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Smart City Street Lighting System

Urban Lighting Design Report

Revision F

April 2020

City of Miami Beach

Smart City Street Lighting System

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E	4/28/20	Final Submittal –4th Revision	L. Glaser	F. Wong	L. Glaser

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Acronyms and Abbreviations

ADT	Average Daily Trips
CCL	Coastal Construction Line
CMB	City of Miami Beach
FDOT	Florida Department of Transportation
FPL	Florida Power and Light
FWC	Florida Fish and Wildlife Conservation Commission
LED	Light Emitting Diode
ROW	Right of Way

1. Introduction

The purpose of this report is to assist in the implementation of the City of Miami Beach (CMB) Smart City Street Lighting System – Design, Build, Operate and Maintain, RFQ #2017-119-KB. The need for a Smart City Lighting approach was determined as a result of visual inconsistencies within current lighting levels citywide. Many areas experience over-lit conditions, while other areas do not currently have lighting, resulting in decreased night vision. Other areas suffer from a high contrast between the lit and underlit areas which results in poor uniformity and poor visibility along the travel path. With redevelopment and improvements around the city over time, lighting levels often lack consistency across similar land uses. Drivers for increased safety in various locations citywide have also been a catalyst for an increase in the number of light fixtures, as well as increased lighting levels, which has directly contributed to inconsistencies in lighting levels between neighborhoods and corridors citywide. The intent of this project is to provide a 1 for 1 replacement of all city owned luminaires within the right of way (ROW) of CMB to address these inconsistencies and provide a platform for future smart city development. This standard shall only be used for the replacement of lighting within designated CMB-maintained corridors and districts highlighted within this report. A survey of all existing lights within the City was performed in May 2019. Information showing the overall extents of this survey can be found in **Appendix A** with details of the survey available electronically.

The City was divided into Lighting Design Zones to aid in implementation of smart city technology and establish a baseline for light levels, fixture styles, and controls. The goal of this report is to establish a baseline for roadways and districts when luminaries are replaced. This report is also meant to introduce standards on smart adaptive lighting within corridors and districts which can help to remedy existing conditions. The Miami Beach Citywide Lighting Standards found in **Appendix B** are the basis to establish all lighting levels, luminaire specifications, and controls within the City.

2. Lighting Design Zones

All roadways and areas within CMB ROW were divided up into different lighting design zones to aid in the identification of different lighting areas/schemes. A map of all these zones can be found in **Appendix C**. In general, the lighting requirements for each district will be found in the Miami Beach Citywide Lighting Standards in **Appendix B**. This document will go into more detail on the specific lighting requirements unique to these areas, not covered in the standards.

2.1 Corridors

The corridor zone comprises of most lighting within CMB. These corridors are Major, Collector, and Local roadway types and cover all roadways operated and maintained by CMB. Each of these corridor types will fall under different density classifications of residential or commercial applications. The lighting design requirements for the corridors can be found in the Miami Beach Citywide Lighting Standards.

2.1.1 Major

Figure 1 – Washington Street near the Convention Center and the Fillmore

Major roads are moderate to high capacity thoroughfares, which typically serve longer distance trips, allowing higher speeds with limited access points and driveways to adjacent land uses. Major roads typically experience higher average daily trips (ADT) and serve as primary emergency and evacuation routes for CMB, resulting in wider overall right-of-way widths that often contain wider sidewalks, bike lanes, multiple, delineated multimodal travel lanes, turn lanes, and medians. Major roads are designed to provide access between neighborhoods and regionally-served uses such as employment centers and commercial and industrial hubs, which are critical in the movement of goods and services for not only CMB, but the South Florida region. Washington Street, 5th Street and portions of Collins Avenue are examples of this roadway type.

2.1.2 Collector Roads

Figure 2 – Meridian Avenue near the Holocaust Memorial

Collector roads serve a critical role in the overall roadway network, accepting traffic from local roads and funneling traffic to major roads. This roadway type serves both land use access and traffic circulation functions amongst residential, commercial, and industrial zoning districts. Collector roads typically penetrate through residential neighborhoods, often used for shorter-distance trips of three-quarters of a mile or less. Like Major Roads, Collector Roads often have wider sidewalks with vegetated buffers for pedestrian comfort, along with bicycle lanes. Vehicular speeds are typically low to moderate with more signalized intersections for various modes of transportation. Meridian Avenue, 16th Street and 47th Street are examples of this roadway type.

2.1.3 Local Roads

Figure 3 – Marseille Drive in the Normandy Isle neighborhood

The largest percentage of roads within the City of Miami Beach, both in quantity and length, local roads are intended for shorter distance trips for passenger vehicles, personal transport devices, and pedestrians with less transport type lane delineation. They are often designed to discourage through traffic, resulting in lower volumes of traffic and narrow right-of-way corridors. Local roads provide direct access to adjacent land uses with a greater number of access points and driveways, while providing direct access to Collector roads. These types of roads will be typical for most neighborhoods.

2.2 Hospital District

The hospital district covers the Mount Sinai Medical Center Campus. Currently, there are no other hospital districts within CMB. Due to the emergency operation and 24-hour access to this area along with heavy pedestrian circulation, this area requires consistent lighting levels at all times, but may be dimmed to a lower lighting level during off late-night hours.

2.3 Mixed-Use Entertainment District

This mixed-use entertainment zoning district includes the historic art-deco district located in the south beach area. The historic character of this district has defined CMB's brand as a global destination and serves as one of south Florida's primary tourist destinations. As the City's "front door" for tourism, the Mixed-Use Entertainment District hosts various land uses such as dining, retail, entertainment, and hospitality, with direct beach access. The nature of these uses creates the need for 24-hour activity and safety for heavy pedestrian use, with a focus on the night-time experience. Lighting fixtures in this area should be provided to complement the historic character of the area.

2.4 Town Center Area District

Located in the north beach area near 69th Street and Indian Creek Drive, the Town Center Area serves the local population of Miami Beach, offering daily goods and services by local businesses and daily-use destinations. To maintain and enhance this center of the north beach area for economic development, lighting will be a critical component in activating this district for the residents and workforce of the north beach area. Lighting in this area should be able to dim after hours to a lower level.

2.5 Open Space and Parks

Figure 4 - Fairway Park in the Normandy Isles neighborhood

The open space and parks district are not a contiguous district, but rather comprises a system of corridors and areas which host casual and programmed recreation across the various neighborhoods of CMB. This district offers open and/or green space designed to serve from a larger regional scale, down to a local neighborhood scale in size and complexity of uses. It is expected that sporadic intervals of nighttime programmed activities and casual use will occur within this district, where adaptive lighting levels will be critical for service and safety.

2.6 Convention Center District

The Convention Center District is a global destination, located at Convention Center Drive and 17th Street. This district hosts medium to large-scale planned gatherings, bringing global users that directly support the local hospitality economy. Generally programmed events occur during daytime hours with some events lagging into the early to late evening hours. While the convention center is one of the primary destinations of this district, the adjacent Holocaust Memorial, Botanical Garden, the Fillmore, and New World Center serve as important cultural destinations, not only to the visitors to the Convention Center District, but regularly draws visitors and residents from across CMB.

Figure 5 - Typical fixture within the Convention Center District

2.7 Parking Facilities

Public parking lots and structures are generally located within proximity to city services and city maintained facilities. Parking areas need to accommodate large vehicles as well as micromobility vehicles such as bicycles, scooters, and other electric and pedal-assisted forms of transportation.

Parking lots, structures, and facilities owned and/or maintained by the CMB primarily host daytime users with occasional users who participate in evening events. Because of the expected night-time expected use parking areas should consider adaptive lighting that advances levels that are inviting and provide safety, while not overlighting conditions particularly during low-peak times. Additionally, consideration should be given to Public Parking structures where lighting may be in line of sight to Oceanfront Environmental Zone, even from long distances. Luminaires and lighting within line of sight to Oceanfront Environmental Zone shall comply with the requirements in the Coastal districts within the Miami Beach Citywide Lighting Standards.

2.8 City Hall / City Services

Adjacent to the Convention Center District, the City Hall campus is a contiguous district serving as the center of City administration uses, while City Services span across the City of Miami Beach and include uses such as schools, sanitation, utility administration, and safety services. While most of the uses with the City Hall / City Services District will occur during daytime hours, lighting should be adaptive to sporadic nighttime activities and events as needs arise, particularly in emergency situations.

Figure 6- City of Miami Beach City Hall

2.9 Oceanfront Environmental

Figure 7 - Miami Beach Beachwalk near 17th Street

This zone is unique in that requirements are not defined by land use, but rather is an overlay across multiple districts and some local corridors along the oceanfront coast. Driven by the environmental regulations set by the Florida Fish and Wildlife Conservation Commission (FWC), this overlay is meant to set a standard across CMB that is adaptive to the nesting schedule of threatened or endangered loggerhead, green, and leather back sea turtle populations. Some lighting conditions have shown to disrupt sea turtle nesting activities resulting in nesting failures and fatalities from disorientation. This zone was established primarily at the coastal construction line (CCL) to inland corridors and buildings which shield lighting conditions within coastal areas. Consideration was also given to any lights within line of site of the nesting areas. In this zone, all lighting should be amber in color, for approved use by the FWC.

2.10 Lincoln Road Pedestrian Mall

Lincoln Road Pedestrian mall is a unique destination use of retail and dining serving primarily local and visiting pedestrian users, as passenger vehicles are prohibited within this zone. With the scale and character of this linear space designed to a human scale, lighting conditions need to consider safety. Lighting conditions also need to exhibit a scale and detail that enhances human interaction, placemaking and space activation.

Figure 8 - Shopping and outdoor seating line this popular shopping destination

3. Design Approach

The matrix fond in **Appendix E** is the lighting design matrix to establish the lighting requirements specific to each zone. This matrix covers overall lighting levels, color temperature, lighting specification, fixture style and controls sequence to be applied to each zone. This matrix was developed to set the minimum lighting standards to be used in each lighting zone. The lighting levels numbers were based on likely pedestrian traffic and function of the roadway. The controls sequence was based on expected pedestrian activity, and consideration to light trespass in the area. For further information and lighting standards refer to the Miami Beach Citywide Lighting Standards in **Appendix B**.

