard (*3*) horizontal illuminance measures

(6 in. above ground). The research team conducted a calibration experiment to set up the conversion between measured horizontal illuminance (5 ft 3 in.) and standard horizontal illuminance (6 in.).

2.2.1 Calibration Experiment

A field experiment was conducted at a selected testing location to measure horizontal illuminance at 5 ft 3 in and 6 in, respectively, at the same spot on the testing site. Figure 3 shows the horizontal lighting measurements at the two different heights. The experiment was repeated at 30 spots with different lighting levels and collected 50 readings for each height. In total, 3,000 observations were collected for developing conversion equations.

Figure 3. Measurement of Horizontal Illuminance at 5 ft 3 in. (*left*) and 6 in. (*right*)

2.2.2 Conversion Equation

A statistical regression analysis was applied to the sample data. Figure 4 shows the curve and equation for converting measured horizontal illuminance from 5 ft 3 in. to 6 in. The R^2 value of the polynomial equation (0.9986) is very close to 1, indicating that the equation can convert horizontal illuminance from 5 ft 3 in. to 6 in. perfectly. The conversion equation is given in Eq. 1.

$$y = 0.0041 \cdot x^3 + 0.0701 \cdot x^2 + 1.1037 \cdot x + 0.2122 \quad (1)$$

where y is the converted horizontal illuminance at 6 in.; x is the measured horizontal illuminance at 5 ft 3 in.

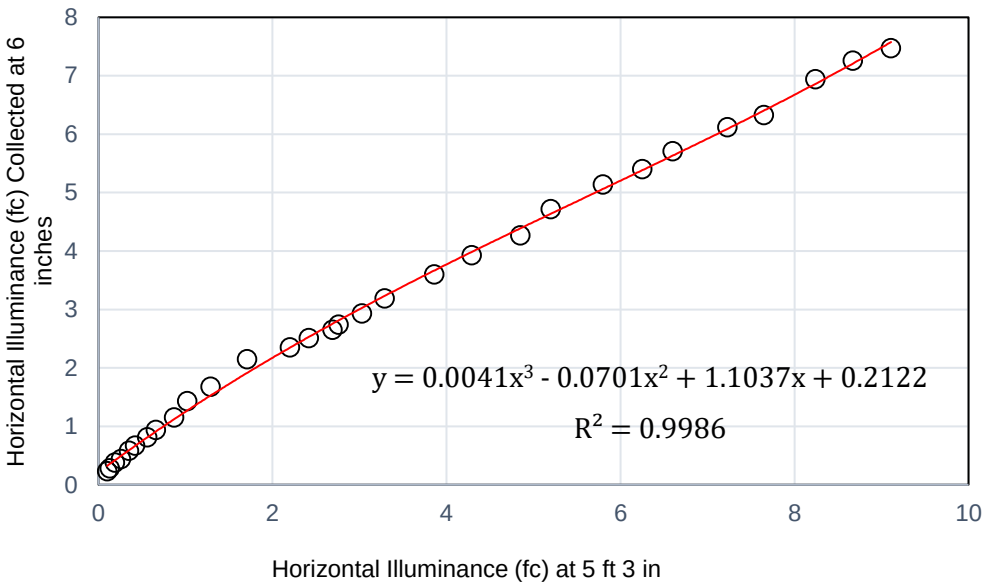

Figure 4. Conversion Equation for Horizontal Illuminance

2.2.3 Signal Lighting Experiment

A test to examine the influence of the traffic signals on horizontal and vertical illuminance measurement was conducted. Traffic signals present three colors—red, green, and amber. Lighting measurements were collected with three different signal scenarios (red, green, and amber), holding other factors constant. The test was conducted in two different locations, representing the typical measurement points in this project. The first location was directly under the traffic signal, as shown in Figure 5. Traffic signals potentially can influence horizontal measurement in this position. In the test shown in Figure 6, the system was placed on the crosswalk opposite the traffic light with the vertical meter facing the traffic signal. This test aimed to examine the influence of traffic signals on vertical measurement.

Figure 5. Test of Signal Light Influence under Traffic Signal

Figure 6. Test of Signal Light Influence on Crosswalk

For each test, 150 samples were collected for each traffic signal color. Table 1 and Table 2 show comparisons of horizontal/vertical illuminance of the three signal colors under the signal and on the crosswalk. The results show that traffic signal color does not influence horizontal and vertical illuminance measurements.

Table 1. Comparison of Illuminance Data under Traffic Signals

Illuminance	Red	Green	Amber
Horizontal (fc)	2.4	2.4	2.4
Vertical (fc)	0.3	0.3	0.3

Table 2. Comparison of Illuminance Data at Crosswalk

Illuminance	Red	Green	Amber
Horizontal (fc)	1.3	1.3	1.3
Vertical (fc)	0.4	0.4	0.4

2.3 Development of Data Collection Procedure

The research team developed a standard lighting measurement and analysis procedure that operators can follow for field measurement to ensure data accuracy, operation efficiency, and operator safety. The procedure is shown in Figure 7.

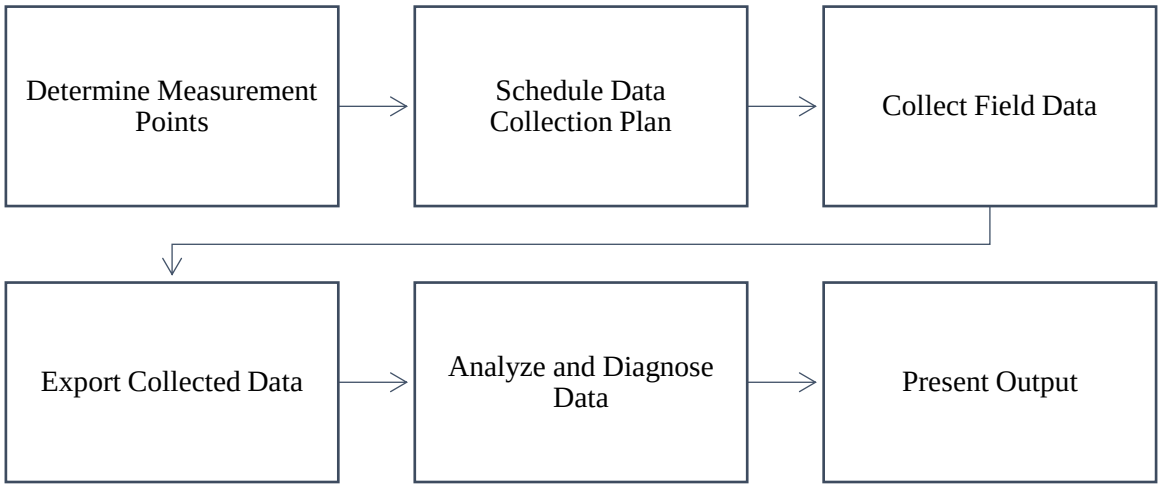

Figure 7. Standard Procedure for Field Lighting Measurement

2.3.1 Determine Measurement Points

The research team reviewed the lighting design files provided by FDOT and identified 36 points on crosswalks at each intersection, as shown in Figure 8, where theoretical illuminance data (horizontal and vertical) were available. The exact positions of the 36 points were determined by measuring the distance of the points from a reference line (e.g., zebra line or edge of the crosswalk) in a Google map. The location information was used to locate measurement points in the field.

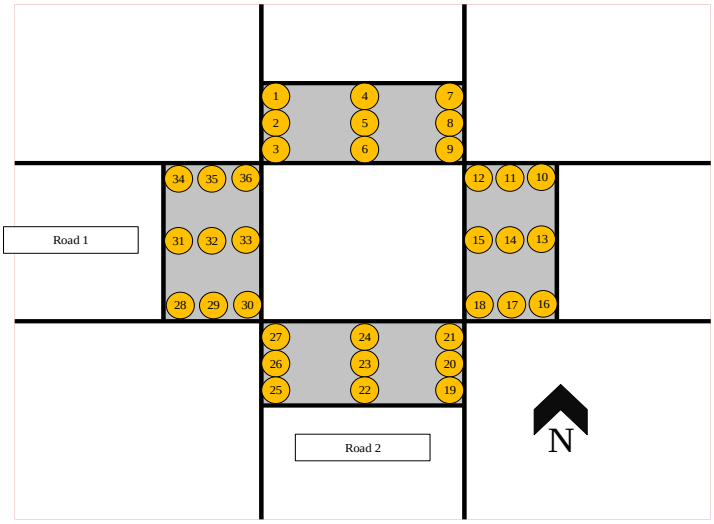

Figure 8. Typical Intersection Data Collection Methodology

2.3.2 Schedule Data Collection Plan

The data collection plan was scheduled based on the following criteria:

- Time – 1:30–4:00 AM to minimize influence from traffic.
- Not conducted in adverse weather (rain or fog).
- Avoided on a full moon night to minimize influence from moonlight.

2.3.3 Collect Field Data

Following the scheduled data collection plan, operators first checked the lighting measurement system for operation readiness, including tablet/system battery, connection, SD cards, etc. If the system was ready, the lighting measure system was placed at a previously-determined measurement point during a vehicle clearance period (no approaching vehicles). Then, as shown in Figure 9, the operators stayed in a safe place and triggered the device to measure the horizontal and vertical illuminance at the point. One trigger activates 10 readings, and, in total, 50 readings (samples) were measured at each point. The trigger timing was when there were no approaching vehicles to exclude influence from vehicle headlights. Operators repeated this procedure for all 36 measurement points and collected 1,800 sample pairs (horizontal and vertical) at each intersection.

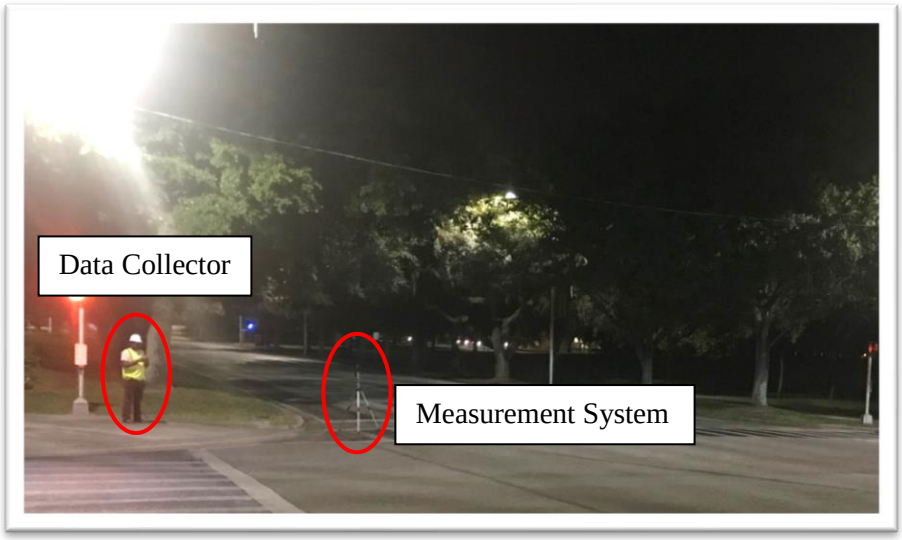

Figure 9. Illustration of Field Data Collection

2.3.4 Export Collected Data

All measured data were stored on the SD card of the lighting measurement system. The collected data fields are shown in Table 3. The collected data was transferred to an Excel table for analysis.

Table 3. Lighting Measurement Data Fields

Data Field	Description
Longitude	GPS provides longitude value
Latitude	GPS provides latitude value
Date	Measurement date
Time	Measurement time for each reading in milliseconds
Horizontal Illuminance	Foot candle
Vertical Illuminance	Foot candle
Unique Event Identification	A unique event identification number to indicate each reading
Measure Point	Measure point ID to indicate measurement location

2.3.5 Analyze and Diagnose Data

The research team calculated the mean and standard deviation of measured lighting data at each measurement point. For horizontal illuminance, the conversion equation (Figure 4) was applied to convert the measured values from 5 ft 3 in. to 6 in. above the ground.

The measured lighting data was compared to the theoretical lighting data at the same measurement points. The difference ($Diff$) and relative difference ($Diff\%$) between the measured lighting measurements and the theoretical lighting data were calculated using the following equations:

$$Diff = Measured\ illuminance - Theoretical\ illuminace \quad (2)$$

$$Diff\% = \frac{Measured\ illuminance - Theoretical\ illuminace}{Theoretical\ illuminace} \times \% \quad (3)$$

Examples of data comparison for horizontal and vertical measurements are presented in Table 4 and Table 5, respectively. The theoretical values were available at eight measurement points in the design files; thus, the comparison of vertical measurements was conducted at eight points only. Based on the comparison, the measurement points with a significant difference (either positive or negative) were examined to address the causes.

2.3.6 Present Output

The research team produced a map that presents the measured and theoretical lighting data. Field pictures are attached on the map to explain the significant difference between the measurement and theoretical values.

Table 4. Example of Horizontal Measurement Comparison

Horizontal Measurement								
Approach	**ID**	**Measured at 5 ft 3 in.**		**Calculated at 6 in.**		**Theoretical Value**	**Diff.**	**%**
		Mean	***SD***	***Mean***	***SD***			
SB	1	1.5	0.02	1.7	0.02	1.0	0.7	70%
	2	0.6	0.07	0.8	0.08	0.9	-0.1	-11%
	3	0.4	0.01	0.6	0.01	1.0	-0.4	-40%
	4	1.4	0.04	1.6	0.03	1.4	0.2	14%
	5	1.3	0.05	1.5	0.04	1.4	0.1	7%
	6	1.3	0.03	1.5	0.03	1.3	0.2	15%
	7	1.4	0.02	1.6	0.02	1.4	0.2	14%
	8	1.3	0.03	1.5	0.03	1.4	0.1	7%
	9	1.2	0.02	1.4	0.02	1.3	0.1	8%
WB	10	0.9	0.01	1.2	0.01	1.3	-0.1	-8%
	11	0.9	0.02	1.2	0.01	1.3	-0.1	-8%
	12	0.7	0.01	0.9	0.01	1.3	-0.4	-31%
	13	3.1	0.04	3.1	0.03	2.9	0.2	7%
	14	3.1	0.05	3.1	0.04	2.9	0.2	7%
	15	3.1	0.04	3.1	0.03	3.0	0.1	3%
	16	5.3	0.04	4.7	0.03	3.6	1.1	31%
	17	5.6	0.04	4.9	0.03	4.1	0.8	20%
	18	5.9	0.04	5.1	0.03	4.3	0.8	19%
NB	19	1.6	0.02	1.8	0.02	1.6	0.2	13%
	20	1.7	0.02	1.9	0.02	1.7	0.2	12%
	21	1.8	0.03	2.0	0.02	1.7	0.3	18%
	22	1.8	0.04	2.0	0.03	1.6	0.4	25%
	23	1.7	0.03	1.9	0.03	1.6	0.3	19%
	24	1.6	0.04	1.8	0.04	1.7	0.1	6%
	25	2.7	0.04	2.8	0.03	2.1	0.7	33%
	26	2.4	0.05	2.6	0.04	2.2	0.4	18%
	27	2.5	0.03	2.6	0.03	2.3	0.3	13%
EB	28	1.0	0.02	1.3	0.02	0.9	0.4	44%
	29	1.5	0.02	1.7	0.02	0.6	1.1	183%
	30	2.1	0.03	2.3	0.03	1.8	0.5	28%
	31	2.2	0.03	2.3	0.03	1.5	0.8	53%
	32	2.0	0.03	2.2	0.03	1.4	0.8	57%
	33	1.9	0.03	2.1	0.03	1.4	0.7	50%
	34	2.6	0.03	2.6	0.02	1.5	1.1	73%
	35	2.5	0.03	2.6	0.02	1.6	1.0	63%
	36	2.6	0.03	2.7	0.03	1.7	1.0	59%

Table 5. Example of Vertical Measurement Comparison

Vertical Measurement						
Approach	**ID**	**Measured at 5 ft**		**Theoretical Value**	**Diff.**	**%**
		Mean	***SD***			
SB	1	1.0	0.02			
	2	1.0	0.05	0.9	0.1	11%
	3	0.8	0.02			
	4	2.9	0.05			
	5	2.7	0.04	2.7	0.0	0%
	6	2.5	0.03			
	7	2.8	0.06			
	8	2.5	0.04			
	9	2.3	0.03			
WB	10	0.7	0.02			
	11	0.8	0.04	0.4	0.4	100%
	12	0.7	0.07			
	13	1.4	0.02			
	14	1.4	0.06	0.6	0.8	133%
	15	1.7	0.06			
	16	2.3	0.13			
	17	2.2	0.03			
	18	2.2	0.07			
NB	19	1.4	0.03			
	20	1.7	0.02	1.7	0.0	0%
	21	1.9	0.04			
	22	2.3	0.04			
	23	2.2	0.08	2.1	0.1	5%
	24	2.4	0.07			
	25	3.0	0.05			
	26	3.1	0.04			
	27	3.1	0.04			
EB	28	1.4	0.02			
	29	1.2	0.02	0.6	0.6	100%
	30	1.3	0.02			
	31	2.2	0.03			
	32	2.3	0.04	1.4	0.9	64%
	33	2.5	0.04			
	34	2.1	0.03			
	35	2.4	0.04			
	36	2.7	0.04			

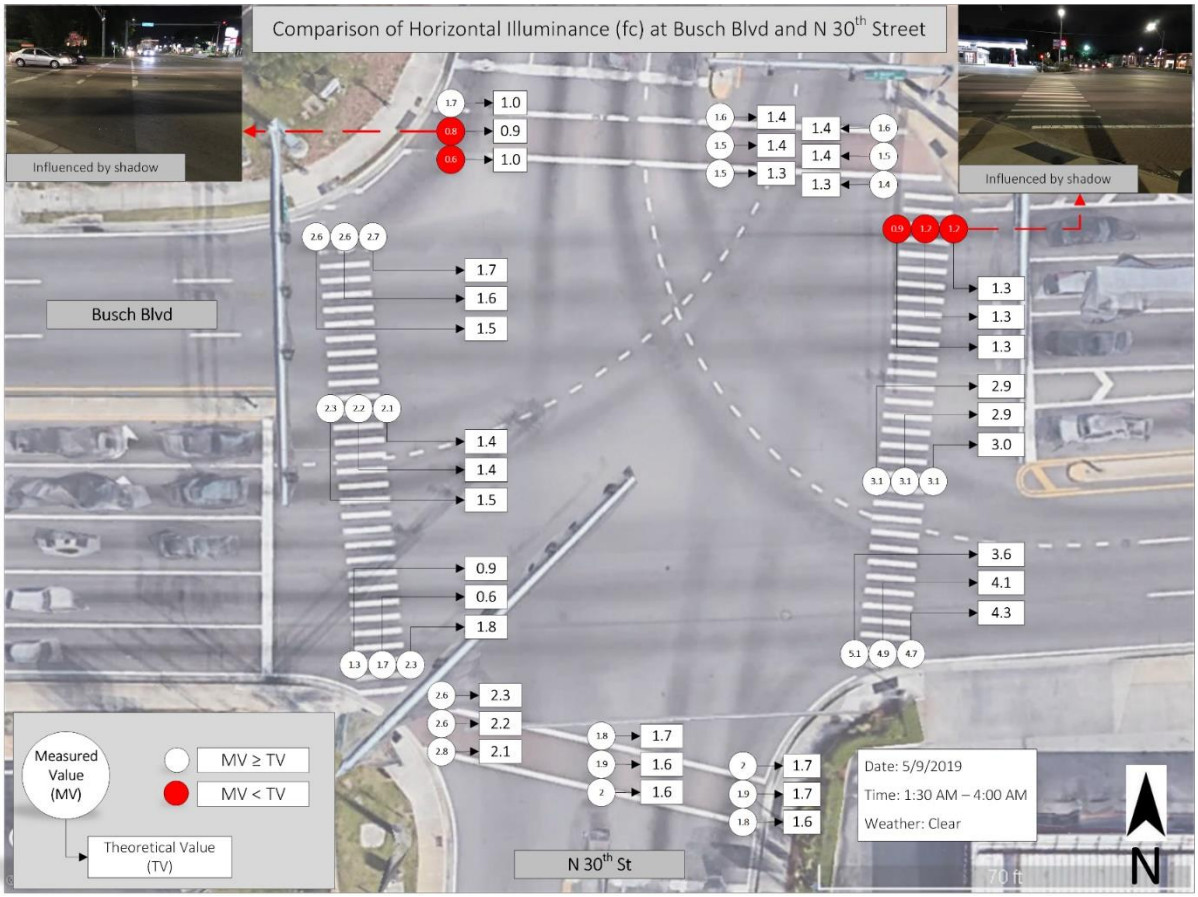

Figure 10. Example of Horizontal Measurement Map

3 Data Collection

The research team completed data collection at 23 signalized intersections in six FDOT Districts following the developed guidance. At each point, 50 samples were collected. The mean and standard deviation of the samples were calculated. The horizontal illuminance data were converted using Eq.1. The statistics of illuminance data are presented in the following sections.

3.1 Data Collection in District 1

The data collection was conducted at four signalized intersections in District 1, as summarized in Table 6.

Table 6. Overview of Data Collection in FDOT District 1

FDOT District 1	1st St and Fowler St	Tamiami Tr and Pondella Rd	McGregor Blvd and Colonial Blvd	McGregor Blvd and College Pkwy
Date	5/31/2019	5/31/2019	6/04/2019	6/04/2019
Time	1:00 AM–4:00 AM	1:00 AM–4:00 AM	1:00 AM–4:00 AM	1:00 AM–4:00 AM
Weather	Clear	Clear	Clear	Clear
# of measure points – horizontal	36	39	36	57
# of measure points – vertical	36	39	36	57
Intersection type	Normal	Normal	Interchange	Interchange
Approaches	4	4	Multiple	Multiple

The illuminance data collected at the four signalized intersections are described in Table 7 through Table 10.

Table 7. D1 - 1st St and Fowler St

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SEB	1	4.4	0.10	4.0	0.08	2.7	0.10
	2	4.3	0.09	4.0	0.07	2.8	0.10
	3	4.3	0.12	4.0	0.09	3.2	0.11
	4	7.1	0.17	5.9	0.12	3.6	0.14
	5	6.8	0.12	5.8	0.09	4.1	0.09
	6	6.5	0.11	5.6	0.08	4.2	0.09
	7	7.6	0.11	6.3	0.09	4.6	0.07
	8	7.0	0.13	5.9	0.10	4.8	0.12
	9	6.1	0.11	5.3	0.08	4.5	0.11
SWB	10	3.0	0.09	3.0	0.07	3.9	0.08
	11	3.2	0.07	3.1	0.05	3.5	0.10
	12	3.8	0.09	3.6	0.07	3.1	0.08
	13	2.6	0.09	2.7	0.08	3.3	0.11
	14	2.8	0.08	2.8	0.07	3.3	0.09
	15	3.1	0.08	3.1	0.06	3.2	0.09
	16	2.3	0.09	2.5	0.07	2.2	0.10
	17	3.0	0.12	3.0	0.09	2.0	0.09
	18	3.8	0.09	3.6	0.07	2.0	0.08
NWB	19	6.3	0.11	5.4	0.08	2.5	0.11
	20	5.6	0.11	4.9	0.08	2.6	0.11
	21	4.9	0.10	4.4	0.07	2.6	0.09
	22	6.5	0.12	5.5	0.08	2.5	0.10
	23	6.0	0.12	5.2	0.08	2.8	0.11
	24	5.3	0.25	4.7	0.18	2.7	0.10
	25	1.8	0.10	2.0	0.09	1.9	0.10
	26	1.8	0.09	2.0	0.08	2.0	0.10
	27	1.6	0.10	1.8	0.09	2.0	0.10
NEB	28	3.6	0.13	3.5	0.10	4.0	0.17
	29	3.0	0.12	3.0	0.09	4.1	0.17
	30	1.9	0.10	2.1	0.08	3.0	0.14
	31	5.6	0.12	4.9	0.08	6.2	0.16
	32	4.7	0.11	4.3	0.08	5.8	0.15
	33	4.4	0.13	4.0	0.10	5.1	0.15
	34	4.4	0.15	4.1	0.11	4.8	0.20
	35	4.5	0.14	4.2	0.10	5.3	0.19
	36	4.5	0.11	4.1	0.08	5.0	0.17

Table 8. D1 - Tamiami Tr and Pondella Rd

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	1.3	0.08	1.6	0.07	1.8	0.08
	2	1.7	0.08	1.9	0.07	2.0	0.10
	3	1.7	0.08	1.9	0.07	2.0	0.09
	4	2.1	0.07	2.3	0.06	2.0	0.08
	5	2.1	0.05	2.3	0.05	1.9	0.09
	6	2.1	0.08	2.3	0.07	1.8	0.09
	7	1.3	0.07	1.6	0.06	1.1	0.06
	8	1.4	0.07	1.7	0.06	0.9	0.08
	9	1.6	0.07	1.8	0.07	1.0	0.07
WB	10	1.7	0.08	1.9	0.07	1.4	0.06
	11	1.8	0.08	2.0	0.07	1.6	0.08
	12	2.1	0.07	2.3	0.06	1.6	0.09
	13	2.2	0.07	2.3	0.06	2.2	0.07
	14	2.0	0.07	2.2	0.06	2.0	0.08
	15	1.9	0.09	2.1	0.08	2.1	0.06
	16	1.1	0.07	1.4	0.07	1.0	0.08
	17	1.1	0.08	1.3	0.07	0.9	0.06
	18	1.1	0.07	1.4	0.07	0.9	0.09
NB	19	1.1	0.09	1.3	0.08	0.9	0.08
	20	1.1	0.09	1.3	0.08	1.0	0.07
	21	1.1	0.08	1.3	0.08	0.9	0.07
	22	1.6	0.08	1.8	0.07	2.1	0.08
	23	1.6	0.07	1.8	0.07	2.1	0.09
	24	1.5	0.06	1.8	0.06	2.0	0.10
	25	0.8	0.09	1.1	0.09	1.2	0.08
	26	0.6	0.06	0.9	0.06	1.2	0.06
	27	0.7	0.06	0.9	0.06	1.1	0.09
EB	28	0.6	0.07	0.9	0.07	1.0	0.08
	29	0.6	0.06	0.8	0.06	0.8	0.07
	30	0.6	0.06	0.8	0.06	0.9	0.08
	31	1.2	0.07	1.4	0.07	2.0	0.09
	32	1.2	0.07	1.4	0.07	1.9	0.07
	33	1.1	0.08	1.4	0.08	1.8	0.07
	34	1.8	0.10	2.0	0.09	2.3	0.10
	35	1.7	0.08	1.9	0.08	2.3	0.08
	36	1.6	0.08	1.8	0.08	2.3	0.09
SEB	37	0.9	0.07	1.2	0.07	0.9	0.06
	38	0.9	0.07	1.1	0.07	0.7	0.06
	39	0.9	0.07	1.2	0.07	0.6	0.06

Table 9. D1 - McGregor Blvd and Colonial Blvd

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	2.2	0.17	2.3	0.14	1.5	0.15
	2	2.2	0.20	2.3	0.17	1.7	0.18
	3	2.5	0.21	2.6	0.17	2.1	0.19
	4	4.5	0.11	4.2	0.08	3.2	0.10
	5	4.4	0.10	4.0	0.07	3.4	0.12
	6	3.9	0.07	3.7	0.05	3.3	0.09
	7	5.0	0.08	4.5	0.06	3.9	0.10
	8	4.6	0.10	4.2	0.07	3.4	0.09
	9	3.7	0.08	3.5	0.06	3.6	0.09
NWB	10	2.9	0.09	2.9	0.07	1.4	0.07
	11	2.7	0.09	2.8	0.07	1.6	0.09
	12	2.4	0.08	2.6	0.07	1.8	0.08
	13	2.2	0.09	2.3	0.08	1.4	0.08
	14	1.8	0.09	2.0	0.08	1.4	0.09
	15	1.7	0.08	1.9	0.08	1.6	0.09
	16	1.3	0.10	1.5	0.09	1.1	0.09
	17	1.3	0.10	1.6	0.09	1.2	0.10
	18	1.4	0.07	1.7	0.07	1.3	0.08
NB	19	2.7	0.09	2.7	0.07	1.8	0.08
	20	2.6	0.11	2.7	0.09	1.8	0.10
	21	2.6	0.11	2.7	0.09	2.0	0.11
	22	1.9	0.10	2.1	0.09	1.5	0.11
	23	2.2	0.12	2.3	0.10	1.7	0.10
	24	2.2	0.12	2.3	0.11	1.6	0.09
	25	1.3	0.14	1.5	0.13	1.5	0.11
	26	1.2	0.10	1.5	0.09	1.5	0.10
	27	1.3	0.10	1.5	0.10	1.5	0.12
EB	28	1.8	0.11	2.0	0.10	0.8	0.14
	29	4.0	0.09	3.7	0.07	3.4	0.11
	30	2.2	0.10	2.3	0.08	1.6	0.12
	31	5.7	0.10	5.0	0.07	4.8	0.11
	32	5.6	0.14	4.9	0.10	5.2	0.12
	33	5.4	0.12	4.8	0.09	5.3	0.12
	34	2.7	0.11	2.7	0.09	2.4	0.10
	35	2.8	0.12	2.9	0.10	2.7	0.13
	36	2.9	0.09	2.9	0.07	2.9	0.11

Table 10. D1 - McGregor Blvd and College Pkwy

ID	Horizontal Measurement				Vertical Measurement	
	Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
1	3.8	0.10	3.6	0.07	1.1	0.10
2	4.0	0.09	3.8	0.07	1.0	0.10
3	4.5	0.10	4.1	0.07	0.9	0.09
4	4.6	0.12	4.2	0.08	3.2	0.12
5	4.2	0.12	3.9	0.08	3.0	0.12
6	4.0	0.11	3.8	0.08	2.8	0.11
7	1.2	0.10	1.4	0.09	1.6	0.13
8	1.1	0.11	1.3	0.11	1.4	0.11
9	1.1	0.11	1.3	0.10	1.4	0.09
10	0.6	0.09	0.8	0.10	0.7	0.11
11	0.8	0.09	1.0	0.09	0.6	0.08
12	0.8	0.09	1.1	0.09	0.7	0.08
13	0.8	0.08	1.0	0.08	1.1	0.08
14	0.9	0.09	1.2	0.09	1.1	0.11
15	1.1	0.09	1.3	0.09	1.4	0.09
16	1.4	0.08	1.6	0.07	2.3	0.10
17	1.3	0.08	1.5	0.08	2.1	0.11
18	1.2	0.08	1.4	0.07	1.8	0.09
19	1.0	0.09	1.3	0.09	2.2	0.08
20	1.0	0.08	1.2	0.08	2.0	0.11
21	0.9	0.07	1.1	0.07	1.7	0.08
22	0.7	0.08	1.0	0.08	1.5	0.08
23	0.7	0.07	0.9	0.07	1.4	0.07
24	0.7	0.09	0.9	0.10	1.3	0.08
25	1.6	0.09	1.8	0.08	1.0	0.08
26	1.4	0.08	1.6	0.07	1.1	0.09
27	1.3	0.09	1.6	0.08	1.2	0.12
28	3.6	0.08	3.5	0.06	1.4	0.10
29	3.4	0.12	3.3	0.10	1.4	0.10
30	3.2	0.11	3.2	0.09	1.4	0.08
31	4.4	0.12	4.1	0.09	3.6	0.08
32	5.4	0.08	4.8	0.06	3.8	0.08
33	6.6	0.09	5.6	0.06	4.0	0.11
34	10.1	0.11	8.5	0.10	7.2	0.08
35	8.9	0.11	7.4	0.09	7.0	0.11
36	7.5	0.13	6.3	0.10	7.0	0.11
37	2.4	0.06	2.5	0.05	1.5	0.07
38	2.5	0.11	2.6	0.09	1.6	0.09
39	2.5	0.09	2.6	0.08	2.0	0.09
40	2.7	0.07	2.7	0.06	1.4	0.11
41	3.1	0.10	3.1	0.08	1.9	0.10

Table 10, continued

42	3.2	0.10	3.2	0.08	2.6	0.10
43	2.3	0.06	2.4	0.05	1.1	0.10
44	3.7	0.10	3.5	0.08	1.4	0.09
45	5.2	0.11	4.6	0.08	1.4	0.07
46	2.3	0.09	2.4	0.08	1.6	0.09
47	2.4	0.09	2.6	0.07	1.1	0.29
48	2.7	0.10	2.8	0.08	1.1	0.08
49	2.3	0.15	2.4	0.13	2.7	0.23
50	2.1	0.16	2.3	0.14	2.6	0.20
51	2.0	0.10	2.2	0.09	2.3	0.19
52	2.3	0.15	2.4	0.13	2.7	0.23
53	2.1	0.16	2.3	0.14	2.6	0.2
54	2	0.1	2.2	0.09	2.3	0.19
55	5.7	0.11	5.0	0.08	1.7	0.12
56	6.5	0.10	5.6	0.07	1.7	0.11
57	7.0	0.10	5.9	0.07	1.6	0.09

3.2 Data Collection in District 2

The data collection was conducted at four signalized intersections in District 2. The data collection efforts are summarized in Table 11.

Table 11. Overview of Data Collection in District 2

FDOT District 2	Collins Blvd and SR-21	Jammes Rd and SR-128	Wesconnett Blvd and SR-134	Youngerman Cr and SR-21
Date	6/14/2019	6/14/2019	6/13/2019	6/13/2019
Time	1:00 AM–4:00 AM	1:00 AM–4:00 AM	1:00 AM–4:00 AM	1:00 AM–4:00 AM
Weather	Clear	Clear	Clear	Clear
# of measure points - horizontal	36	36	36	36
# of measure points - vertical	36	36	36	36
Intersection type	Normal	Normal	Normal	Normal
Approaches	4	4	4	4

The illuminance data collected at the four signalized intersections are described in following Table 12 through Table 15.

Table 12. D2 - Collins Blvd and SR-21

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	2.3	0.11	2.5	0.09	1.6	0.07
	2	2.3	0.08	2.4	0.07	1.8	0.07
	3	2	0.09	2.2	0.08	1.7	0.08
	4	1.7	0.08	1.9	0.07	2.2	0.09
	5	1.8	0.14	2	0.12	2.2	0.09
	6	1.7	0.08	1.9	0.07	2.4	0.11
	7	3.2	0.13	3.2	0.1	4.5	0.09
	8	2.6	0.08	2.7	0.06	4	0.1
	9	2.2	0.08	2.3	0.07	3.4	0.11
WB	10	1.5	0.07	1.7	0.07	0.8	0.07
	11	1.4	0.08	1.6	0.07	0.9	0.09
	12	1.3	0.08	1.5	0.08	0.9	0.08
	13	0.8	0.08	1.1	0.08	0.6	0.11
	14	0.8	0.06	1	0.06	0.6	0.08
	15	0.8	0.09	1	0.09	0.7	0.11
	16	0.9	0.08	1.2	0.08	0.2	0.09
	17	1.1	0.16	1.4	0.16	0.2	0.11
	18	1.2	0.1	1.4	0.1	0.2	0.1
NB	19	4.2	0.1	3.9	0.07	3.8	0.09
	20	3.7	0.11	3.5	0.09	3.6	0.1
	21	3.3	0.13	3.2	0.1	3.8	0.11
	22	1.8	0.09	2	0.08	1.2	0.1
	23	1.8	0.08	2	0.07	1.3	0.09
	24	1.8	0.1	2	0.09	1.4	0.11
	25	5.8	0.11	5.1	0.08	1.8	0.12
	26	5.7	0.1	5	0.07	2.6	0.08
	27	5.3	0.13	4.7	0.09	3.1	0.08
EB	28	2	0.09	2.2	0.08	2.2	0.13
	29	2.3	0.09	2.4	0.08	2.2	0.11
	30	2.6	0.13	2.7	0.1	2.2	0.15
	31	1.5	0.1	1.7	0.09	1.7	0.12
	32	1.4	0.1	1.6	0.09	1.7	0.08
	33	1.4	0.08	1.6	0.07	1.6	0.1
	34	0.4	0.11	0.6	0.12	0.8	0.09
	35	1.9	0.13	2.1	0.11	0.9	0.16
	36	1.9	0.14	2.1	0.12	1.1	0.11

Table 13. D2 - Jammes Rd and SR-128

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	1.7	0.09	1.9	0.09	2.5	0.09
	2	1.9	0.11	2	0.1	2.7	0.1
	3	2.2	0.08	2.3	0.07	2.7	0.1
	4	2.1	0.11	2.2	0.09	2.4	0.11
	5	2.3	0.08	2.4	0.07	2.4	0.11
	6	2.4	0.11	2.5	0.1	2	0.09
	7	1.4	0.1	1.7	0.09	1.7	0.11
	8	1.4	0.1	1.7	0.09	1.5	0.09
	9	1.4	0.08	1.6	0.07	1.3	0.09
WB	10	0.3	0.08	0.6	0.09	0.6	0.12
	11	0.3	0.11	0.6	0.11	0.6	0.08
	12	0.4	0.09	0.6	0.09	0.6	0.11
	13	0.2	0.09	0.4	0.09	0.6	0.1
	14	0.2	0.12	0.5	0.13	0.5	0.1
	15	0.3	0.1	0.5	0.11	0.5	0.11
	16	0.2	0.09	0.5	0.1	0.6	0.09
	17	0.2	0.09	0.5	0.1	0.6	0.09
	18	0.2	0.09	0.4	0.09	0.6	0.08
NB	19	0.2	0.09	0.4	0.1	0.2	0.09
	20	0.2	0.08	0.4	0.09	0.2	0.07
	21	0.2	0.09	0.4	0.1	0.2	0.1
	22	0.3	0.15	0.5	0.16	0.1	0.1
	23	0.4	0.22	0.7	0.23	0.3	0.09
	24	0.4	0.23	0.7	0.24	0.2	0.12
	25	0.3	0.15	0.6	0.16	0.2	0.08
	26	0.8	0.38	1	0.37	0.2	0.08
	27	1.1	0.71	1.3	0.68	0.2	0.11
EB	28	0.3	0.12	0.6	0.13	0.1	0.09
	29	0.6	0.16	0.9	0.17	0.2	0.13
	30	1.3	0.54	1.6	0.51	1.5	0.81
	31	2.2	0.11	2.3	0.1	0.3	0.09
	32	2.3	0.11	2.4	0.09	0.3	0.11
	33	2.4	0.12	2.5	0.1	0.3	0.1
	34	0.7	0.14	1	0.14	0.4	0.1
	35	1.1	0.11	1.4	0.11	0.3	0.07
	36	2	0.12	2.2	0.1	0.3	0.12

Table 14. D2 - Wesconnett Blvd and SR-134

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	1.1	0.07	1.4	0.07	1.1	0.1
	2	1	0.1	1.3	0.1	1	0.09
	3	0.9	0.07	1.2	0.07	1	0.09
	4	0.7	0.09	1	0.09	0.6	0.1
	5	0.7	0.08	1	0.08	0.5	0.09
	6	0.7	0.08	1	0.08	0.6	0.11
	7	0.5	0.08	0.7	0.09	0.5	0.08
	8	0.5	0.08	0.7	0.08	0.4	0.1
	9	0.5	0.11	0.8	0.11	0.4	0.07
WB	10	1	0.1	1.3	0.09	0.8	0.08
	11	1	0.08	1.2	0.08	1	0.1
	12	0.9	0.08	1.1	0.08	0.9	0.09
	13	3.4	0.09	3.4	0.07	2.8	0.09
	14	3.9	0.08	3.7	0.06	3.2	0.09
	15	4.1	0.1	3.9	0.07	3.8	0.09
	16	1.6	0.09	1.8	0.08	1.3	0.09
	17	1.2	0.09	1.5	0.09	1.1	0.09
	18	0.9	0.08	1.1	0.07	0.8	0.08
NB	19	0.3	0.08	0.6	0.09	0.4	0.08
	20	0.3	0.1	0.6	0.1	0.3	0.08
	21	0.4	0.1	0.6	0.11	0.3	0.09
	22	1.8	0.09	2	0.08	0.3	0.08
	23	2.4	0.09	2.5	0.08	0.3	0.09
	24	2.7	0.11	2.8	0.09	0.3	0.08
	25	4.6	0.09	4.2	0.06	0.3	0.09
	26	4.4	0.11	4.1	0.08	0.3	0.1
	27	4.8	0.11	4.3	0.08	0.4	0.08
EB	28	2.3	0.09	2.4	0.08	2	0.09
	29	1.7	0.08	1.9	0.07	1.8	0.11
	30	1.4	0.1	1.6	0.09	1.6	0.09
	31	2	0.08	2.2	0.07	2.1	0.10
	32	1.9	0.08	2.1	0.07	2	0.10
	33	2	0.11	2.1	0.1	1.9	0.08
	34	0.7	0.09	1.0	0.09	1	0.08
	35	0.5	0.09	0.8	0.09	0.6	0.10
	36	0.7	0.09	0.9	0.09	0.6	0.09

Table 15. D2 - Youngerman Cr and SR-21

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	0.2	0.07	0.4	0.07	0.2	0.07
	2	0.2	0.07	0.4	0.07	0.2	0.06
	3	0.2	0.08	0.4	0.08	0.2	0.05
	4	0.7	0.08	1	0.08	0.9	0.08
	5	0.7	0.07	1	0.07	1	0.07
	6	0.7	0.07	0.9	0.07	0.8	0.05
	7	1.4	0.06	1.6	0.05	1.5	0.08
	8	1.5	0.09	1.7	0.08	1.5	0.06
	9	1.6	0.09	1.8	0.08	1.7	0.08
WB	10	0.9	0.07	1.2	0.07	0.6	0.07
	11	1	0.08	1.3	0.08	0.7	0.09
	12	1.1	0.07	1.3	0.07	0.6	0.08
	13	2.5	0.09	2.6	0.07	0.6	0.08
	14	2.6	0.09	2.7	0.08	0.9	0.1
	15	2.6	0.08	2.7	0.07	1	0.08
	16	2.6	0.08	2.7	0.07	0.5	0.08
	17	2.6	0.11	2.7	0.09	0.5	0.07
	18	2.6	0.07	2.7	0.06	0.7	0.06
NB	19	5	0.08	4.5	0.06	2	0.08
	20	4.5	0.09	4.2	0.06	2.2	0.08
	21	4	0.09	3.8	0.06	2.3	0.07
	22	1.5	0.06	1.7	0.05	1	0.07
	23	1.5	0.07	1.7	0.07	1.2	0.08
	24	1.5	0.08	1.7	0.07	1.2	0.07
	25	4.9	0.07	4.4	0.05	1.7	0.07
	26	4.9	0.08	4.4	0.06	1.9	0.08
	27	5	0.07	4.5	0.05	2.1	0.08
EB	28	3.9	0.07	3.7	0.05	0.6	0.06
	29	4	0.07	3.8	0.05	0.8	0.08
	30	4.2	0.07	3.9	0.05	0.9	0.05
	31	1.2	0.07	1.5	0.07	0.5	0.07
	32	1.2	0.06	1.5	0.06	0.5	0.06
	33	1.1	0.08	1.4	0.08	0.7	0.09
	34	0.2	0.07	0.5	0.07	0.2	0.08
	35	0.2	0.07	0.4	0.07	0.2	0.06
	36	0.2	0.07	0.4	0.07	0.3	0.07

3.3 Data Collection in District 3

The data collection was conducted at three signalized intersections in District 3. The data collection efforts are summarized in Table 16.

Table 16. Overview of Data Collection in District 3

FDOT District 3	Lillian Hwy and N 57th Ave	Lillian Hwy and N 65th Ave	Lillian Hwy and N 69th Ave
Date	6/11/2019	6/11/2019	6/12/2019
Time	1:00 AM–4:00 AM	1:00 AM–4:00 AM	1:00 AM–4:00 AM
Weather	Clear	Clear	Clear
# of measure points – horizontal	36	36	36
# of measure points – vertical	36	36	36
Intersection type	Normal	Normal	Normal
Approaches	4	4	4

The illuminance data collected at the four signalized intersections are described in Table 17 and Table 19.

Table 17. D3 - Lillian Hwy and N 57th Ave

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	2.3	0.11	2.4	0.1	1.8	0.11
	2	2.4	0.09	2.5	0.08	1.5	0.09
	3	2.4	0.12	2.6	0.1	1.5	0.11
	4	4.3	0.1	4	0.07	3.2	0.11
	5	4.2	0.10	3.9	0.07	3	0.11
	6	4.1	0.09	3.8	0.07	2.8	0.10
	7	7.2	0.14	6	0.1	2.3	0.10
	8	6.9	0.09	5.9	0.07	2.8	0.07
	9	6.8	0.10	5.7	0.07	3.5	0.07
WB	10	3.9	0.09	3.7	0.06	2.3	0.06
	11	4.1	0.08	3.8	0.06	1.9	0.08
	12	4.3	0.11	4	0.08	2	0.08
	13	4.8	0.12	4.4	0.09	5.8	0.10
	14	4.7	0.10	4.3	0.07	6.3	0.10
	15	4.5	0.09	4.1	0.07	6.2	0.10
	16	5.9	0.14	5.1	0.1	7.1	0.13
	17	5.1	0.10	4.6	0.07	6.7	0.14
	18	4.4	0.10	4	0.07	6.2	0.11
NB	19	3.5	0.08	3.4	0.06	4.7	0.08
	20	3.2	0.11	3.2	0.08	5	0.10
	21	3.1	0.09	3.1	0.07	4.3	0.10
	22	3.5	0.09	3.4	0.07	4.9	0.11
	23	3.3	0.09	3.2	0.07	4.2	0.10
	24	3.3	0.10	3.2	0.08	3.7	0.08
	25	1.3	0.08	1.5	0.07	0.7	0.08
	26	1.8	0.08	2	0.07	0.7	0.08
	27	2.9	0.08	2.9	0.07	0.7	0.10
EB	28	9.3	0.14	7.7	0.12	4.2	0.10
	29	8.2	0.15	6.8	0.11	5	0.12
	30	7.2	0.12	6.1	0.09	5.5	0.11
	31	4.4	0.09	4	0.07	2.6	0.07
	32	4.1	0.08	3.9	0.06	3.5	0.10
	33	3.7	0.08	3.6	0.06	3.7	0.17
	34	3.7	0.11	3.5	0.08	3.5	0.08
	35	3.5	0.08	3.4	0.06	3.7	0.10
	36	3.3	0.09	3.3	0.07	3.9	0.08

Table 18. D3 - Lillian Hwy and N 65th Ave

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	1.1	0.12	1.4	0.12	2.7	0.08
	2	1.1	0.1	1.4	0.1	2.4	0.1
	3	1.1	0.08	1.3	0.07	2.2	0.1
	4	1.7	0.09	1.9	0.08	3.6	0.09
	5	1.5	0.1	1.7	0.09	3.3	0.07
	6	1.4	0.1	1.6	0.1	3.2	0.12
	7	0.6	0.07	0.8	0.07	1	0.07
	8	0.4	0.1	0.7	0.1	0.8	0.08
	9	0.5	0.08	0.8	0.08	0.5	0.09
WB	10	0.9	0.07	1.1	0.07	1.9	0.09
	11	0.8	0.08	1.1	0.08	1.7	0.1
	12	0.8	0.09	1.1	0.09	1.7	0.13
	13	1.2	0.1	1.5	0.09	3.1	0.1
	14	1.2	0.08	1.4	0.08	3.1	0.1
	15	1.1	0.1	1.3	0.09	2.9	0.11
	16	0.7	0.12	0.9	0.12	1.7	0.11
	17	0.7	0.08	1	0.09	1.9	0.09
	18	0.7	0.11	0.9	0.11	2	0.08
NB	19	1.2	0.1	1.5	0.1	1.9	0.09
	20	1.3	0.09	1.5	0.09	1.8	0.08
	21	1.2	0.09	1.5	0.08	1.7	0.1
	22	4.3	0.13	4	0.09	6.2	0.15
	23	3.9	0.09	3.7	0.07	5.9	0.11
	24	3.6	0.11	3.5	0.08	5.8	0.12
	25	0.5	0.1	0.8	0.1	0.1	0.08
	26	0.3	0.1	0.6	0.11	0.2	0.1
	27	0.4	0.07	0.7	0.07	0.2	0.1
EB	28	0.1	0.1	0.4	0.11	0.2	0.12
	29	0.1	0.08	0.3	0.09	0.1	0.07
	30	0.4	0.07	0.6	0.08	0.1	0.09
	31	10.2	0.14	8.5	0.13	3.1	0.09
	32	9.5	0.14	7.9	0.13	4	0.08
	33	8.8	0.18	7.3	0.15	4.9	0.33
	34	8.5	0.13	7	0.11	2.5	0.09
	35	7.2	0.12	6	0.09	3.3	0.09
	36	5.7	0.12	5	0.08	3.9	0.12

Table 19. D3 - Lillian Hwy and N 69th Ave

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	5.2	0.10	4.6	0.07	6.5	0.13
	2	5.0	0.10	4.5	0.07	6.2	0.11
	3	4.9	0.13	4.4	0.09	5.6	0.12
	4	5.6	0.10	4.9	0.07	7.3	0.14
	5	5.3	0.10	4.7	0.07	7.4	0.12
	6	5.0	0.09	4.5	0.06	7.0	0.12
	7	2.7	0.13	2.7	0.11	1.6	0.11
	8	3.2	0.10	3.2	0.08	1.5	0.10
	9	4.1	0.11	3.9	0.08	1.5	0.12
WB	10	6.6	0.11	5.7	0.08	6.7	0.12
	11	6.1	0.13	5.3	0.09	6.7	0.13
	12	5.5	0.10	4.8	0.07	6.2	0.12
	13	4.4	0.11	4	0.08	4.6	0.12
	14	4.0	0.10	3.8	0.07	4.9	0.09
	15	3.7	0.11	3.5	0.08	4.5	0.09
	16	2.1	0.10	2.2	0.08	2.0	0.10
	17	2.0	0.10	2.1	0.08	2.3	0.11
	18	2.0	0.09	2.1	0.08	2.3	0.10
NB	19	2.6	0.09	2.6	0.08	5.4	0.10
	20	2.4	0.10	2.5	0.08	4.5	0.10
	21	2.6	0.09	2.7	0.07	4.0	0.09
	22	2.6	0.09	2.7	0.07	4.4	0.10
	23	2.6	0.09	2.7	0.08	3.9	0.09
	24	2.6	0.08	2.7	0.07	3.4	0.08
	25	1.0	0.08	1.3	0.07	0.5	0.10
	26	1.2	0.12	1.5	0.11	0.5	0.09
	27	1.5	0.07	1.7	0.07	0.4	0.08
EB	28	3.0	0.09	3.0	0.07	3.8	0.10
	29	3.1	0.09	3.1	0.07	4.0	0.11
	30	3.3	0.09	3.2	0.07	3.7	0.10
	31	5.0	0.12	4.5	0.08	5.1	0.10
	32	5.3	0.09	4.7	0.06	4.8	0.10
	33	5.6	0.11	4.9	0.08	4.3	0.10
	34	4.9	0.11	4.4	0.08	2.4	0.08
	35	5.5	0.10	4.8	0.07	2.1	0.09
	36	6.3	0.11	5.4	0.08	1.8	0.11

3.4 Data Collection in District 4

The data collection was conducted at four signalized intersections in District 4. The data collection efforts are summarized in Table 20.

Table 20. Overview of Data Collection in District 4

FDOT District 4	Commercial Blvd and 6th Ave	Glades Rd and SR-7	Sunrise Blvd and Sunset Strip	Sunset Strip and University Dr
Date	6/25/2019	6/25/2019	6/26/2019	6/13/2019
Time	1:00 AM–4:00 AM	1:00 AM–4:00 AM	1:00 AM–4:00 AM	1:00 AM–4:00 AM
Weather	Clear	Clear	Clear	Clear
# of measure points – horizontal	36	36	27	36
# of measure points – vertical	36	36	27	36
Intersection type	Normal	Normal	T	Normal
Approaches	4	4	3	4

The illuminance data collected at the four signalized intersections are described in following Table 21 through Table 24.

Table 21. D4 - Commercial Blvd and 6th Ave

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	0.4	0.09	0.6	0.09	0.3	0.09
	2	0.4	0.07	0.7	0.07	0.5	0.09
	3	0.4	0.07	0.7	0.07	0.6	0.09
	4	0.5	0.08	0.7	0.08	0.5	0.11
	5	0.5	0.10	0.7	0.10	0.5	0.09
	6	0.5	0.10	0.7	0.11	0.5	0.11
	7	1.1	0.08	1.4	0.08	0.7	0.09
	8	1.0	0.09	1.2	0.09	0.6	0.09
	9	0.9	0.09	1.2	0.09	0.8	0.09
WB	10	1.3	0.07	1.6	0.07	1.2	0.08
	11	1.2	0.09	1.4	0.09	1.0	0.08
	12	1.2	0.09	1.4	0.09	1.3	0.08
	13	1.8	0.10	2.0	0.09	2.0	0.10
	14	1.6	0.10	1.8	0.09	1.8	0.11
	15	1.5	0.10	1.7	0.09	1.7	0.10
	16	0.5	0.10	0.8	0.11	0.9	0.10
	17	0.5	0.09	0.7	0.09	0.7	0.10
	18	0.5	0.09	0.7	0.10	0.6	0.09
NB	19	0.2	0.09	0.4	0.10	0.5	0.08
	20	0.2	0.09	0.4	0.10	0.4	0.09
	21	0.2	0.09	0.4	0.10	0.4	0.09
	22	0.3	0.10	0.5	0.10	0.5	0.09
	23	0.3	0.10	0.6	0.11	0.5	0.10
	24	0.3	0.09	0.6	0.10	0.7	0.08
	25	0.7	0.09	0.9	0.09	1.7	0.14
	26	0.7	0.10	0.9	0.10	1.6	0.14
	27	0.5	0.10	0.7	0.10	1.3	0.13
EB	28	1.2	0.10	1.5	0.10	2.2	0.18
	29	1.1	0.13	1.4	0.13	2.1	0.17
	30	1.0	0.13	1.2	0.12	1.8	0.21
	31	1.4	0.11	1.6	0.10	1.2	0.11
	32	1.3	0.10	1.5	0.09	1.2	0.09
	33	1.1	0.10	1.3	0.10	1.3	0.09
	34	1.2	0.09	1.5	0.08	1.0	0.11
	35	1.1	0.10	1.4	0.09	1.0	0.10
	36	1.0	0.10	1.2	0.09	1.0	0.10

Table 22. D4 - Glades Rd and SR-7

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	2.3	0.10	2.5	0.08	2.6	0.07
	2	2.2	0.08	2.3	0.07	2.4	0.08
	3	2.0	0.09	2.2	0.07	2.1	0.08
	4	4.1	0.09	3.9	0.07	2.4	0.09
	5	4.1	0.08	3.8	0.06	3.1	0.08
	6	1.9	0.08	2.1	0.07	1.5	0.07
	7	10.2	0.10	8.6	0.09	3.7	0.07
	8	5.7	0.10	5.0	0.07	1.8	0.08
	9	9.1	0.12	7.6	0.10	4.6	0.08
WB	10	11.1	0.14	9.4	0.15	3.8	0.19
	11	10.2	0.11	8.6	0.11	4.0	0.09
	12	9.6	0.10	8.0	0.09	5.0	0.08
	13	1.1	0.07	1.4	0.07	1.1	0.09
	14	1.2	0.08	1.4	0.08	1.0	0.08
	15	1.2	0.10	1.5	0.10	1.2	0.11
	16	0.9	0.10	1.1	0.10	1.1	0.09
	17	0.6	0.09	0.8	0.09	1.0	0.08
	18	0.6	0.07	0.8	0.07	0.9	0.08
NB	19	2.3	0.08	2.4	0.07	3.2	0.07
	20	1.8	0.07	2.0	0.07	2.8	0.08
	21	1.5	0.08	1.7	0.08	2.6	0.10
	22	2.5	0.09	2.6	0.07	2.1	0.09
	23	2.4	0.07	2.5	0.06	2.6	0.07
	24	2.3	0.09	2.4	0.08	2.9	0.08
	25	6.0	0.07	5.2	0.05	4.4	0.09
	26	5.1	0.10	4.5	0.07	4.5	0.11
	27	3.5	0.09	3.4	0.07	3.2	0.09
EB	28	7.4	0.10	6.2	0.07	3.6	0.07
	29	6.0	0.09	5.2	0.06	3.9	0.09
	30	5.1	0.09	4.6	0.06	4.2	0.06
	31	1.9	0.09	2.1	0.08	2.2	0.11
	32	2.1	0.09	2.3	0.07	2.5	0.08
	33	2.0	0.09	2.2	0.08	2.5	0.08
	34	6.7	0.10	5.7	0.07	2.5	0.07
	35	5.5	0.12	4.9	0.08	3.6	0.09
	36	5.1	0.11	4.6	0.08	4.2	0.09

Table 23. D4 - Sunrise Blvd and Sunset Strip

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	1.1	0.07	1.4	0.06	1.6	0.07
	2	0.9	0.08	1.1	0.08	1.4	0.09
	3	0.7	0.07	1.0	0.07	1.3	0.10
	4	1.6	0.09	1.8	0.08	1.9	0.08
	5	1.5	0.08	1.7	0.07	2.0	0.10
	6	1.6	0.08	1.8	0.07	2.5	0.11
	7	2.4	0.12	2.5	0.10	2.2	0.09
	8	1.9	0.08	2.1	0.07	2.1	0.12
	9	1.6	0.08	1.8	0.07	2.1	0.10
WB	10	0.3	0.08	0.6	0.08	1.0	0.10
	11	0.5	0.07	0.8	0.08	1.0	0.09
	12	0.7	0.08	0.9	0.08	1.0	0.09
	13	0.2	0.09	0.5	0.10	1.0	0.10
	14	0.3	0.06	0.5	0.07	1.0	0.08
	15	0.3	0.10	0.5	0.11	1.0	0.07
	16	0.1	0.07	0.4	0.07	0.7	0.10
	17	0.2	0.09	0.4	0.10	0.7	0.11
	18	0.2	0.11	0.4	0.12	0.7	0.10
EB	28	0.1	0.08	0.3	0.09	0.2	0.10
	29	0.1	0.07	0.3	0.08	0.2	0.09
	30	0.1	0.07	0.3	0.08	0.2	0.09
	31	0.2	0.10	0.4	0.11	0.2	0.07
	32	0.2	0.08	0.4	0.09	0.2	0.08
	33	0.2	0.08	0.4	0.09	0.2	0.06
	34	0.3	0.08	0.5	0.09	0.3	0.08
	35	0.2	0.09	0.5	0.09	0.2	0.10
	36	0.2	0.09	0.5	0.09	0.2	0.09

Table 24. D4 - Sunset Strip and University Dr

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	3.2	0.08	3.2	0.06	1.2	0.08
	2	2.7	0.09	2.8	0.08	1.5	0.08
	3	2.5	0.08	2.6	0.07	1.9	0.09
	4	2.4	0.08	2.5	0.06	0.9	0.08
	5	2.3	0.07	2.4	0.06	0.9	0.05
	6	2.3	0.08	2.3	0.07	1.2	0.07
	7	1.7	0.08	1.9	0.07	0.6	0.07
	8	2.0	0.05	2.2	0.05	1.1	0.08
	9	2.0	0.07	2.2	0.06	1.4	0.07
WB	10	0.3	0.08	0.6	0.08	0.2	0.07
	11	0.4	0.06	0.6	0.07	0.1	0.07
	12	0.5	0.07	0.8	0.07	0.2	0.08
	13	0.2	0.07	0.4	0.07	0.2	0.07
	14	0.3	0.07	0.6	0.07	0.2	0.07
	15	0.3	0.06	0.5	0.06	0.2	0.08
	16	0.1	0.07	0.3	0.08	0.2	0.09
	17	0.2	0.07	0.4	0.08	0.2	0.07
	18	0.3	0.08	0.5	0.08	0.2	0.09
NB	19	1.5	0.07	1.7	0.06	1.0	0.07
	20	1.2	0.10	1.4	0.09	1.6	0.08
	21	0.4	0.08	0.6	0.08	0.6	0.07
	22	0.9	0.06	1.2	0.06	1.2	0.08
	23	0.9	0.07	1.2	0.07	1.2	0.07
	24	0.9	0.08	1.2	0.08	1.2	0.07
	25	0.3	0.06	0.6	0.07	0.7	0.09
	26	0.4	0.06	0.7	0.07	0.7	0.09
	27	0.4	0.08	0.6	0.08	0.7	0.07
EB	28	1.0	0.07	1.3	0.07	1.8	0.08
	29	0.9	0.07	1.1	0.07	1.9	0.09
	30	0.7	0.07	1.0	0.07	1.6	0.06
	31	0.8	0.07	1.1	0.07	1.4	0.08
	32	0.8	0.08	1.0	0.08	1.3	0.08
	33	0.8	0.07	1.1	0.07	1.3	0.10
	34	0.4	0.08	0.5	0.09	0.7	0.15
	35	0.5	0.08	0.8	0.08	0.6	0.07
	36	0.7	0.08	0.9	0.08	0.6	0.10

3.5 Data Collection in District 6

The data collection was conducted at four signalized intersections in District 6. The data collection efforts are summarized in Table 25.

Table 25. Overview of Data Collection in District 6

FDOT District 6	1st St and 22nd Ave	SW 8th Ave and SW 6th St	NW 17th St and NW 27th Ave	W Flagler St and W 25th Ave
Date	6/27/2019	6/27/2019	6/28/2019	6/28/2019
Time	1:00 AM–4:00 AM	1:00 AM–4:00 AM	1:00 AM–4:00 AM	1:00 AM–4:00 AM
Weather	Clear	Clear	Clear	Clear
# of measure points – horizontal	36	36	27	36
# of measure points – vertical	36	36	27	36
Intersection type	Normal	Normal	T	Normal
Approaches	4	4	3	4

The illuminance data collected at the four signalized intersections are described in following Table 26 through Table 29.

Table 26. D6 - 1st St and 22nd Ave

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	9.7	0.11	8.0	0.10	1.8	0.07
	2	9.4	0.09	7.8	0.08	2.6	0.09
	3	9.8	0.13	8.1	0.11	3.6	0.09
	4	2.6	0.11	2.7	0.09	2.1	0.07
	5	2.7	0.11	2.8	0.09	2.0	0.07
	6	3.0	0.09	3.0	0.07	2.5	0.10
	7	0.6	0.10	0.8	0.10	1.0	0.08
	8	0.7	0.10	0.9	0.10	0.9	0.09
	9	0.8	0.10	1.0	0.10	0.9	0.09
WB	10	1.6	0.08	1.8	0.07	0.7	0.11
	11	1.6	0.10	1.9	0.09	0.8	0.10
	12	1.5	0.06	1.8	0.05	1.2	0.07
	13	3.5	0.08	3.4	0.06	0.8	0.10
	14	3.8	0.11	3.6	0.08	1.4	0.10
	15	3.9	0.08	3.7	0.06	1.4	0.09
	16	4.7	0.13	4.3	0.09	1.8	0.12
	17	4.9	0.11	4.4	0.08	2.1	0.08
	18	4.6	0.11	4.2	0.08	2.2	0.08
NB	19	4.9	0.09	4.4	0.06	6.9	0.18
	20	3.2	0.11	3.2	0.09	5.7	0.15
	21	3.6	0.09	3.4	0.06	5.4	0.17
	22	2.5	0.11	2.6	0.09	4.8	0.20
	23	2.3	0.09	2.5	0.07	5.0	0.22
	24	2.3	0.11	2.4	0.09	4.9	0.16
	25	0.4	0.10	0.6	0.11	0.5	0.09
	26	0.7	0.09	0.9	0.09	0.8	0.11
	27	0.8	0.11	1.0	0.11	1.1	0.09
EB	28	0.6	0.07	0.9	0.08	0.2	0.10
	29	0.8	0.07	1.0	0.07	0.2	0.09
	30	0.9	0.08	1.2	0.08	0.3	0.11
	31	2.6	0.08	2.7	0.07	0.8	0.07
	32	3.0	0.08	3.0	0.06	0.6	0.08
	33	3.5	0.10	3.4	0.07	0.5	0.09
	34	2.6	0.08	2.7	0.07	0.8	0.09
	35	3.6	0.09	3.5	0.06	0.7	0.09
	36	5.1	0.09	4.6	0.06	0.7	0.09

Table 27. D6 - SW 8th Ave and SW 6th St

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	1.8	0.07	2.0	0.06	4.1	0.10
	2	1.7	0.10	1.9	0.09	3.7	0.09
	3	1.5	0.10	1.7	0.09	3.4	0.09
	4	1.6	0.07	1.8	0.07	3.4	0.12
	5	1.4	0.09	1.6	0.08	3.1	0.10
	6	1.3	0.09	1.5	0.08	2.8	0.07
	7	0.9	0.10	1.1	0.10	1.9	0.08
	8	0.7	0.08	1.0	0.08	1.8	0.08
	9	0.7	0.08	0.9	0.08	1.5	0.08
WB	10	0.2	0.08	0.4	0.09	0.3	0.07
	11	0.5	0.08	0.7	0.09	0.3	0.10
	12	0.6	0.09	0.9	0.09	0.2	0.08
	13	0.4	0.09	0.6	0.10	0.4	0.10
	14	0.4	0.06	0.7	0.06	0.2	0.11
	15	0.5	0.11	0.8	0.11	0.2	0.08
	16	0.3	0.10	0.5	0.11	0.5	0.08
	17	0.4	0.10	0.6	0.10	0.4	0.11
	18	0.6	0.08	0.8	0.09	0.4	0.08
NB	19	0.1	0.07	0.3	0.07	0.3	0.07
	20	0.2	0.07	0.5	0.07	0.3	0.07
	21	0.3	0.08	0.5	0.09	0.6	0.10
	22	2.1	0.10	2.3	0.08	3.8	0.09
	23	2.0	0.09	2.1	0.08	3.4	0.10
	24	1.7	0.10	1.9	0.09	3.2	0.09
	25	2.5	0.10	2.6	0.09	3.4	0.09
	26	2.5	0.10	2.6	0.08	3.6	0.07
	27	2.6	0.12	2.6	0.10	3.3	0.09
EB	28	2.7	0.20	2.7	0.16	3.4	0.24
	29	3.2	0.16	3.2	0.13	3.1	0.21
	30	2.7	0.11	2.8	0.09	2.6	0.17
	31	2.3	0.10	2.4	0.09	2.3	0.15
	32	2.1	0.14	2.2	0.12	2.0	0.12
	33	1.9	0.11	2.1	0.10	1.8	0.14
	34	1.6	0.11	1.8	0.10	1.2	0.10
	35	1.5	0.09	1.7	0.08	1.0	0.11
	36	1.5	0.09	1.7	0.08	1.1	0.10

Table 28. D6 - NW 17th St and NW 27th Ave

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	2.0	0.07	2.1	0.06	0.5	0.09
	2	1.7	0.10	1.9	0.09	0.6	0.10
	3	1.7	0.11	1.9	0.10	0.7	0.09
	4	2.5	0.07	2.6	0.05	1.2	0.06
	5	2.5	0.08	2.6	0.07	1.5	0.07
	6	2.5	0.10	2.6	0.08	1.8	0.07
	7	1.8	0.09	2.0	0.08	0.7	0.05
	8	1.6	0.08	1.8	0.07	0.9	0.06
	9	1.5	0.08	1.7	0.07	1.1	0.08
NB	19	1.7	0.07	1.9	0.06	2.7	0.09
	20	1.5	0.07	1.8	0.06	2.8	0.07
	21	1.4	0.07	1.6	0.06	2.8	0.07
	22	3.4	0.10	3.3	0.08	4.4	0.10
	23	3.2	0.09	3.1	0.07	4.5	0.09
	24	1.3	0.09	1.6	0.09	3.1	0.12
	25	2.4	0.10	2.5	0.09	2.5	0.08
	26	2.1	0.08	2.2	0.07	2.6	0.09
	27	1.8	0.07	2.0	0.06	1.5	0.09
EB	28	1.2	0.08	1.4	0.08	1.7	0.07
	29	1.1	0.07	1.3	0.07	1.7	0.09
	30	1.0	0.08	1.2	0.08	1.6	0.08
	31	2.5	0.07	2.6	0.06	2.5	0.07
	32	2.4	0.08	2.5	0.07	2.7	0.08
	33	2.4	0.08	2.5	0.07	2.6	0.10
	34	4.8	0.10	4.3	0.07	2.6	0.08
	35	4.5	0.08	4.2	0.06	3.6	0.09
	36	4.3	0.10	4.0	0.07	3.7	0.07

Table 29. D6 - W Flagler St and W 25th Ave

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	3.9	0.13	3.7	0.10	3.9	0.11
	2	3.9	0.10	3.7	0.08	3.9	0.11
	3	4.0	0.09	3.8	0.07	4.0	0.15
	4	3.9	0.10	3.7	0.08	3.9	0.12
	5	3.4	0.09	3.3	0.07	3.4	0.10
	6	3.3	0.11	3.3	0.08	3.3	0.09
	7	3.1	0.09	3.1	0.07	3.1	0.11
	8	2.6	0.10	2.7	0.09	2.6	0.10
	9	2.5	0.13	2.6	0.11	2.5	0.08
WB	10	1.3	0.09	1.6	0.08	1.3	0.09
	11	1.4	0.10	1.7	0.09	1.4	0.10
	12	1.5	0.12	1.7	0.11	1.5	0.12
	13	2.3	0.09	2.4	0.08	2.3	0.09
	14	2.0	0.10	2.1	0.09	2.0	0.08
	15	1.8	0.09	2.0	0.08	1.8	0.10
	16	0.2	0.08	0.5	0.09	0.2	0.09
	17	0.6	0.10	0.9	0.10	0.6	0.10
	18	0.3	0.08	0.6	0.08	0.3	0.10
NB	19	1.2	0.09	1.5	0.08	1.2	0.11
	20	1.1	0.09	1.4	0.09	1.1	0.08
	21	0.9	0.08	1.2	0.08	0.9	0.08
	22	2.6	0.16	2.7	0.13	2.6	0.17
	23	1.8	0.10	2.0	0.09	1.8	0.11
	24	1.5	0.08	1.7	0.07	1.5	0.10
	25	2.0	0.09	2.1	0.08	2.0	0.09
	26	1.4	0.09	1.6	0.08	1.4	0.12
	27	1.0	0.08	1.3	0.08	1.0	0.09
EB	28	1.2	0.09	1.4	0.08	1.2	0.09
	29	1.1	0.09	1.3	0.09	1.1	0.09
	30	1.0	0.06	1.3	0.06	1.0	0.07
	31	2.6	0.09	2.6	0.07	2.6	0.08
	32	2.4	0.10	2.5	0.08	2.4	0.11
	33	2.5	0.09	2.6	0.08	2.5	0.08
	34	2.6	0.10	2.7	0.08	2.6	0.11
	35	2.7	0.09	2.8	0.07	2.7	0.09
	36	3.1	0.08	3.1	0.06	3.1	0.10

3.6 Data Collection in District 7

The data collection was conducted at four signalized intersections in District 7. The data collection efforts are summarized in Table 30.

Table 30. Overview of Data Collection in District 7

FDOT District 7	Busch Blvd and N 30th St	Busch Blvd and Nebraska Ave	Hillsborough Ave and N 15th St	Hillsborough and N 40th St
Date	5/09/2019	5/10/2019	5/13/2019	5/15/2019
Time	1:30 AM–4:00 AM	1:30 AM–4:00 AM	1:30 AM–4:00 AM	1:30 AM–4:00 AM
Weather	Clear	Clear	Clear	Clear
# of measure points – horizontal	36	36	36	36
# of measure points – vertical	36	36	36	36
Intersection type	Normal	Normal	Normal	Normal
Approaches	4	4	4	4

The illuminance data collected at the four signalized intersections are described in following Table 31 through Table 34.

Table 31. D7 - Busch Blvd and N 30th St

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	1.5	0.02	1.7	0.02	1.0	0.02
	2	0.6	0.07	0.8	0.08	1.0	0.05
	3	0.4	0.01	0.6	0.01	0.8	0.02
	4	1.4	0.04	1.6	0.03	2.9	0.05
	5	1.3	0.05	1.5	0.04	2.7	0.04
	6	1.3	0.03	1.5	0.03	2.5	0.03
	7	1.4	0.02	1.6	0.02	2.8	0.06
	8	1.3	0.03	1.5	0.03	2.5	0.04
	9	1.2	0.02	1.4	0.02	2.3	0.03
WB	10	0.9	0.01	1.2	0.01	0.7	0.02
	11	0.9	0.02	1.2	0.01	0.8	0.04
	12	0.7	0.01	0.9	0.01	0.7	0.07
	13	3.1	0.04	3.1	0.03	1.4	0.02
	14	3.1	0.05	3.1	0.04	1.4	0.06
	15	3.1	0.04	3.1	0.03	1.7	0.06
	16	5.3	0.04	4.7	0.03	2.3	0.13
	17	5.6	0.04	4.9	0.03	2.2	0.03
	18	5.9	0.04	5.1	0.03	2.2	0.07
NB	19	1.6	0.02	1.8	0.02	1.4	0.03
	20	1.7	0.02	1.9	0.02	1.7	0.02
	21	1.8	0.03	2.0	0.02	1.9	0.04
	22	1.8	0.04	2.0	0.03	2.3	0.04
	23	1.7	0.03	1.9	0.03	2.2	0.08
	24	1.6	0.04	1.8	0.04	2.4	0.07
	25	2.7	0.04	2.8	0.03	3.0	0.05
	26	2.4	0.05	2.6	0.04	3.1	0.04
	27	2.5	0.03	2.6	0.03	3.1	0.04
EB	28	1.0	0.02	1.3	0.02	1.4	0.02
	29	1.5	0.02	1.7	0.02	1.2	0.02
	30	2.1	0.03	2.3	0.03	1.3	0.02
	31	2.2	0.03	2.3	0.03	2.2	0.03
	32	2.0	0.03	2.2	0.03	2.3	0.04
	33	1.9	0.03	2.1	0.03	2.5	0.04
	34	2.6	0.03	2.6	0.02	2.1	0.03
	35	2.5	0.03	2.6	0.02	2.4	0.04
	36	2.6	0.03	2.7	0.03	2.7	0.04

Table 32. D7 - Busch Blvd and Nebraska Ave

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	2.9	0.15	2.9	0.12	0.9	0.09
	2	3.1	0.04	3.1	0.03	1.5	0.05
	3	3.1	0.04	3.1	0.03	1.5	0.02
	4	2.3	0.03	2.4	0.03	1.5	0.02
	5	2.3	0.04	2.4	0.03	1.4	0.02
	6	2.3	0.06	2.4	0.05	1.5	0.02
	7	2.4	0.03	2.5	0.02	1.0	0.02
	8	2.4	0.03	2.5	0.03	0.8	0.11
	9	2.5	0.03	2.6	0.02	1.0	0.02
WB	10	1.7	0.04	1.9	0.03	0.8	0.01
	11	1.9	0.05	2.1	0.05	1.2	0.01
	12	2.4	0.06	2.6	0.05	1.0	0.20
	13	3.0	0.11	3.0	0.09	1.9	0.10
	14	2.8	0.08	2.9	0.06	2.1	0.14
	15	2.7	0.09	2.8	0.07	2.0	0.10
	16	3.1	0.10	3.0	0.08	1.7	0.10
	17	2.9	0.10	2.9	0.08	2.0	0.08
	18	2.7	0.10	2.8	0.08	2.2	0.09
NB	19	2.2	0.12	2.3	0.10	0.9	0.08
	20	2.2	0.09	2.3	0.08	0.9	0.09
	21	2.2	0.12	2.4	0.10	0.7	0.11
	22	1.1	0.13	1.3	0.13	0.3	0.01
	23	1.0	0.07	1.2	0.07	0.3	0.06
	24	1.0	0.09	1.3	0.09	0.3	0.01
	25	1.1	0.08	1.4	0.08	0.2	0.01
	26	1.2	0.02	1.4	0.02	0.2	0.07
	27	1.3	0.03	1.5	0.03	0.2	0.01
EB	28	2.9	0.05	2.9	0.04	2.8	0.09
	29	2.5	0.04	2.6	0.03	2.8	0.07
	30	2.1	0.03	2.2	0.03	2.5	0.07
	31	2.5	0.03	2.6	0.03	2.2	0.05
	32	2.4	0.03	2.5	0.03	2.4	0.04
	33	2.2	0.03	2.4	0.03	2.5	0.04
	34	3.1	0.03	3.1	0.03	2.9	0.41
	35	3.1	0.03	3.1	0.02	3.1	0.03
	36	3.0	0.10	3.0	0.08	3.1	0.03

Table 33. D7 - Hillsborough Ave and N 15th St

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	5.0	0.07	4.5	0.05	3.3	0.09
	2	4.8	0.09	4.3	0.07	3.3	0.08
	3	4.2	0.08	3.9	0.06	4.0	0.23
	4	4.1	0.09	3.8	0.06	2.9	0.07
	5	3.9	0.08	3.7	0.06	2.3	0.07
	6	3.8	0.08	3.6	0.06	2.5	0.09
	7	2.6	0.07	2.7	0.06	1.8	0.08
	8	2.8	0.07	2.9	0.06	1.8	0.09
	9	3.0	0.09	3.0	0.08	2.1	0.17
WB	10	2.8	0.08	2.9	0.06	1.9	0.07
	11	2.6	0.09	2.7	0.08	1.8	0.08
	12	2.7	0.08	2.7	0.06	1.9	0.09
	13	3.1	0.13	3.1	0.10	1.4	0.14
	14	3.6	0.09	3.5	0.06	1.7	0.06
	15	3.6	0.11	3.5	0.08	2.1	0.07
	16	2.1	0.08	2.3	0.07	0.8	0.06
	17	3.2	0.11	3.2	0.08	0.8	0.08
	18	3.9	0.09	3.7	0.07	0.8	0.07
NB	19	5.7	0.08	5.0	0.06	0.9	0.07
	20	5.2	0.09	4.7	0.06	1.5	0.07
	21	4.6	0.09	4.2	0.06	2.0	0.08
	22	5.7	0.08	5.0	0.06	0.8	0.08
	23	5.8	0.11	5.1	0.08	1.5	0.08
	24	5.8	0.06	5.1	0.04	2.0	0.08
	25	4.5	0.07	4.1	0.05	1.0	0.08
	26	4.8	0.08	4.3	0.06	1.4	0.09
	27	5.0	0.11	4.5	0.08	1.8	0.15
EB	28	5.1	0.08	4.6	0.06	2.5	0.06
	29	4.7	0.07	4.2	0.05	3.1	0.09
	30	4.6	0.09	4.2	0.07	3.2	0.07
	31	2.7	0.06	2.8	0.05	1.9	0.08
	32	3.0	0.08	3.0	0.06	2.5	0.08
	33	3.3	0.12	3.2	0.09	2.7	0.09
	34	5.1	0.09	4.6	0.06	3.6	0.13
	35	4.3	0.08	4.0	0.05	4.4	0.10
	36	4.2	0.09	3.9	0.07	4.6	0.08

Table 34. D7 - Hillsborough Ave and N 40th St

Approach	ID	Horizontal Measurement				Vertical Measurement	
		Measured at 5 ft 3 in.		Calculated at 6 in.		Measured at 5 ft	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SB	1	2.2	0.07	2.4	0.06	2.2	0.08
	2	2.1	0.09	2.2	0.08	2.4	0.08
	3	1.8	0.08	2.0	0.07	2.4	0.08
	4	1.6	0.08	1.8	0.08	1.7	0.07
	5	1.4	0.07	1.6	0.07	1.3	0.07
	6	1.3	0.06	1.6	0.05	1.6	0.05
	7	2.4	0.08	2.5	0.07	1.6	0.06
	8	2.1	0.08	2.3	0.07	1.7	0.07
	9	1.9	0.09	2.1	0.08	1.8	0.07
WB	10	2.3	0.09	2.4	0.08	3.9	0.07
	11	2.3	0.08	2.4	0.07	3.6	0.08
	12	2.0	0.06	2.2	0.06	3.6	0.10
	13	2.3	0.08	2.5	0.07	2.9	0.08
	14	2.3	0.07	2.4	0.06	3.2	0.08
	15	2.2	0.09	2.3	0.08	3.3	0.08
	16	2.0	0.06	2.2	0.05	2.2	0.07
	17	1.9	0.09	2.1	0.08	2.1	0.07
	18	1.9	0.08	2.1	0.07	2.0	0.08
NB	19	3.7	0.07	3.5	0.05	1.8	0.10
	20	3.5	0.08	3.4	0.06	2.1	0.08
	21	3.2	0.09	3.1	0.07	2.3	0.08
	22	2.7	0.07	2.8	0.06	2.7	0.08
	23	2.7	0.07	2.7	0.06	3.3	0.08
	24	2.2	0.09	2.4	0.08	3.4	0.10
	25	6.5	0.10	5.6	0.07	6.5	0.08
	26	6.3	0.10	5.4	0.07	7.4	0.10
	27	6.0	0.11	5.2	0.08	7.5	0.10
EB	28	3.9	0.07	3.7	0.05	2.7	0.09
	29	3.7	0.08	3.6	0.06	2.5	0.08
	30	3.8	0.09	3.6	0.07	2.7	0.08
	31	1.3	0.07	1.5	0.07	1.9	0.08
	32	1.2	0.08	1.5	0.07	2.0	0.08
	33	1.2	0.07	1.4	0.07	2.0	0.08
	34	1.0	0.07	1.3	0.07	1.0	0.09
	35	1.1	0.09	1.3	0.09	1.0	0.09
	36	1.0	0.08	1.3	0.08	1.0	0.09

4 Data Analysis

The CUTR team compared the theoretical values from the design files and the mean of measured values at each measuring point for the 23 intersections. The measured horizontal illuminance has been converted to the value at 6 in. The difference ($Diff$) and relative difference ($Diff\%$) were calculated for horizontal illuminance and vertical illuminance, respectively, using Eq. 2 and Eq.3. The comparison results for are presented in tables and satellite maps. Note that not all measured vertical illuminance have a corresponding theoretical value.

4.1 Data Analysis in District 1

4.1.1 1st St and Fowler St

The comparison of illuminance data is given in Table 35. Figure 11 and Figure 12 present the comparisons of horizontal and vertical illuminance, respectively. Based on the comparison, the following findings were obtained:

- Approximately 89% of the horizontal measured values are equal or higher theoretical values.
- All vertical measured values are higher than the theoretical values (at the points where theoretical value are available).