4. Analysis of Existing Lighting

A citywide photometric study was performed in 2017, which can be found in **Appendix D**. Citelum measured and recorded the lighting levels in foot-candles of all roadways within CMB. This report indicated areas that were over and below standard lighting levels. In general, it was found that most major and collector roadways were below standard and local loads were above standard and most roadways within the project area meet the criteria for average to minimum uniformity ratios. Most of the poor uniformity ratios were found on expressways and major roadways. It will be the smart city Contractor's responsibility to perform lighting calculations with proposed light fixtures on all roadways to ensure lighting levels and uniformity ratios are maintained based on the Miami Beach Citywide Lighting Standards.

For the environmentally sensitive areas, further analysis of site context needs to be determined as conditions change. All lighting needs to align with requirements set for sea turtle lighting criteria. Close attention should be paid to areas noted in the Citelum report which have been identified as being insufficient.

Maps of the above standard and below standard areas within CMB can be found in Section IV of the Citelum Report. Most of the below standard areas were found on collector and major roads, like Chase Ave and N. Bay Road. A list of the main areas noted to be deficient in the Citelum Report are noted in Table 1, however it's the Contractors responsibility to verify and rectify all deficiencies within the project limits.

Table 1, Deficient Lighting Areas

Area	Roadway	Below Standard	Above Standard	Poor Uniformity
North Beach	Normandy Drive	√		√
	71st Street	√		
	Abbott Avenue and Collins Avenue		√	
	South Shore and South Drive			√
	Fairway Drive			√
	Collins Ave	√		√
	Most Roads running North/South			√
	Biscayne Point Circle			√
Mid-Beach	Alton Road	√		√
	Pine Tree Drive	√		√
	La Gorce Drive	√		√
	Collins Ave			√
	Julia Tuttle Causeway	√		√
South Beach	Venetian Causeway	√		√
	1st Street through 21st Street		√	
	Washington Avenue		√	
	Meridian Avenue		√	√
	MacArthur Causeway			√
	East of Collins streets 28th through 42nd		√	√
	15th and 16th Street			√

Note: All areas noted in table are based on the Citelum Report and are a sample of the largest overall deficiencies within the City.

Based on the Citelum report, areas that fall below or above the standard are not isolated to a specific region or one neighborhood of Miami Beach. Because this report addresses one-for-one replacements only, it is recommended that as improvements or enhancements occur across the CMB, lighting for these respective efforts considers adjacent lighting levels to maintain uniformity. For all corridors and districts, it is recommended that illumination shall only occur within publicly owned-maintained spaces to prevent light trespass, particularly when light trespass could occur within environmentally sensitive areas and through windows of residential zoning districts or land uses. This lighting trespass can be mitigated by using luminaires with good glare and backlight control.

Adaptive lighting shall be considered to control uniformity throughout the City, particularly where public properties are adjacent to private property. There are also corridors and districts which may benefit from varying lighting levels that are based on frequency of use and/or presence of users. Scheduled adaptive lighting can provide adequate lighting levels, while conserving energy, and preventing overspill between weekday and weekend users, as well as for intermittent night-time events.

The Miami Beach Citywide Lighting Standards was created to provide more uniformity in lighting levels across the city, as well as provide guidance for all future improvements and enhancements. It is recommended that further lighting measurements be collected to remedy areas below or above the standard. For below standard areas the lumen output of the luminaire should be evaluated and adjusted to a higher lumen equivalent than the existing light fixture to be replaced, however, consideration must be given to ensure uniformity ratio is maintained.

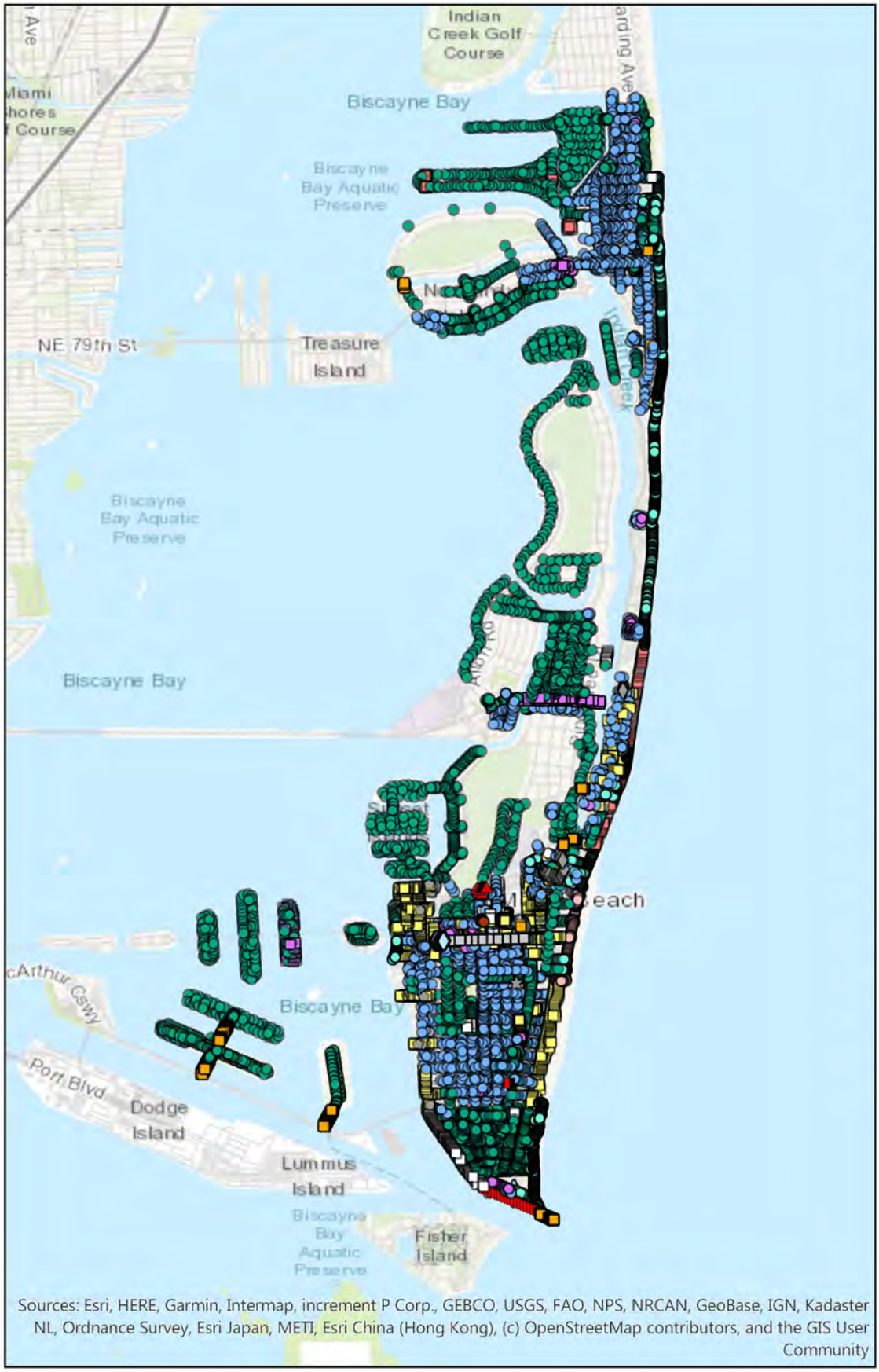
Above standard areas were found mostly in the north beach and south beach areas. Caution should be given when changing lighting in above standard areas, since some of these areas may be above standard for crime prevention reasons. If area is deemed above standard and not designed so on purpose, these areas should be evaluated and adjusted to a lower lumen equivalent than the existing light fixture to be replaced. However, further consideration must be given to ensure uniformity ratio is maintained.

For areas with poor uniformity ratios the optics of the luminaire must be evaluated to see if different optics may yield better uniformity ratios. Typically, on roadways a Type II or Type III optical distribution is preferred which creates longer oval shape pattern of light. Most uniformity issues are caused by the darkness located between two distant light fixtures, by elongating the optical area of distribution, this will allow light to reach these farther places helping to achieve a more uniform light level. In addition, the poor uniformity may just be caused by an obstruction like a tree in the area, so consideration should be made for location of fixtures relative to the landscaping in the area. The area may be remedied by just a simple tree trimming, or by shifting the pole. If these solutions do not work, then evaluation of additional poles may be required for this area to ensure uniformity throughout the roadway.

The Citelum report evaluated only lighting levels and the uniformity of adjacent roadways. The citywide standards must be used for further evaluation to ensure new lights have good optical control, are dark sky friendly, and meet the luminaire specification criteria required within the City.

The goal of this project is to put the right light at the right place at the right time. The city of Miami Beach contains over 9000 lights with roughly 169 miles of roadway to light. With the help of the citywide lighting standards in addition to this report, the smart city contractor will be able to successfully provide a lighting system that meets the city's safety needs and provide the delicate balance required for the environmental concerns as well.