Table 35. Comparison of Illuminance Data for 1st St and Fowler St

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SEB	1	4.0	2.6	1.4	54%	2.7			
	2	4.0	2.6	1.4	54%	2.8	1.1	1.7	155%
	3	4.0	3.1	0.9	29%	3.2			
	4	5.9	3.8	2.1	55%	3.6			
	5	5.8	3.9	1.9	49%	4.1	3.2	0.9	0%
	6	5.6	4.1	1.5	37%	4.2			
	7	6.3	3.3	3.0	91%	4.6			
	8	5.9	3.9	2.0	51%	4.8	2.3		
	9	5.3	3.8	1.5	39%	4.5			
SWB	10	3.0	3.1	-0.1	-3%	3.9			
	11	3.1	3.1	0.0	0%	3.5	3.6	-0.1	-3%
	12	3.6	3.1	0.5	16%	3.1			
	13	2.7	2.5	0.2	8%	3.3			
	14	2.8	2.5	0.3	12%	3.3	2.8	0.5	18%
	15	3.1	3.2	-0.1	-3%	3.2			
	16	2.5	1.9	0.6	32%	2.2			
	17	3.0	2.0	1.0	50%	2.0	1.3	0.7	54%
	18	3.6	2.9	0.7	24%	2.0			
NWB	19	5.4	2.7	2.7	100%	2.5			
	20	4.9	2.4	2.5	104%	2.6			
	21	4.4	3.2	1.2	38%	2.6			
	22	5.5	2.7	2.8	104%	2.5			
	23	5.2	3.0	2.2	73%	2.8			
	24	4.7	3.3	1.4	42%	2.7			
	25	2.0	2.2	-0.2	-9%	1.9			
	26	2.0	2.0	0.0	0%	2.0			
	27	1.8	2.6	-0.8	-31%	2.0			
NEB	28	3.5	2.5	1.0	40%	4.0			
	29	3.0	2.1	0.9	43%	4.1	0.9	3.2	356%
	30	2.1	2.7	-0.6	-22%	3.0			
	31	4.9	2.9	2.0	69%	6.2			
	32	4.3	3.2	1.1	34%	5.8	2.9	2.9	100%
	33	4.0	3.6	0.4	11%	5.1			
	34	4.1	3.0	1.1	37%	4.8			
	35	4.2	3.2	1.0	31%	5.3			
	36	4.1	3.2	0.9	28%	5.0			

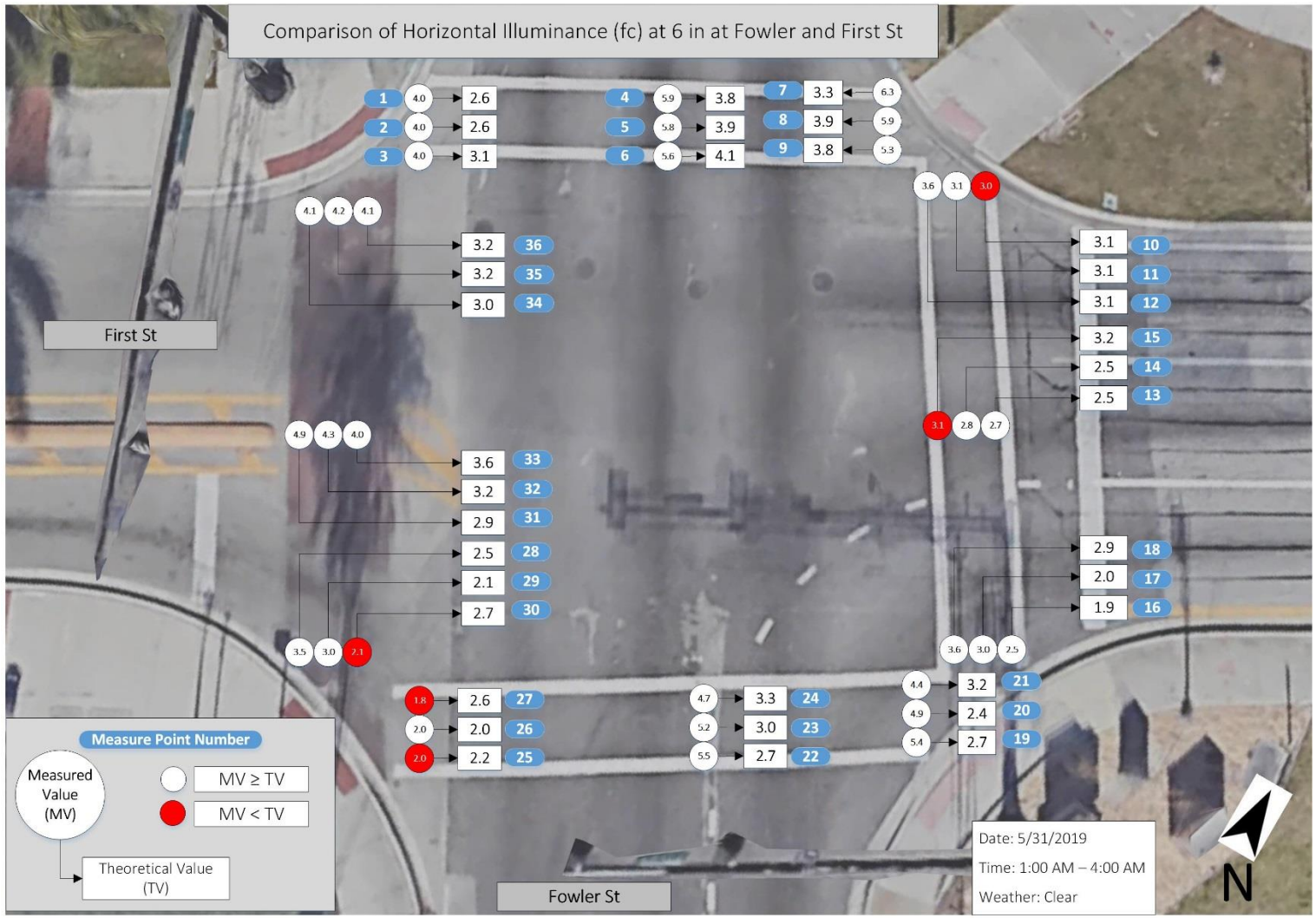

Figure 11. Comparison of Horizontal Illuminance at 1st St and Fowler St

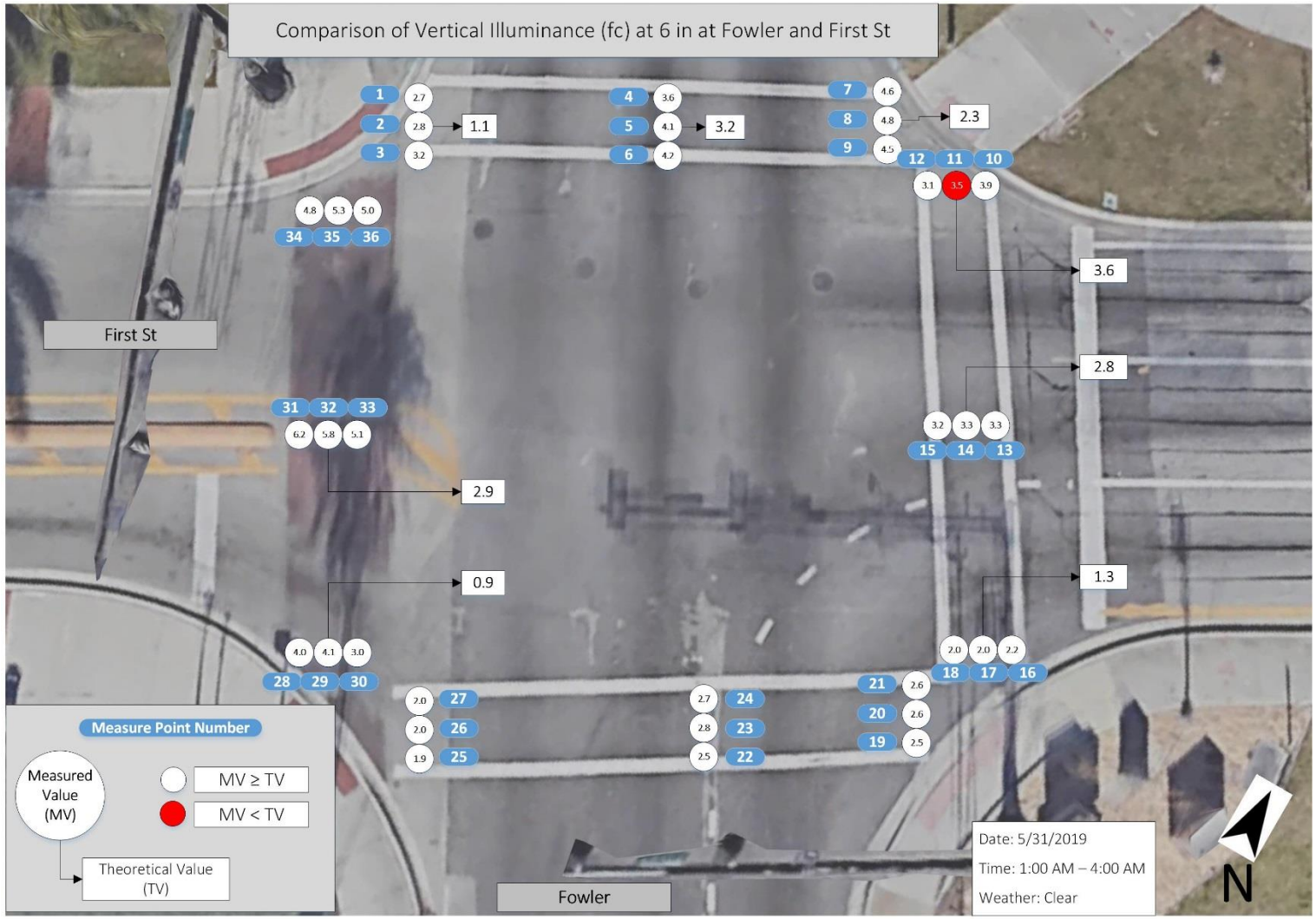

Figure 12. Comparison of Vertical Illuminance at 1st St and Fowler St

4.1.2 Tamiami Tr and Pondella Rd

The comparison of illuminance data is given in Table 36. Figure 13 and Figure 14 present the comparisons of horizontal and vertical illuminance, respectively, at Tamiami Tr and Pondella Rd. Based on the comparison, the following findings were obtained:

- Most measure points experience an equal or higher measured horizontal illuminance than theoretical values.
- The measured horizontal values on northbound and one side of westbound are less than the theoretical values.

Table 36. Comparison of Illuminance Data for Tamiami Tr and Pondella Rd

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	1.6	1.6	0.0	0%	1.8			
	2	1.9	1.6	0.3	19%	2.0	2.4	-0.42	-17%
	3	1.9	1.5	0.4	27%	2.0			
	4	2.3	1.9	0.4	21%	2.0			
	5	2.3	1.9	0.4	21%	1.9	1.3	0.6	46%
	6	2.3	1.9	0.4	21%	1.8			
	7	1.6	1.4	0.2	14%	1.1			
	8	1.7	1.3	0.4	31%	0.9			
	9	1.8	1.5	0.3	20%	1.0			
WB	10	1.9	1.9	0.0	0%	1.4			
	11	2.0	2.1	-0.1	-5%	1.6	1.8	-0.2	-11%
	12	2.3	2.5	-0.2	-8%	1.6			
	13	2.3	1.9	0.4	21%	2.2			
	14	2.2	2.0	0.2	10%	2.0	2.8	-0.8	-28%
	15	2.1	2.1	0.0	0%	2.1			
	16	1.4	1.2	0.2	17%	1.0			
	17	1.3	1.3	0.0	0%	0.9			
	18	1.4	1.2	0.2	17%	0.9			
NB	19	1.3	1.3	0.0	0%	0.9			
	20	1.3	1.6	-0.3	-19%	1.0	0.7	0.3	37%
	21	1.3	1.5	-0.2	-13%	0.9			
	22	1.8	2.0	-0.2	-10%	2.1			
	23	1.8	1.9	-0.1	-5%	2.1	2.6	-0.5	-19%
	24	1.8	2.0	-0.2	-10%	2.0			
	25	1.1	1.0	0.1	10%	1.2			
	26	0.9	0.8	0.1	13%	1.2			
	27	0.9	0.7	0.2	29%	1.1			
EB	28	0.9	0.9	0.0	0%	1.0			
	29	0.8	0.8	0.0	0%	0.8	0.9	-0.1	-6%
	30	0.8	0.8	0.0	0%	0.9			
	31	1.4	1.2	0.2	17%	2.0			
	32	1.4	1.2	0.2	17%	1.9	1.9	0.0	0%
	33	1.4	1.1	0.3	27%	1.8			
	34	2.0	1.7	0.3	18%	2.3			
	35	1.9	1.7	0.2	12%	2.3			
	36	1.8	1.8	0.0	0%	2.3			
SEB	37	1.2	1.5	-0.3	-20%	0.9			
	38	1.1	1.1	0.0	0%	0.7			
	39	1.2	1.2	0.0	0%	0.6			

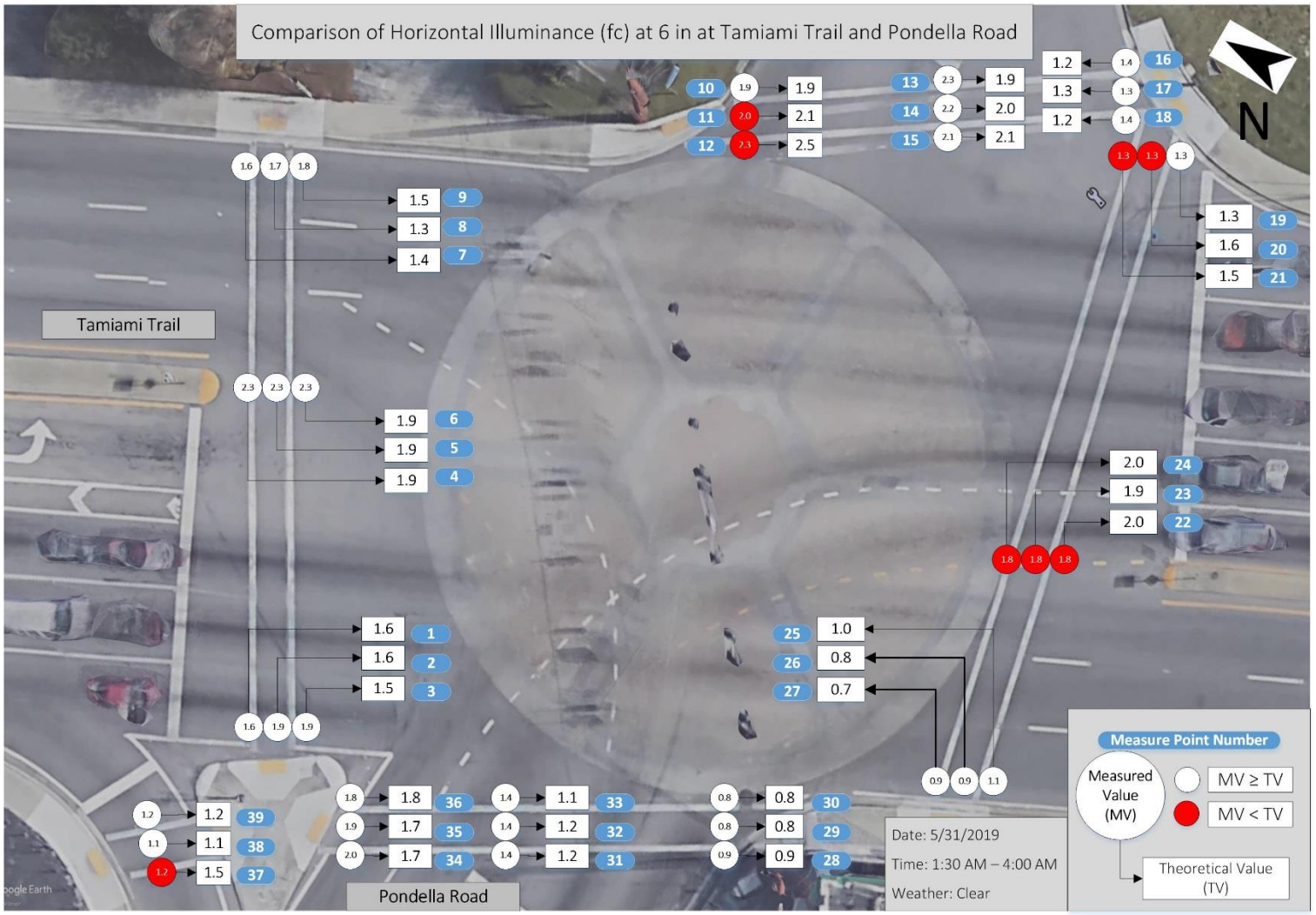

Figure 13. Comparison of Horizontal Illuminance at Tamiami Tr and Pondella Rd

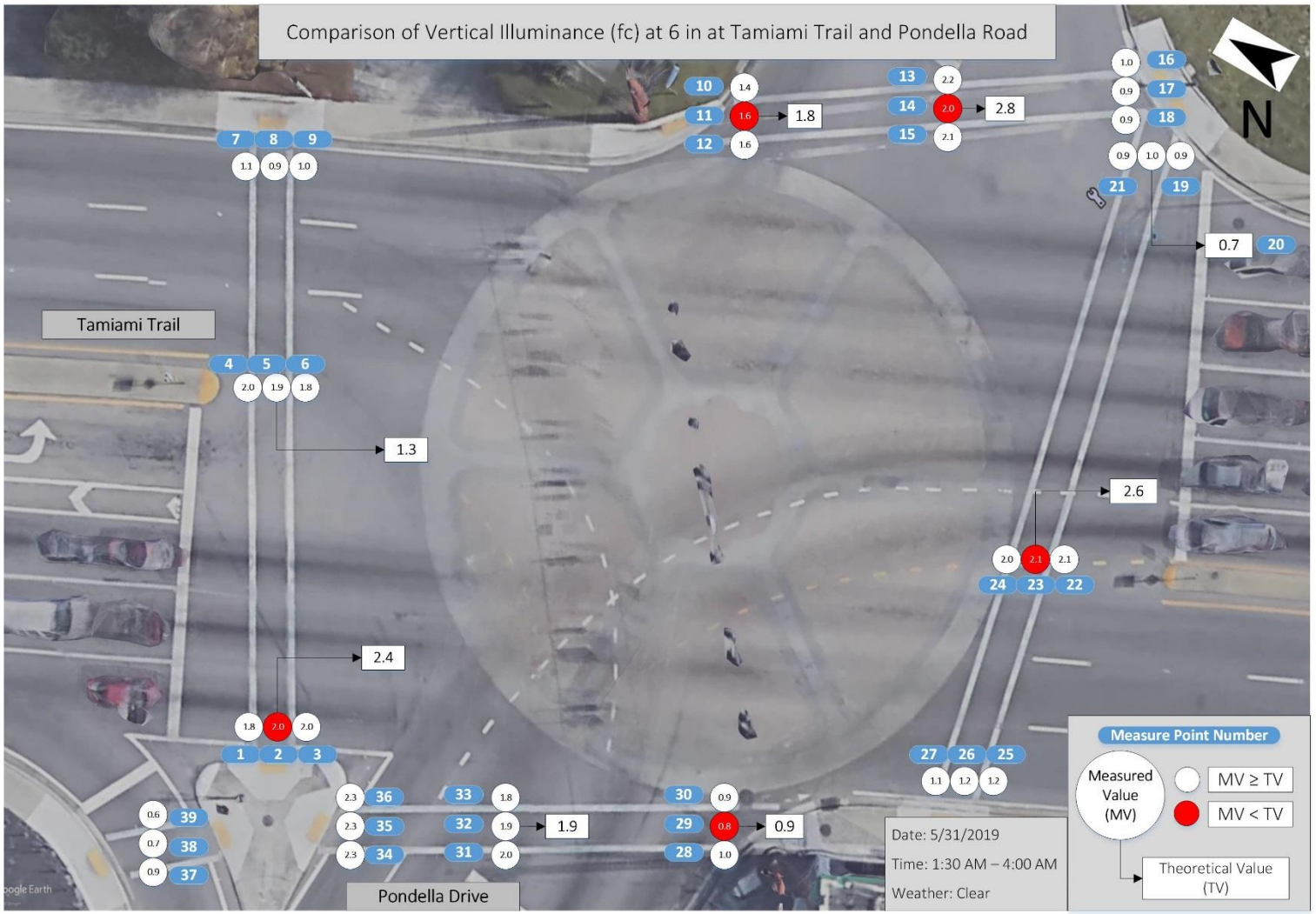

Figure 14. Comparison of Vertical Illuminance at Tamiami Tr and Pondella Rd

4.1.3 McGregor Blvd and Colonial Blvd

The comparison of illuminance data is given in Table 37. Figure 15 and Figure 16 present the horizontal illuminance of the north side and south side, respectively. Figure 17 and Figure 18 present the vertical illuminance of the north side and south side, respectively. The theoretical values of horizontal and vertical illuminance are absent at measure points 19–27 (south side).

Table 37. Comparison of Illuminance Data for McGregor Blvd and Colonial Blvd

Side	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
North	1	2.3	2.8	-0.5	-18%	1.5			
	2	2.3	3.0	-0.7	-23%	1.7	2.1	-0.4	-19%
	3	2.6	3.1	-0.5	-16%	2.1			
	4	4.2	4.7	-0.5	-11%	3.2			
	5	4.0	4.4	-0.4	-9%	3.4	3.4	0	0%
	6	3.7	4.3	-0.6	-14%	3.3			
	7	4.5	3.3	1.2	36%	3.9			
	8	4.2	3.5	0.7	20%	3.4			
	9	3.5	3.2	0.3	9%	3.6			
	10	2.9	2.4	0.5	21%	1.4			
	11	2.8	2.3	0.5	22%	1.6	1.9	-0.3	-16%
	12	2.6	2.2	0.4	18%	1.8			
	13	2.3	1.9	0.4	21%	1.4			
	14	2.0	1.8	0.2	11%	1.4	1.7	-0.3	-18%
	15	1.9	1.7	0.2	12%	1.6			
	16	1.5	1.3	0.2	15%	1.1			
	17	1.6	1.4	0.2	14%	1.2	1.5	-0.3	-20%
	18	1.7	1.5	0.2	13%	1.3			
South	19	2.7				1.8			
	20	2.7				1.8			
	21	2.7				2.0			
	22	2.1				1.5			
	23	2.3				1.7			
	24	2.3				1.6			
	25	1.5				1.5			
	26	1.5				1.5			
	27	1.5				1.5			
	28	2.0	2.4	-0.4	-17%	0.8			
	29	3.7	2.0	1.7	85%	3.4	2.1	1.3	62%
	30	2.3	1.8	0.5	28%	1.6			
	31	5.0	3.7	1.3	35%	4.8			
	32	4.9	3.6	1.3	36%	5.2	3.3	1.9	58%
	33	4.8	3.5	1.3	37%	5.3			
	34	2.7	1.9	0.8	42%	2.4			
	35	2.9	2.2	0.7	32%	2.7			
	36	2.9	2.4	0.5	21%	2.9			

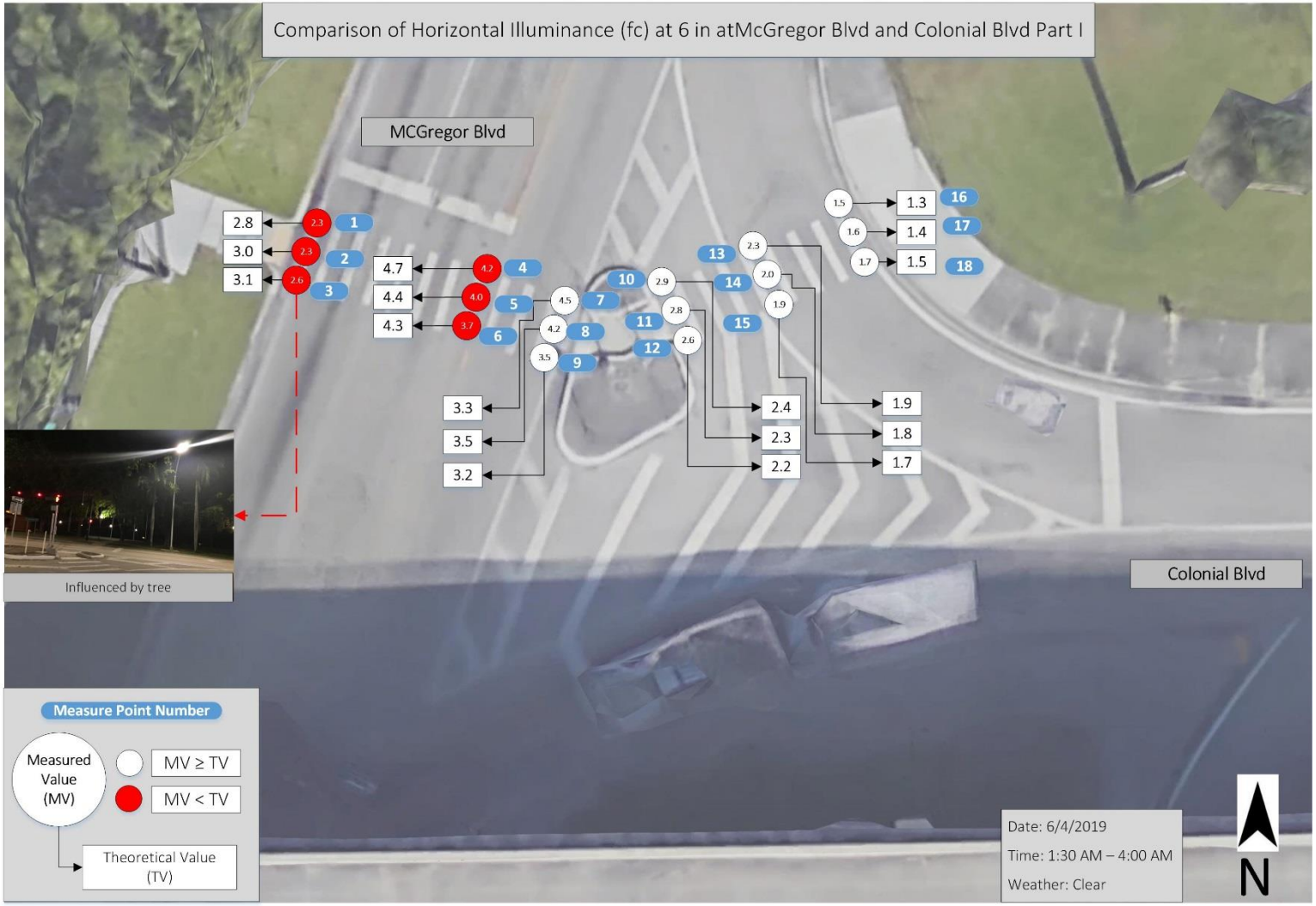

Figure 15. Comparison of Horizontal Illuminance at McGregor Blvd and Colonial Blvd (North Side)

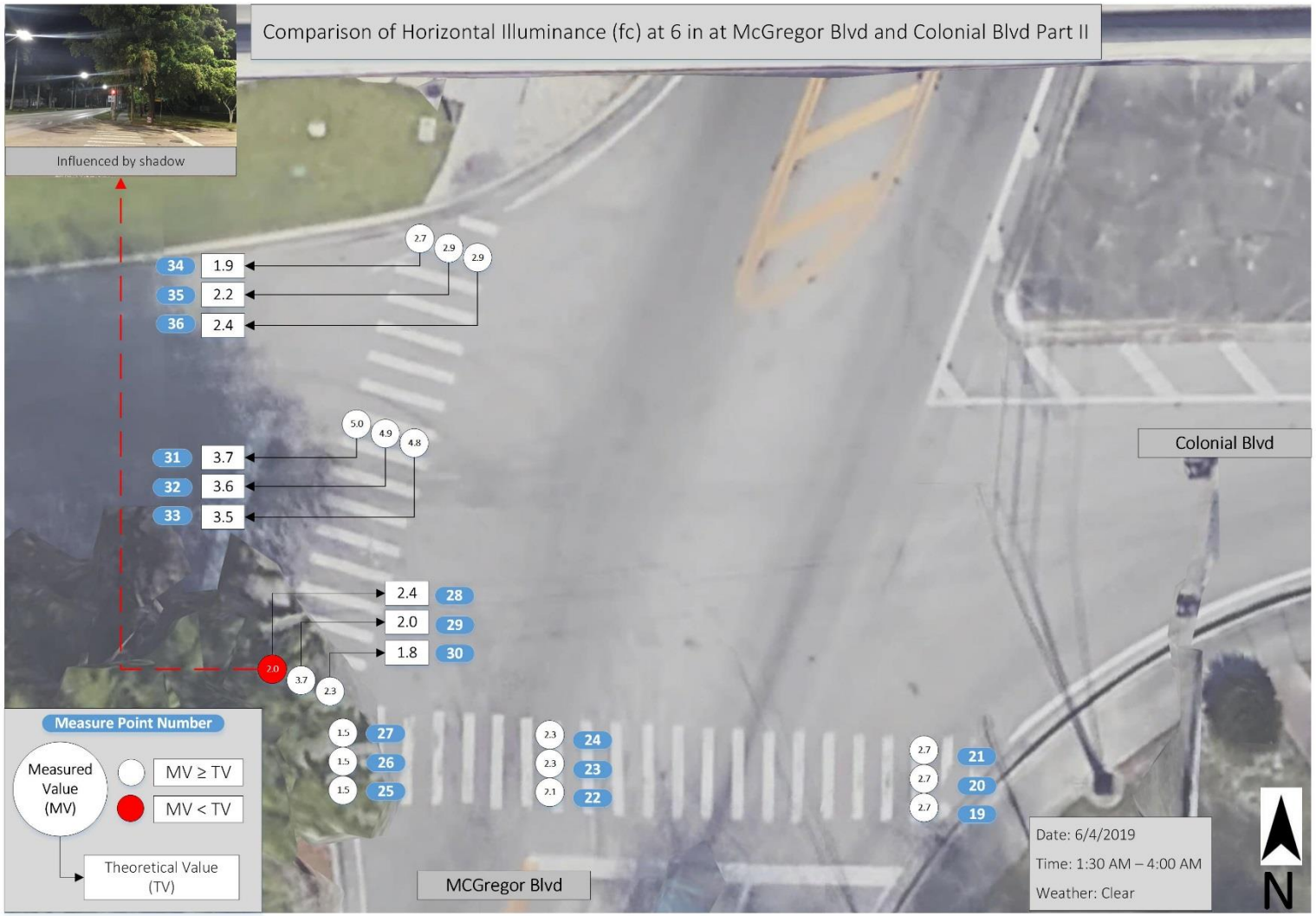

Figure 16. Comparison of Horizontal Illuminance at McGregor Blvd and Colonial Blvd (South Side)

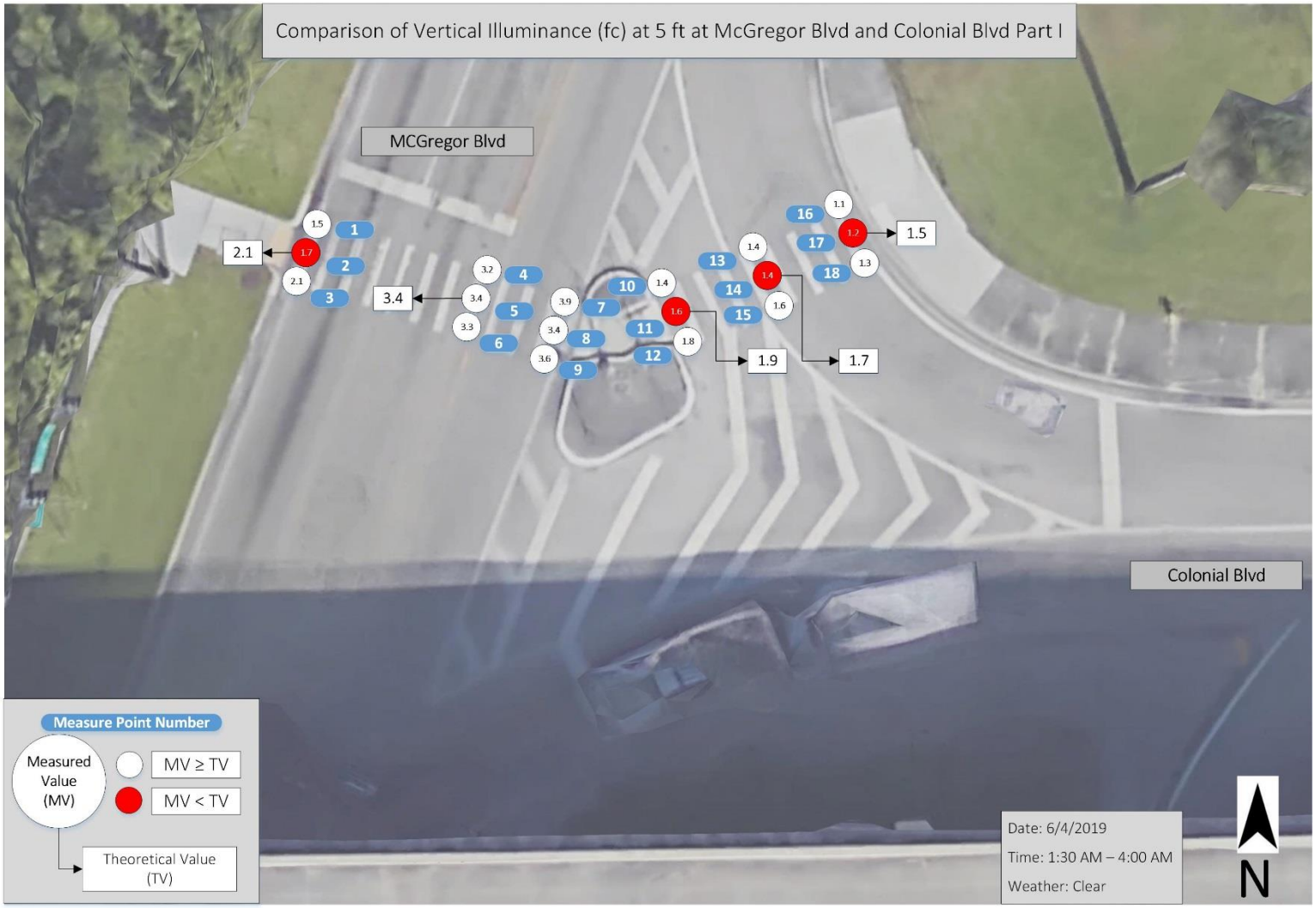

Figure 17. Comparison of Vertical Illuminance at McGregor Blvd and Colonial Blvd (North Side)

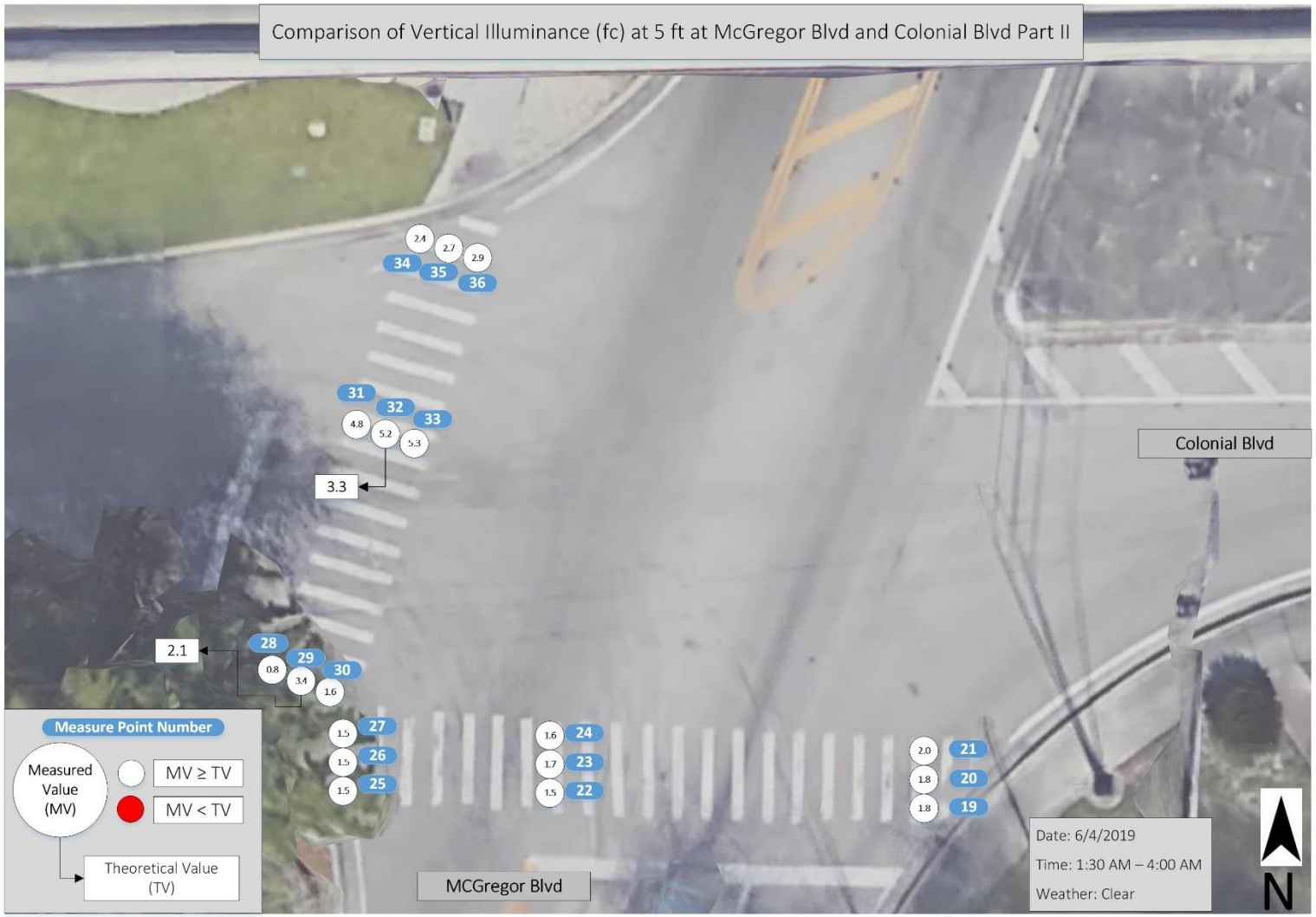

Figure 18. Comparison of Vertical Illuminance at McGregor Blvd and Colonial Blvd (South Side)

4.1.4 McGregor Blvd and College Pkwy

The comparison of illuminance data is given in Table 38. Figure 19 and Figure 20 present the horizontal illuminance on the north side and south side, respectively. Figure 21 and Figure 22 present the vertical illuminance on the north side and south side, respectively.

Table 38. Comparison of Illuminance Data for McGregor Blvd and College Pkwy

Side	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
North	1	3.6	3.4	0.2	6%	1.1		1.1	
	2	3.8	3.1	0.7	23%	1	2.2	-1.2	-55%
	3	4.1	3.1	1	32%	0.9		0.9	
	4	4.2	4.3	-0.1	-2%	3.2		3.2	
	5	3.9	4.1	-0.2	-5%	3	2.8	0.2	7%
	6	3.8	4.0	-0.2	-5%	2.8		2.8	
	7	1.4	1.6	-0.2	-13%	1.6		1.6	
	8	1.3	1.6	-0.3	-19%	1.4	0.7	0.7	100%
	9	1.3	1.6	-0.3	-19%	1.4		1.4	
	10	0.8	1.3	-0.5	-38%	0.7		0.7	
	11	1	1.3	-0.3	-23%	0.6		0.6	
	12	1.1	1.4	-0.3	-21%	0.7		0.7	
	13	1	1.3	-0.3	-23%	1.1		1.1	
	14	1.2	1.3	-0.1	-8%	1.1	2	-0.9	-45%
	15	1.3	1.3	0	0%	1.4		1.4	
	16	1.6	1.5	0.1	7%	2.3		2.3	
	17	1.5	1.4	0.1	7%	2.1	2.1	0	0%
	18	1.4	1.4	0	0%	1.8		1.8	
	19	1.3	1.5	-0.2	-13%	2.2		2.2	
	20	1.2	1.4	-0.2	-14%	2	1.7	0.3	18%
	21	1.1	1.4	-0.3	-21%	1.7		1.7	
	22	1	1.1	-0.1	-9%	1.5		1.5	
	23	0.9	1.3	-0.4	-31%	1.4	0.8	0.6	75%
	24	0.9	1.6	-0.7	-44%	1.3		1.3	

Table 38, continued

	25	1.8	3.7	-1.9	-51%	1		1	
	26	1.6	3.7	-2.1	-57%	1.1		1.1	
	27	1.6	3.7	-2.1	-57%	1.2		1.2	
	28	3.5	4.3	-0.8	-19%	1.4		1.4	
	29	3.3	4.3	-1	-23%	1.4		1.4	
	30	3.2	4.3	-1.1	-26%	1.4		1.4	
	31	4.1	4.0	0.1	2%	3.6		3.6	
	32	4.8	4.0	0.8	20%	3.8	2.4	1.4	58%
	33	5.6	5.2	0.4	8%	4		4	
	34	8.5	7.7	0.8	10%	7.2		7.2	
	35	7.4	6.9	0.5	7%	7	4.3	2.7	63%
	36	6.3	6.1	0.2	3%	7		7	
South	37	2.5	2.3	0.2	9%	1.5		1.5	
	38	2.6	2.0	0.6	30%	1.6	1.9	-0.3	-16%
	39	2.6	1.7	0.9	53%	2		2	
	40	2.7	4.8	-2.1	-44%	1.4		1.4	
	41	3.1	4.8	-1.7	-35%	1.9		1.9	
	42	3.2	4.3	-1.1	-26%	2.6		2.6	
	43	2.4	4.0	-1.6	-40%	1.1		1.1	
	44	3.5	4.0	-0.5	-13%	1.4	1.5	-0.1	-7%
	45	4.6	4.0	0.6	15%	1.4		1.4	
	46	4	6.2	-2.2	-35%	2.3		2.3	
	47	4.3	6.7	-2.4	-36%	2.1	3.8	-1.7	-45%
	48	4.6	7.0	-2.4	-34%	2.3		2.3	
	49	1.1	1.8	-0.7	-39%	0.7		0.7	
	50	1.1	1.8	-0.7	-39%	0.6	1.8	-1.2	-67%
	51	1.2	1.7	-0.5	-29%	0.5		0.5	
	52	2.4	3.1	-0.7	-23%	2.7		2.7	
	53	2.3	3.1	-0.8	-26%	2.6		2.6	
North	54	2.2	3.1	-0.9	-29%	2.3		2.3	
	55	5	4.3	0.7	16%	1.7		1.7	
	56	5.6	4.8	0.8	17%	1.7		1.7	
	57	5.9	5.4	0.5	9%	1.6		1.6	

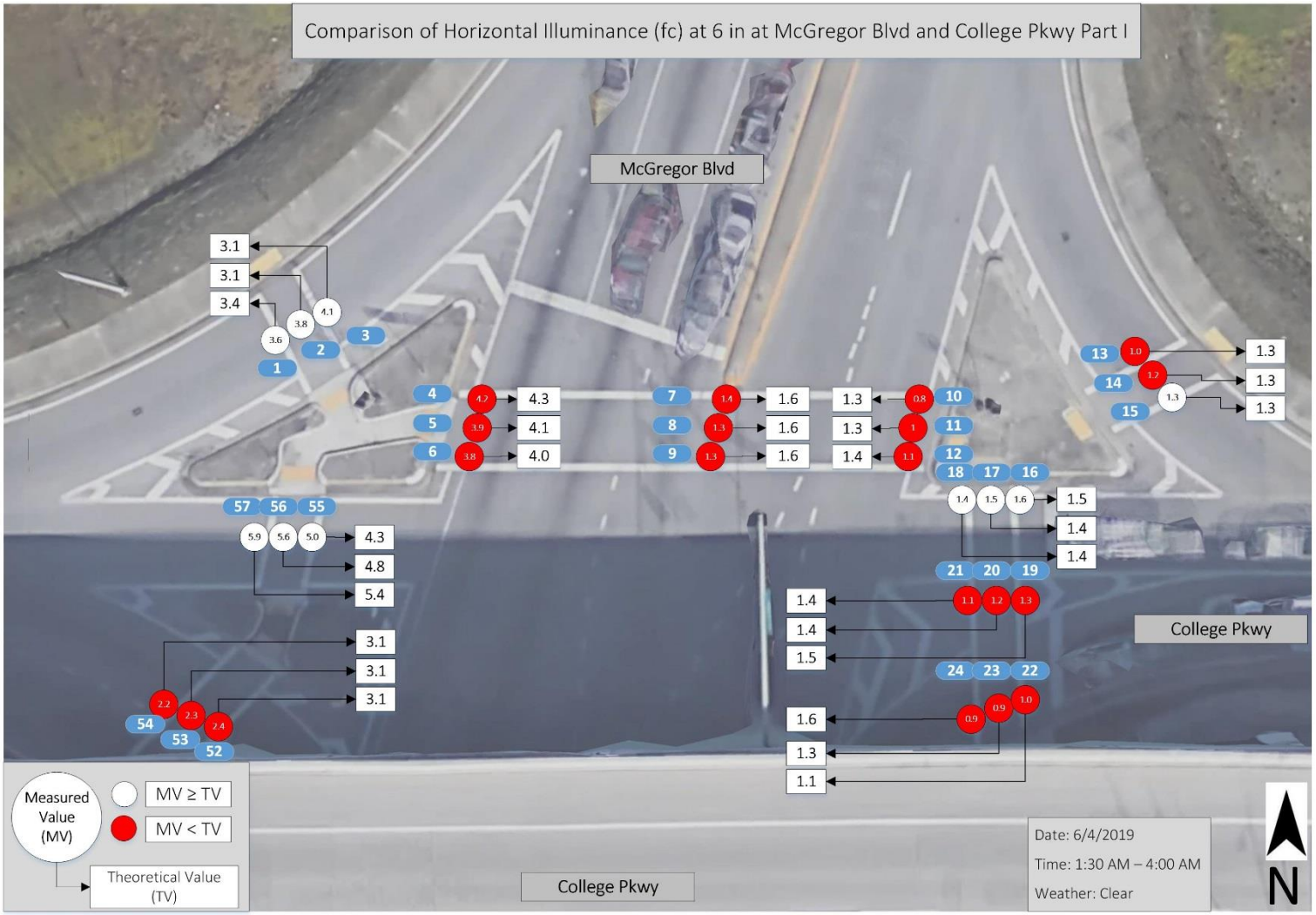

Figure 19. Comparison of Horizontal Illuminance at McGregor Blvd and College Pkwy (North Side)

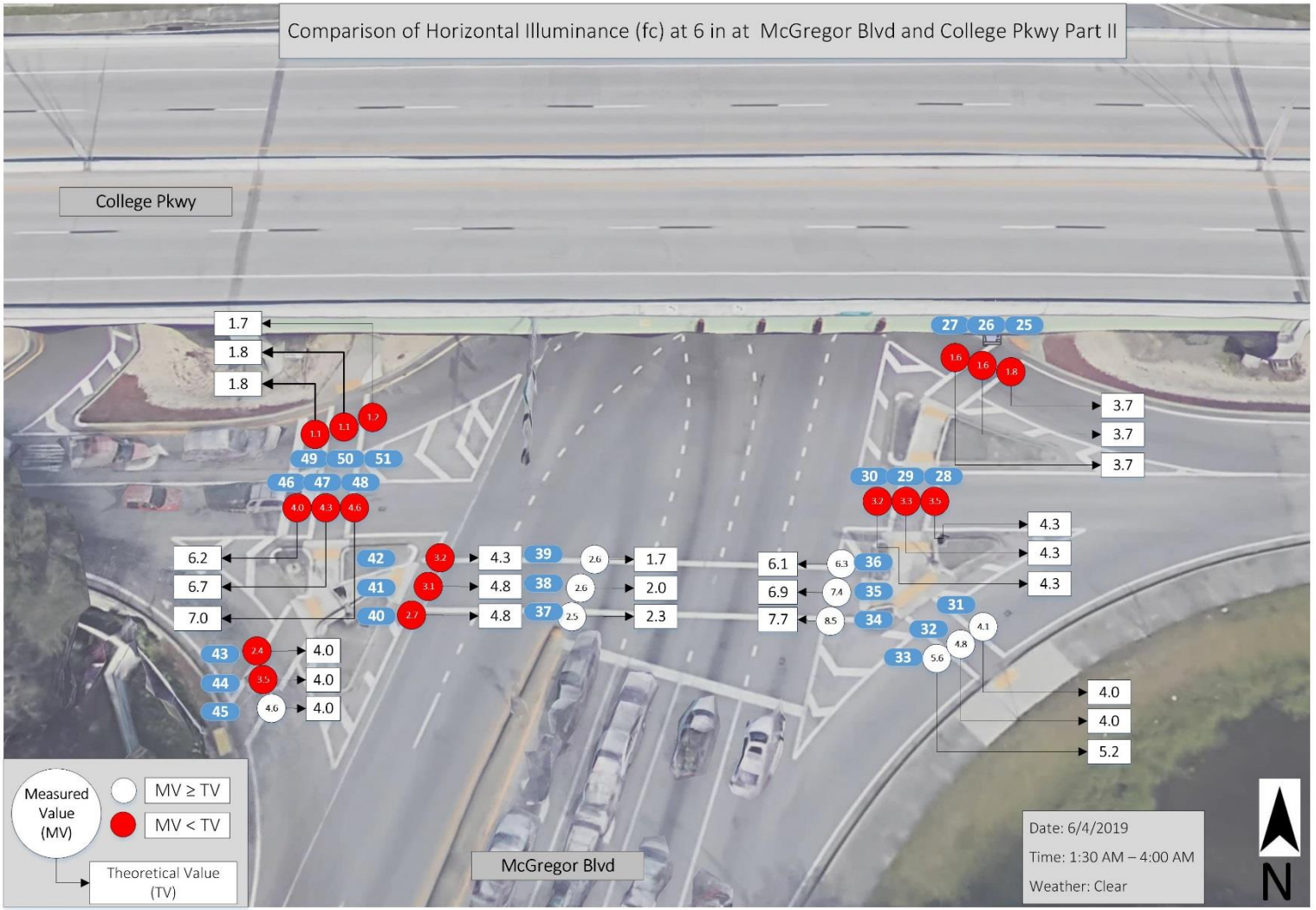

Figure 20. Comparison of Horizontal Illuminance at McGregor Blvd and College Pkwy (South Side)

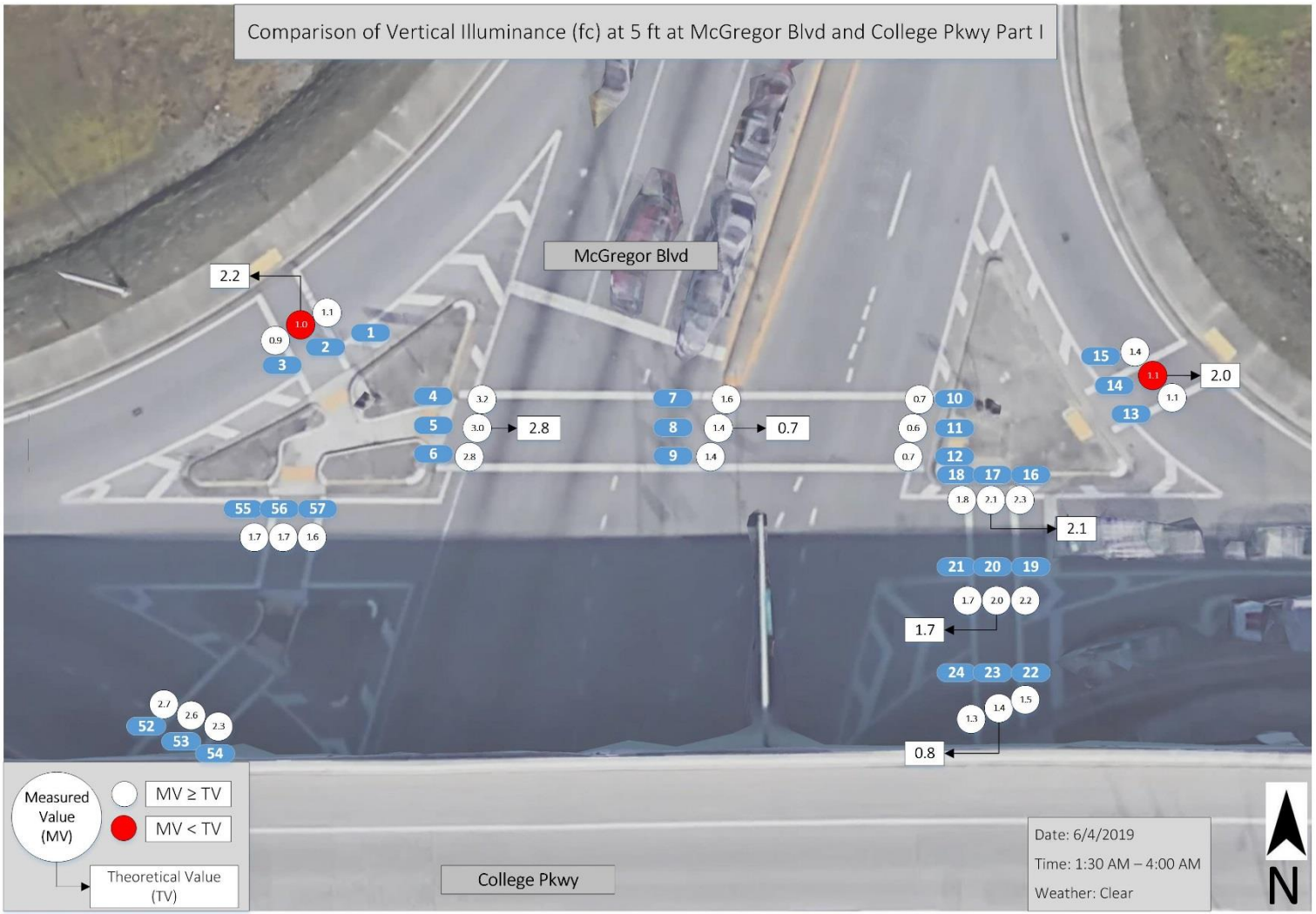

Figure 21. Comparison of Vertical Illuminance at McGregor Blvd and College Pkwy (North Side)

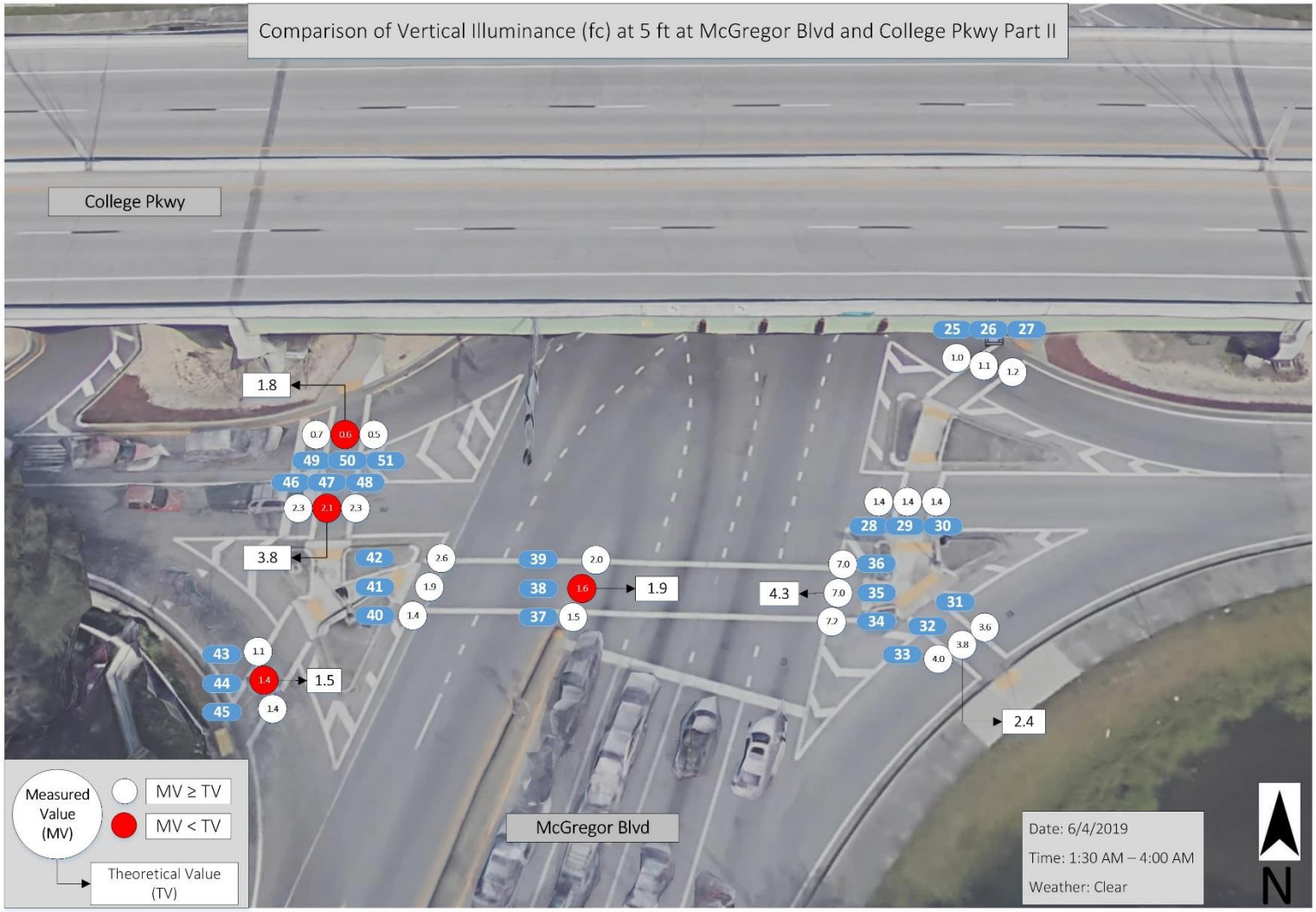

Figure 22. Comparison of Vertical Illuminance at McGregor Blvd and College Pkwy (South Side)

4.2 Data Collection in District 2

4.2.1 Collins Blvd and SR-21

The comparison of illuminance data is given in Table 39. Figure 23 and Figure 24 present the comparisons of horizontal and vertical illuminance, respectively, at Collins Blvd and SR-21. Based on the field examination, the following findings were obtained:

- Theoretical vertical values are unavailable for westbound and eastbound.
- Shadows influence the measured horizontal values on one side of eastbound.
- External lights influence the measured horizontal values on one side of northbound.

Table 39. Comparison of Illuminance Data for Collins Blvd and SR-21

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	2.5	1.9	0.6	32%	1.6			
	2	2.4	1.7	0.7	41%	1.8	0.9	0.9	100%
	3	2.2	1.6	0.6	38%	1.7			
	4	1.9	1.4	0.5	36%	2.2			
	5	2	1.4	0.6	43%	2.2	1	1.2	120%
	6	1.9	1.3	0.6	46%	2.4			
	7	3.2	1.2	2	167%	4.5			
	8	2.7	1	1.7	170%	4			
	9	2.3	0.8	1.5	188%	3.4			
WB	10	1.7	1.4	0.3	21%	0.8			
	11	1.6	1.1	0.5	45%	0.9			
	12	1.5	1	0.5	50%	0.9			
	13	1.1	0.6	0.5	83%	0.6			
	14	1	0.6	0.4	67%	0.6			
	15	1	0.6	0.4	67%	0.7			
	16	1.2	0.1	1.1	1100%	0.2			
	17	1.4	0.1	1.3	1300%	0.2			
	18	1.4	0.1	1.3	1300%	0.2			
NB	19	3.9	1.8	2.1	117%	3.8			
	20	3.5	1.8	1.7	94%	3.6	2.2	1.4	64%
	21	3.2	1.7	1.5	88%	3.8			
	22	2	0.4	1.6	400%	1.2			
	23	2	0.4	1.6	400%	1.3	0.2	1.1	550%
	24	2	0.4	1.6	400%	1.4			
	25	5.1	1.6	3.5	219%	1.8			
	26	5	1.4	3.6	257%	2.6			
	27	4.7	1.2	3.5	292%	3.1			
EB	28	2.2	0.5	1.7	340%	2.2			
	29	2.4	0.5	1.9	380%	2.2			
	30	2.7	0.5	2.2	440%	2.2			
	31	1.7	1.7	0	0%	1.7			
	32	1.6	1.7	-0.1	-6%	1.7			
	33	1.6	1.6	0	0%	1.6			
	34	0.6	1.7	-1.1	-65%	0.8			
	35	2.1	2	0.1	5%	0.9			
	36	2.1	2.1	0	0%	1.1			

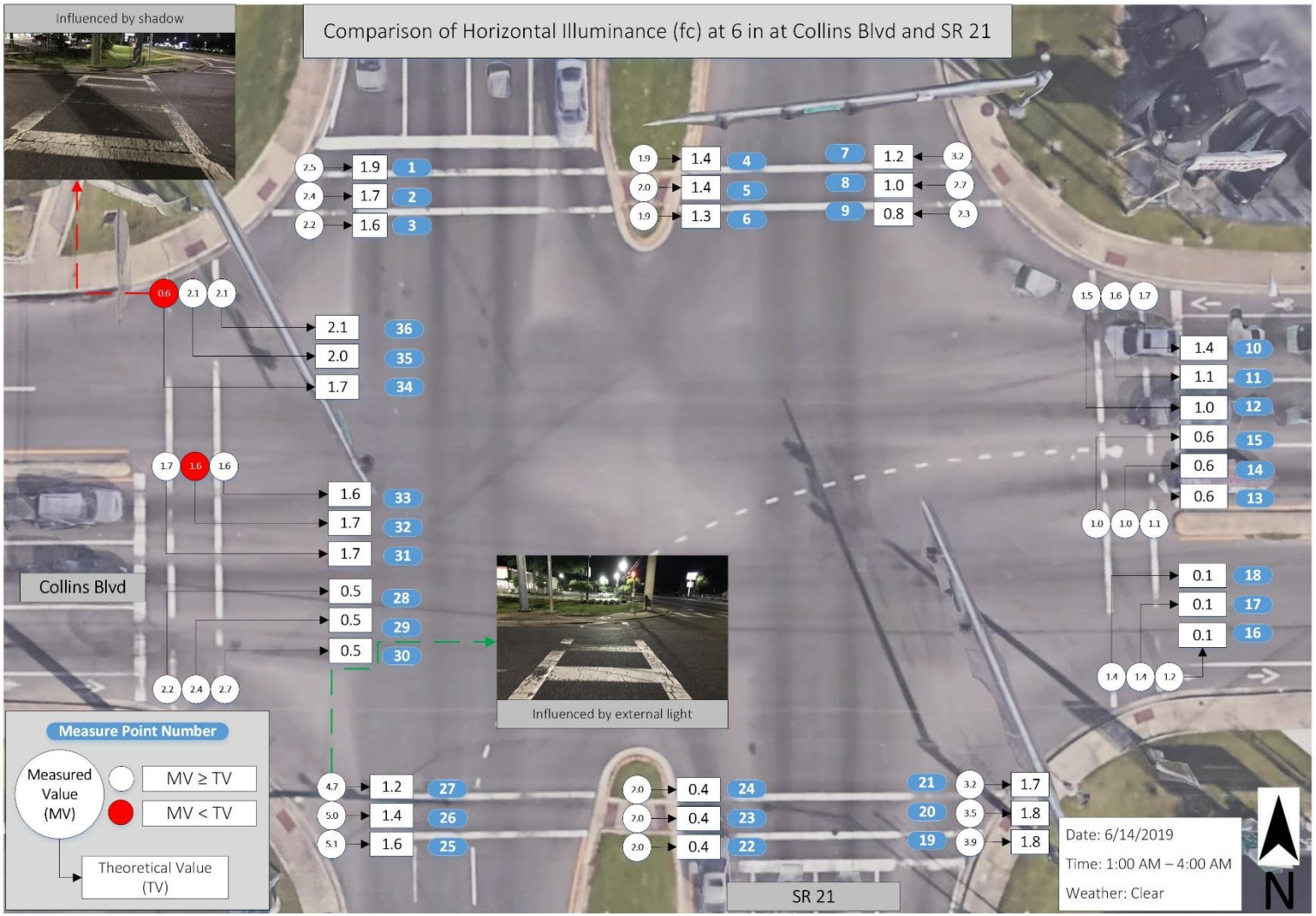

Figure 23. Comparison of Horizontal Illuminance at Collins Blvd and SR-21

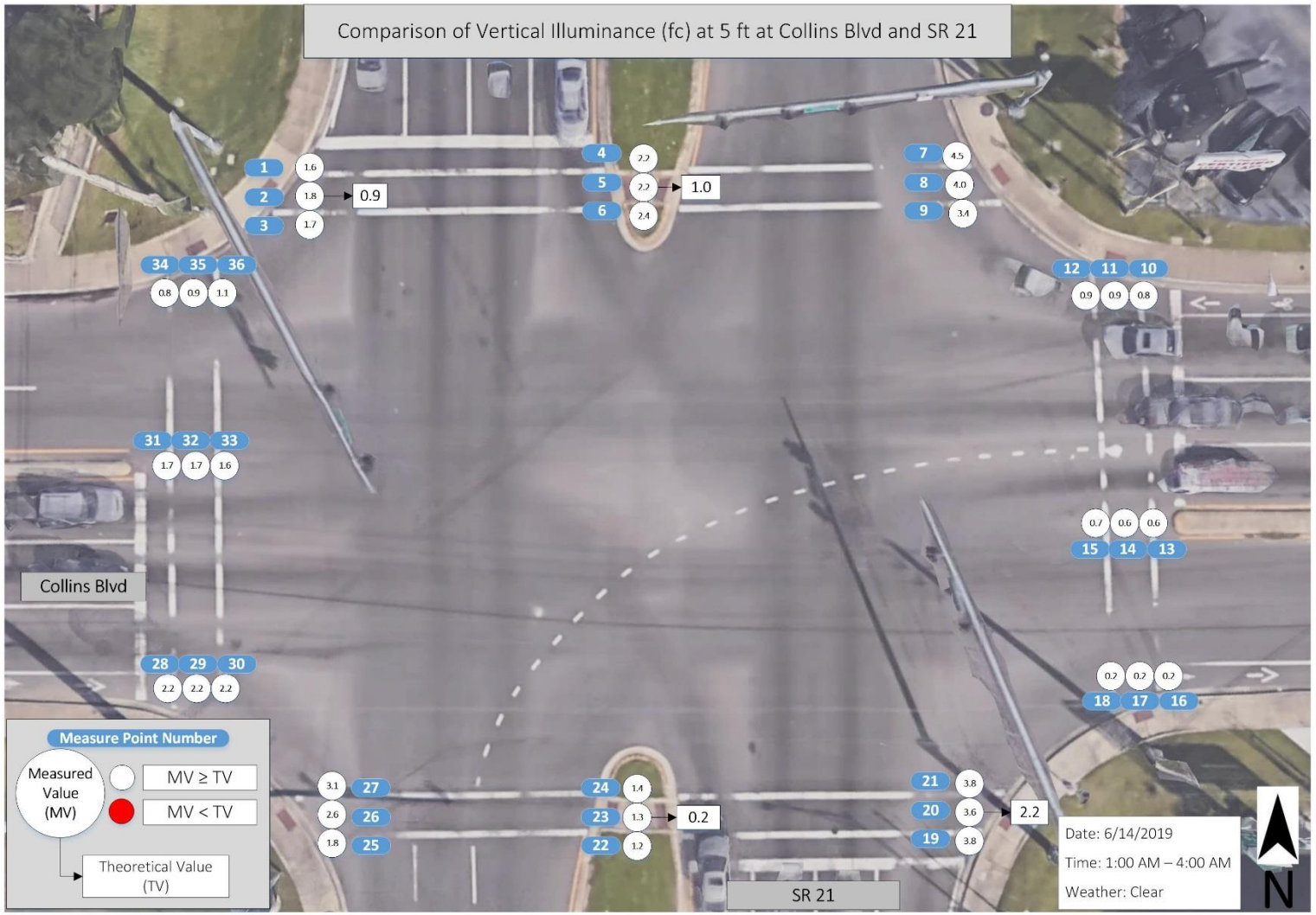

Figure 24. Comparison of Vertical Illuminance at Collins Blvd and SR-21

4.2.2 Jammes Rd and SR-128

The comparison of illuminance data is given in Table 40. Figure 25 and Figure 26 present the comparisons of horizontal and vertical illuminance, respectively, at Jammes Rd and SR-128. Theoretical vertical values are unavailable.

Table 40. Comparison of Illuminance Data for Jammes Rd and SR-128

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	1.9	2.3	-0.4	-17%	2.5			
	2	2	2.3	-0.3	-13%	2.7			
	3	2.3	2.3	0	0%	2.7			
	4	2.2	2.3	-0.1	-4%	2.4			
	5	2.4	2.2	0.2	9%	2.4			
	6	2.5	2.2	0.3	14%	2			
	7	1.7	1.9	-0.2	-11%	1.7			
	8	1.7	1.8	-0.1	-6%	1.5			
	9	1.6	1.8	-0.2	-11%	1.3			
WB	10	0.6	0.5	0.1	20%	0.6			
	11	0.6	0.6	0	0%	0.6			
	12	0.6	0.6	0	0%	0.6			
	13	0.4	0.4	0	0%	0.6			
	14	0.5	0.4	0.1	25%	0.5			
	15	0.5	0.5	0	0%	0.5			
	16	0.5	0.3	0.2	67%	0.6			
	17	0.5	0.3	0.2	67%	0.6			
	18	0.4	0.3	0.1	33%	0.6			
NB	19	0.4	0.2	0.2	100%	0.2			
	20	0.4	0.2	0.2	100%	0.2			
	21	0.4	0.2	0.2	100%	0.2			
	22	0.5	0.3	0.2	67%	0.1			
	23	0.7	0.3	0.4	133%	0.3			
	24	0.7	0.4	0.3	75%	0.2			
	25	0.6	0.3	0.3	100%	0.2			
	26	1	0.4	0.6	150%	0.2			
	27	1.3	0.4	0.9	225%	0.2			
EB	28	0.6	0.8	-0.2	-25%	0.1			
	29	0.9	0.8	0.1	13%	0.2			
	30	1.6	0.9	0.7	78%	1.5			
	31	2.3	1.7	0.6	35%	0.3			
	32	2.4	1.7	0.7	41%	0.3			
	33	2.5	1.8	0.7	39%	0.3			
	34	1	2	-1	-50%	0.4			
	35	1.4	2.1	-0.7	-33%	0.3			
	36	2.2	2.3	-0.1	-4%	0.3			

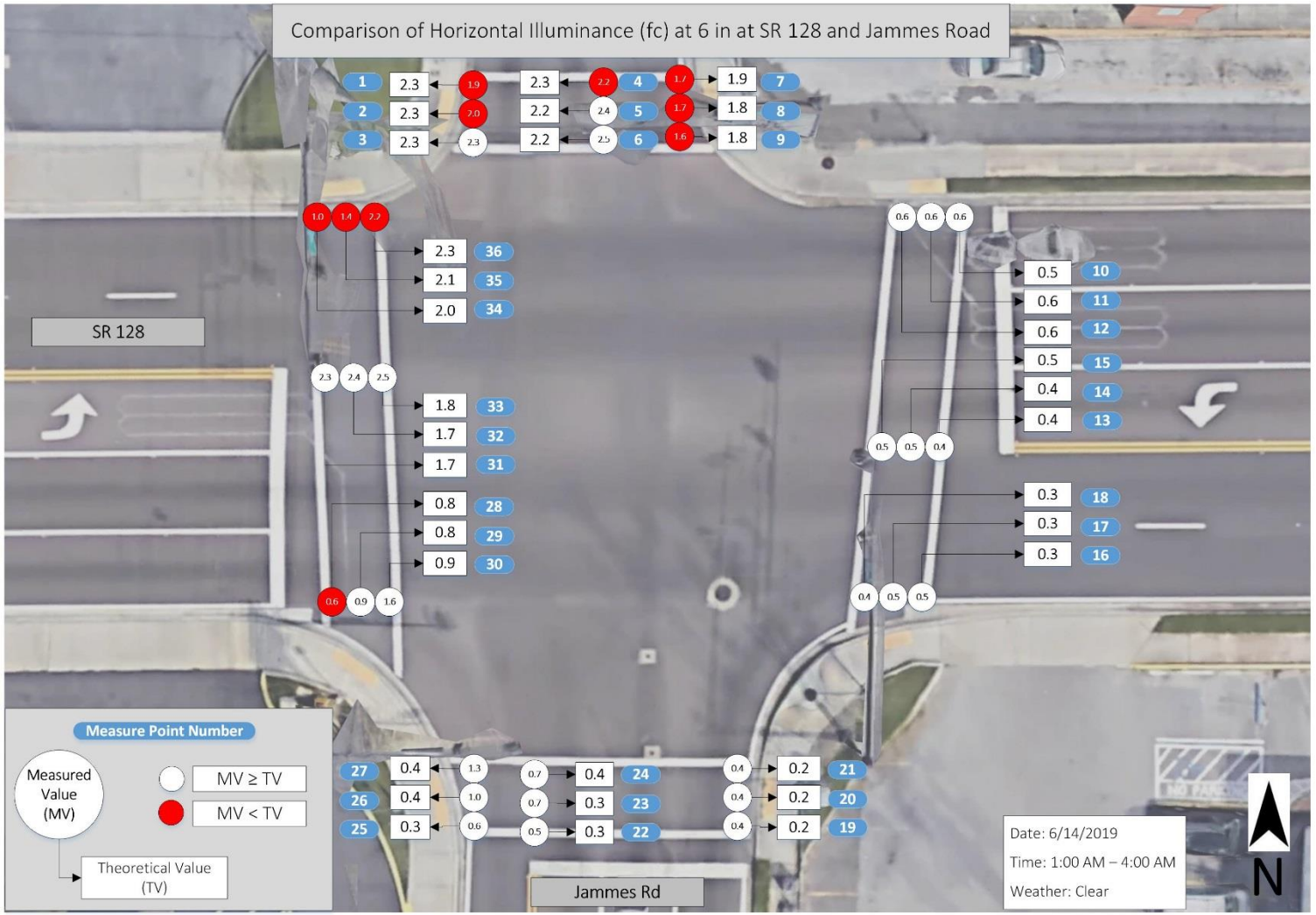

Figure 25. Comparison of Horizontal Illuminance at SR-128 and Jammes Rd

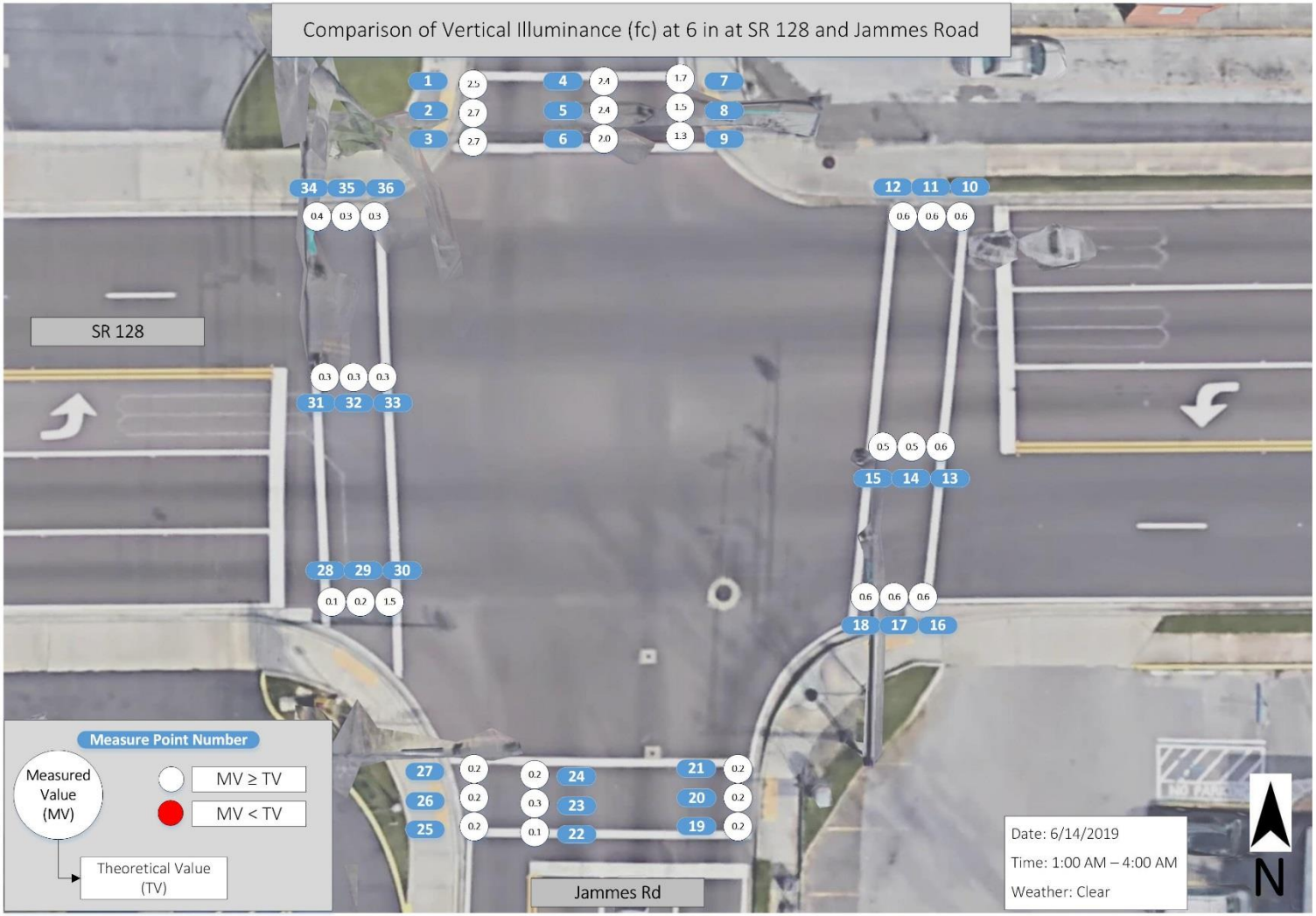

Figure 26. Comparison of Vertical Illuminance at SR-128 and Jammes Rd

4.2.3 Wesconnett Blvd and SR-134

The comparison of illuminance data is given in Table 41. Figure 27 and Figure 28 present the comparisons of horizontal and vertical illuminance, respectively, at Wesconnett Blvd and SR-134. Based on the comparison, the following findings were obtained:

- Theoretical vertical illuminance data are unavailable on southbound and northbound.
- More than half of the horizontal measured values are less than the theoretical values.
- Shadows influence the measured horizontal values on eastbound, westbound, and northbound.
- Most vertical measured values are higher than the theoretical values (at the points where theoretical value are available).

Table 41. Comparison of Illuminance Data for Wesconnett Blvd and SR-134

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	1.4	1.4	0	0%	1.1			
	2	1.3	1.3	0	0%	1			
	3	1.2	1.2	0	0%	1			
	4	1	1.3	-0.3	-23%	0.6			
	5	1	1.3	-0.3	-23%	0.5			
	6	1	1.3	-0.3	-23%	0.6			
	7	0.7	1.2	-0.5	-42%	0.5			
	8	0.7	1.2	-0.5	-42%	0.4			
	9	0.8	1.2	-0.4	-33%	0.4			
WB	10	1.3	1.7	-0.4	-24%	0.8			
	11	1.2	1.7	-0.5	-29%	1	0.8	0.2	25%
	12	1.1	1.6	-0.5	-31%	0.9			
	13	3.4	3	0.4	13%	2.8			
	14	3.7	3.1	0.6	19%	3.2	2.4	0.8	33%
	15	3.9	3	0.9	30%	3.8			
	16	1.8	2.2	-0.4	-18%	1.3			
	17	1.5	2.3	-0.8	-35%	1.1			
	18	1.1	2.3	-1.2	-52%	0.8			
NB	19	0.6	1.2	-0.6	-50%	0.4			
	20	0.6	1.3	-0.7	-54%	0.3			
	21	0.6	1.3	-0.7	-54%	0.3			
	22	2	2	0	0%	0.3			
	23	2.5	2.1	0.4	19%	0.3			
	24	2.8	2.1	0.7	33%	0.3			
	25	4.2	2.5	1.7	68%	0.3			
	26	4.1	2.6	1.5	58%	0.3			
	27	4.3	2.6	1.7	65%	0.4			
EB	28	2.4	2.3	0.1	4%	2			
	29	1.9	2.1	-0.2	-10%	1.8	1.9	-0.1	-5%
	30	1.6	3	-1.4	-47%	1.6			
	31	2.2	2.6	-0.4	-15%	2.1			
	32	2.1	2.5	-0.4	-16%	2	1.8	0.2	11%
	33	2.1	2.6	-0.5	-19%	1.9			
	34	1	0.9	0.1	11%	1			
	35	0.8	1	-0.2	-20%	0.6			
	36	0.9	1.1	-0.2	-18%	0.6			

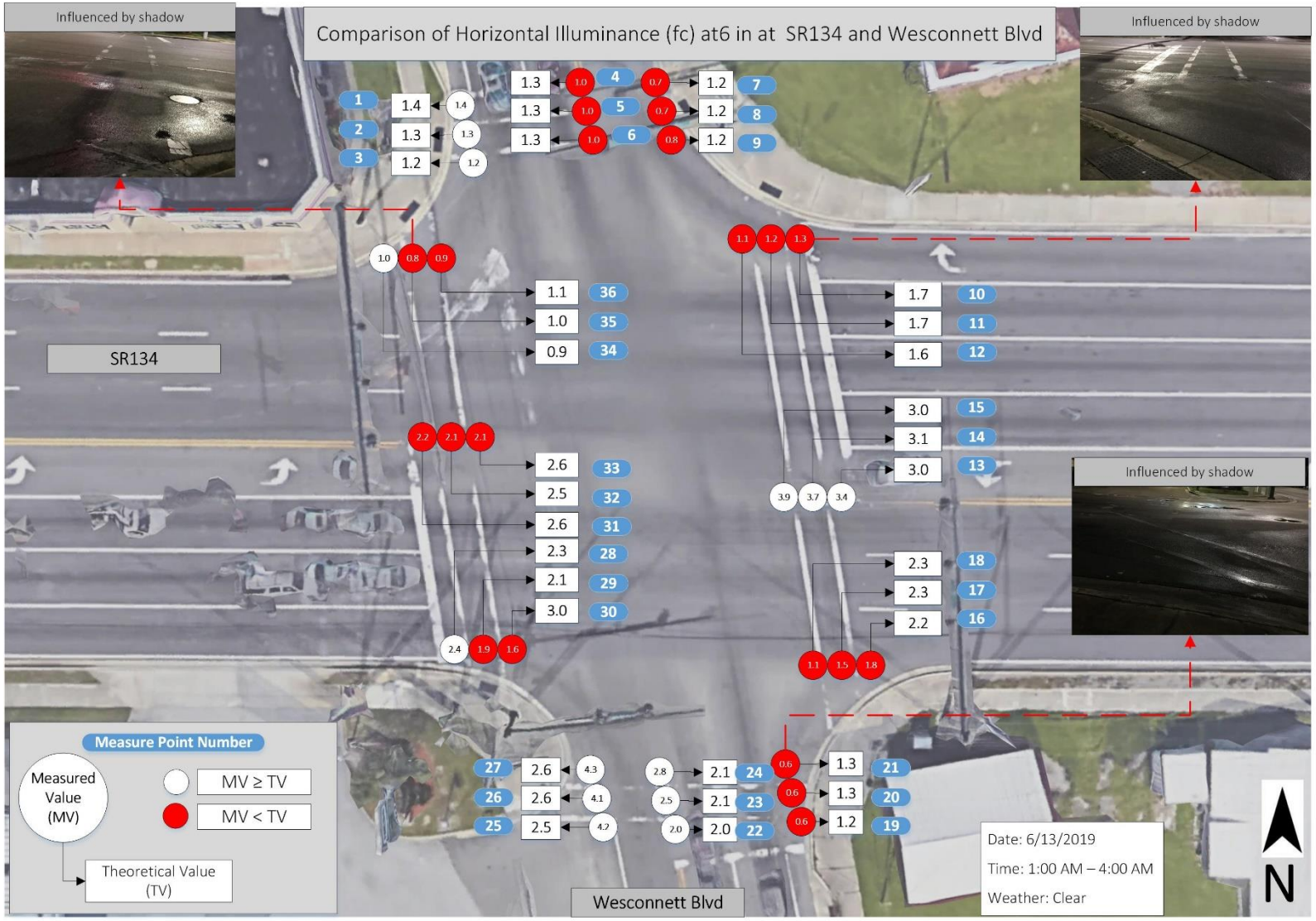

Figure 27. Comparison of Horizontal Illuminance at SR-134 and Wesconnett Blvd

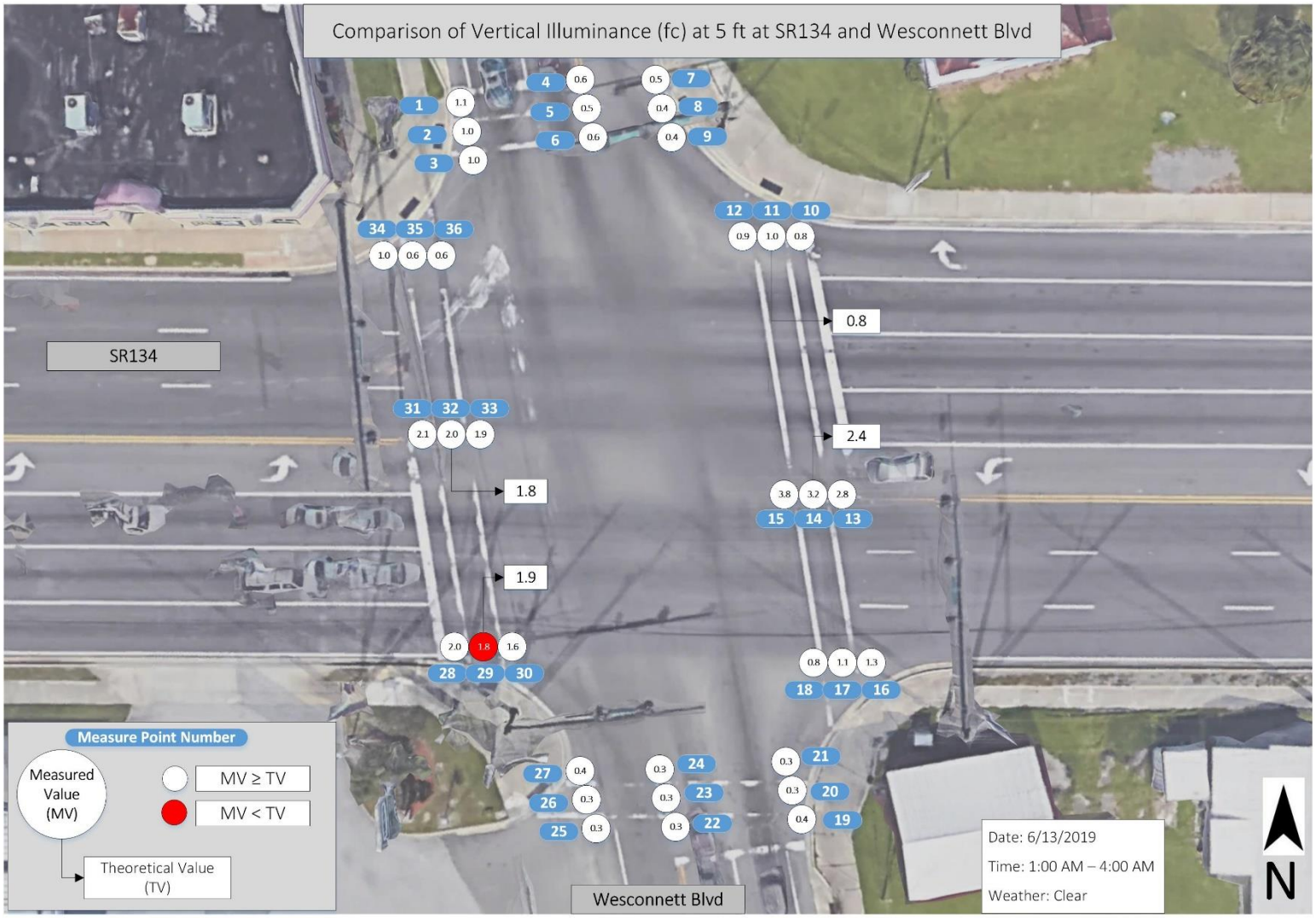

Figure 28. Comparison of Vertical Illuminance at SR-134 and Wesconnett Blvd

4.2.4 Youngerman Cr and SR-21

The comparison of illuminance data is given in Table 42. Figure 29 and Figure 30 present the comparisons of horizontal and vertical illuminance, respectively, at Youngerman Cr and SR-21. Based on the field observation, the following findings were obtained:

- Theoretical vertical illuminance data are unavailable for southbound, westbound, and eastbound.
- One streetlight on southbound is not working.
- The nonfunctional streetlight effects the measured horizontal values on one side of southbound.
- External lights influence the measured horizontal values on one side of northbound.