Appendix A
Street Lighting Inventory



City of Miami Beach Street Lights

Fixture Model

- Barn Light
- Bollard
- Cap
- Cobrahead
- CrownCastle Cobra
- Double Cobrahead
- Flood
- Large Cage
- Louis Poulsen
- Memorial
- Other
- Pendant - Bell
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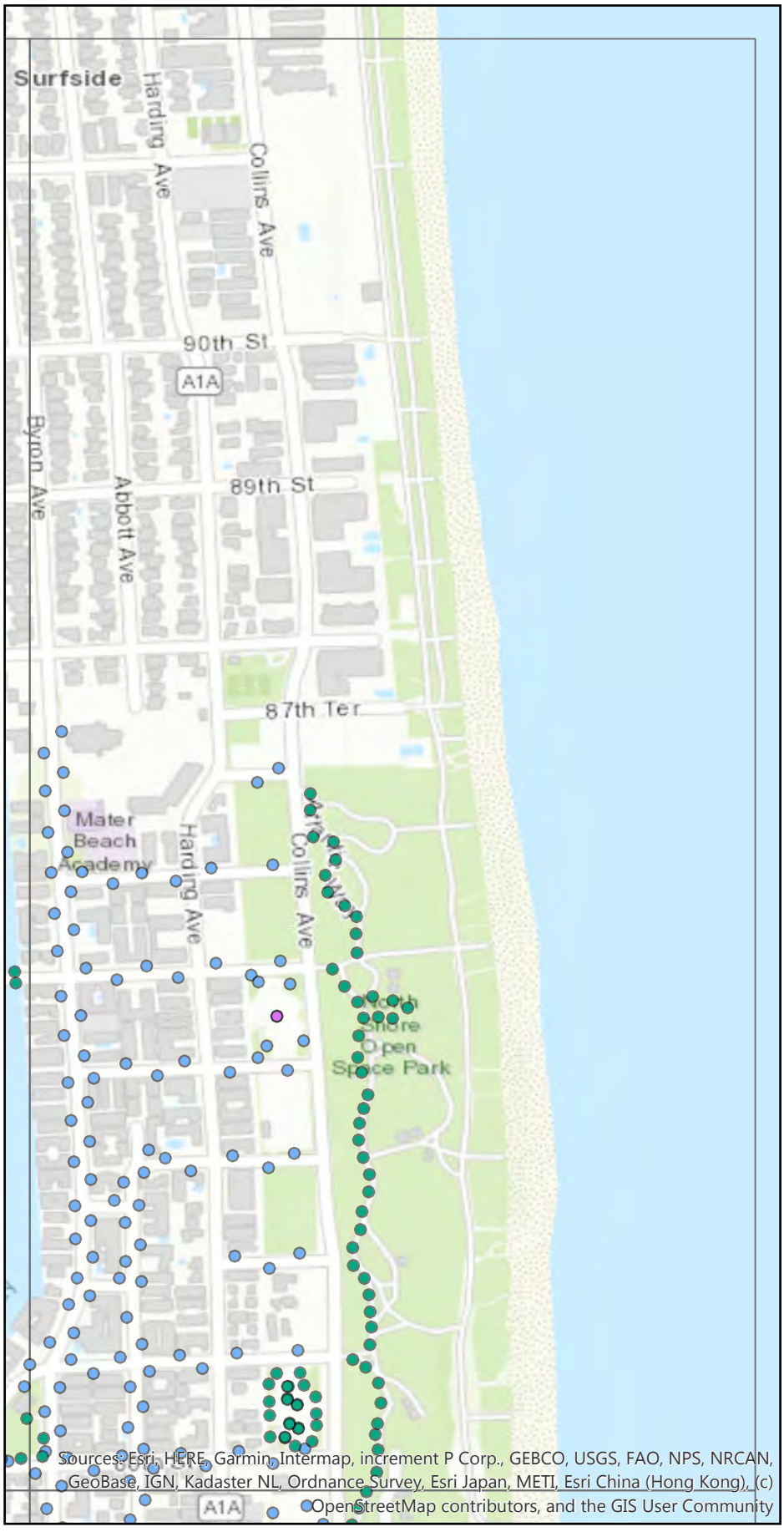

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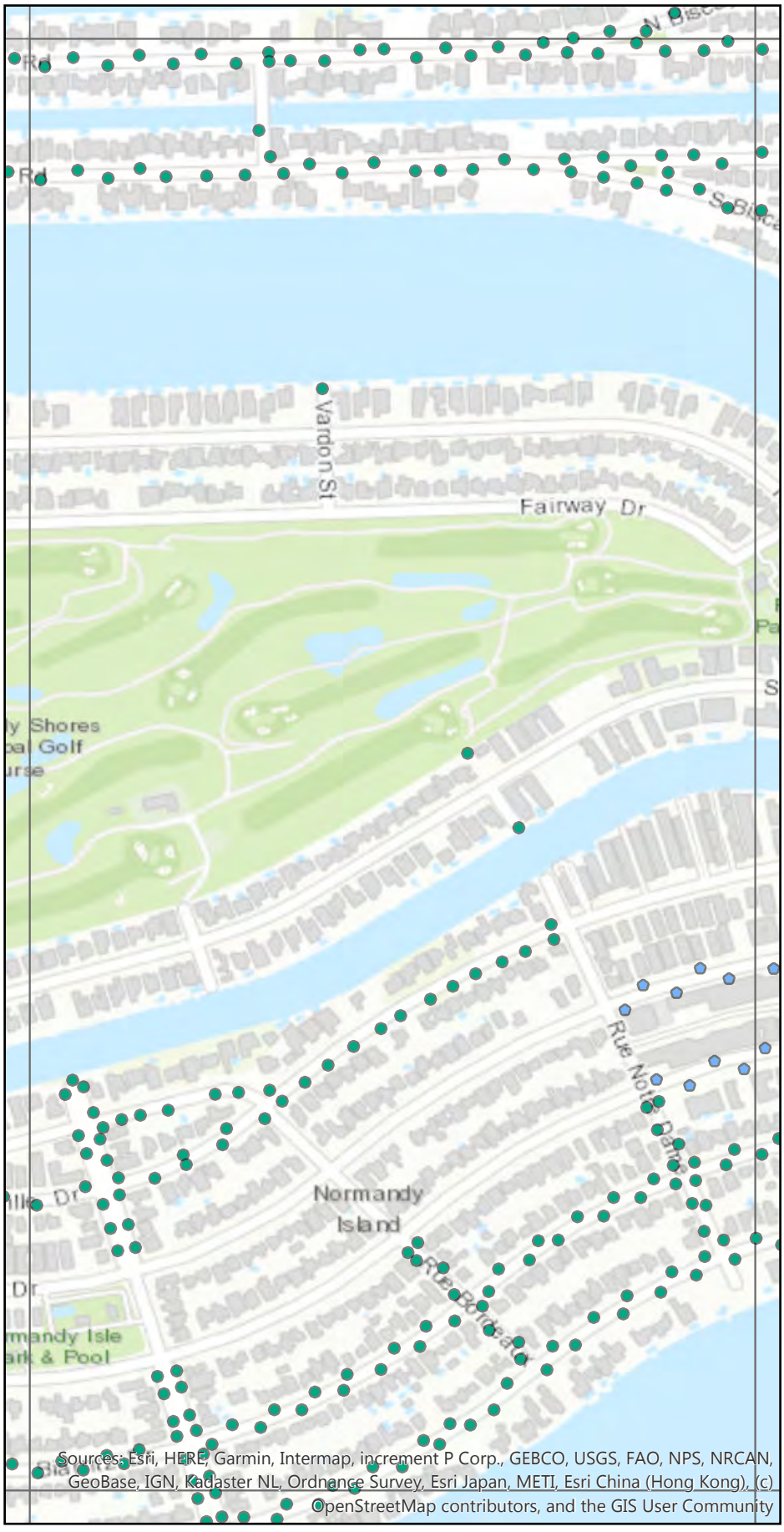

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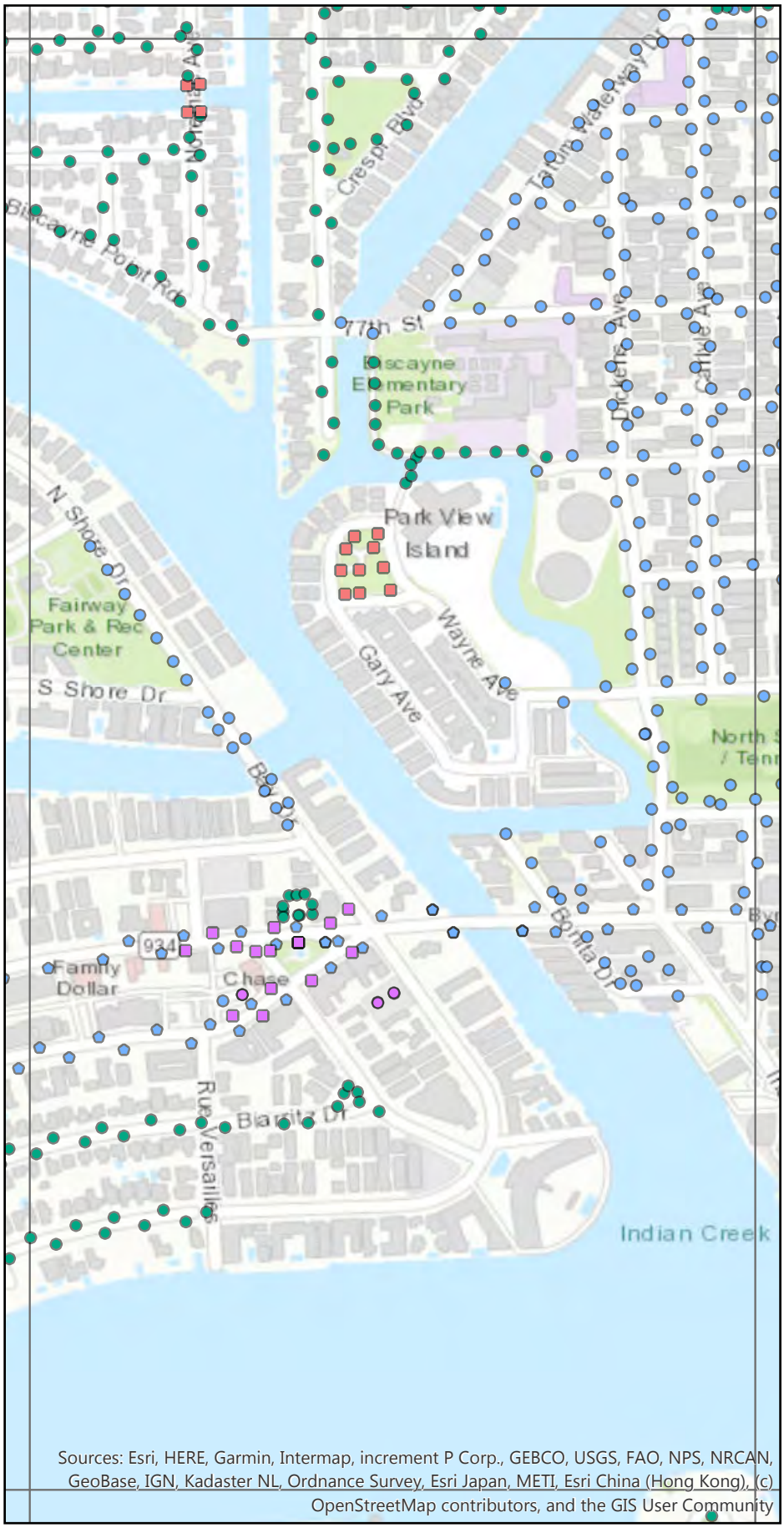