Table 42. Comparison of Illuminance Data for Youngerman Cr and SR-21

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	0.4	1.6	-1.2	-75%	0.2			
	2	0.4	1.7	-1.3	-76%	0.2			
	3	0.4	1.7	-1.3	-76%	0.2			
	4	1.0	0.9	0.1	11%	0.9			
	5	1.0	0.9	0.1	11%	1.0			
	6	0.9	0.9	0.0	0%	0.8			
	7	1.6	2.3	-0.7	-30%	1.5			
	8	1.7	2.0	-0.3	-15%	1.5			
	9	1.8	2.0	-0.2	-10%	1.7			
WB	10	1.2	1.1	0.1	9%	0.6			
	11	1.3	1.5	-0.2	-13%	0.7			
	12	1.3	2.0	-0.7	-35%	0.6			
	13	2.6	1.7	0.9	53%	0.6			
	14	2.7	2.0	0.7	35%	0.9			
	15	2.7	2.0	0.7	35%	1.0			
	16	2.7	1.7	1.0	59%	0.5			
	17	2.7	1.8	0.9	50%	0.5			
	18	2.7	1.8	0.9	50%	0.7			
NB	19	4.5	2.2	2.3	105%	2.0			
	20	4.2	2.1	2.1	100%	2.2	1.2	1	83%
	21	3.8	2.0	1.8	90%	2.3			
	22	1.7	0.9	0.8	89%	1.0			
	23	1.7	1.0	0.7	70%	1.2	0.2	1	500%
	24	1.7	1.1	0.6	55%	1.2			
	25	4.4	2.0	2.4	120%	1.7			
	26	4.4	2.1	2.3	110%	1.9			
	27	4.5	2.1	2.4	114%	2.1			
EB	28	3.7	1.9	1.8	95%	0.6			
	29	3.8	1.9	1.9	100%	0.8			
	30	3.9	1.9	2.0	105%	0.9			
	31	1.5	1.2	0.3	25%	0.5			
	32	1.5	1.3	0.2	15%	0.5			
	33	1.4	1.3	0.1	8%	0.7			
	34	0.5	0.8	-0.3	-38%	0.2			
	35	0.4	1.0	-0.6	-60%	0.2			
	36	0.4	1.1	-0.7	-64%	0.3			

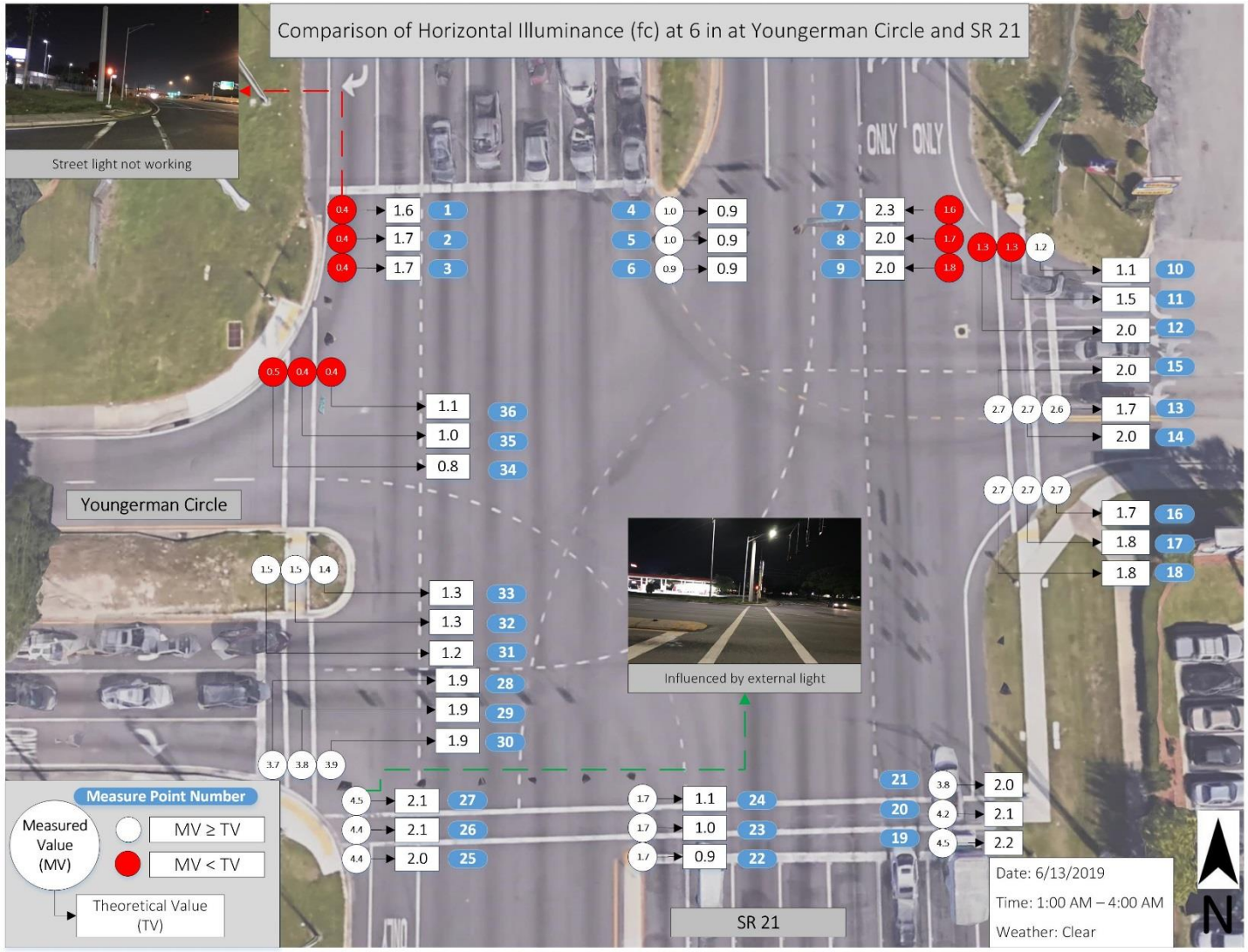

Figure 29. Comparison of Horizontal Illuminance at Youngerman Cr and SR-21

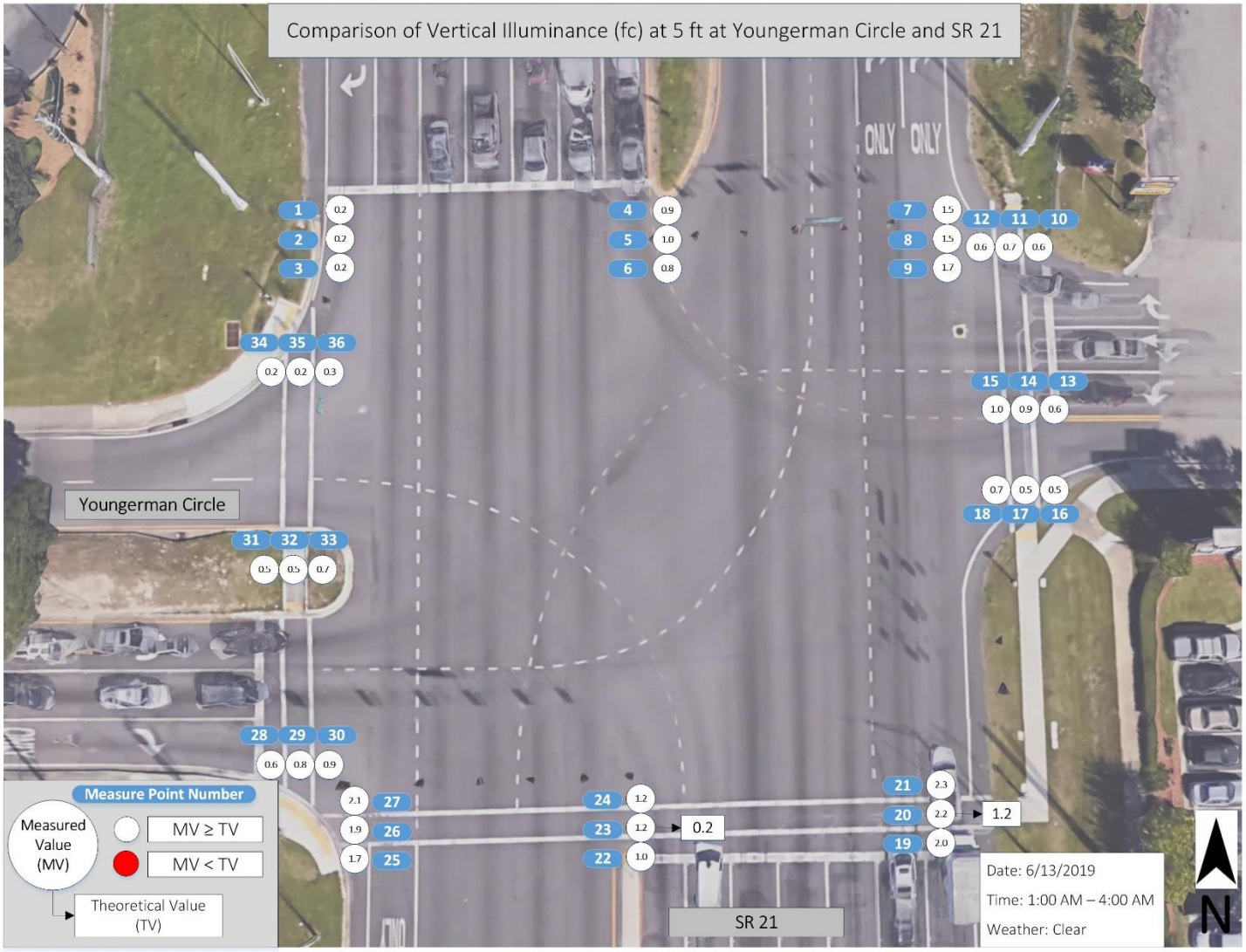

Figure 30. Comparison of Vertical Illuminance at Youngerman Cr and SR-21

4.3 Data Collection in District 3

4.3.1 Lillian Hwy and N 57th Ave

The comparison of illuminance data is given in Table 43. Figure 31 and Figure 32 present the comparisons of horizontal and vertical illuminance, respectively, at Lillian Hwy and N 57th Ave. Based on the comparison, the following findings were obtained:

- Most horizontal measured values on eastbound are less than theoretical values.
- The measured horizontal values on northbound and westbound are less than the theoretical values.
- Theoretical vertical values are unavailable.

Table 43. Comparison of Illuminance Data for Lillian Hwy and N 57th Ave

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	2.4	2.2	0.2	9%	1.8			
	2	2.5	2.2	0.3	14%	1.5			
	3	2.6	2.3	0.3	13%	1.5			
	4	4	2.2	1.8	82%	3.2			
	5	3.9	2.3	1.6	70%	3			
	6	3.8	2.3	1.5	65%	2.8			
	7	6	2.4	3.6	150%	2.3			
	8	5.9	2.4	3.5	146%	2.8			
	9	5.7	2.4	3.3	138%	3.5			
WB	10	3.7	2.4	1.3	54%	2.3			
	11	3.8	2.5	1.3	52%	1.9			
	12	4	2.3	1.7	74%	2			
	13	4.4	4	0.4	10%	5.8			
	14	4.3	3.6	0.7	19%	6.3			
	15	4.1	3.2	0.9	28%	6.2			
	16	5.1	4	1.1	28%	7.1			
	17	4.6	3.5	1.1	31%	6.7			
	18	4	3.2	0.8	25%	6.2			
NB	19	3.4	2.9	0.5	17%	4.7			
	20	3.2	2.6	0.6	23%	5			
	21	3.1	2.4	0.7	29%	4.3			
	22	3.4	3.7	-0.3	-8%	4.9			
	23	3.2	3.4	-0.2	-6%	4.2			
	24	3.2	3.1	0.1	3%	3.7			
	25	1.5	1.8	-0.3	-17%	0.7			
	26	2	1.9	0.1	5%	0.7			
	27	2.9	2.1	0.8	38%	0.7			
EB	28	7.7	6.5	1.2	18%	4.2			
	29	6.8	6.5	0.3	5%	5			
	30	6.1	5.6	0.5	9%	5.5			
	31	4	4.9	-0.9	-18%	2.6			
	32	3.9	4.7	-0.8	-17%	3.5			
	33	3.6	4.6	-1	-22%	3.7			
	34	3.5	4.3	-0.8	-19%	3.5			
	35	3.4	4	-0.6	-15%	3.7			
	36	3.3	3.8	-0.5	-13%	3.9			

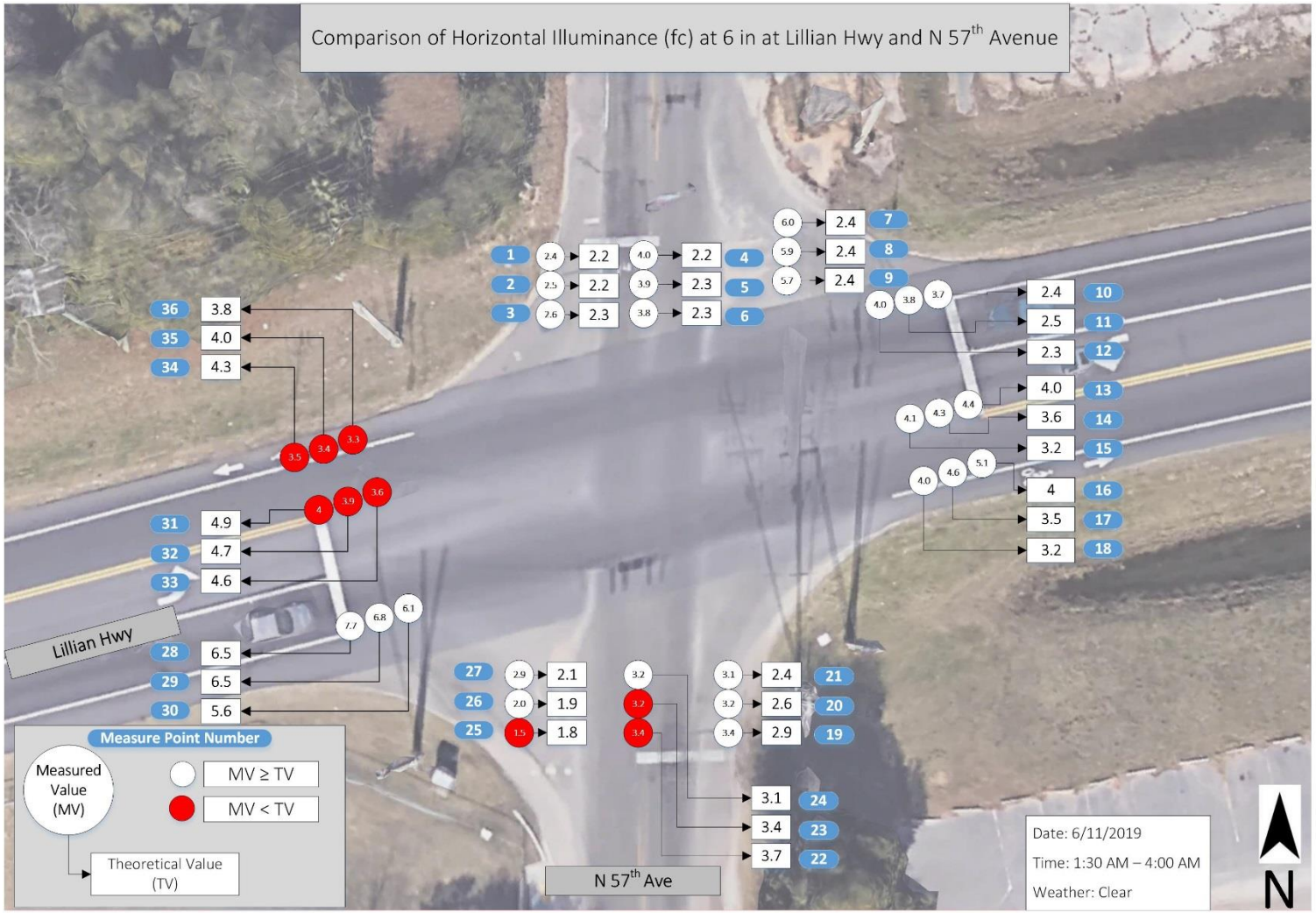

Figure 31. Comparison of Horizontal Illuminance at Lillian Hwy and N 57th Ave

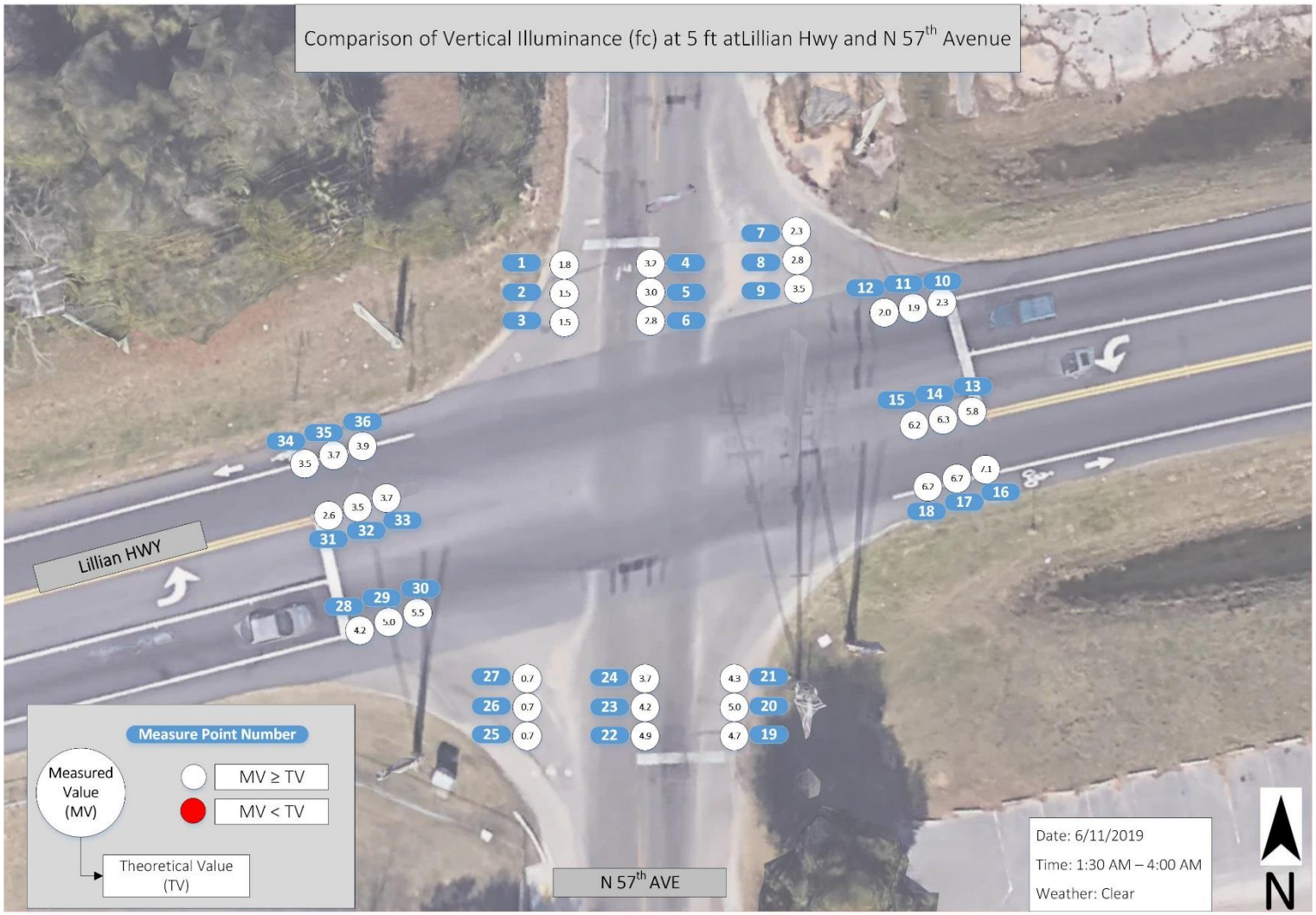

Figure 32. Comparison of Vertical Illuminance at Lillian Hwy and N 57th Ave

4.3.2 Lillian Hwy and N 65th Ave

The comparison of illuminance data is given in Table 44. Figure 33 and Figure 34 present the comparisons of horizontal and vertical illuminance, respectively, at Lillian Hwy and N 65th Ave. Based on the comparison, the following findings were obtained:

- Trees and shadows influence some measured horizontal values on northbound and eastbound.
- Some measured horizontal values on northbound are less than theoretical values.
- Theoretical vertical values are unavailable.

Table 44. Comparison of Illuminance Data for Lillian Hwy and N 65th Ave

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	1.4	1.1	0.3	27%	2.7			
	2	1.4	1	0.4	40%	2.4			
	3	1.3	1	0.3	30%	2.2			
	4	1.9	1.3	0.6	46%	3.6			
	5	1.7	1.1	0.6	55%	3.3			
	6	1.6	1	0.6	60%	3.2			
	7	0.8	0.7	0.1	14%	1			
	8	0.7	0.7	0	0%	0.8			
	9	0.8	0.8	0	0%	0.5			
WB	10	1.1	1.1	0	0%	1.9			
	11	1.1	1	0.1	10%	1.7			
	12	1.1	0.9	0.2	22%	1.7			
	13	1.5	1.3	0.2	15%	3.1			
	14	1.4	1.2	0.2	17%	3.1			
	15	1.3	1	0.3	30%	2.9			
	16	0.9	1.2	-0.3	-25%	1.7			
	17	1	1	0	0%	1.9			
	18	0.9	0.9	0	0%	2			
NB	19	1.5	2.1	-0.6	-29%	1.9			
	20	1.5	2	-0.5	-25%	1.8			
	21	1.5	1.9	-0.4	-21%	1.7			
	22	4	2.8	1.2	43%	6.2			
	23	3.7	3.6	0.1	3%	5.9			
	24	3.5	3.3	0.2	6%	5.8			
	25	0.8	3.2	-2.4	-75%	0.1			
	26	0.6	3.4	-2.8	-82%	0.2			
	27	0.7	3.5	-2.8	-80%	0.2			
EB	28	0.4	3.1	-2.7	-87%	0.2			
	29	0.3	3.1	-2.8	-90%	0.1			
	30	0.6	3.1	-2.5	-81%	0.1			
	31	8.5	7	1.5	21%	3.1			
	32	7.9	6.5	1.4	22%	4			
	33	7.3	5.6	1.7	30%	4.9			
	34	7	6.5	0.5	8%	2.5			
	35	6	5.2	0.8	15%	3.3			
	36	5	4.9	0.1	2%	3.9			

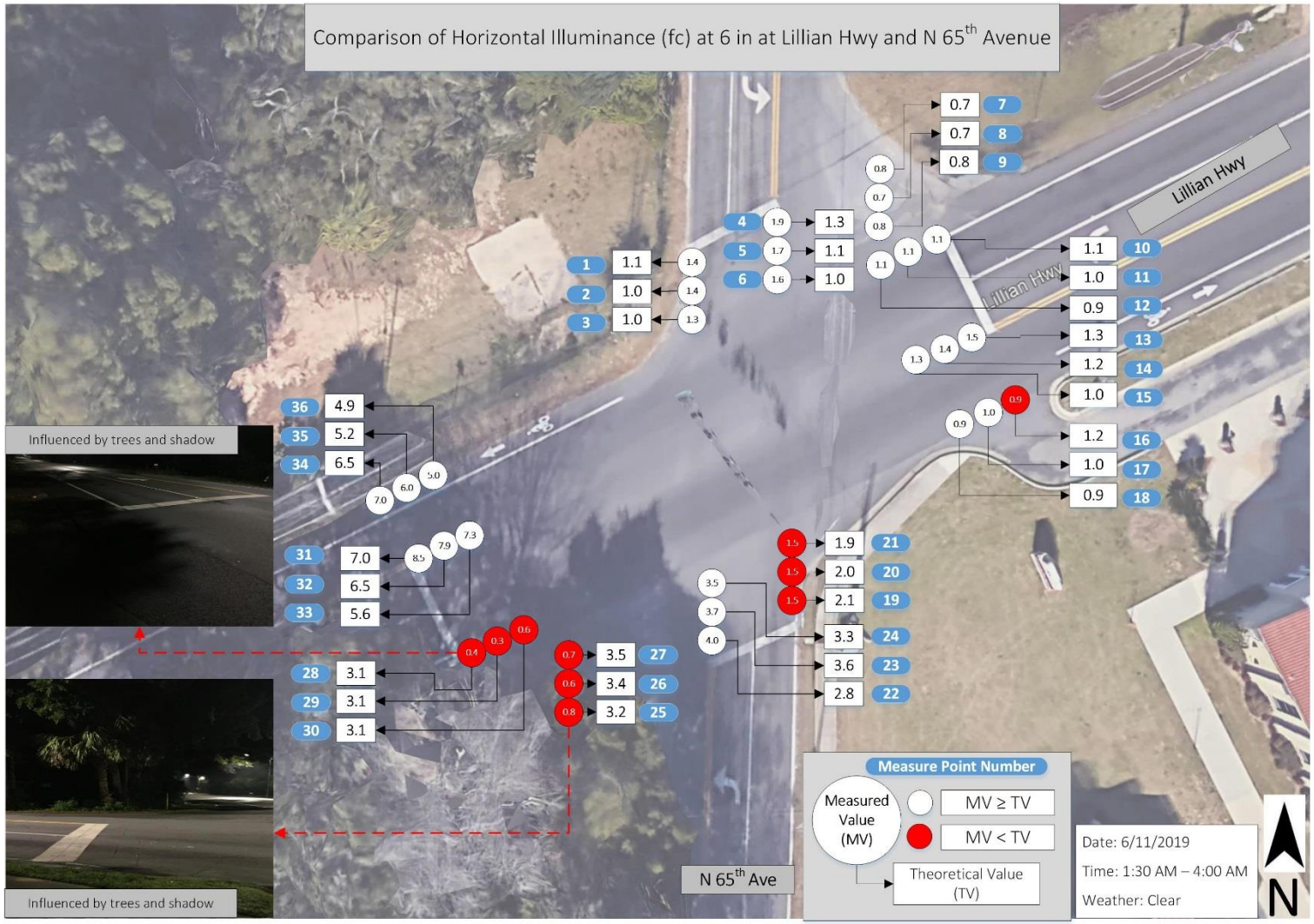

Figure 33. Comparison of Horizontal Illuminance at Lillian Hwy and N 65th Ave

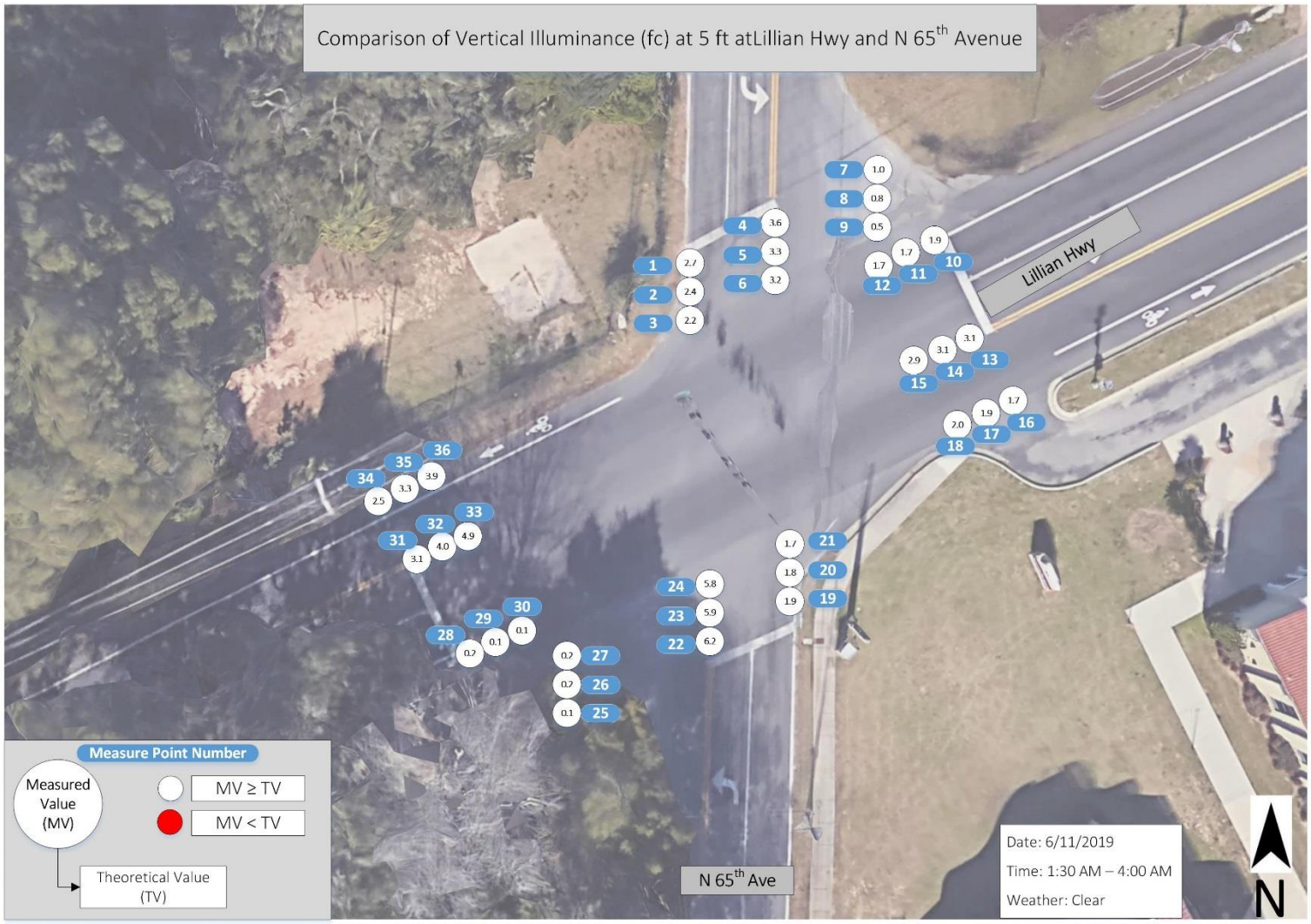

Figure 34. Comparison of Vertical Illuminance at Lillian Hwy and N 65th Ave

4.3.3 Lillian Hwy and N 69th Ave

The comparison of illuminance data is given in Table 45. Figure 35 and Figure 36 present the comparisons of horizontal and vertical illuminance, respectively, at Lillian Hwy and N 69th Ave. Based on the comparison, the following findings were obtained:

- Theoretical vertical data are unavailable.
- Most measured horizontal values on northbound and westbound are less than theoretical values

Table 45. Comparison of Illuminance Data for Lillian Hwy and N 69th Ave

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	4.6	4	0.6	15%	6.5			
	2	4.5	3.4	1.1	32%	6.2			
	3	4.4	3.2	1.2	38%	5.6			
	4	4.9	5.7	-0.8	-14%	7.3			
	5	4.7	4.9	-0.2	-4%	7.4			
	6	4.5	4.5	0	0%	7			
	7	2.7	2.7	0	0%	1.6			
	8	3.2	3.2	0	0%	1.5			
	9	3.9	3.8	0.1	3%	1.5			
WB	10	5.7	5	0.7	14%	6.7			
	11	5.3	4.8	0.5	10%	6.7			
	12	4.8	4.6	0.2	4%	6.2			
	13	4	4.3	-0.3	-7%	4.6			
	14	3.8	4.2	-0.4	-10%	4.9			
	15	3.5	4.1	-0.6	-15%	4.5			
	16	2.2	3.2	-1	-31%	2			
	17	2.1	3.3	-1.2	-36%	2.3			
	18	2.1	3.4	-1.3	-38%	2.3			
NB	19	2.6	3.2	-0.6	-19%	5.4			
	20	2.5	3.1	-0.6	-19%	4.5			
	21	2.7	3	-0.3	-10%	4			
	22	2.7	3.5	-0.8	-23%	4.4			
	23	2.7	3.2	-0.5	-16%	3.9			
	24	2.7	3	-0.3	-10%	3.4			
	25	1.3	1.6	-0.3	-19%	0.5			
	26	1.5	1.6	-0.1	-6%	0.5			
	27	1.7	1.6	0.1	6%	0.4			
EB	28	3	1.8	1.2	67%	3.8			
	29	3.1	1.7	1.4	82%	4			
	30	3.2	1.6	1.6	100%	3.7			
	31	4.5	2.1	2.4	114%	5.1			
	32	4.7	1.9	2.8	147%	4.8			
	33	4.9	1.8	3.1	172%	4.3			
	34	4.4	2.5	1.9	76%	2.4			
	35	4.8	2.2	2.6	118%	2.1			
	36	5.4	2	3.4	170%	1.8			

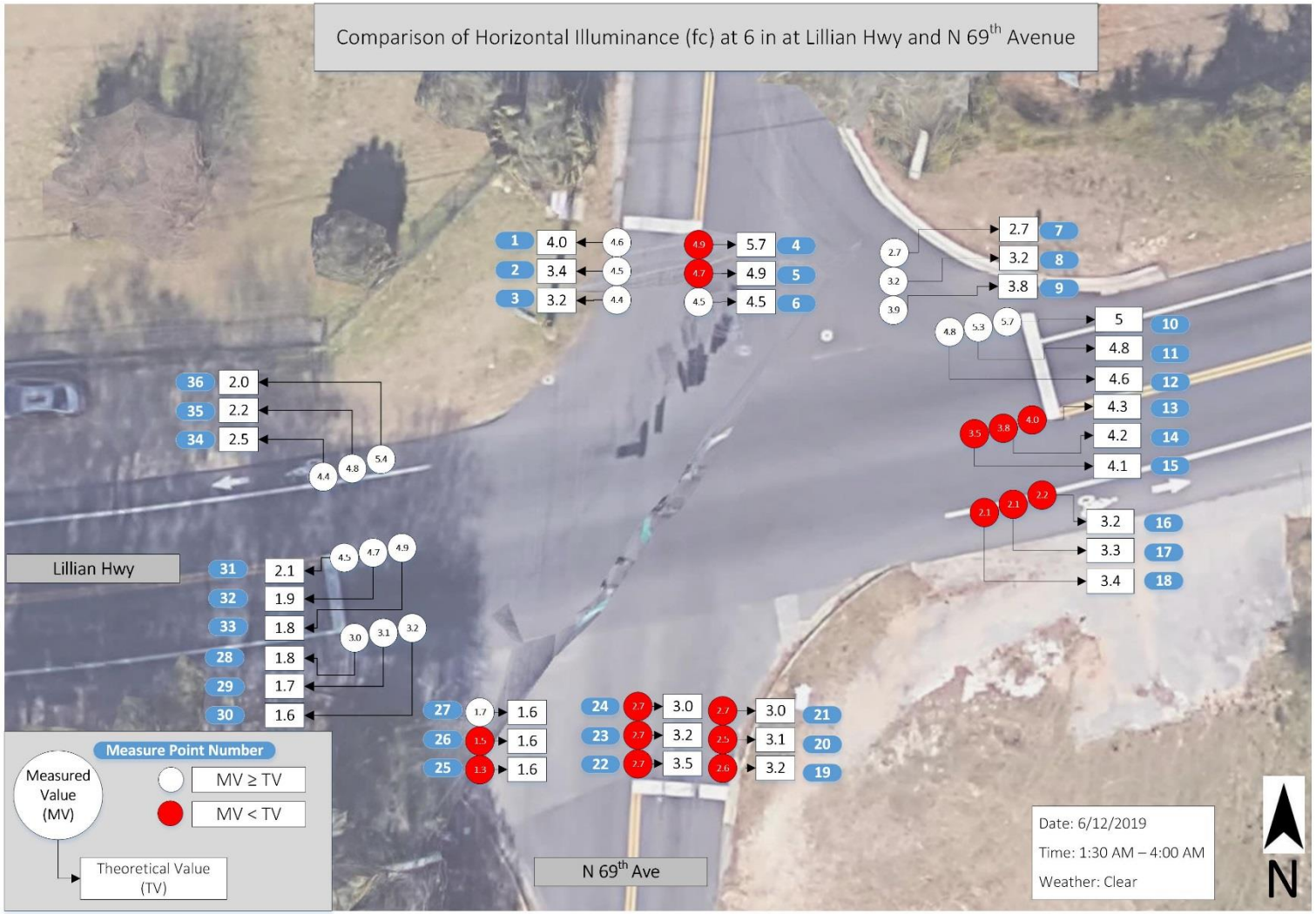

Figure 35. Comparison of Horizontal Illuminance at Lillian Hwy and N 69th Ave

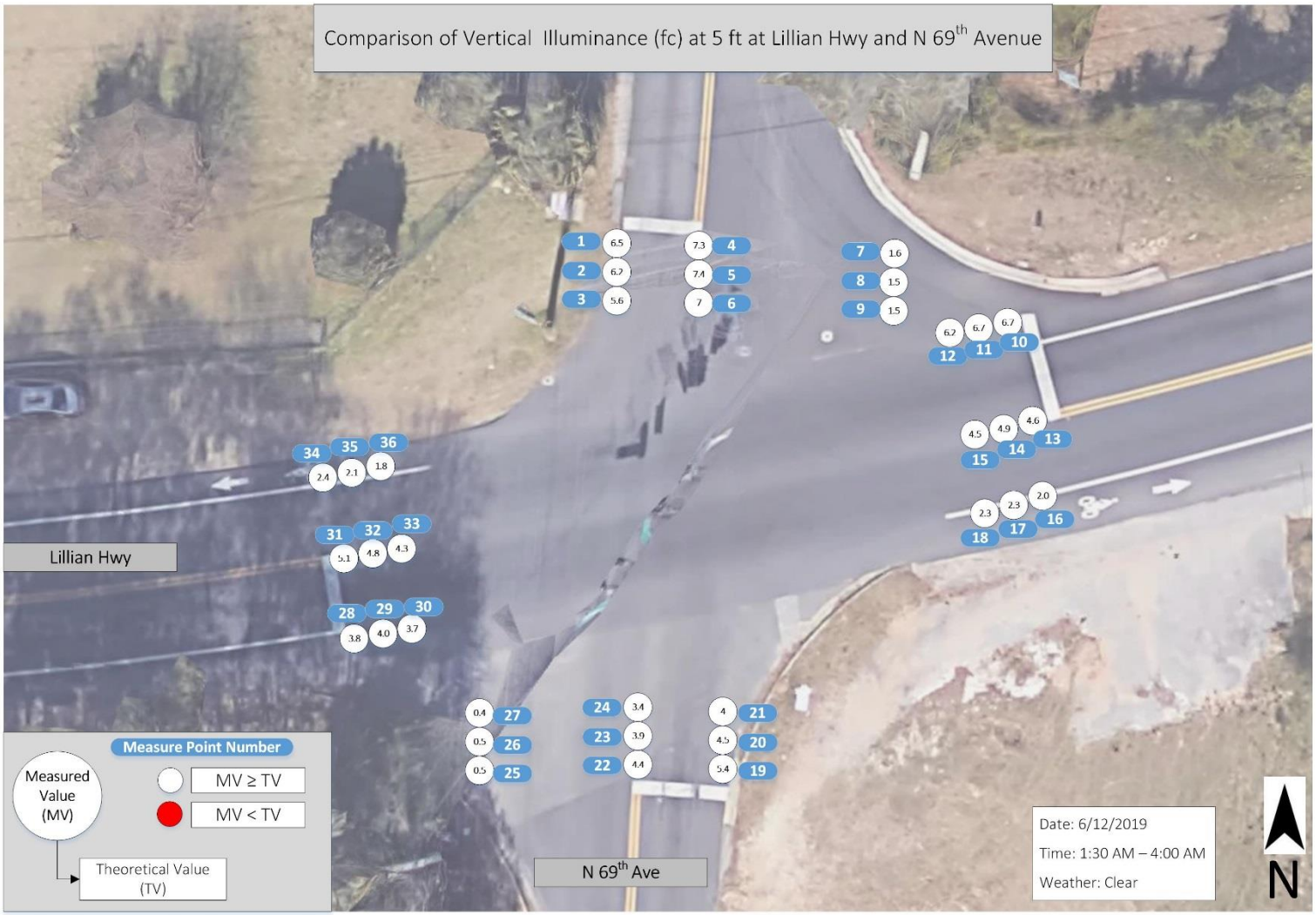

Figure 36. Comparison of Vertical Illuminance at Lillian Hwy and N 69th Ave

4.4 Data Collection in District 4

4.4.1 Commercial Blvd and 6th Ave

The comparison of illuminance data is given in Table 46. Figure 37 and Figure 38 present the comparisons of horizontal and vertical illuminance, respectively, at Commercial Blvd and 6th Ave.