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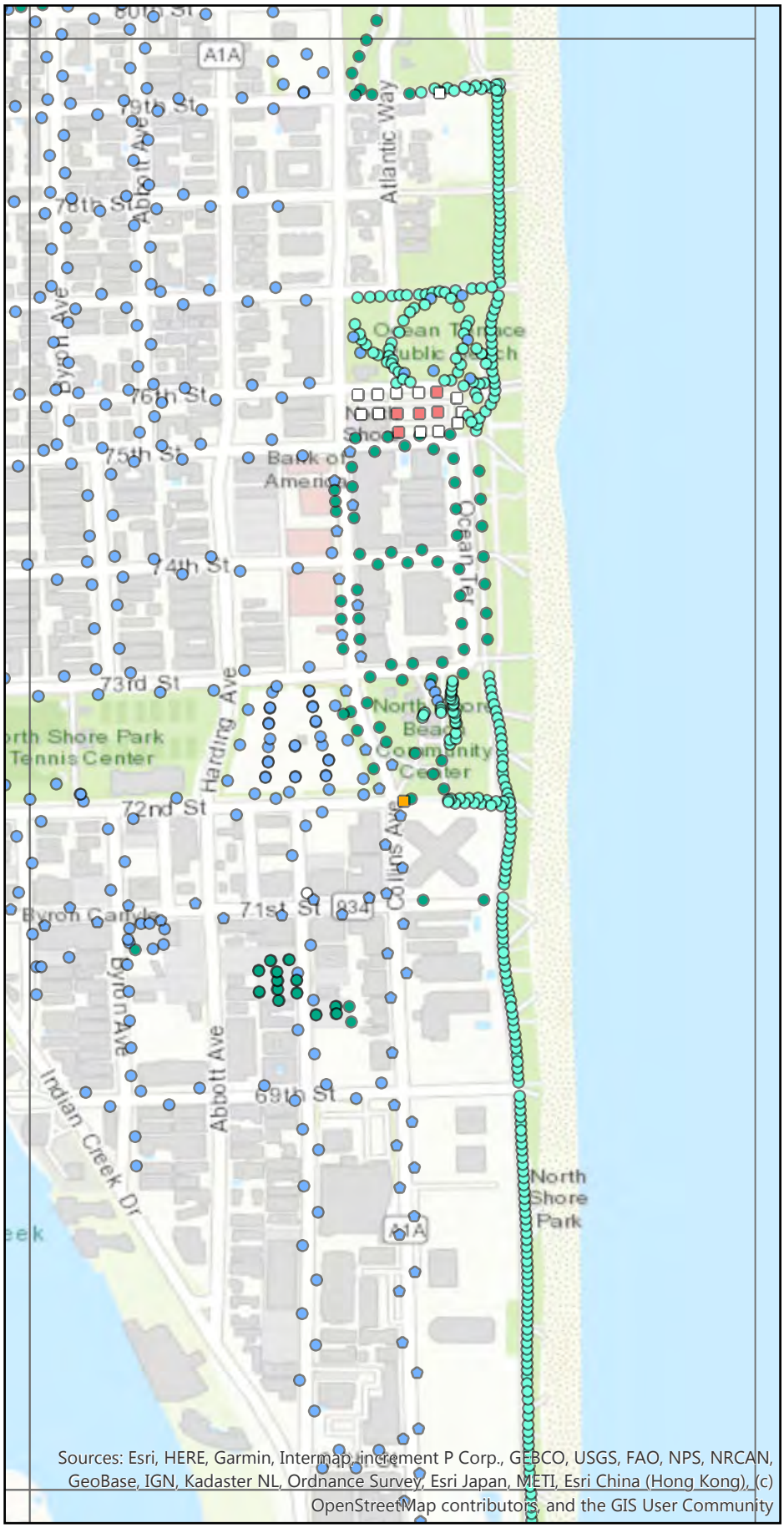

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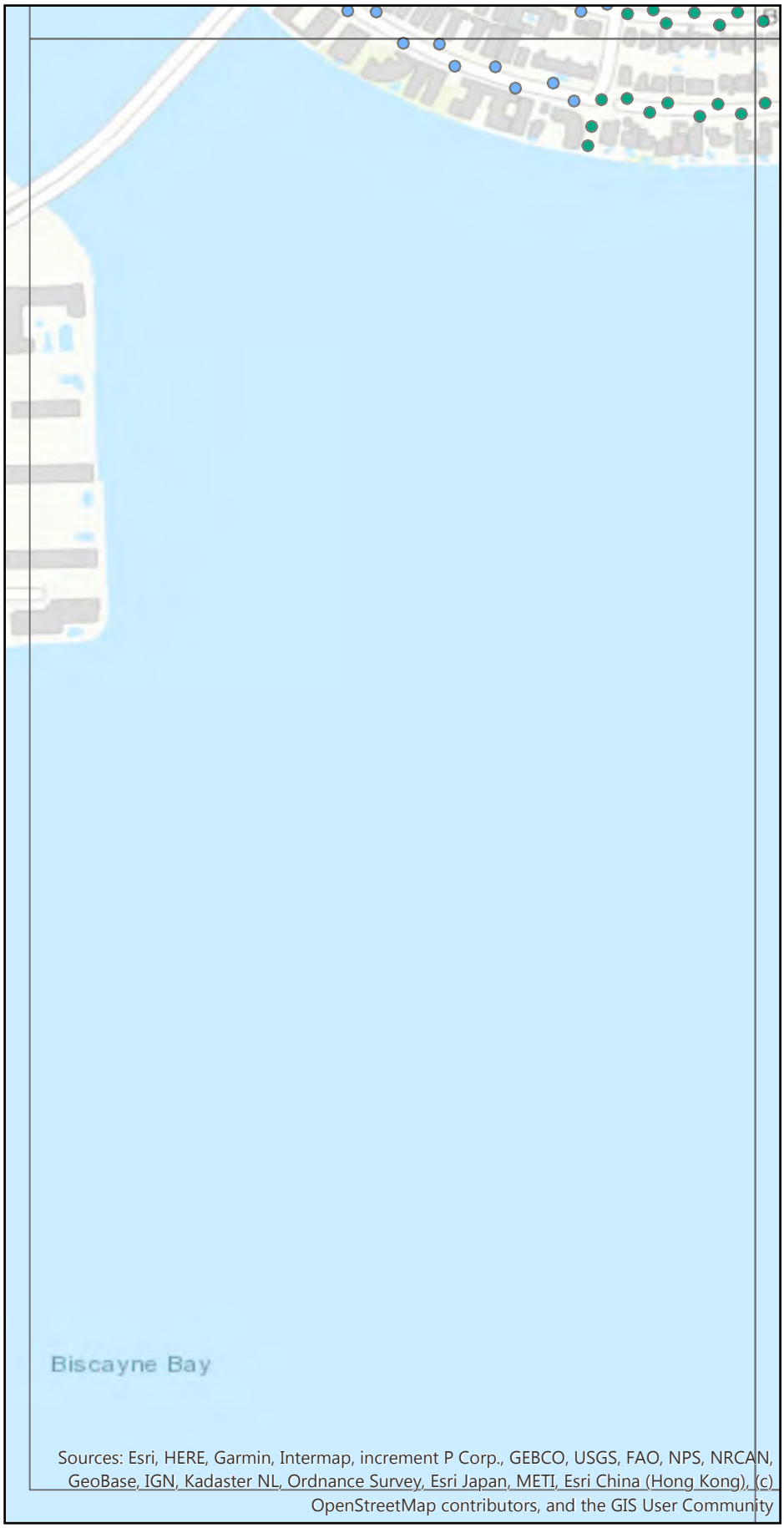