Table 46. Comparison of Illuminance Data for Commercial Blvd and 6th Ave

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	0.6	2.3	-1.7	-74%	0.3			
	2	0.7	2.2	-1.5	-68%	0.5	2.2	-1.7	-77%
	3	0.7	2.2	-1.5	-68%	0.6			
	4	0.7	2.5	-1.8	-72%	0.5			
	5	0.7	2.6	-1.9	-73%	0.5	2.3	-1.8	-78%
	6	0.7	2.6	-1.9	-73%	0.5			
	7	1.4	0.7	0.7	100%	0.7			
	8	1.2	0.8	0.4	50%	0.6			
	9	1.2	0.8	0.4	50%	0.8			
WB	10	1.6	2.6	-1.0	-38%	1.2			
	11	1.4	2.4	-1.0	-42%	1.0	1.9	-0.9	-47%
	12	1.4	2.2	-0.8	-36%	1.3			
	13	2.0	2.5	-0.5	-20%	2.0			
	14	1.8	2.4	-0.6	-25%	1.8	1.8	0	0%
	15	1.7	2.3	-0.6	-26%	1.7			
	16	0.8	0.7	0.1	14%	0.9			
	17	0.7	0.7	0.0	0%	0.7			
	18	0.7	0.7	0.0	0%	0.6			
NB	19	0.4	1.6	-1.2	-75%	0.5			
	20	0.4	1.2	-0.8	-67%	0.4	1.2	-0.8	-67%
	21	0.4	1.0	-0.6	-60%	0.4			
	22	0.5	1.8	-1.3	-72%	0.5			
	23	0.6	1.8	-1.2	-67%	0.5	1.2	-0.7	-58%
	24	0.6	1.7	-1.1	-65%	0.7			
	25	0.9	0.5	0.4	80%	1.7			
	26	0.9	0.5	0.4	80%	1.6			
	27	0.7	0.6	0.1	17%	1.3			
EB	28	1.5	0.8	0.7	88%	2.2			
	29	1.4	0.7	0.7	100%	2.1	0.8	1.3	163%
	30	1.2	0.7	0.5	71%	1.8			
	31	1.6	2.5	-0.9	-36%	1.2			
	32	1.5	2.3	-0.8	-35%	1.2	2.3	-1.1	-48%
	33	1.3	2.2	-0.9	-41%	1.3			
	34	1.5	1.7	-0.2	-12%	1.0			
	35	1.4	1.5	-0.1	-7%	1.0			
	36	1.2	1.4	-0.2	-14%	1.0			

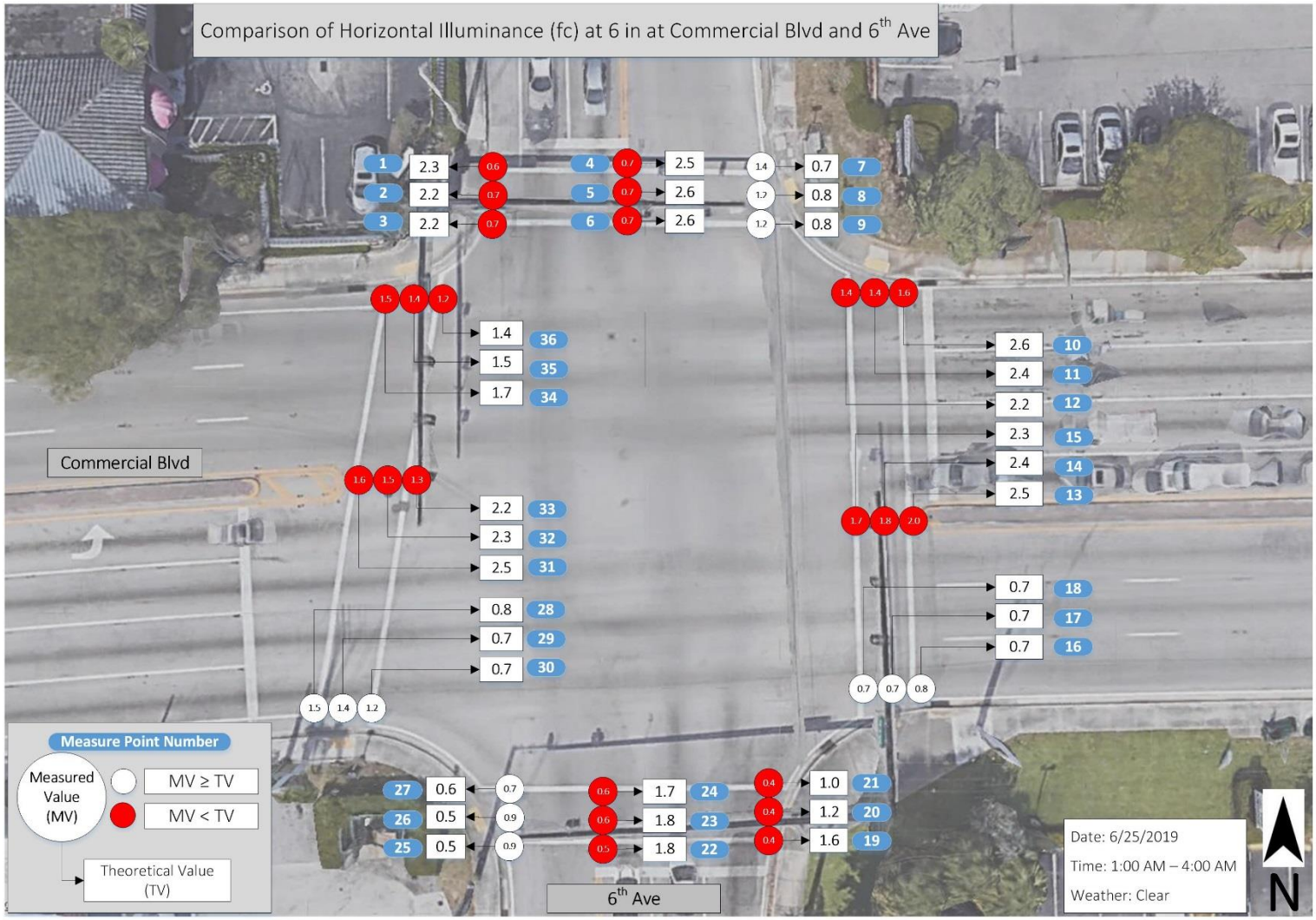

Figure 37. Comparison of Horizontal Illuminance at Commercial Blvd and 6th Ave

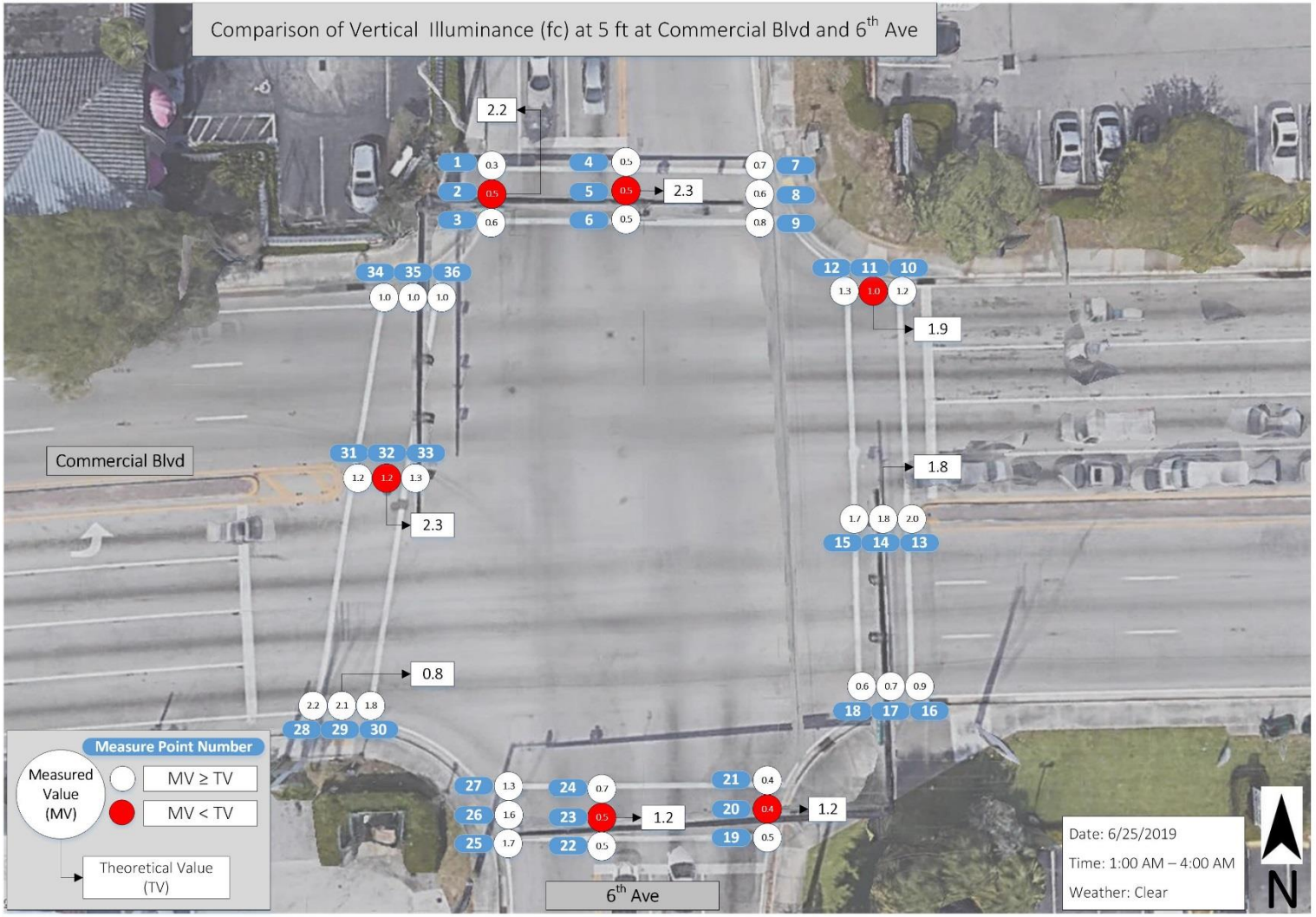

Figure 38. Comparison of Vertical Illuminance at Commercial Blvd and 6th Ave

4.4.2 Glades Rd and SR-7

The comparison of illuminance data is given in Table 47. Figure 39 and Figure 40 present the comparisons of horizontal and vertical illuminance, respectively, at Glades Rd and SR-7. Based on the comparison, the following findings were obtained:

- Most measure points experience measured horizontal illuminance lower than theoretical values.
- The streetlight on northbound is not working.
- Theoretical vertical values are unavailable on southbound and northbound.

Table 47. Comparison of Illuminance Data for Glades Rd and SR-7

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	2.5	7.5	-5.0	-67%	2.6			
	2	2.3	6.6	-4.3	-65%	2.4			
	3	2.2	6.2	-4.0	-65%	2.1			
	4	3.9	4.4	-0.5	-11%	2.4			
	5	3.8	4.5	-0.7	-16%	3.1			
	6	2.1	4.6	-2.5	-54%	1.5			
	7	8.6	8.8	-0.2	-2%	3.7			
	8	5.0	8.7	-3.7	-43%	1.8			
	9	7.6	9.1	-1.5	-16%	4.6			
WB	10	9.4	10.2	-0.8	-8%	3.8			
	11	8.6	9.3	-0.7	-8%	4.0	0.8	3.2	400%
	12	8.0	8.5	-0.5	-6%	5.0			
	13	1.4	3.2	-1.8	-56%	1.1			
	14	1.4	3.3	-1.9	-58%	1.0	2.4	-1.4	-58%
	15	1.5	3.3	-1.8	-55%	1.2			
	16	1.1	4.5	-3.4	-76%	1.1			
	17	0.8	4.9	-4.1	-84%	1.0			
	18	0.8	5.0	-4.2	-84%	0.9			
NB	19	2.4	4.8	-2.4	-50%	3.2			
	20	2.0	5.0	-3.0	-60%	2.8			
	21	1.7	5.3	-3.6	-68%	2.6			
	22	2.6	3.7	-1.1	-30%	2.1			
	23	2.5	3.8	-1.3	-34%	2.6			
	24	2.4	3.8	-1.4	-37%	2.9			
	25	5.2	6.1	-0.9	-15%	4.4			
	26	4.5	6.2	-1.7	-27%	4.5			
	27	3.4	6.7	-3.3	-49%	3.2			
EB	28	6.2	6.8	-0.6	-9%	3.6			
	29	5.2	6.7	-1.5	-22%	3.9	1.9	2	105%
	30	4.6	6.5	-1.9	-29%	4.2			
	31	2.1	2.8	-0.7	-25%	2.2			
	32	2.3	2.8	-0.5	-18%	2.5	1.8	0.7	39%
	33	2.2	2.8	-0.6	-21%	2.5			
	34	5.7	4.9	0.8	16%	2.5			
	35	4.9	4.7	0.2	4%	3.6			
	36	4.6	4.3	0.3	7%	4.2			

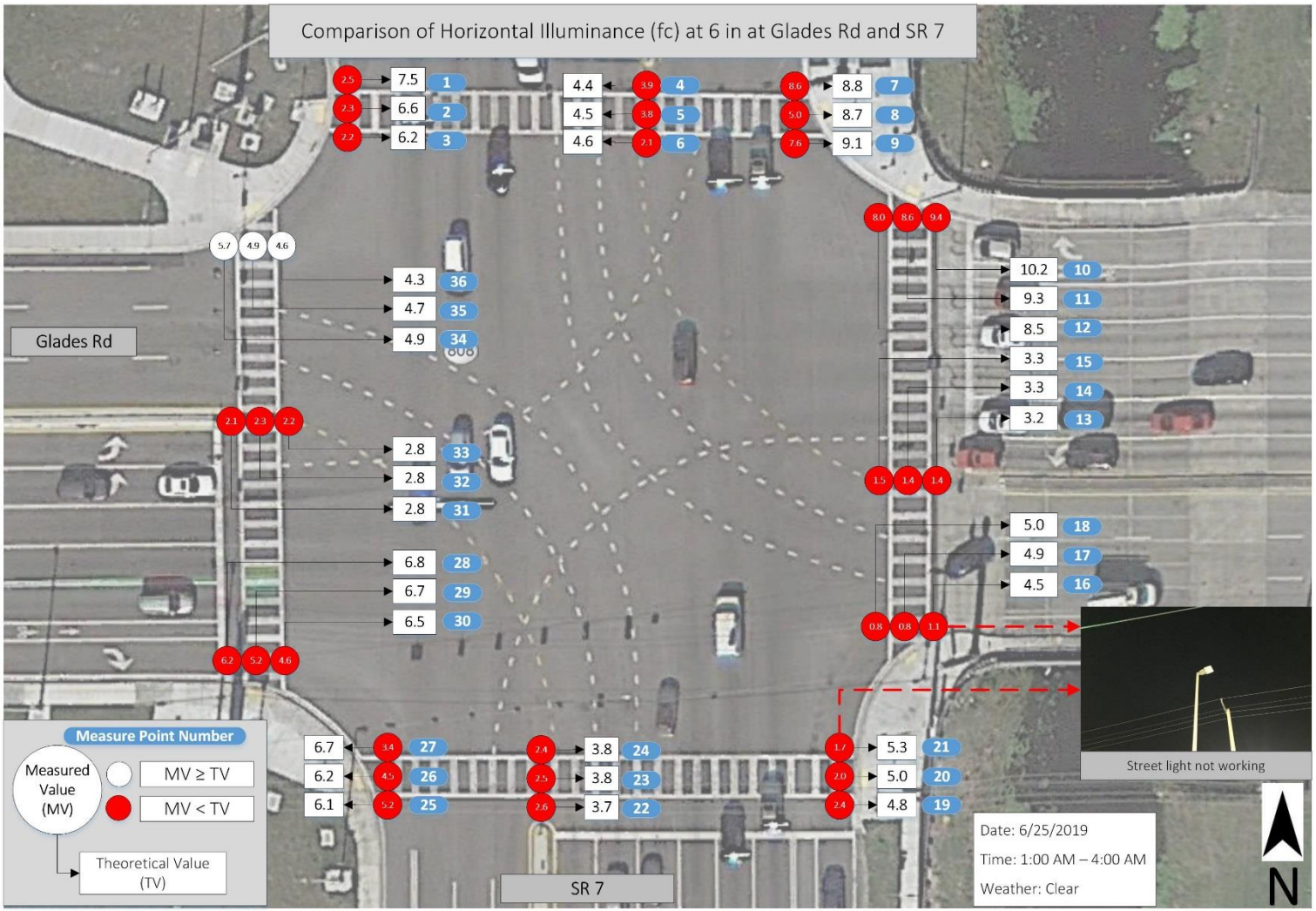

Figure 39. Comparison of Horizontal Illuminance at Glades Rd and SR-7

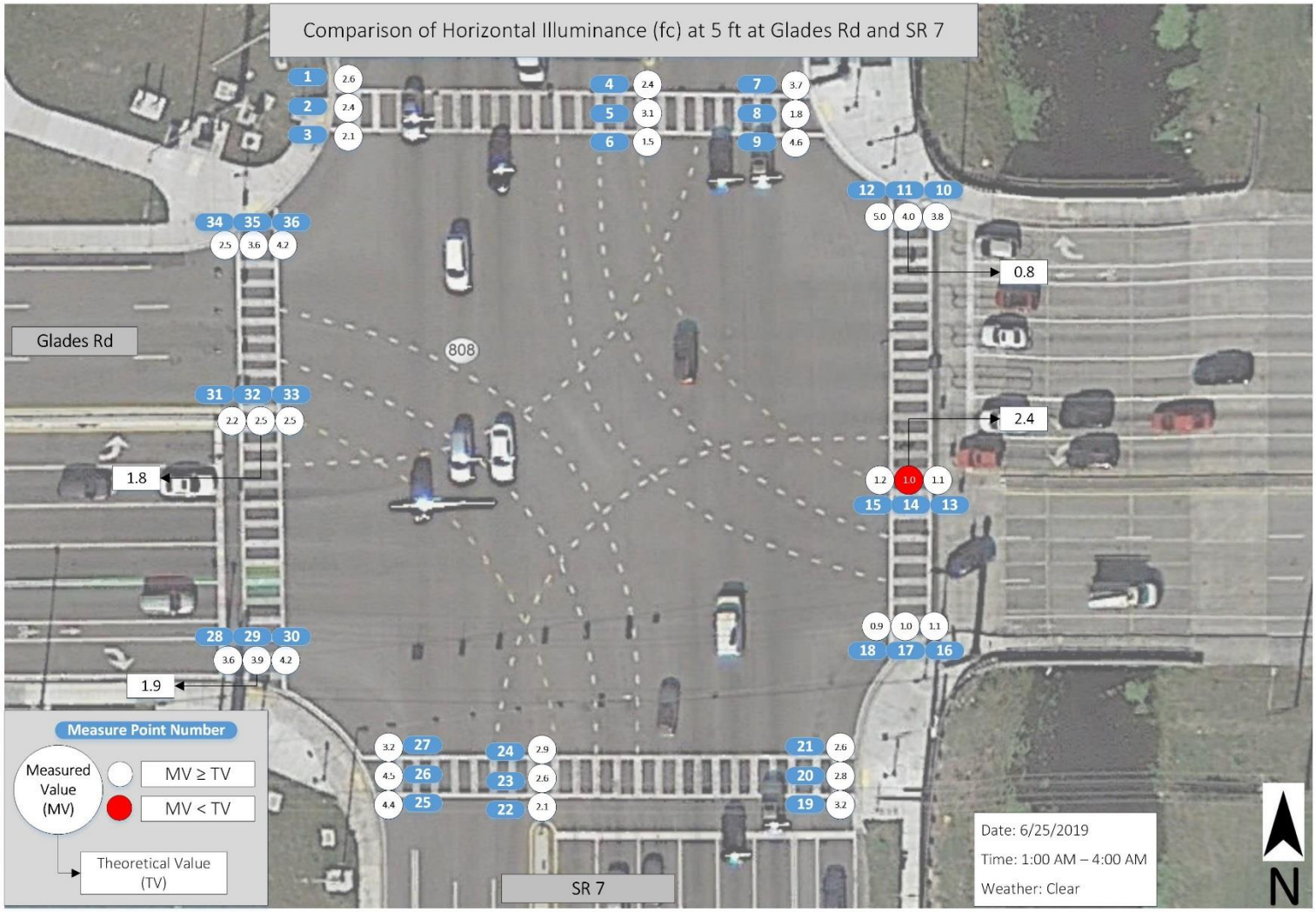

Figure 40. Comparison of Vertical Illuminance at Glades Rd and SR-7

4.4.3 Sunrise Blvd and Sunset Strip

The comparison of illuminance data is given in Table 48. Figure 41 and Figure 42 present the comparisons of horizontal and vertical illuminance, respectively, at Sunrise Blvd and Sunset Strip. Based on the comparison, the following findings were obtained:

- Two streetlights are not working (westbound and eastbound).
- All measure points experience measured horizontal illuminance lower than theoretical values.
- Theoretical vertical values are unavailable.

Table 48. Comparison of Illuminance Data for Sunrise Blvd and Sunset Strip

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	1.4	1.5	-0.1	-7%	1.6			
	2	1.1	1.5	-0.4	-27%	1.4			
	3	1.0	1.6	-0.6	-38%	1.3			
	4	1.8	2.4	-0.6	-25%	1.9			
	5	1.7	2.4	-0.7	-29%	2.0			
	6	1.8	2.4	-0.6	-25%	2.5			
	7	2.5	2.7	-0.2	-7%	2.2			
	8	2.1	2.7	-0.6	-22%	2.1			
	9	1.8	2.8	-1.0	-36%	2.1			
WB	10	0.6	1.6	-1.0	-63%	1.0			
	11	0.8	1.6	-0.8	-50%	1.0			
	12	0.9	1.5	-0.6	-40%	1.0			
	13	0.5	1.6	-1.1	-69%	1.0			
	14	0.5	1.5	-1.0	-67%	1.0			
	15	0.5	1.5	-1.0	-67%	1.0			
	16	0.4	0.9	-0.5	-56%	0.7			
	17	0.4	0.9	-0.5	-56%	0.7			
	18	0.4	0.8	-0.4	-50%	0.7			
EB	28	0.3	0.8	-0.5	-63%	0.2			
	29	0.3	0.8	-0.5	-63%	0.2			
	30	0.3	0.8	-0.5	-63%	0.2			
	31	0.4	1.8	-1.4	-78%	0.2			
	32	0.4	1.8	-1.4	-78%	0.2			
	33	0.4	1.8	-1.4	-78%	0.2			
	34	0.5	1.6	-1.1	-69%	0.3			
	35	0.5	1.5	-1.0	-67%	0.2			
	36	0.5	1.5	-1.0	-67%	0.2			

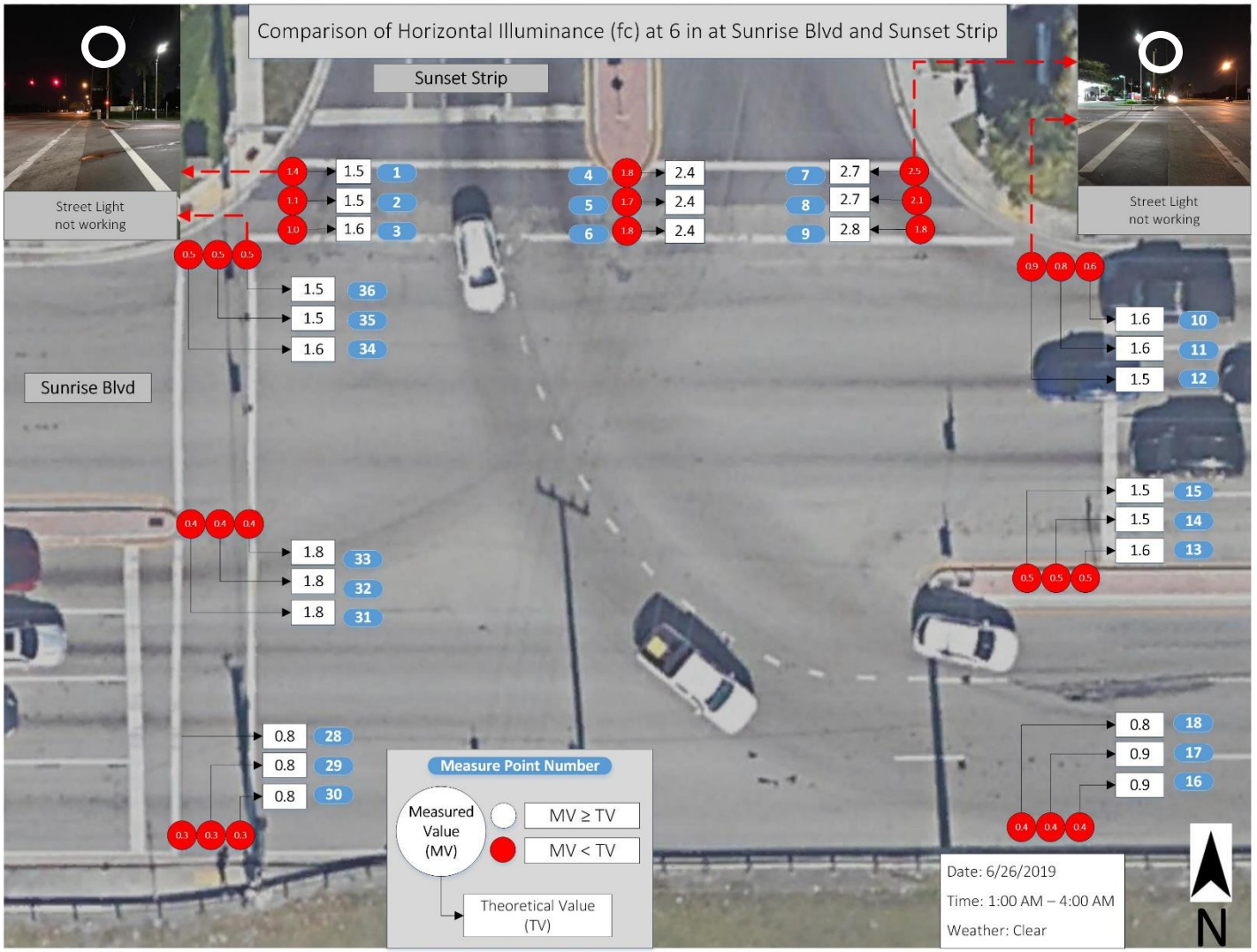

Figure 41. Comparison of Horizontal Illuminance at Sunrise Blvd and Sunset Strip

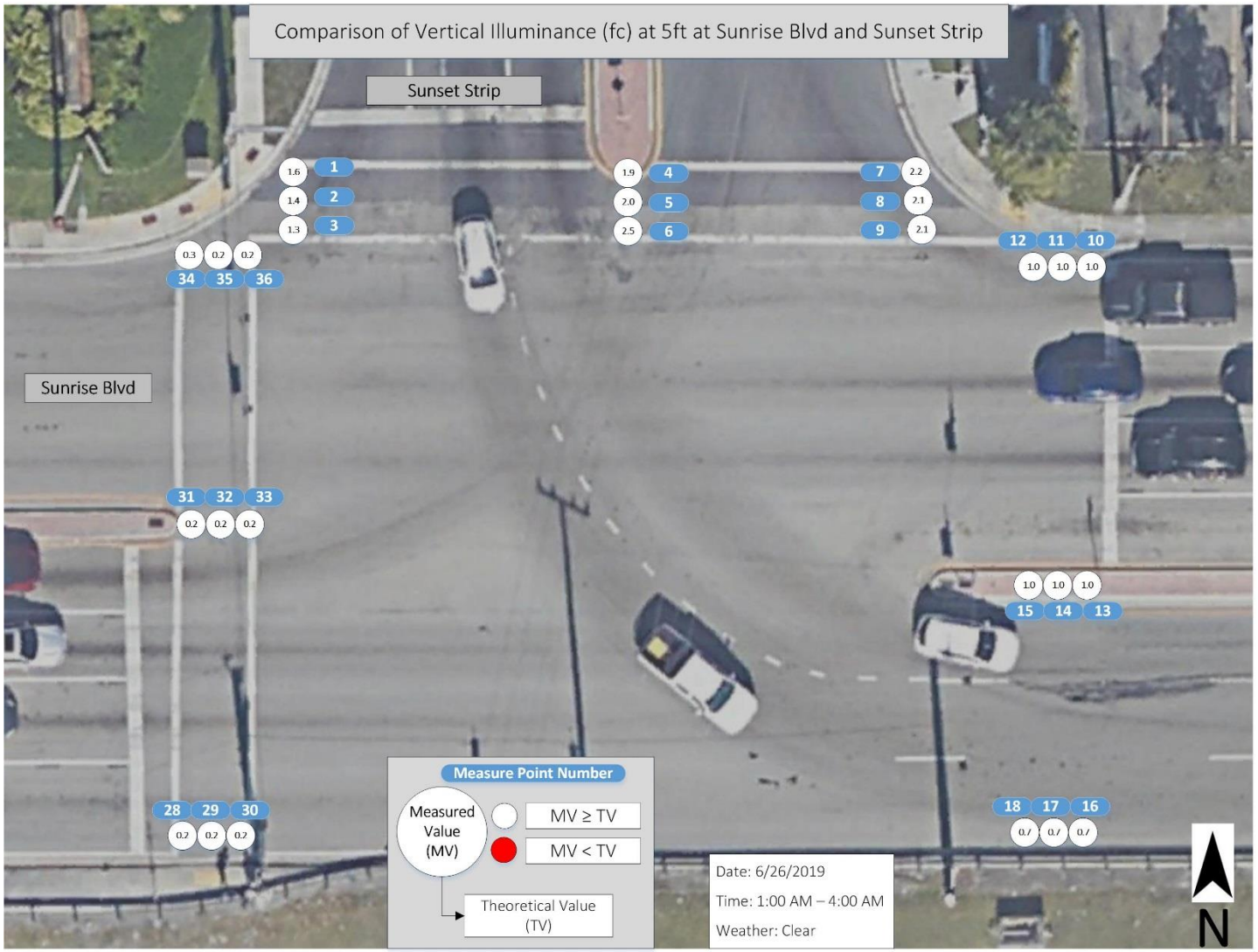

Figure 42. Comparison of Vertical Illuminance at Sunrise Blvd and Sunset Strip

4.4.4 Sunset Strip and University Dr

The comparison of illuminance data is given in Table 49. Figure 43 and Figure 44 present the comparisons of horizontal and vertical illuminance, respectively, at Sunset Strip and University Dr. Based on the comparison and field observation, the following findings were obtained:

- Except eastbound, all approaches experience measured horizontal illuminance lower than theoretical values.
- Trees and shadows influence the measured horizontal values on westbound.
- A streetlight on northbound is not working.
- Theoretical vertical values are unavailable.

Table 49. Comparison of Illuminance Data for Sunset Strip and University Dr

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	3.2	4.9	-1.7	-35%	1.2			
	2	2.8	4.3	-1.5	-35%	1.5			
	3	2.6	4.3	-1.7	-40%	1.9			
	4	2.5	2.9	-0.4	-14%	0.9			
	5	2.4	2.8	-0.4	-14%	0.9			
	6	2.3	2.8	-0.5	-18%	1.2			
	7	1.9	2.8	-0.9	-32%	0.6			
	8	2.2	2.7	-0.5	-19%	1.1			
	9	2.2	2.7	-0.5	-19%	1.4			
WB	10	0.6	5.0	-4.4	-88%	0.2			
	11	0.6	4.1	-3.5	-85%	0.1			
	12	0.8	3.3	-2.5	-76%	0.2			
	13	0.4	1.8	-1.4	-78%	0.2			
	14	0.6	1.6	-1.0	-63%	0.2			
	15	0.5	1.6	-1.1	-69%	0.2			
	16	0.3	1.1	-0.8	-73%	0.2			
	17	0.4	1.0	-0.6	-60%	0.2			
	18	0.5	0.9	-0.4	-44%	0.2			
NB	19	1.7	2.5	-0.8	-32%	1.0			
	20	1.4	2.3	-0.9	-39%	1.6			
	21	0.6	2.4	-1.8	-75%	0.6			
	22	1.2	2.1	-0.9	-43%	1.2			
	23	1.2	2.1	-0.9	-43%	1.2			
	24	1.2	2.2	-1.0	-45%	1.2			
	25	0.6	3.0	-2.4	-80%	0.7			
	26	0.7	3.1	-2.4	-77%	0.7			
	27	0.6	3.2	-2.6	-81%	0.7			
EB	28	1.3	1.1	0.2	18%	1.8			
	29	1.1	1.0	0.1	10%	1.9			
	30	1.0	0.9	0.1	11%	1.6			
	31	1.1	0.8	0.3	38%	1.4			
	32	1.0	0.8	0.2	25%	1.3			
	33	1.1	0.9	0.2	22%	1.3			
	34	0.5	0.5	0.0	0%	0.7			
	35	0.8	0.7	0.1	14%	0.6			
	36	0.9	0.9	0.0	0%	0.6			

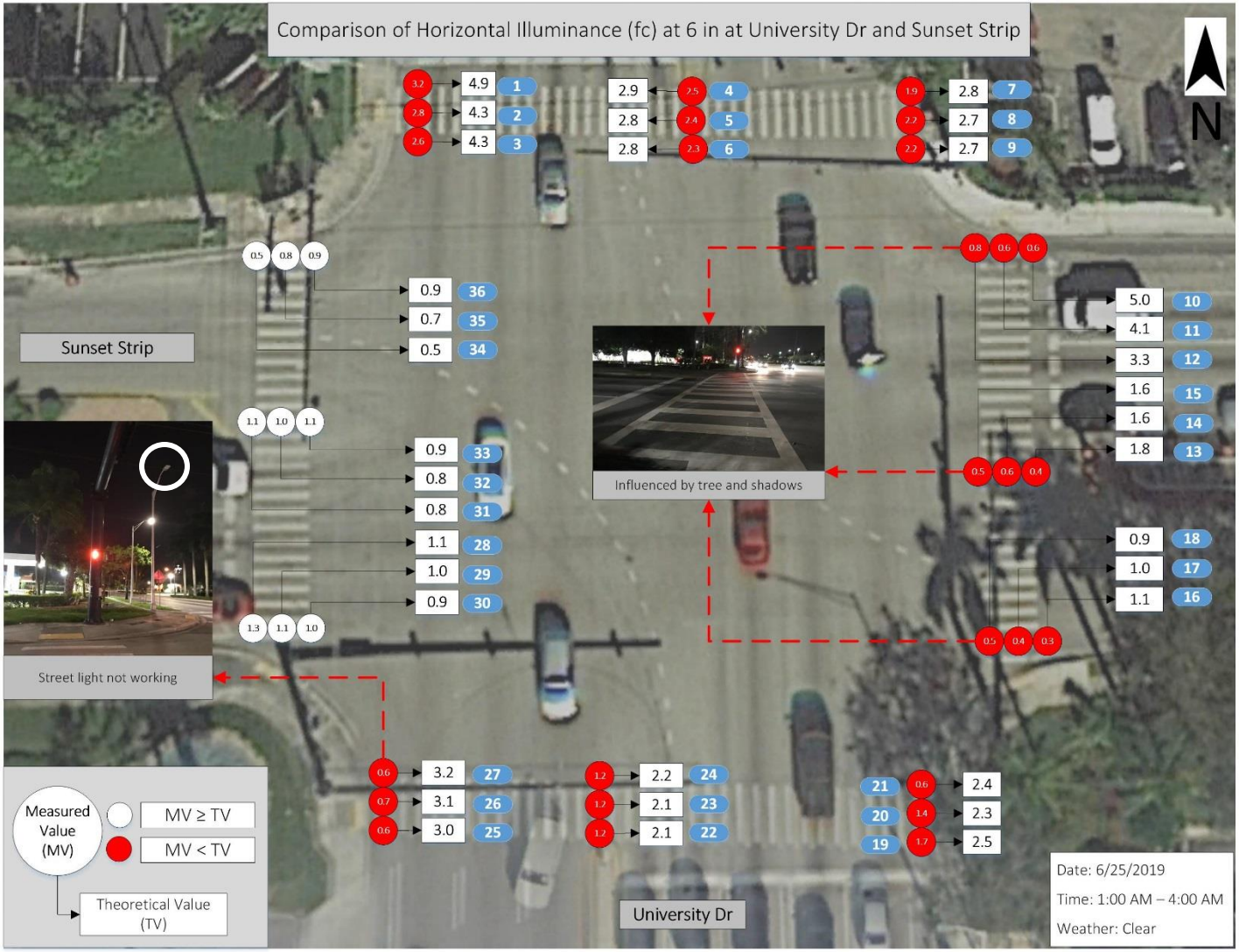

Figure 43. Comparison of Horizontal Illuminance at Sunset Strip and University Dr

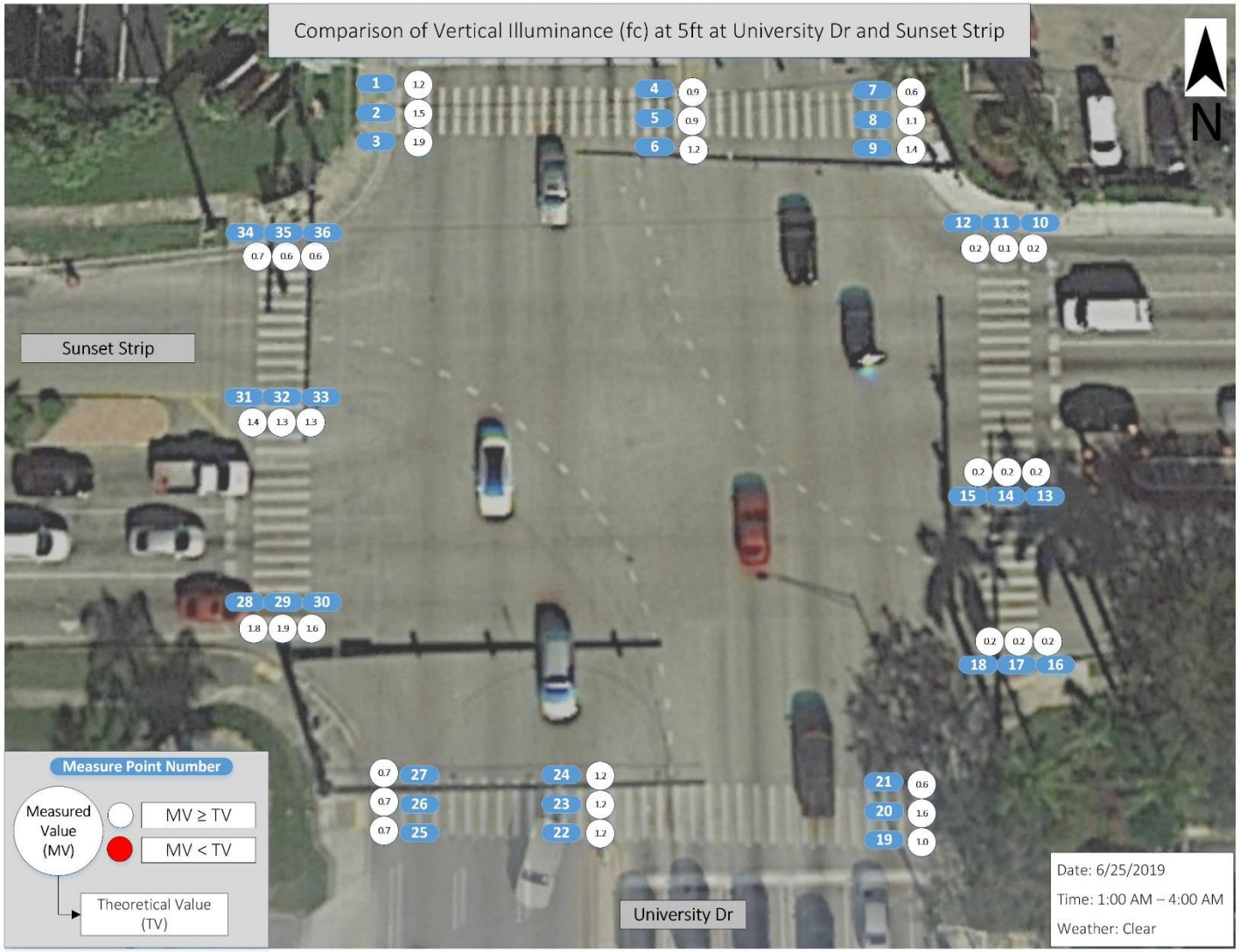

Figure 44. Comparison of Vertical Illuminance at Sunset Strip and University Dr

4.5 Data Collection in District 6

4.5.1 1st St and 22nd Ave

The comparison of illuminance data is given in Table 50. Figure 45 and Figure 46 present the comparisons of horizontal and vertical illuminance, respectively, at 1st St and 22nd Ave. Based on the comparison, the following findings were obtained:

- Most measure points on northbound and southbound experience measured horizontal illuminance lower than theoretical values.
- A streetlight on westbound is not working.
- Theoretical horizontal values are the average values for each approach since the only average, maximum, and minimum values are available in design files.

Table 50. Comparison of Illuminance Data for 1st St and 22nd Ave

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	8.0	2.4	5.6	233%	1.8			
	2	7.8	2.4	5.4	225%	2.6	1.8	0.8	44%
	3	8.1	2.4	5.7	238%	3.6			
	4	2.7	2.4	0.3	13%	2.1			
	5	2.8	2.4	0.4	17%	2.0	2.8	-0.8	-29%
	6	3.0	2.4	0.6	25%	2.5			
	7	0.8	2.4	-1.6	-67%	1.0			
	8	0.9	2.4	-1.5	-63%	0.9			
	9	1.0	2.4	-1.4	-58%	0.9			
WB	10	1.8	2.9	-1.1	-38%	0.7			
	11	1.9	2.9	-1.0	-34%	0.8			
	12	1.8	2.9	-1.1	-38%	1.2			
	13	3.4	2.9	0.5	17%	0.8			
	14	3.6	2.9	0.7	24%	1.4			
	15	3.7	2.9	0.8	28%	1.4			
	16	4.3	2.9	1.4	48%	1.8			
	17	4.4	2.9	1.5	52%	2.1			
	18	4.2	2.9	1.3	45%	2.2			
NB	19	4.4	4.2	0.2	5%	6.9			
	20	3.2	4.2	-1.0	-24%	5.7	2.6	3.1	119%
	21	3.4	4.2	-0.8	-19%	5.4			
	22	2.6	4.2	-1.6	-38%	4.8			
	23	2.5	4.2	-1.7	-40%	5.0	3.5	1.5	43%
	24	2.4	4.2	-1.8	-43%	4.9			
	25	0.6	4.2	-3.6	-86%	0.5			
	26	0.9	4.2	-3.3	-79%	0.8			
	27	1.0	4.2	-3.2	-76%	1.1			
EB	28	0.9	2.7	-1.8	-67%	0.2			
	29	1.0	2.7	-1.7	-63%	0.2	1.8	-1.6	-89%
	30	1.2	2.7	-1.5	-56%	0.3			
	31	2.7	2.7	0.0	0%	0.8			
	32	3.0	2.7	0.3	11%	0.6	3.6	-3	-83%
	33	3.4	2.7	0.7	26%	0.5			
	34	2.7	2.7	0.0	0%	0.8			
	35	3.5	2.7	0.8	30%	0.7	1.6	-0.9	-56%
	36	4.6	2.7	1.9	70%	0.7			

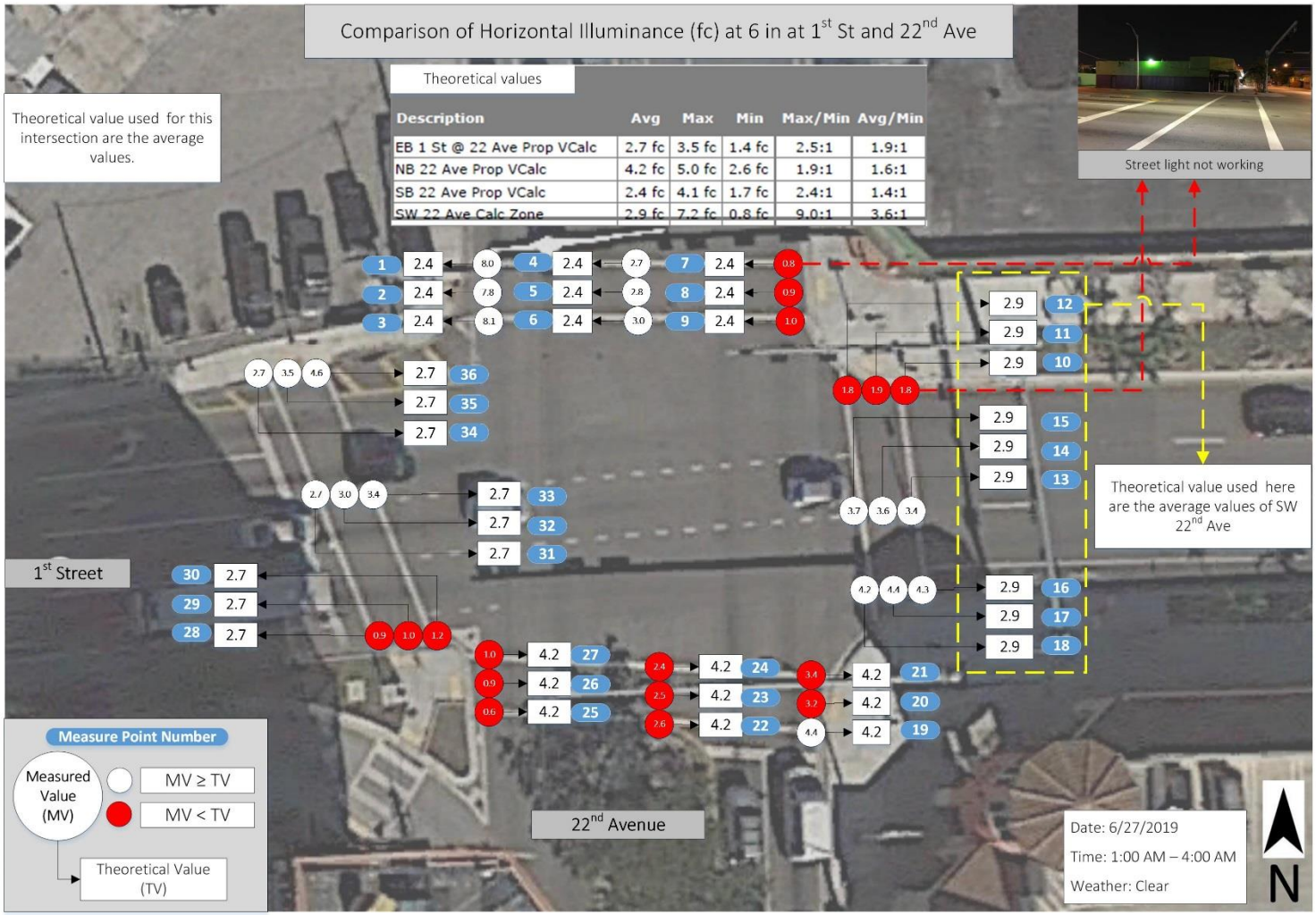

Figure 45. Comparison of Horizontal Illuminance at 1st St and 22nd Ave

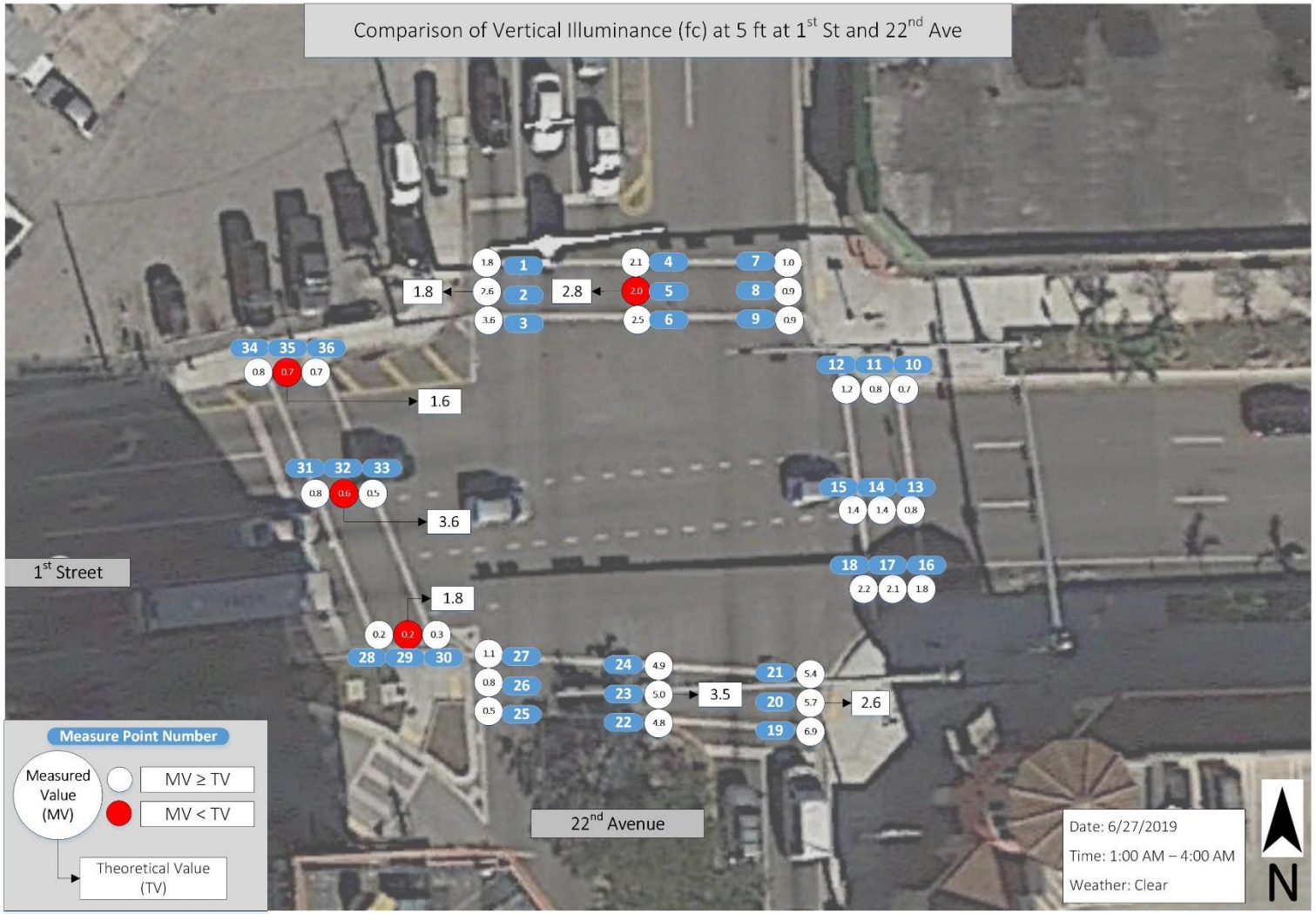

Figure 46. Comparison of Vertical Illuminance at 1st St and 22nd Ave

4.5.2 SW 8th Ave and SW 6th St

The comparison of illuminance data is given in Table 51. Figure 47 and Figure 48 present the comparisons of horizontal and vertical illuminance, respectively, at SW 8th Ave and SW 6th St.

Table 51. Comparison of Illuminance Data for SW 8th Ave and SW 6th St

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	2.0	2.7	-0.7	-26%	4.1			
	2	1.9	3.1	-1.2	-39%	3.7	1.7	2	118%
	3	1.7	3.8	-2.1	-55%	3.4			
	4	1.8	2.9	-1.1	-38%	3.4			
	5	1.6	3.2	-1.6	-50%	3.1	1.8	1.3	72%
	6	1.5	3.8	-2.3	-61%	2.8			
	7	1.1	2.5	-1.4	-56%	1.9			
	8	1.0	2.9	-1.9	-66%	1.8			
	9	0.9	3.6	-2.7	-75%	1.5			
WB	10	0.4	3.5	-3.1	-89%	0.3			
	11	0.7	3.6	-2.9	-81%	0.3	1.8	-1.5	-83%
	12	0.9	3.7	-2.8	-76%	0.2			
	13	0.6	4.0	-3.4	-85%	0.4			
	14	0.7	4.2	-3.5	-83%	0.2	2.2	-2	-91%
	15	0.8	4.2	-3.4	-81%	0.2			
	16	0.5	3.5	-3.0	-86%	0.5			
	17	0.6	3.8	-3.2	-84%	0.4	2.5	-2.1	-84%
	18	0.8	3.8	-3.0	-79%	0.4			
NB	19	0.3	2.8	-2.5	-89%	0.3			
	20	0.5	3.0	-2.5	-83%	0.3	1.4	-1.1	-79%
	21	0.5	3.2	-2.7	-84%	0.6			
	22	2.3	2.8	-0.5	-18%	3.8			
	23	2.1	2.8	-0.7	-25%	3.4	1.1	2.3	209%
	24	1.9	3.1	-1.2	-39%	3.2			
	25	2.6	2.5	0.1	4%	3.4			
	26	2.6	2.6	0.0	0%	3.6			
	27	2.6	2.9	-0.3	-10%	3.3			
EB	28	2.7	3.4	-0.7	-21%	3.4			
	29	3.2	3.6	-0.4	-11%	3.1			
	30	2.8	3.7	-0.9	-24%	2.6			
	31	2.4	5.1	-2.7	-53%	2.3			
	32	2.2	4.8	-2.6	-54%	2.0			
	33	2.1	4.6	-2.5	-54%	1.8			
	34	1.8	4.3	-2.5	-58%	1.2			
	35	1.7	4.6	-2.9	-63%	1.0			
	36	1.7	4.6	-2.9	-63%	1.1			

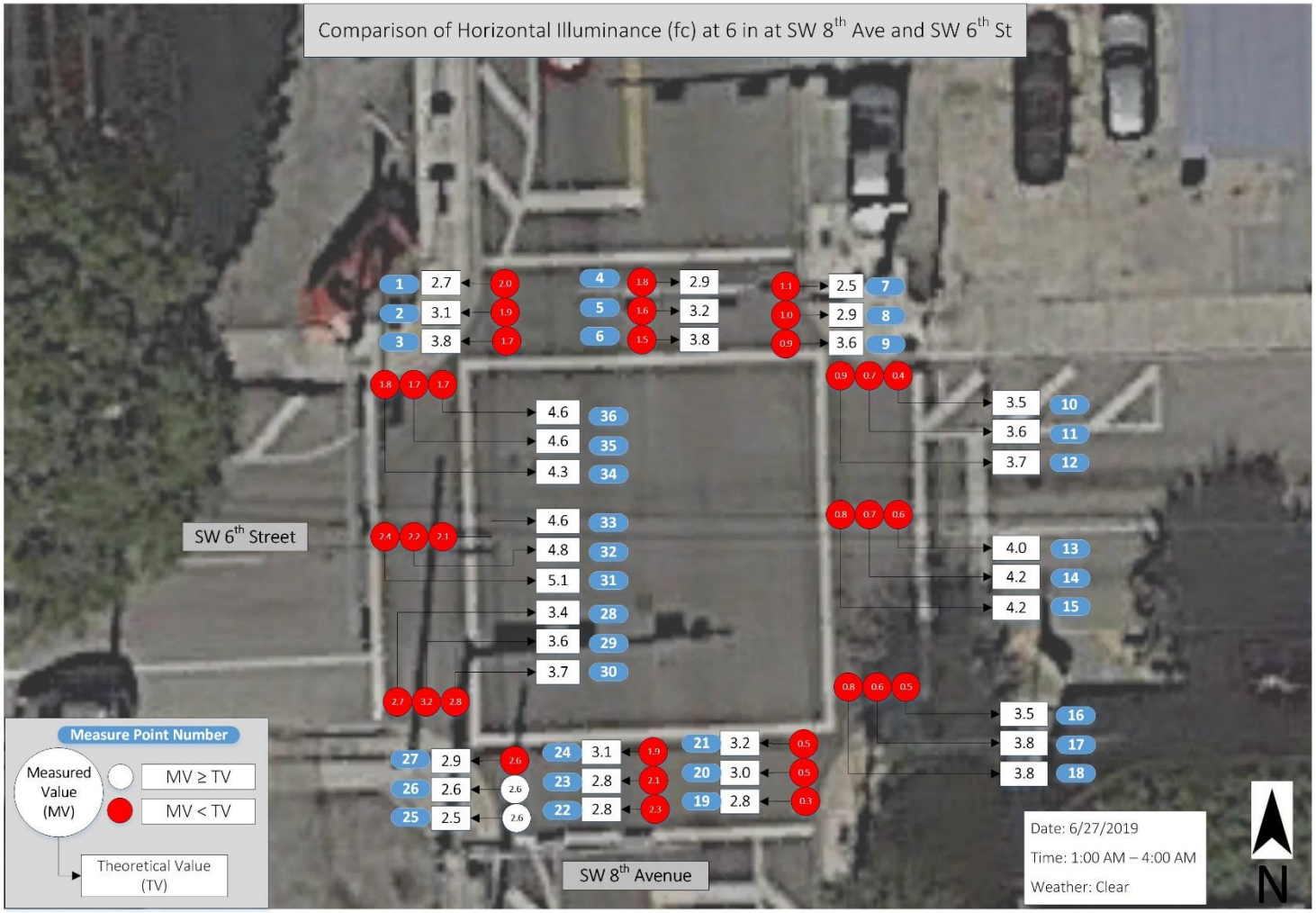

Figure 47. Comparison of Horizontal Illuminance at SW 8th Ave and SW 6th St

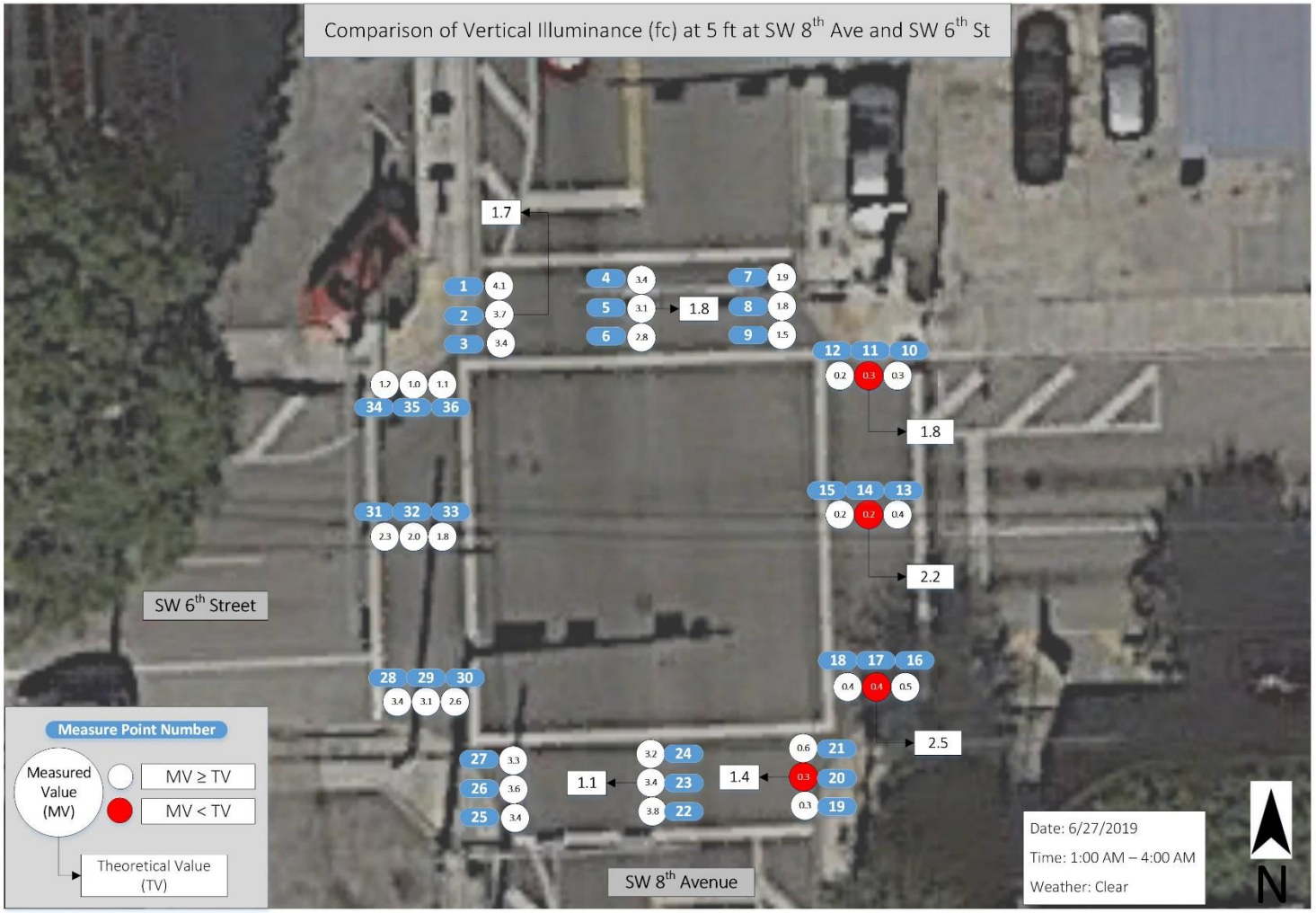

Figure 48. Comparison of Vertical Illuminance at SW 8th Ave and SW 6th St

4.5.3 NW 17th St and NW 27th Ave

The comparison of illuminance data is given in Table 52. Figure 49 and Figure 50 present the comparisons of horizontal and vertical illuminance, respectively, at NW 17th St and NW 27th Ave. Based on the comparison, the following findings were obtained:

- Shadows influence measured horizontal values on eastbound.
- Most measure points on southbound experience measured horizontal illuminance lower than theoretical values.
- Theoretical vertical values are unavailable.
- The theoretical horizontal values are the average values since only average, maximum, and minimum values are available in design files.

Table 52. Comparison of Illuminance Data for NW 17th St and NW 27th Ave

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	2.1	2.5	-0.4	-16%	0.5			
	2	1.9	2.5	-0.6	-24%	0.6			
	3	1.9	2.5	-0.6	-24%	0.7			
	4	2.6	2.5	0.1	4%	1.2			
	5	2.6	2.5	0.1	4%	1.5			
	6	2.6	2.5	0.1	4%	1.8			
	7	2.0	2.5	-0.5	-20%	0.7			
	8	1.8	2.5	-0.7	-28%	0.9			
	9	1.7	2.5	-0.8	-32%	1.1			
NB	19	1.9	2.2	-0.3	-14%	2.7			
	20	1.8	2.2	-0.4	-18%	2.8			
	21	1.6	2.2	-0.6	-27%	2.8			
	22	3.3	2.2	1.1	50%	4.4			
	23	3.1	2.2	0.9	41%	4.5			
	24	1.6	2.2	-0.6	-27%	3.1			
	25	2.5	2.2	0.3	14%	2.5			
	26	2.2	2.2	0.0	0%	2.6			
	27	2.0	2.2	-0.2	-9%	1.5			
EB	28	1.4	1.5	-0.1	-7%	1.7			
	29	1.3	1.5	-0.2	-13%	1.7			
	30	1.2	1.5	-0.3	-20%	1.6			
	31	2.6	1.5	1.1	73%	2.5			
	32	2.5	1.5	1.0	67%	2.7			
	33	2.5	1.5	1.0	67%	2.6			
	34	4.3	1.5	2.8	187%	2.6			
	35	4.2	1.5	2.7	180%	3.6			
	36	4.0	1.5	2.5	167%	3.7			

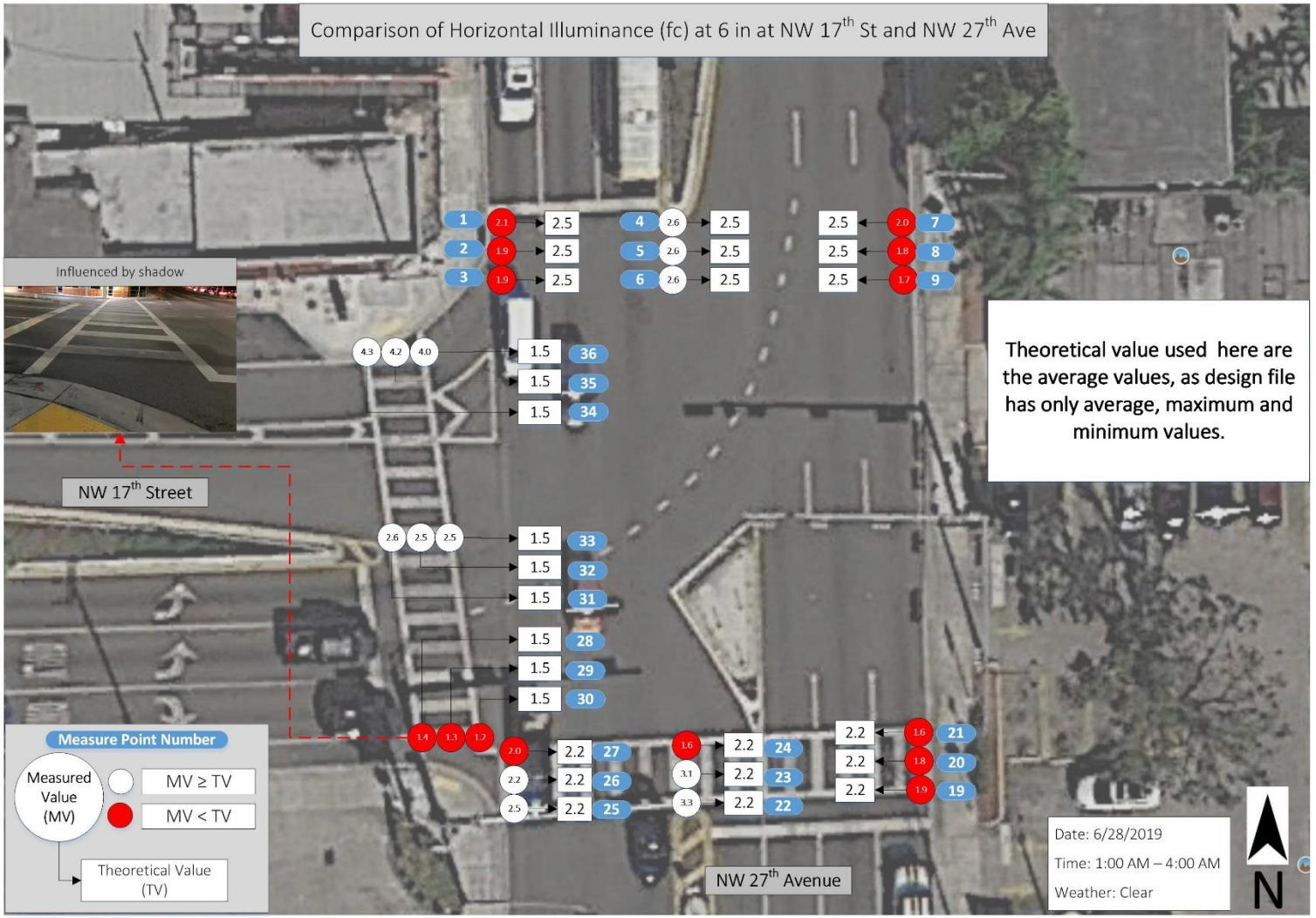

Figure 49. Comparison of Horizontal Illuminance at NW 17th St and NW 27th Ave

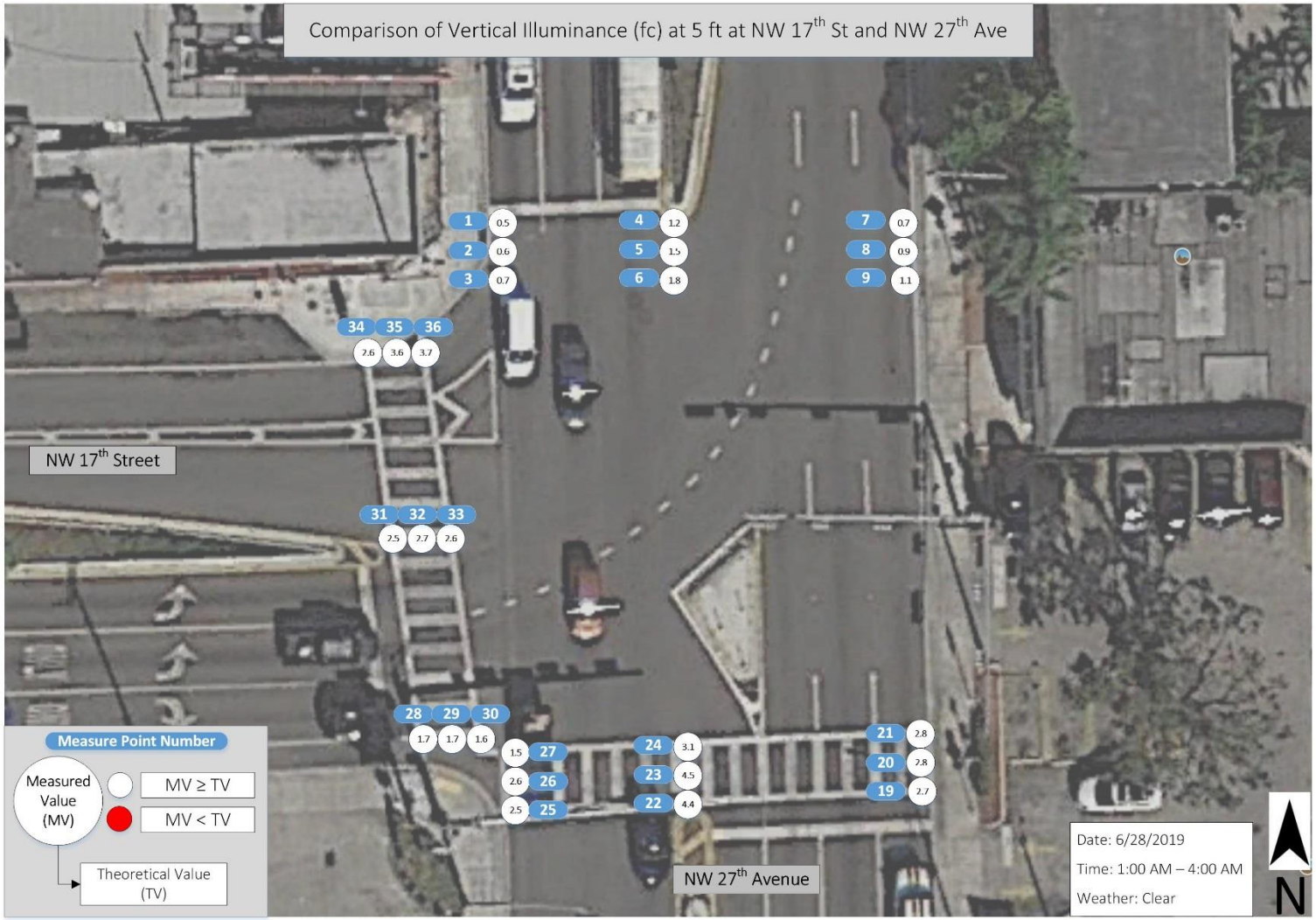

Figure 50. Comparison of Vertical Illuminance at NW 17th St and NW 27th Ave

4.5.4 W Flagler St and W 25th Ave

The comparison of illuminance data is given in Table 53. Figure 51 and Figure 52 present the comparisons of horizontal and vertical illuminance, respectively, at W Flagler St and W 25th Ave. Based on the comparison, the following findings were obtained:

- Most measure points on eastbound, westbound, and northbound experience measured horizontal illuminance lower than theoretical values.
- Trees and shadows influence most measure points on westbound.

Table 53. Comparison of Illuminance Data for W Flagler St and W 25th Ave

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	3.7	2.6	1.1	42%	3.9			
	2	3.7	2.9	0.8	28%	3.9	3.6	0.3	8%
	3	3.8	3.0	0.8	27%	4.0			
	4	3.7	3.2	0.5	16%	3.9			
	5	3.3	3.3	0.0	0%	3.4	4.3	-0.9	-21%
	6	3.3	3.3	0.0	0%	3.3			
	7	3.1	1.9	1.2	63%	3.1			
	8	2.7	2.0	0.7	35%	2.6	2.5	0.1	4%
	9	2.6	2.3	0.3	13%	2.5			
WB	10	1.6	1.6	0.0	0%	1.3			
	11	1.7	1.7	0.0	0%	1.4	1	0.4	40%
	12	1.7	1.8	-0.1	-6%	1.5			
	13	2.4	3.2	-0.8	-25%	2.3			
	14	2.1	3.2	-1.1	-34%	2.0	2.7	-0.7	-26%
	15	2.0	3.2	-1.2	-38%	1.8			
	16	0.5	2.7	-2.2	-81%	0.2			
	17	0.9	2.6	-1.7	-65%	0.6			
	18	0.6	2.6	-2.0	-77%	0.3			
NB	19	1.5	2.8	-1.3	-46%	1.2			
	20	1.4	2.8	-1.4	-50%	1.1	3.6	-2.5	-69%
	21	1.2	2.8	-1.6	-57%	0.9			
	22	2.7	3.2	-0.5	-16%	2.6			
	23	2.0	3.3	-1.3	-39%	1.8	3	-1.2	-40%
	24	1.7	3.4	-1.7	-50%	1.5			
	25	2.1	3.2	-1.1	-34%	2.0			
	26	1.6	3.3	-1.7	-52%	1.4	1.2	0.2	17%
	27	1.3	3.5	-2.2	-63%	1.0			
EB	28	1.4	5.3	-3.9	-74%	1.2			
	29	1.3	5.4	-4.1	-76%	1.1	1.3	-0.2	-15%
	30	1.3	5.4	-4.1	-76%	1.0			
	31	2.6	3.2	-0.6	-19%	2.6			
	32	2.5	3.8	-1.3	-34%	2.4	1.2	1.2	100%
	33	2.6	4.2	-1.6	-38%	2.5			
	34	2.7	2.2	0.5	23%	2.6			
	35	2.8	2.5	0.3	12%	2.7			
	36	3.1	2.8	0.3	11%	3.1			

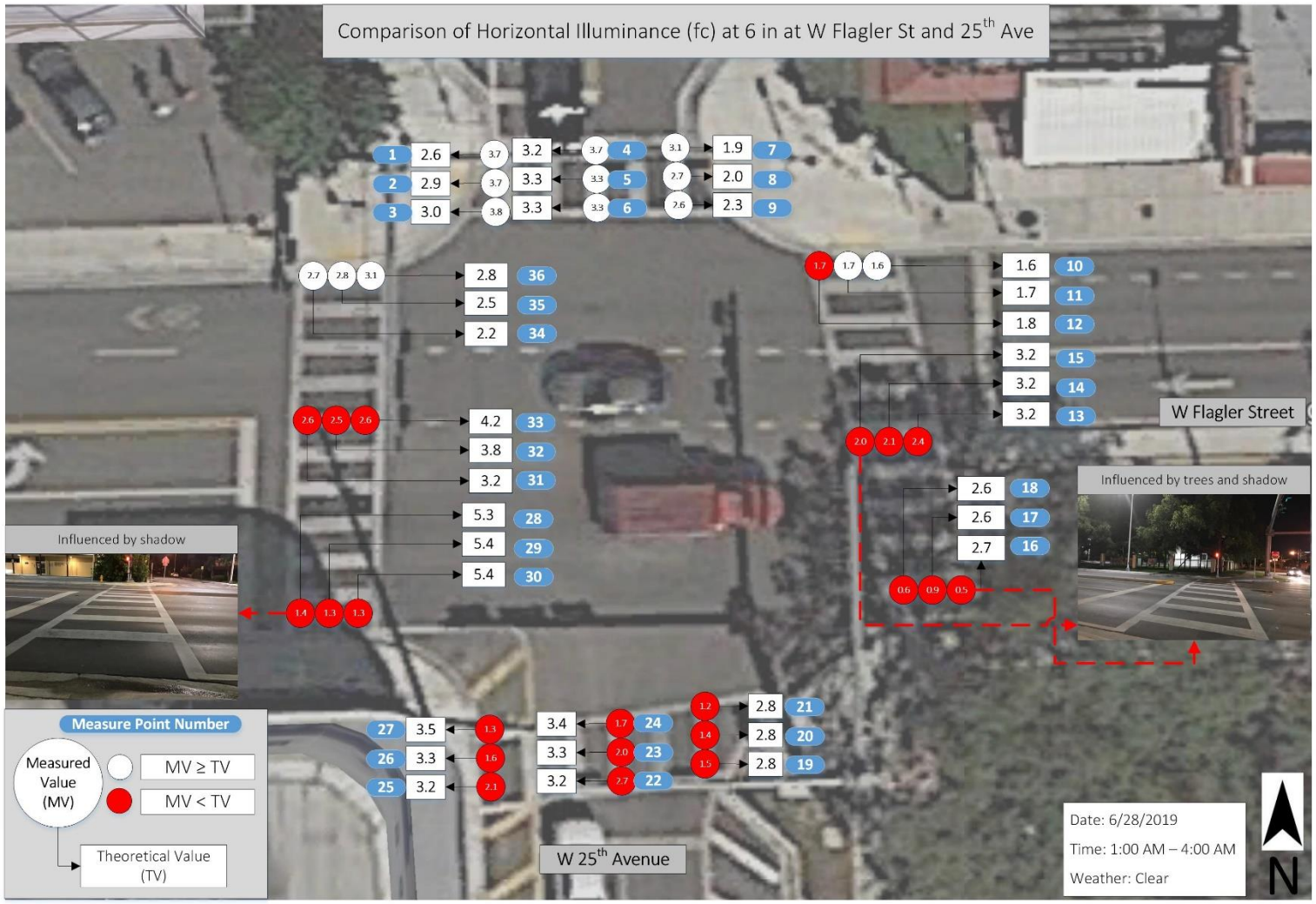

Figure 51. Comparison of Horizontal Illuminance at W Flagler St and W 25th Ave

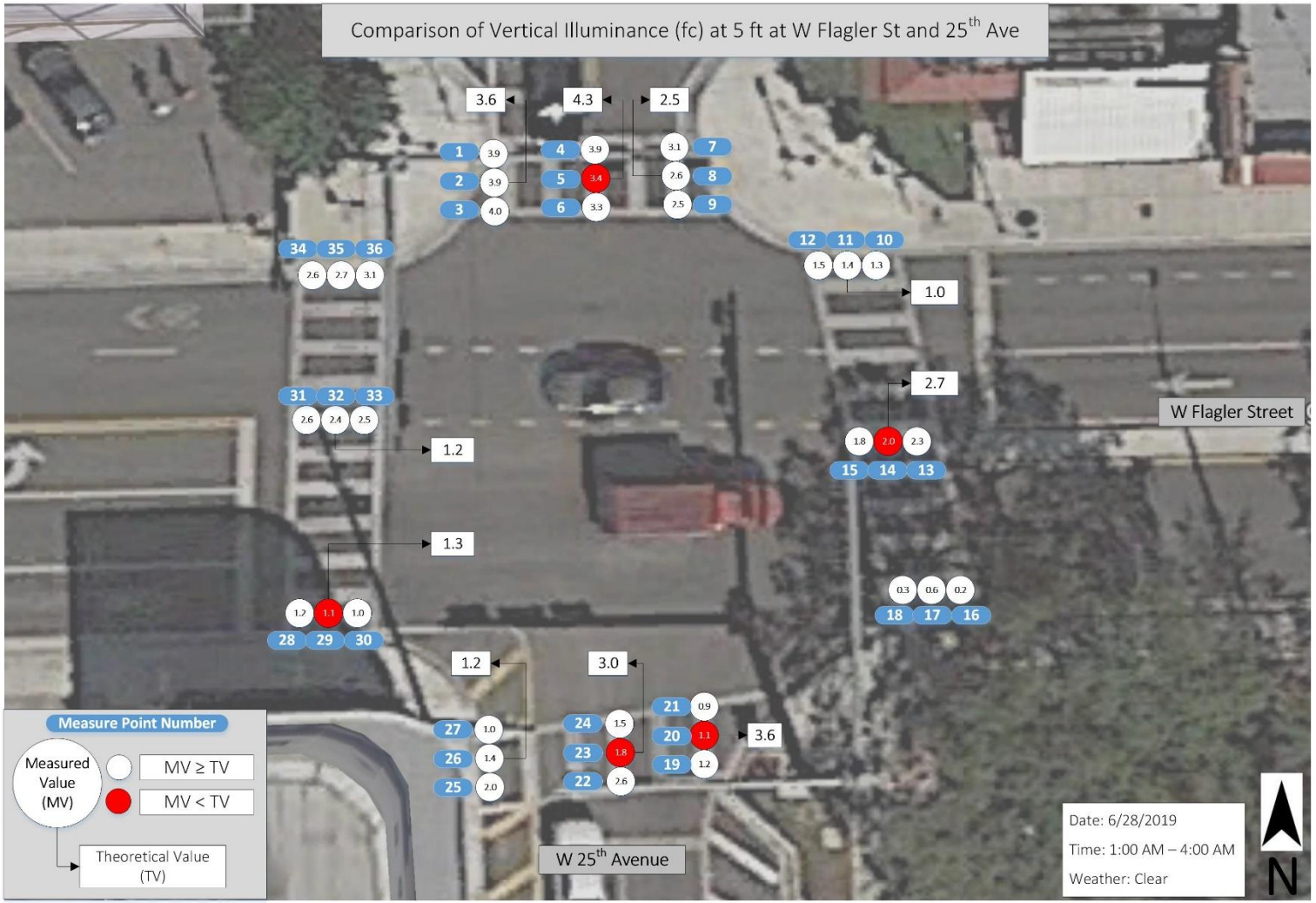

Figure 52. Comparison of Vertical Illuminance at W Flagler St and W 25th Ave

4.6 Data Collection in District 7

4.6.1 Busch Blvd and N 30th St

The comparison of illuminance data is given in Table 54. Figure 53 and Figure 54 present the comparisons of horizontal and vertical illuminance, respectively, at Busch Blvd and N 30th St. Based on the comparison, the following findings were obtained:

- Most measure points experience an equal or higher measured horizontal illuminance than theoretical values.
- Theoretical values influence the measured horizontal values on one side of northbound and westbound.
- Most vertical measured values are higher than the theoretical values (at the points where theoretical value are available).