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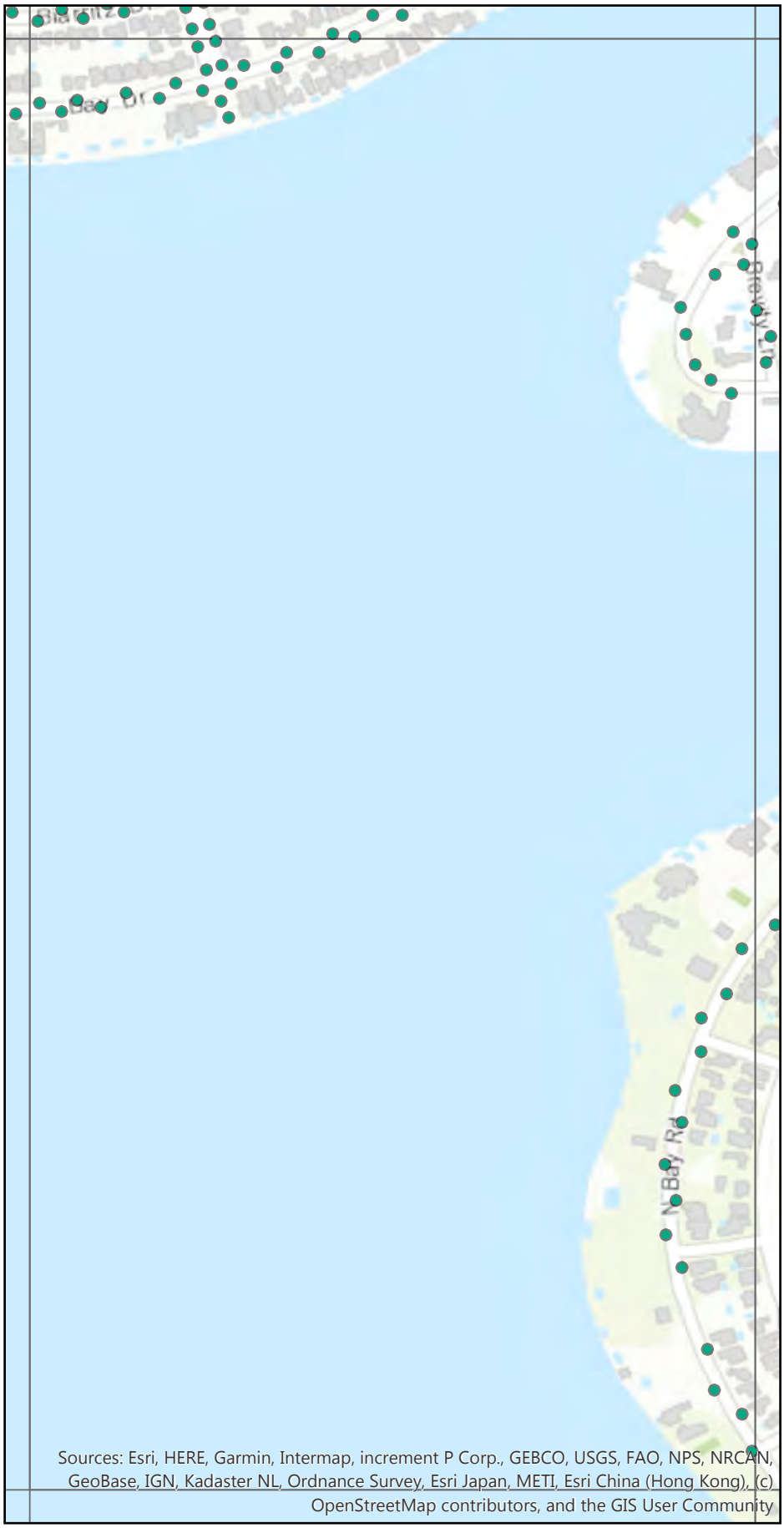

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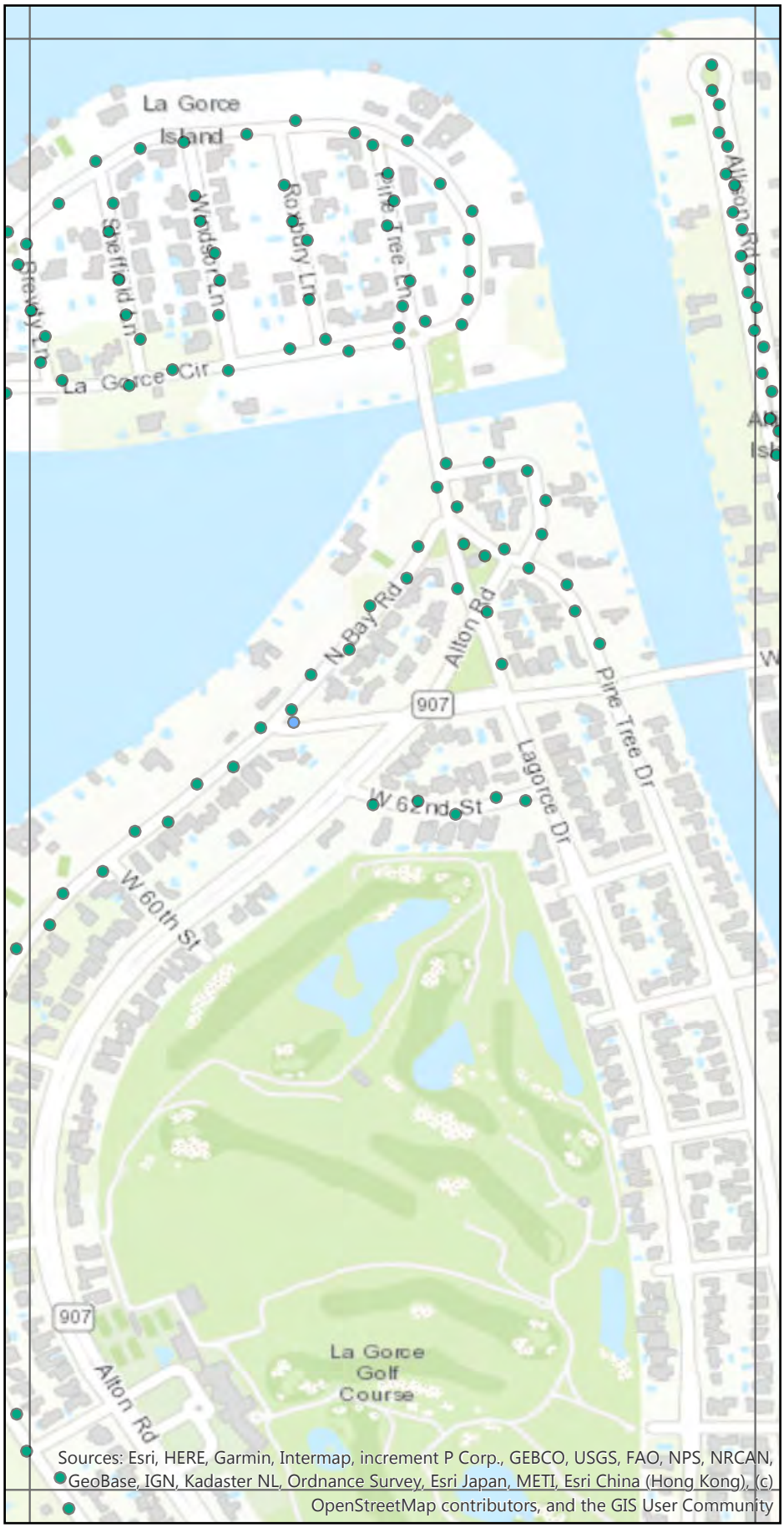

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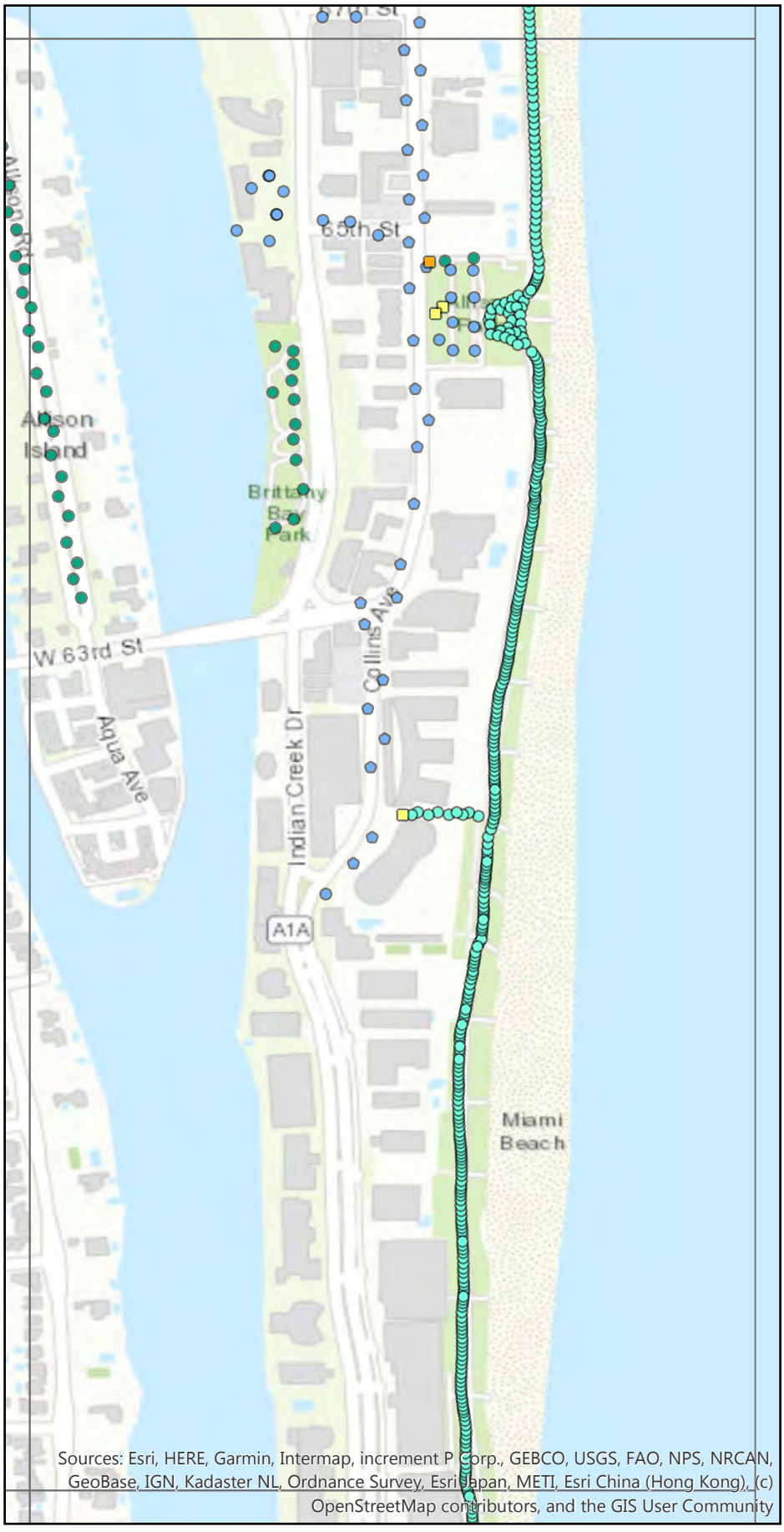

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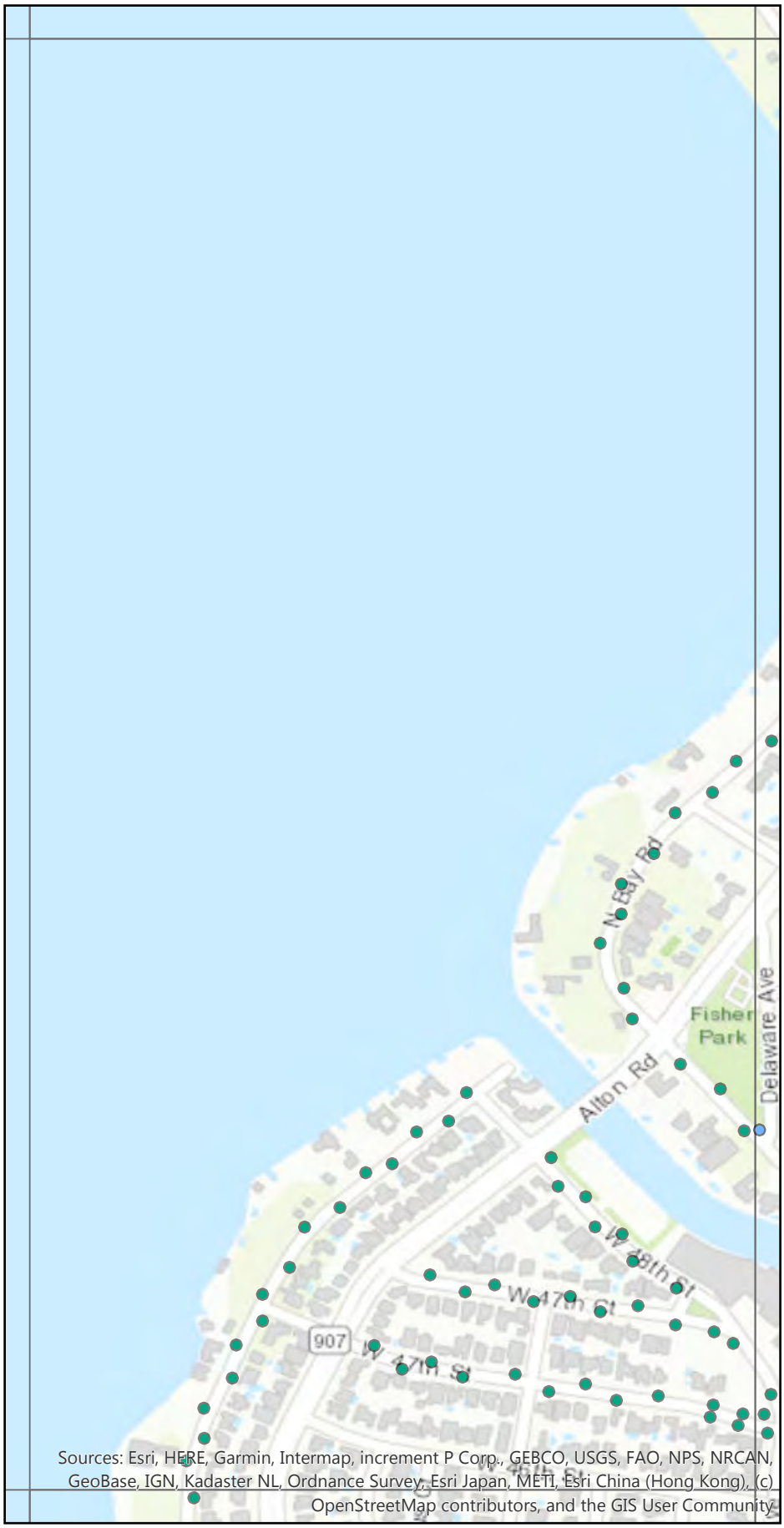

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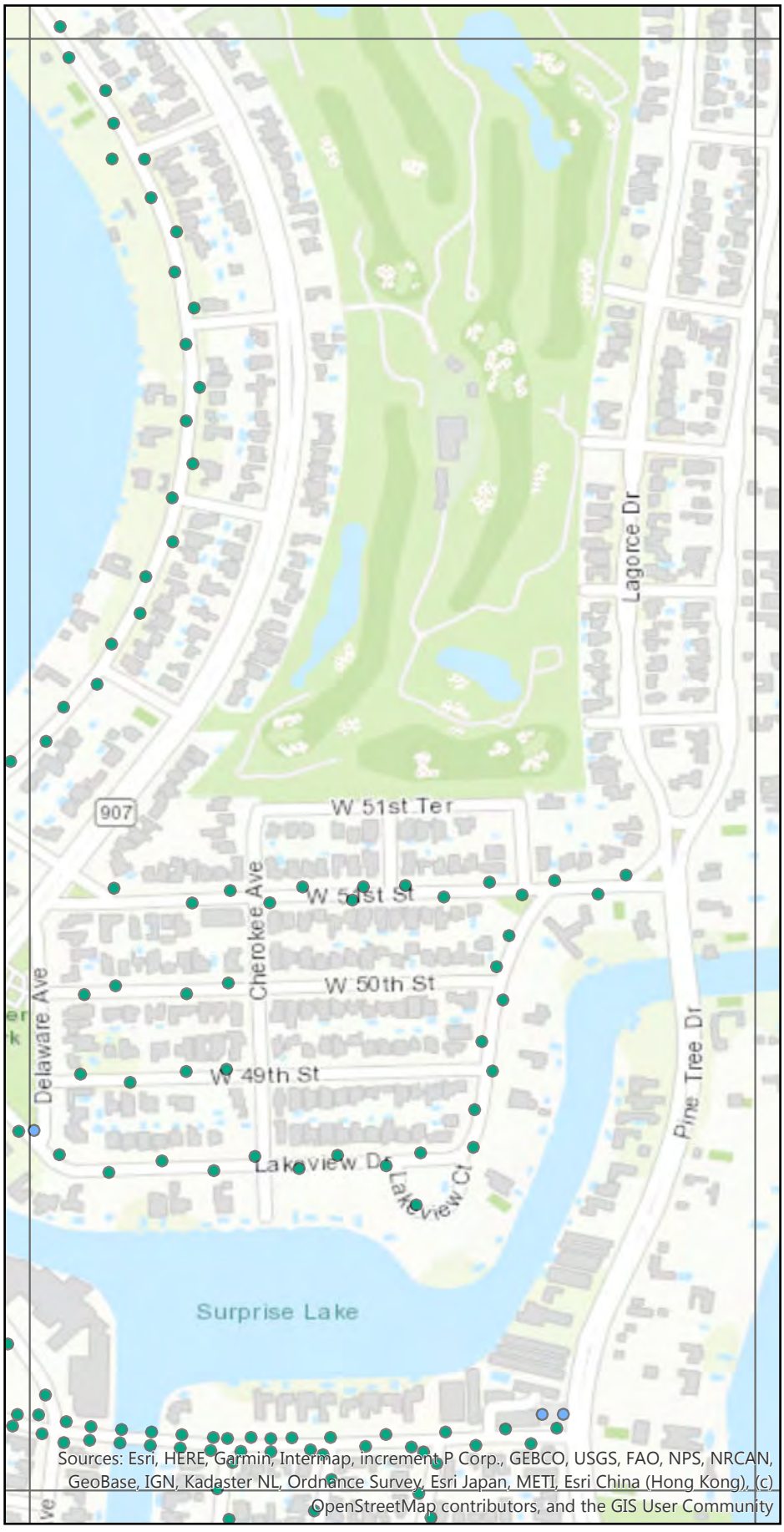

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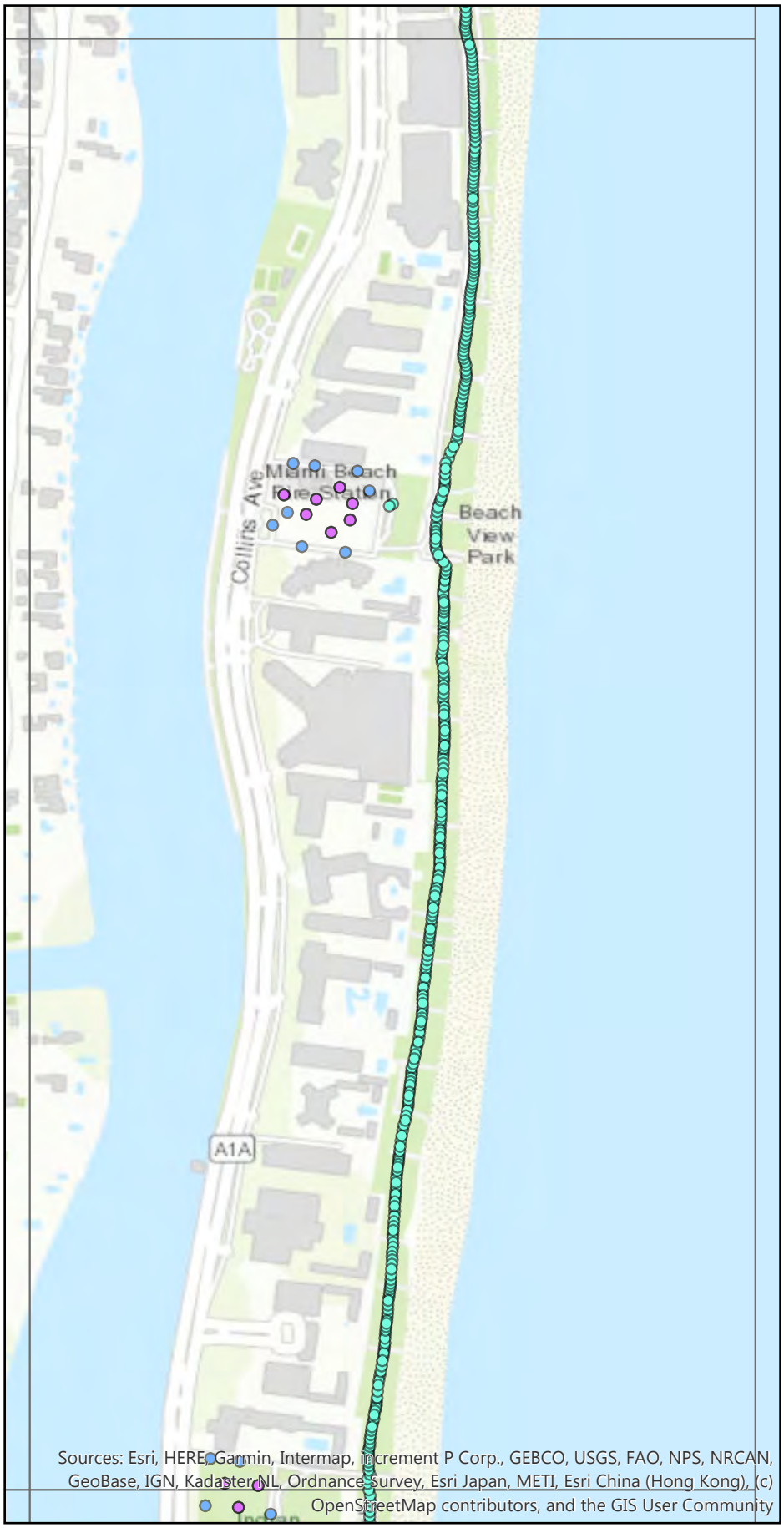