Table 54. Comparison of Illuminance Data for Busch Blvd and N 30th St

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	1.7	1.0	0.7	71%	1.0			
	2	0.8	0.9	-0.1	-6%	1.0	0.9	0.1	11%
	3	0.6	1.0	-0.4	-36%	0.8			
	4	1.6	1.4	0.2	15%	2.9			
	5	1.5	1.4	0.1	10%	2.7	2.7	0.0	0%
	6	1.5	1.3	0.2	15%	2.5			
	7	1.6	1.4	0.2	16%	2.8			
	8	1.5	1.4	0.1	10%	2.5			
	9	1.4	1.3	0.1	10%	2.3			
WB	10	1.2	1.3	-0.1	-9%	0.7			
	11	1.2	1.3	-0.1	-10%	0.8	0.4	0.4	94%
	12	0.9	1.3	-0.4	-30%	0.7			
	13	3.1	2.9	0.2	6%	1.4			
	14	3.1	2.9	0.2	7%	1.4	0.6	0.8	138%
	15	3.1	3.0	0.1	3%	1.7			
	16	4.7	3.6	1.1	31%	2.3			
	17	4.9	4.1	0.8	20%	2.2			
	18	5.1	4.3	0.8	19%	2.2			
NB	19	1.8	1.6	0.2	13%	1.4			
	20	1.9	1.7	0.2	12%	1.7	1.7	0.0	0%
	21	2.0	1.7	0.3	19%	1.9			
	22	2.0	1.6	0.4	25%	2.3			
	23	1.9	1.6	0.3	18%	2.2	2.1	0.1	7%
	24	1.8	1.7	0.1	6%	2.4			
	25	2.8	2.1	0.7	31%	3.0			
	26	2.6	2.2	0.4	16%	3.1			
	27	2.6	2.3	0.3	12%	3.1			
EB	28	1.3	0.9	0.4	43%	1.4			
	29	1.7	0.6	1.1	185%	1.2	0.6	0.6	98%
	30	2.3	1.8	0.5	27%	1.3			
	31	2.3	1.5	0.8	57%	2.2			
	32	2.2	1.4	0.8	57%	2.3	1.4	0.9	65%
	33	2.1	1.4	0.7	50%	2.5			
	34	2.6	1.5	1.1	76%	2.1			
	35	2.6	1.6	1.0	64%	2.4			
	36	2.7	1.7	1.0	57%	2.7			

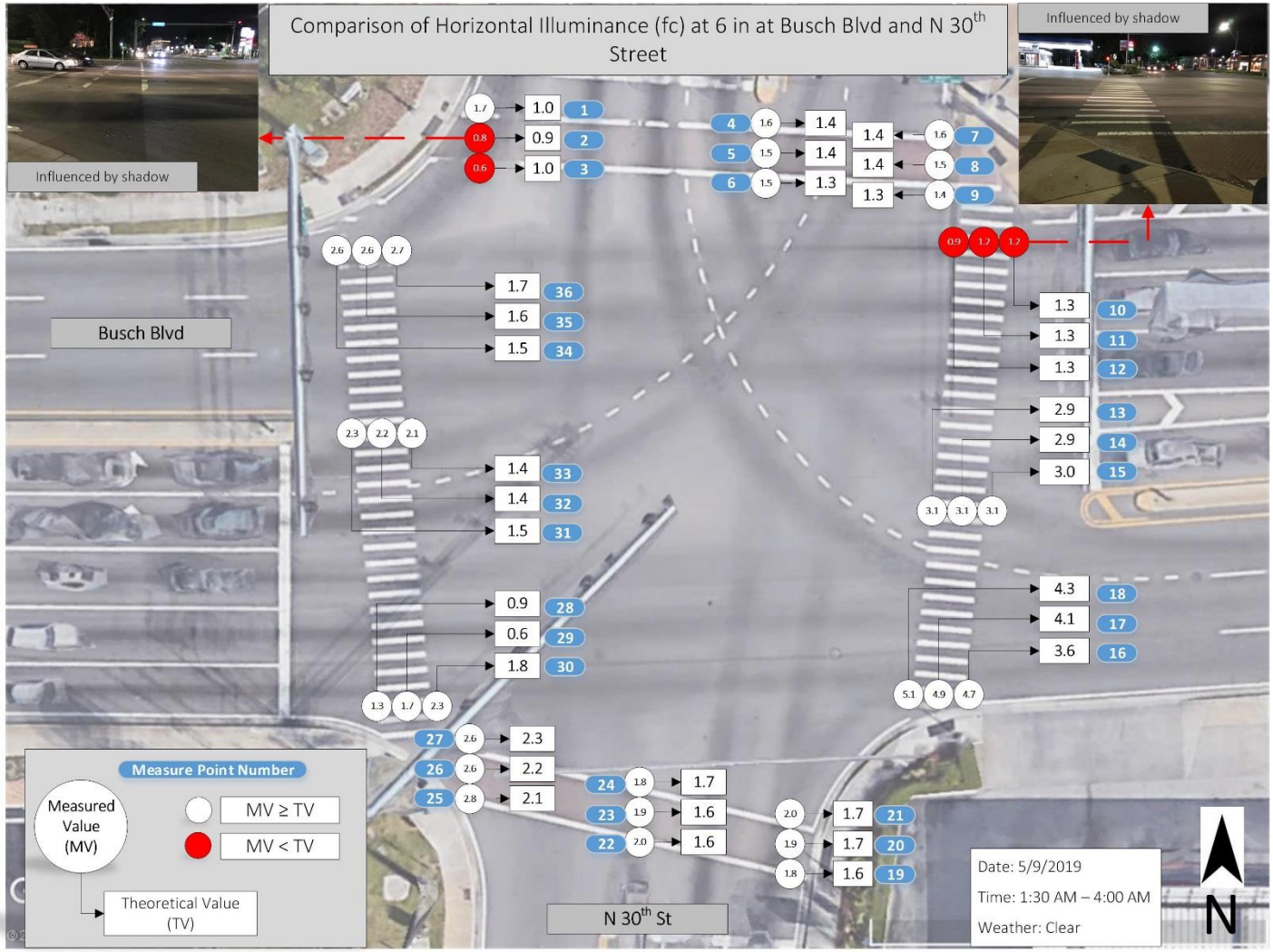

Figure 53. Comparison of Horizontal Illuminance at Busch Blvd and N 30th St

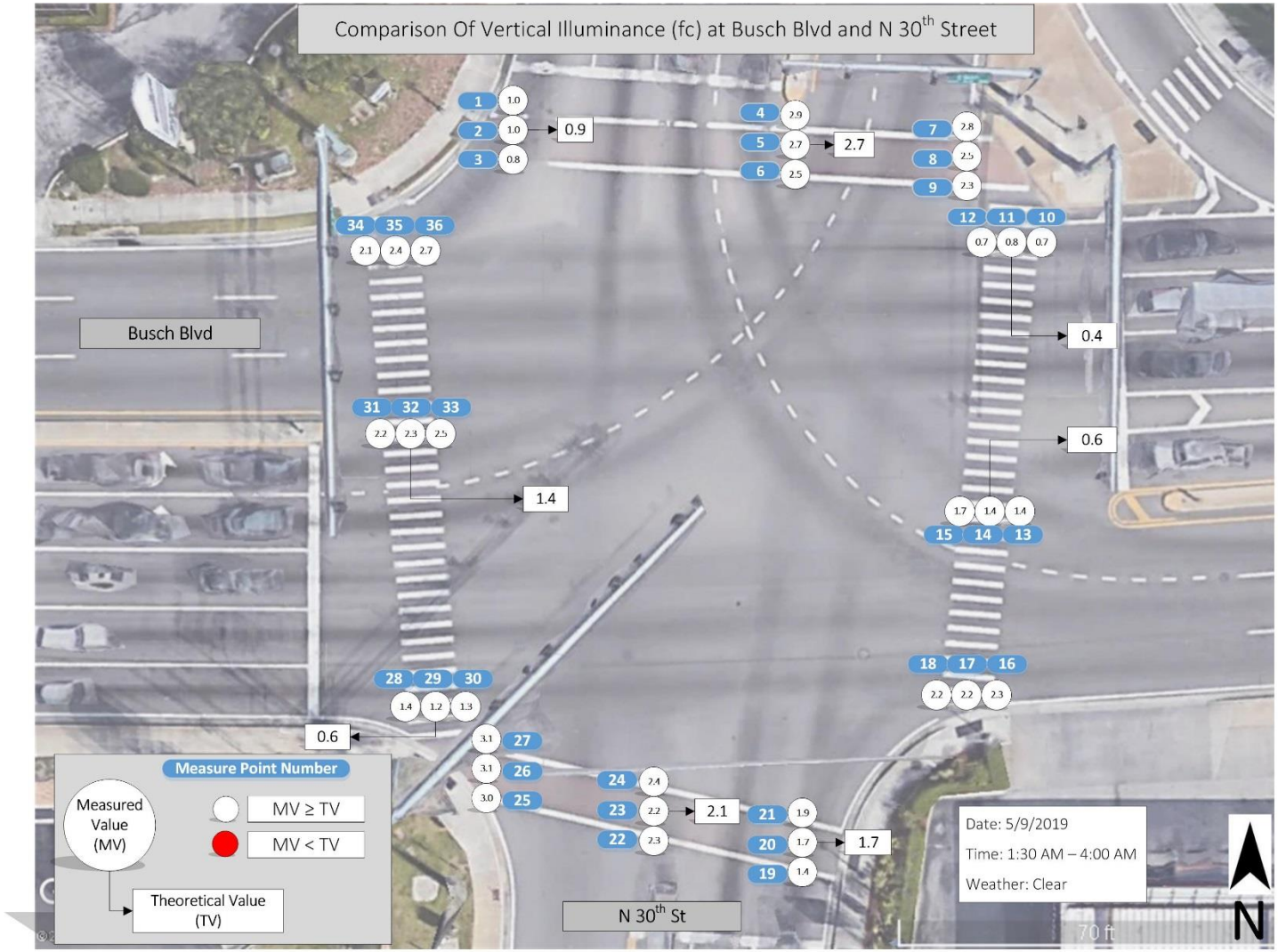

Figure 54. Comparison of Vertical Illuminance at Busch Blvd and N 30th St

4.6.2 Busch Blvd and Nebraska Ave

The comparison of illuminance data is given in Table 55. Figure 55 and Figure 56 present the comparisons of horizontal and vertical illuminance, respectively, at Busch Blvd and Nebraska Ave. Based on the comparison, the following findings were obtained:

- The measured horizontal values in each direction are influenced by shadows.

Table 55. Comparison of Illuminance Data for Busch Blvd and Nebraska Ave

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	2.9	2.6	0.3	12%	0.9			
	2	3.1	3.1	0.0	0%	1.5	1.2	0	0%
	3	3.1	3.2	-0.1	-4%	1.5			
	4	2.4	2.7	-0.3	-11%	1.5			
	5	2.4	2.6	-0.2	-7%	1.4	1.5	-0.1	-7%
	6	2.4	2.5	-0.1	-4%	1.5			
	7	2.5	2.1	0.4	19%	1.0			
	8	2.5	2.1	0.4	19%	0.8			
	9	2.6	2.1	0.5	23%	1.0			
WB	10	1.9	2.2	-0.3	-14%	0.8			
	11	2.1	2.3	-0.2	-9%	1.2	0.7	0.5	67%
	12	2.6	2.5	0.1	2%	1.0			
	13	3.0	3.3	-0.3	-10%	1.9			
	14	2.9	3.3	-0.4	-13%	2.1	1.7	0.4	23%
	15	2.8	3.2	-0.4	-14%	2.0			
	16	3.0	4.6	-1.6	-34%	1.7			
	17	2.9	4.7	-1.8	-38%	2.0			
	18	2.8	4.6	-1.8	-39%	2.2			
NB	19	2.3	5.3	-3.0	-56%	0.9			
	20	2.3	4.7	-2.4	-51%	0.9	2.3	-1.4	-62%
	21	2.4	4.5	-2.1	-47%	0.7			
	22	1.3	1.5	-0.2	-13%	0.3			
	23	1.2	1.4	-0.2	-11%	0.3	0.5	-0.2	-38%
	24	1.3	1.3	0.0	0%	0.3			
	25	1.4	1.3	0.1	7%	0.2			
	26	1.4	1.3	0.1	8%	0.2			
	27	1.5	1.5	0.0	0%	0.2			
EB	28	2.9	2.4	0.5	22%	2.8			
	29	2.6	2.4	0.2	10%	2.8	2.8	0.0	0%
	30	2.2	2.2	0.0	2%	2.5			
	31	2.6	3.2	-0.6	-19%	2.2			
	32	2.5	3.1	-0.6	-20%	2.4	2.7	-0.3	-11%
	33	2.4	2.9	-0.5	-19%	2.5			
	34	3.1	2.9	0.2	6%	2.9			
	35	3.1	3.1	0.0	0%	3.1			
	36	3.0	3.0	0.0	0%	3.1			

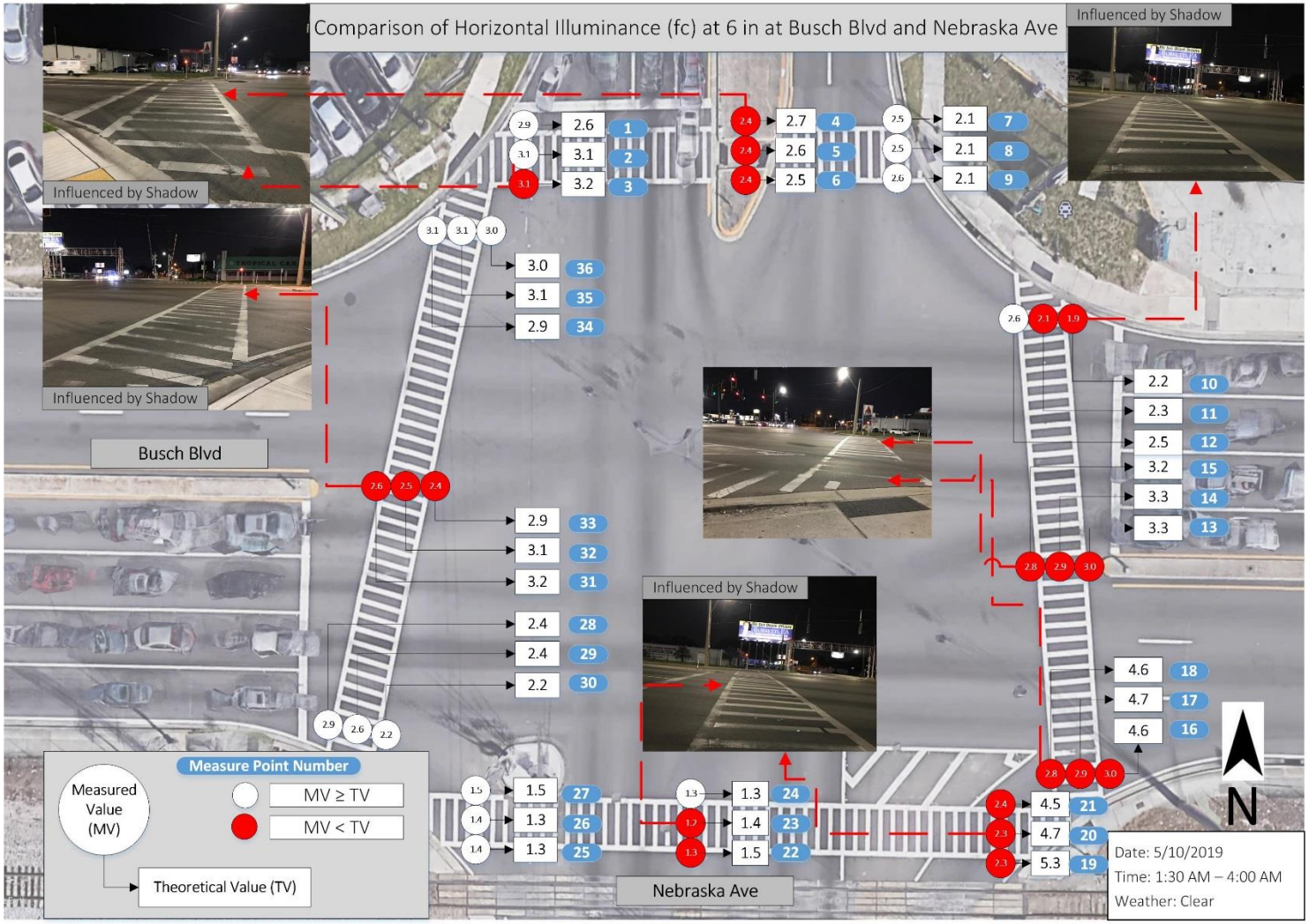

Figure 55. Comparison of Horizontal Illuminance at Busch Blvd and Nebraska Ave

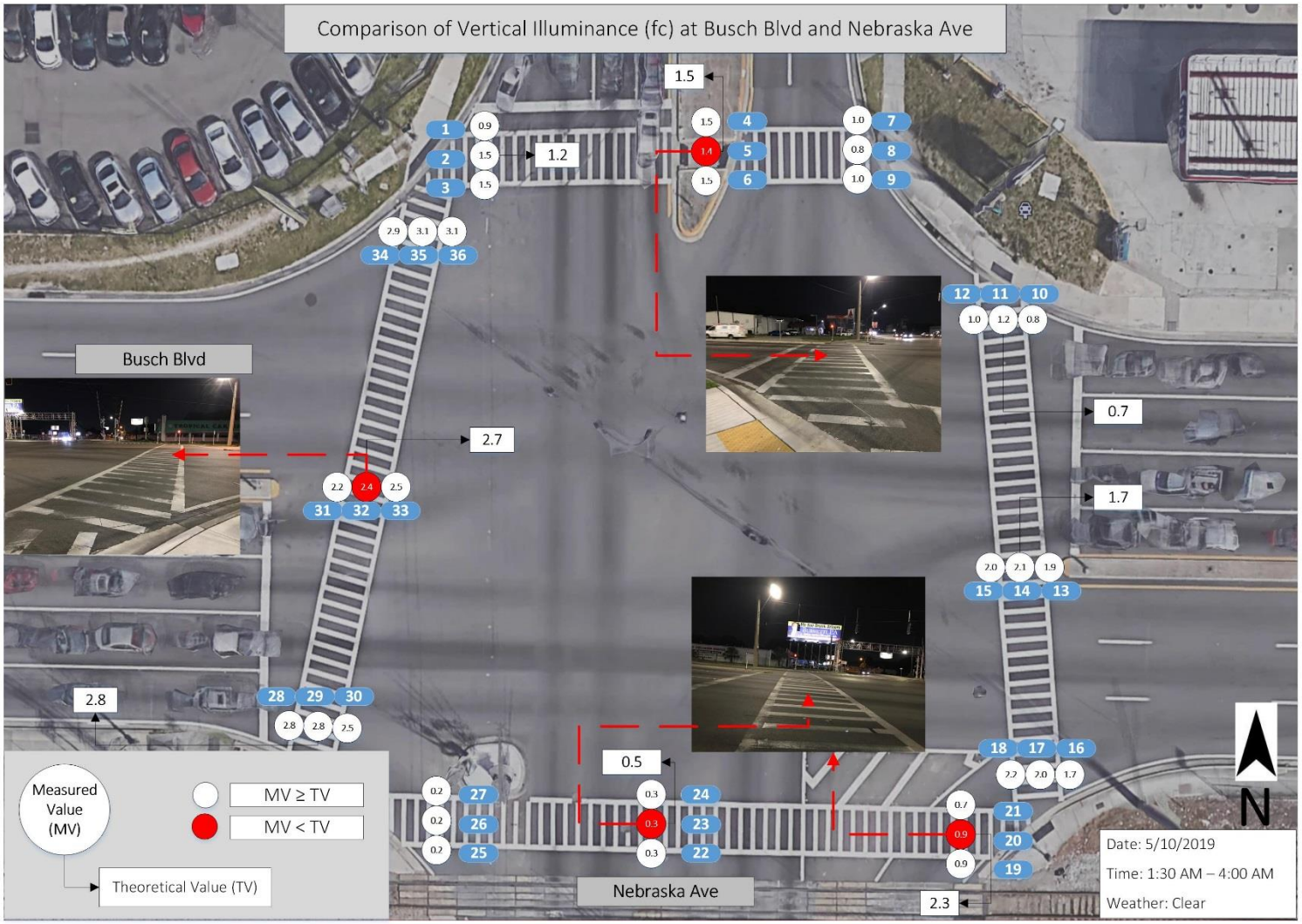

Figure 56. Comparison of Vertical Illuminance at Busch Blvd and Nebraska Ave

4.6.3 Hillsborough Ave and N 15th St

The comparison of illuminance data is given in Table 56. Figure 57 and Figure 58 present the comparisons of horizontal and vertical illuminance, respectively, at Hillsborough Ave and N 15th St. Based on the comparison, the following findings were obtained:

- Most measure points on eastbound and southbound are influenced by external lights.
- Most measure points on westbound and northbound are influenced by trees.

Table 56. Comparison of Illuminance Data for Hillsborough Ave and N 15th St

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	4.5	2.7	1.8	67%	3.3			
	2	4.3	2.5	1.8	73%	3.3	1.9	1.4	76%
	3	3.9	2.2	1.7	79%	4.0			
	4	3.8	3.1	0.7	23%	2.9			
	5	3.7	3.1	0.6	19%	2.3	2.9	-0.6	-20%
	6	3.6	3.1	0.5	17%	2.5			
	7	2.7	2.9	-0.2	-8%	1.8			
	8	2.9	3.0	-0.1	-4%	1.8			
	9	3.0	3.1	-0.1	-4%	2.1			
WB	10	2.9	2.9	0.0	0%	1.9			
	11	2.7	2.9	-0.2	-7%	1.8	2.9	-1.1	-39%
	12	2.7	3.0	-0.3	-9%	1.9			
	13	3.1	4.2	-1.1	-27%	1.4			
	14	3.5	4.2	-0.7	-17%	1.7	2.5	-0.8	-32%
	15	3.5	4.1	-0.6	-15%	2.1			
	16	2.3	4.2	-1.9	-46%	0.8			
	17	3.2	4.0	-0.8	-20%	0.8			
	18	3.7	4.1	-0.4	-10%	0.8			
NB	19	5.0	5.3	-0.3	-6%	0.9			
	20	4.7	5.2	-0.5	-10%	1.5	1.2	0.3	23%
	21	4.2	4.7	-0.5	-10%	2.0			
	22	5.0	4.5	0.5	11%	0.8			
	23	5.1	5.3	-0.2	-4%	1.5	1.3	0.2	19%
	24	5.1	6.0	-0.9	-16%	2.0			
	25	4.1	4.3	-0.2	-4%	1.0			
	26	4.3	4.9	-0.6	-12%	1.4			
	27	4.5	5.2	-0.7	-13%	1.8			
EB	28	4.6	4.3	0.3	6%	2.5			
	29	4.2	4.5	-0.3	-6%	3.1	2.5	0.6	23%
	30	4.2	4.9	-0.7	-14%	3.2			
	31	2.8	1.9	0.9	46%	1.9			
	32	3.0	2.1	0.9	44%	2.5	1.2	1.3	106%
	33	3.2	2.3	0.9	41%	2.7			
	34	4.6	0.7	3.9	553%	3.6			
	35	4.0	1.0	3.0	299%	4.4			
	36	3.9	1.5	2.4	159%	4.6			

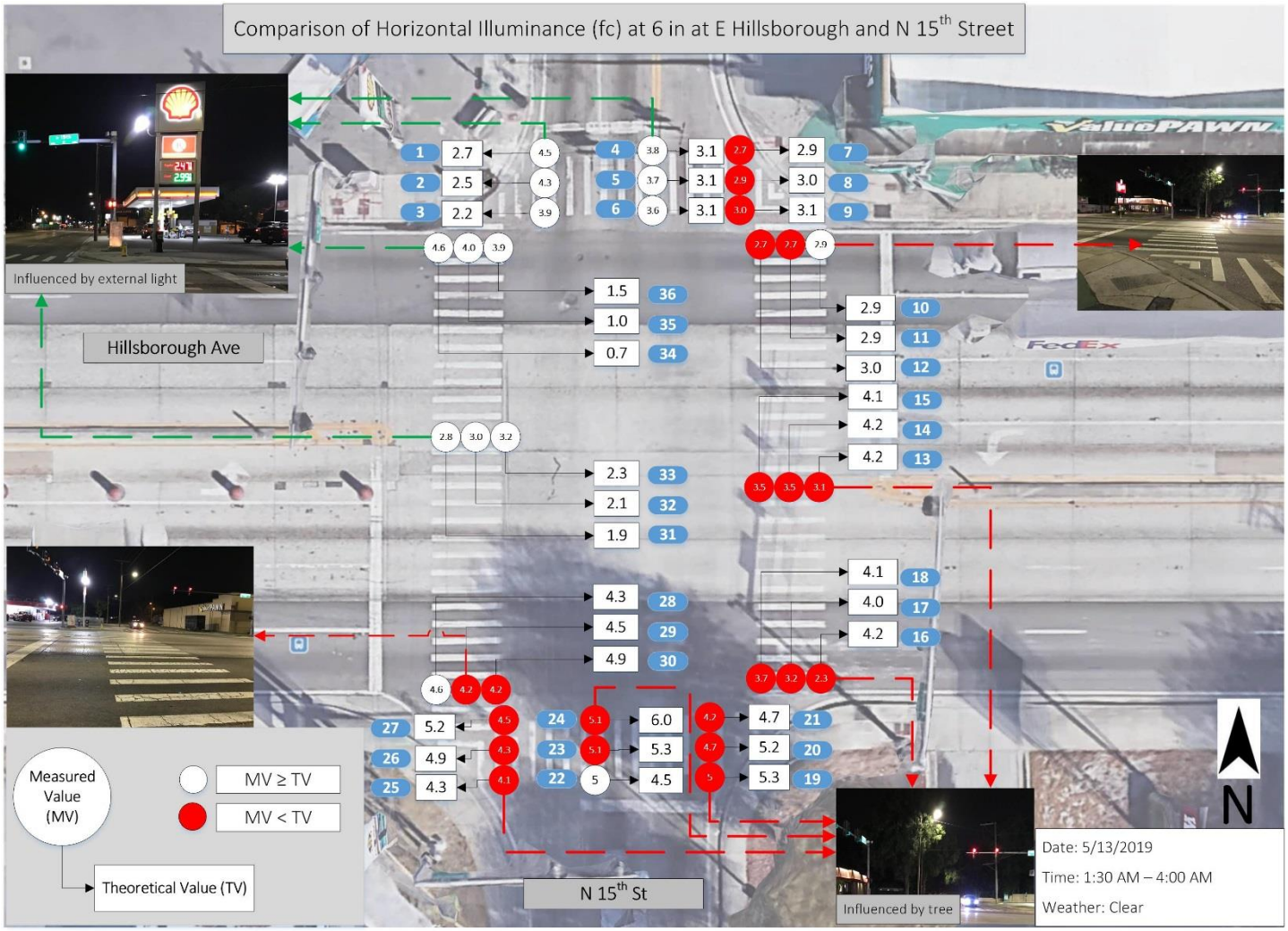

Figure 57. Comparison of Horizontal Illuminance at Hillsborough Ave and N 15th St

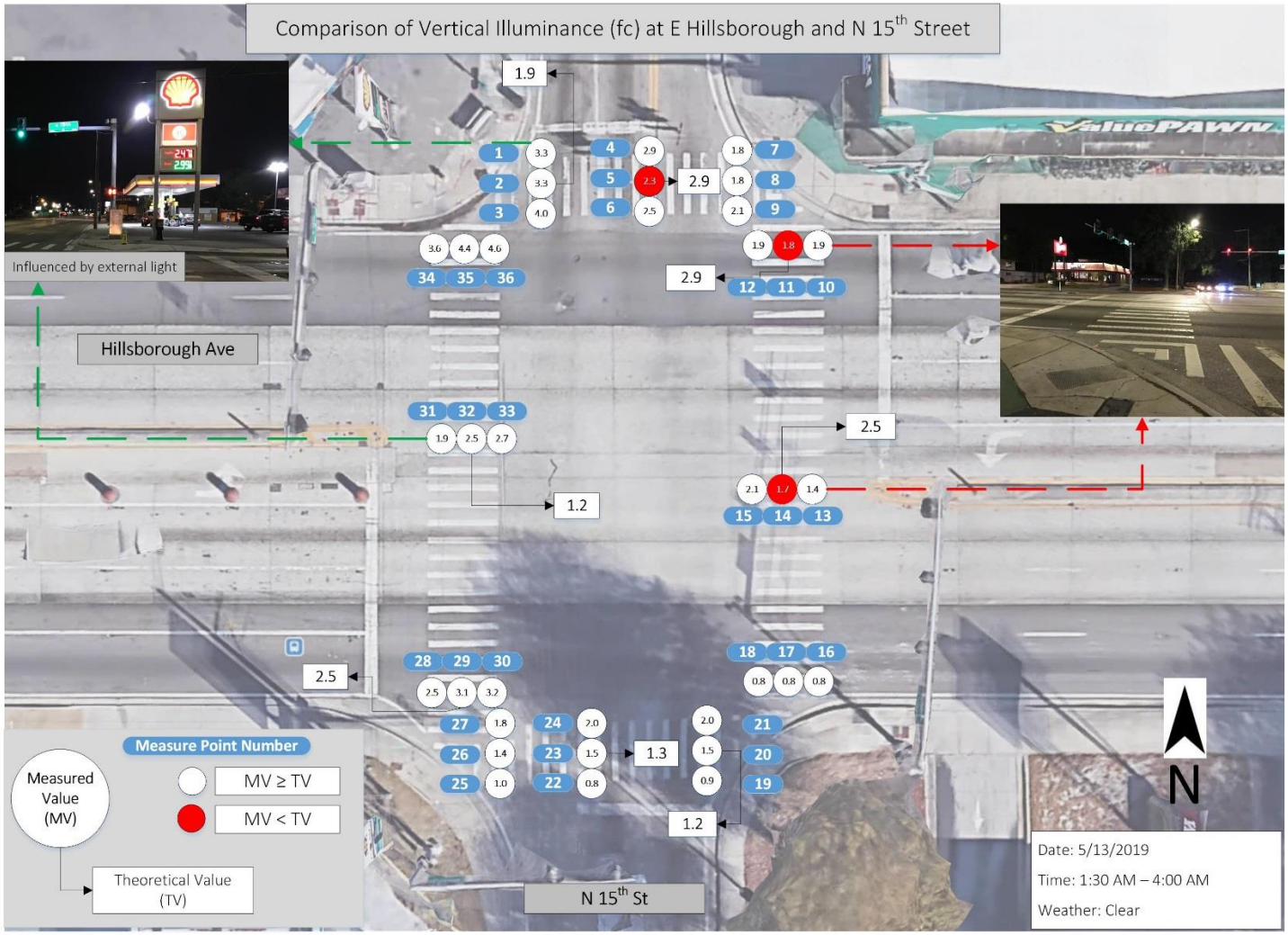

Figure 58. Comparison of Vertical Illuminance at Hillsborough Ave and N 15th St

4.6.4 Hillsborough Ave and N 40th St

The comparison of illuminance data is given in Table 57. Figure 59 and Figure 60 present the comparisons of horizontal and vertical illuminance, respectively, at Hillsborough Ave and N 40th St. Horizontal measured illuminance is influenced by shadows and external lights.

Table 57. Comparison of Illuminance Data for Hillsborough Ave and N 40th St

Approach	ID	Horizontal Measurement				Vertical Measurement			
		Measured	*Theoretical*	*Diff.*	*%*	*Measured*	*Theoretical*	*Diff.*	*%*
SB	1	2.4	2.3	0.1	4%	2.2			
	2	2.2	2.1	0.1	6%	2.4	2.4	0.0	0%
	3	2.0	2.0	0.0	0%	2.4			
	4	1.8	2.0	-0.2	-9%	1.7			
	5	1.6	2.0	-0.4	-20%	1.3	1	0.3	30%
	6	1.6	1.9	-0.3	-17%	1.6			
	7	2.5	1.8	0.7	39%	1.6			
	8	2.3	1.7	0.6	34%	1.7			
	9	2.1	1.7	0.4	24%	1.8			
WB	10	2.4	1.5	0.9	60%	3.9			
	11	2.4	1.4	1.0	73%	3.6	1.8	1.8	97%
	12	2.2	1.4	0.8	58%	3.6			
	13	2.5	2.9	-0.4	-15%	2.9			
	14	2.4	2.9	-0.5	-17%	3.2	3	0.2	7%
	15	2.3	2.9	-0.6	-20%	3.3			
	16	2.2	2.7	-0.5	-19%	2.2			
	17	2.1	2.6	-0.5	-20%	2.1			
	18	2.1	2.5	-0.4	-16%	2.0			
NB	19	3.5	2.4	1.1	46%	1.8			
	20	3.4	2.3	1.1	47%	2.1	1.7	0.4	25%
	21	3.1	2.3	0.8	37%	2.3			
	22	2.8	3.5	-0.7	-21%	2.7			
	23	2.7	3.3	-0.6	-17%	3.3	2.3	1.0	43%
	24	2.4	3.1	-0.7	-23%	3.4			
	25	5.6	3.2	2.4	74%	6.5			
	26	5.4	3.3	2.1	64%	7.4			
	27	5.2	3.1	2.1	67%	7.5			
EB	28	3.7	1.3	2.4	185%	2.7			
	29	3.6	1.5	2.1	138%	2.5	0.2	2.3	1152%
	30	3.6	1.7	1.9	114%	2.7			
	31	1.5	2.0	-0.5	-25%	1.9			
	32	1.5	2.0	-0.5	-27%	2.0	1.9	0.1	3%
	33	1.4	2.0	-0.6	-29%	2.0			
	34	1.3	1.9	-0.6	-32%	1.0			
	35	1.3	1.9	-0.6	-31%	1.0			
	36	1.3	1.9	-0.6	-34%	1.0			

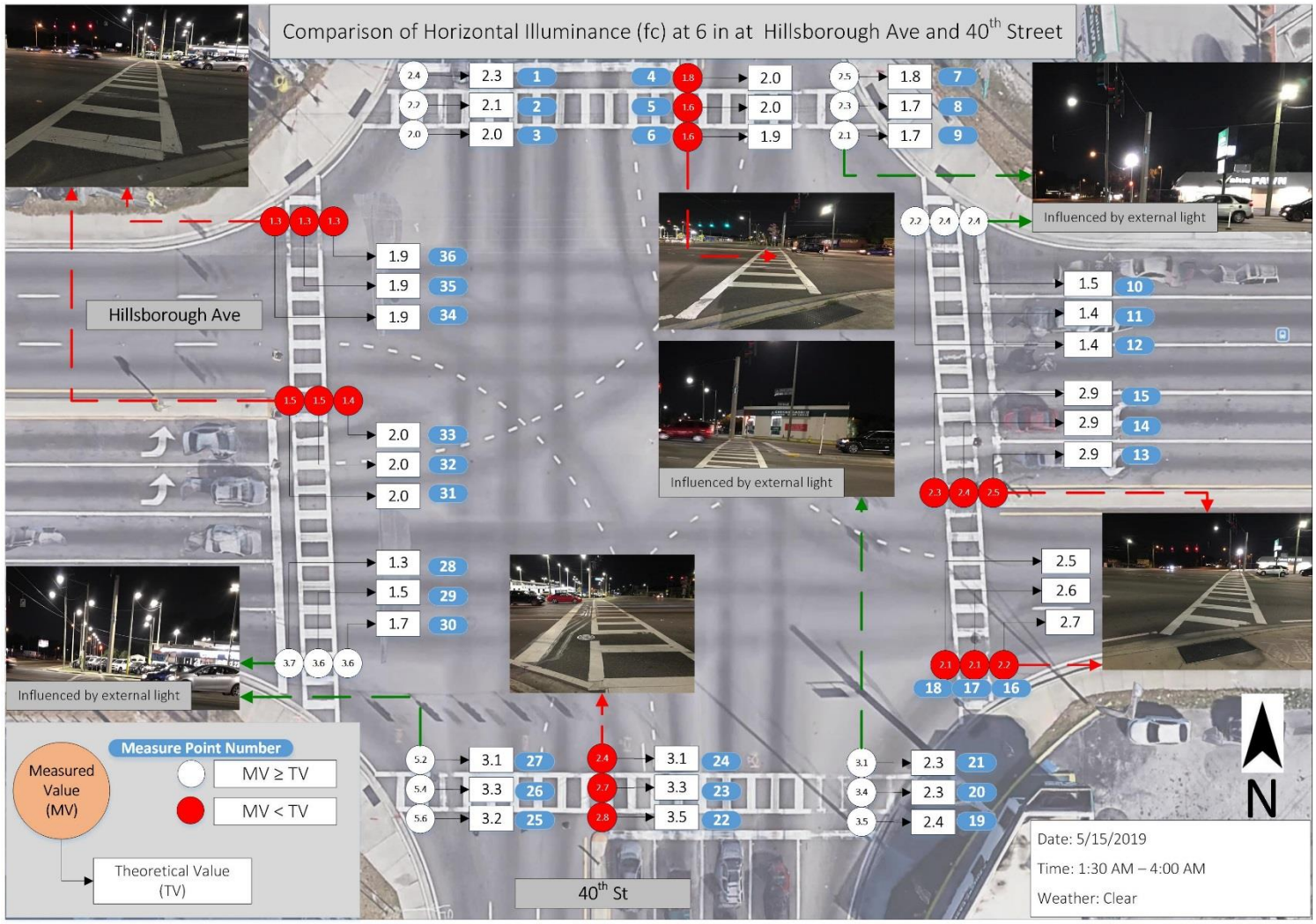

Figure 59. Comparison of Horizontal Illuminance at Hillsborough Ave and 40th St

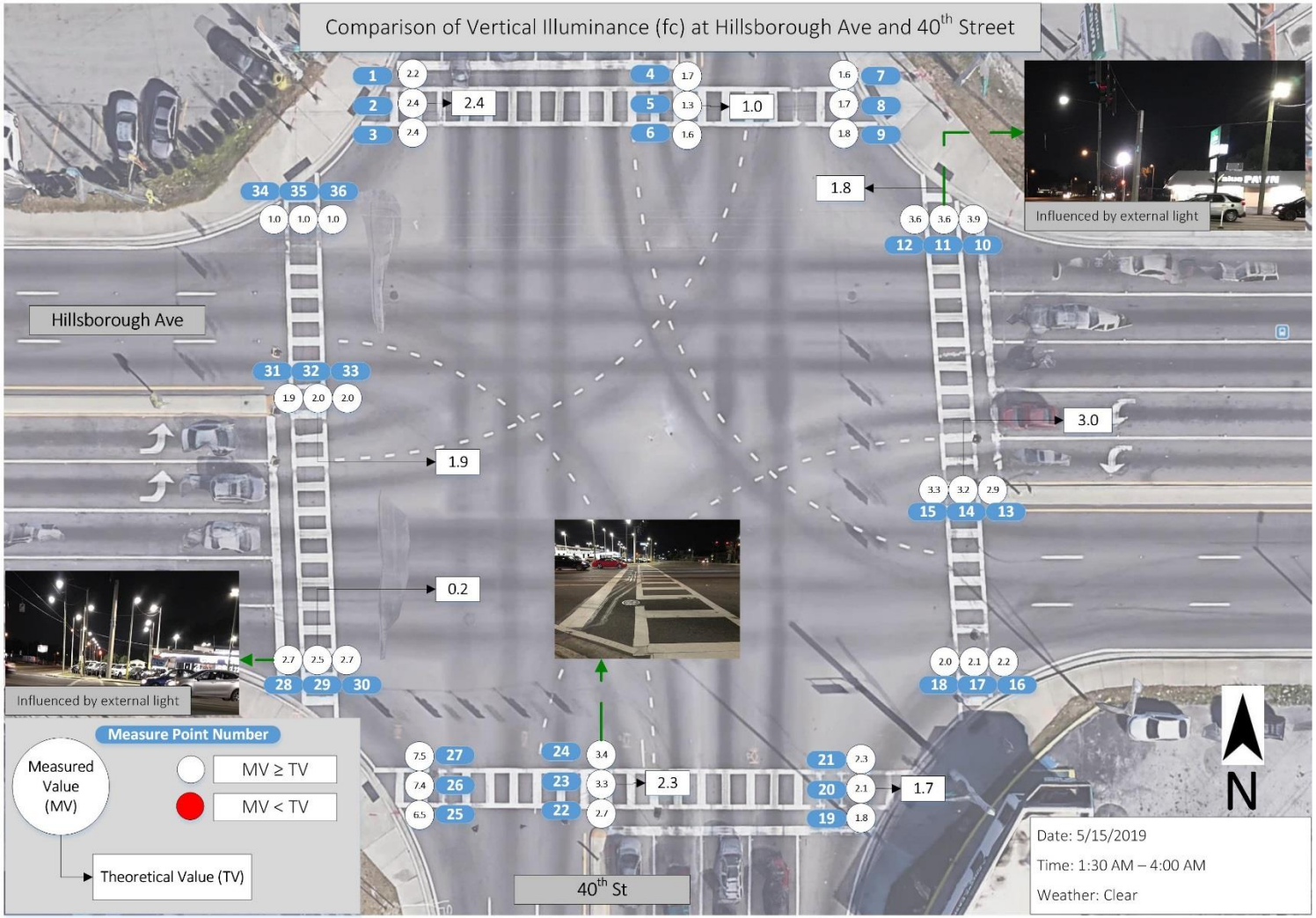

Figure 60. Comparison of Vertical Illuminance at Hillsborough Ave and 40th St

5 Summary and Conclusions

This study measured horizontal and vertical illuminance along crosswalks at 23 signalized intersections across six FDOT Districts in Florida. The measured illuminance data were compared to corresponding theoretical values to verify the intersection illumination upgrading in Florida. The assurance review of intersections lighting retrofits is given in Table 58, including four indictors:

- Percentage of measured horizontal values (MHFC) being higher than theoretical values (THFC)
- Percentage of measured horizontal values (MHFC) being lower than 1.5fc
- Percentage of measured vertical values (MVFC) being higher than theoretical values (TVFC)
- Percentage of measured vertical values (MVFC) being lower than 1.5fc

The measured lighting data represent the “true” lighting pattern in real roadway environments. The percentages of MHFC ≥ THFC at all intersections are under 100%. The percentages of MVFC ≥ TVFC at 13 intersections are under 100%. This lighting pattern may be caused by shadows (e.g., lighting pole, buildings, and structures), tree branches, etc.

Table 58. Assurance Review of Intersection Lighting Retrofits

FDOT District	Intersection	Horizontal (%)		Vertical (%)	
		MHFC ≥THFC	MHFC < 1.5 fc	MVFC ≥ TVFC	MVFC < 1.5 fc
1	1st St and Fowler St	86%	0%	13%	53%
	Tamiami Tr and Pondella Rd	79%	46%	13%	49%
	McGregor Blvd and Colonial Blvd	74%	0%	43%	19%
	McGregor Blvd and College Pkwy	37%	33%	54%	46%
2	Collins Blvd and SR-21	94%	19%	100%	42%
	Jammes Rd and SR-128	72%	61%		75%
	Wesconnett Blvd and SR-134	39%	53%	75%	75%
	Youngerman Cr and SR 21	69%	36%	50%	75%
3	Lillian Hwy and 57th Ave	75%	0%		8%
	Lillian Hwy and 65th Ave	72%	56%		25%
	Lillian Hwy and 69th Ave	56%	3%		8%
4	Commercial Blvd and 6th Ave	33%	78%	25%	78%
	Glades Rd and SR-7	8%	14%	75%	17%
	Sunrise Blvd and Sunset Strip	0%	78%		74%
	Sunset Strip and University Dr	25%	72%		83%
6	1st St and 22nd Ave	44%	25%	43%	58%
	SW 8th Ave and SW 6th St	6%	42%	43%	42%
	NW 17th St and NW 27th Ave	48%	11%		26%
	W Flagler St and W 25th Ave	39%	25%	50%	36%
7	Busch Blvd and N 30th St	86%	22%	50%	47%
	Busch Blvd and Nebraska Ave	33%	17%	100%	33%
	Hillsborough Ave and N 15th St	39%	0%	63%	22%
	Hillsborough Ave and N 40th St	47%	14%	100%	75%

6 References

1. Arduino. *Arduino Uno*. https://www.arduino.cc/en/Guide/ArduinoUno. Accessed June 15, 2019.

2. Konica Minolta. *T-10A Illuminance Meters*. https://sensing.konicaminolta.us/products/t-10a-t-10ma-illuminance-meters/. Accessed July 25, 2019.

3. Gevin J.M., and Humberto C. *Roadway Design Memorandum.* 16-02. Florida Department of Transportation, 2016.