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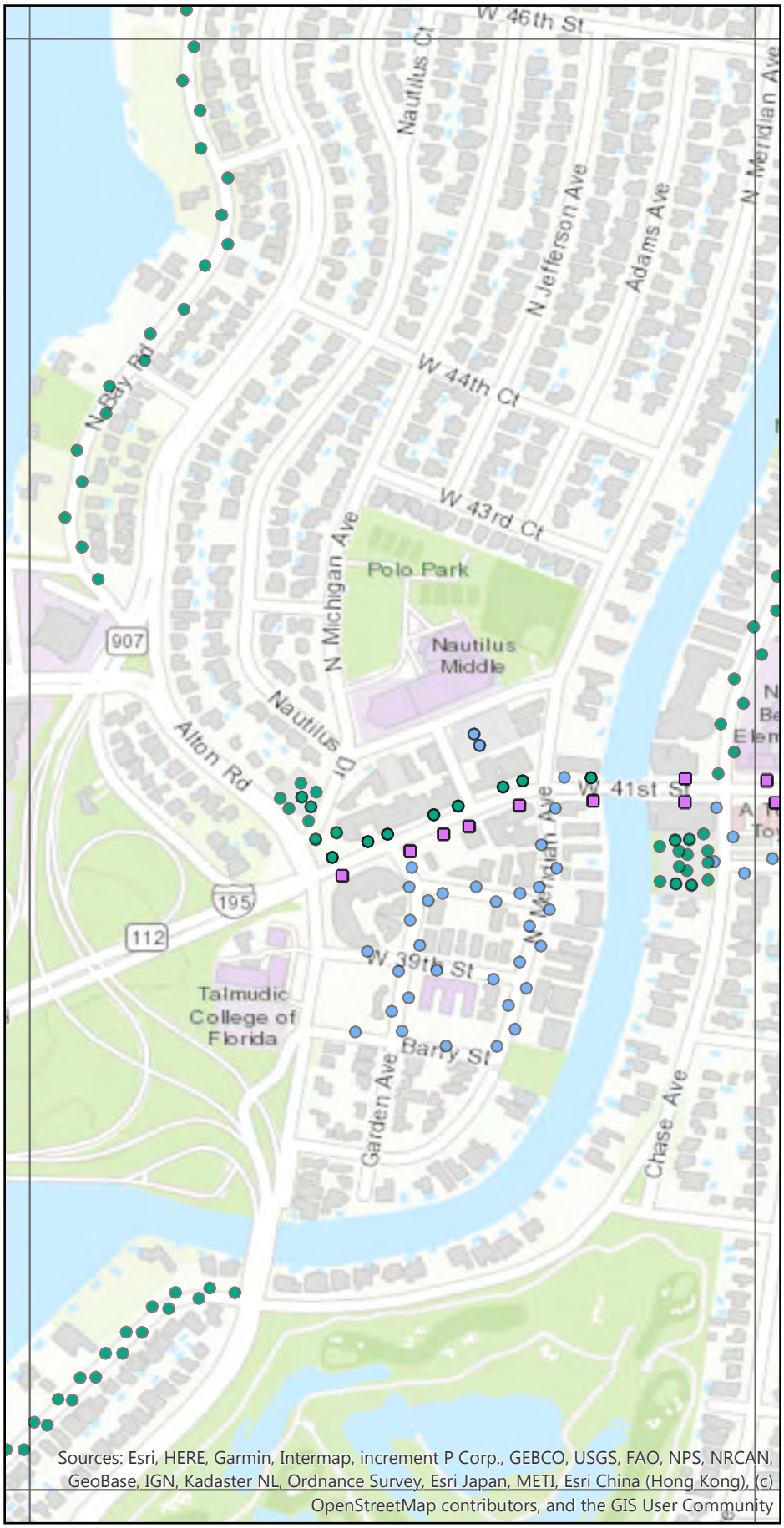

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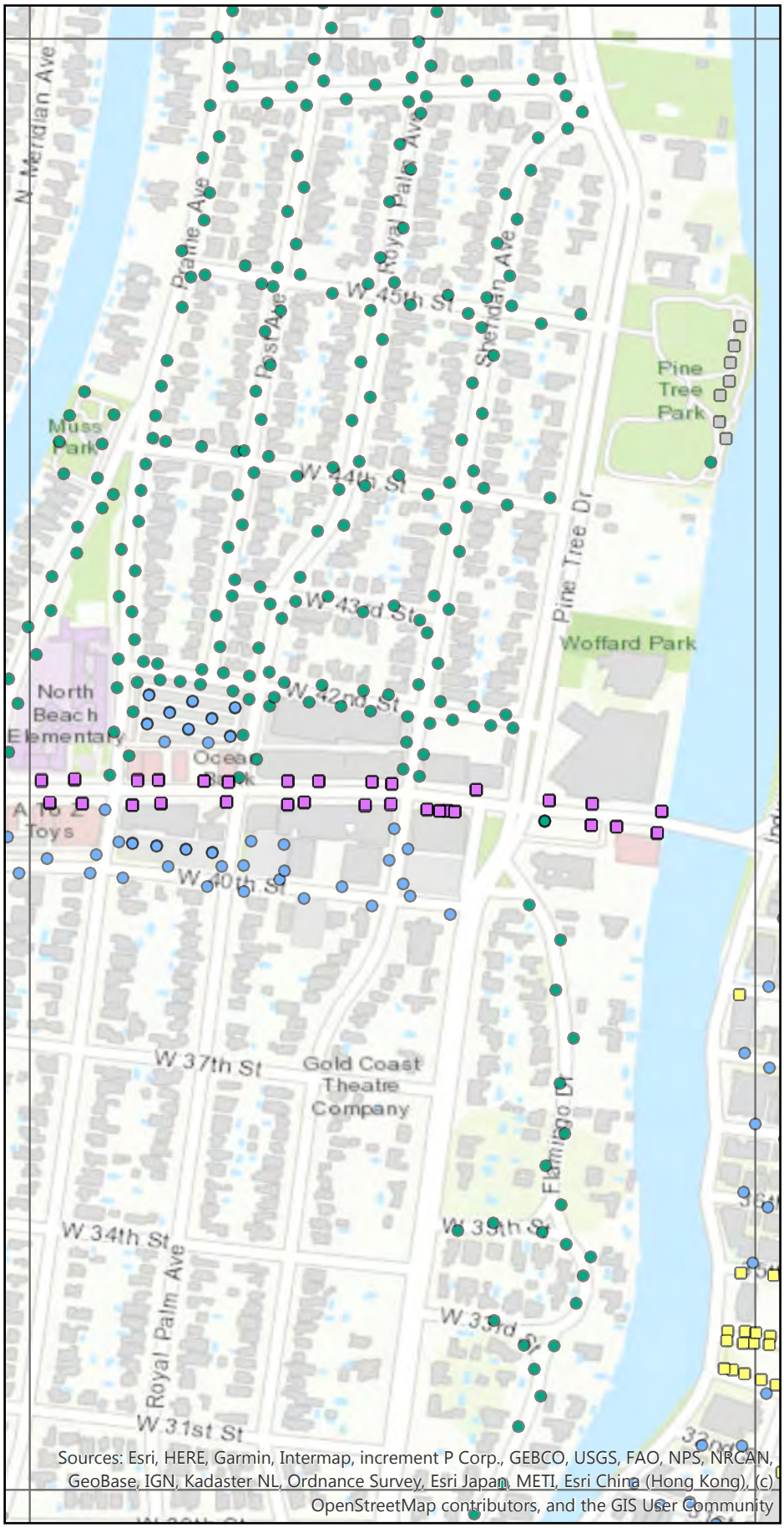

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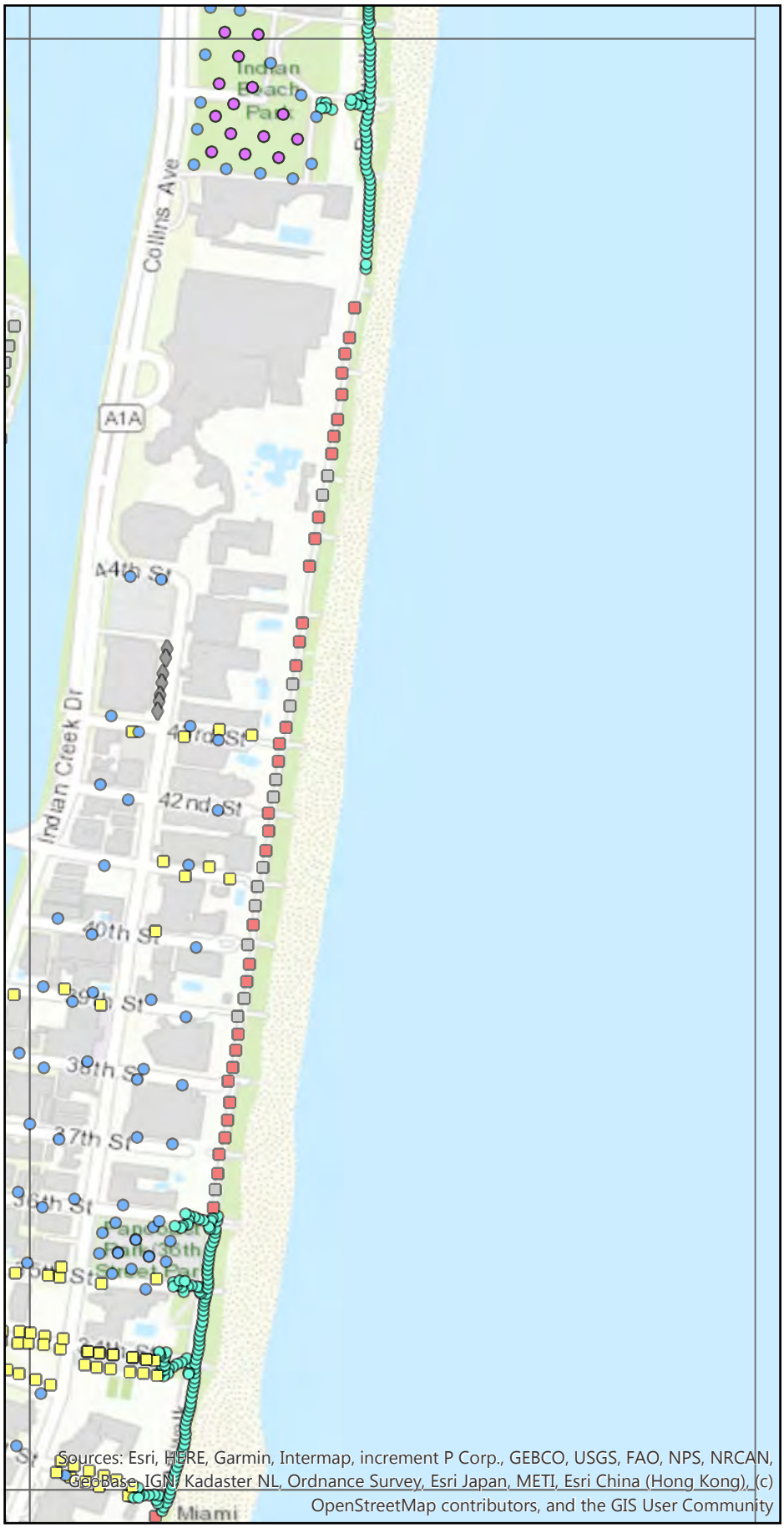

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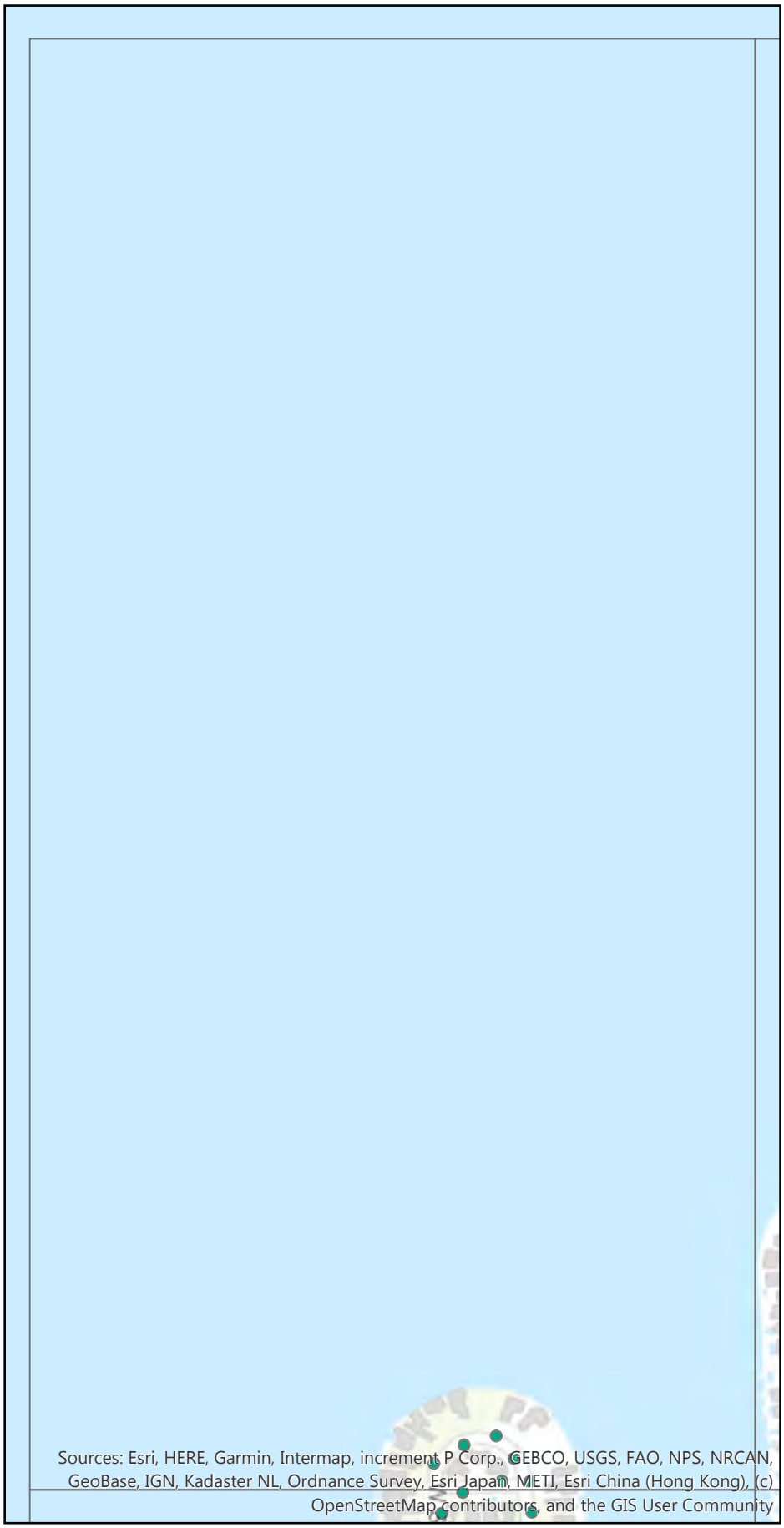

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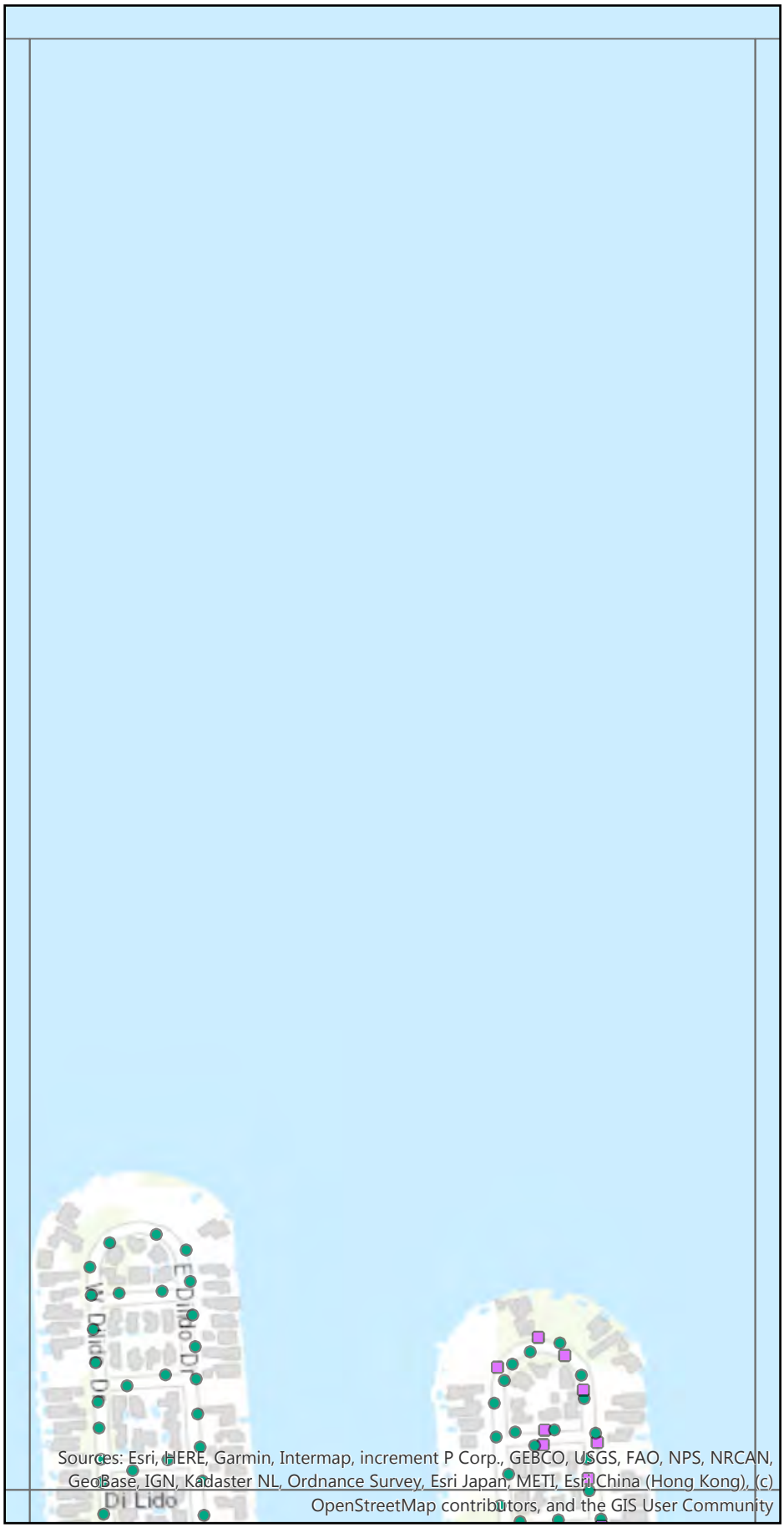

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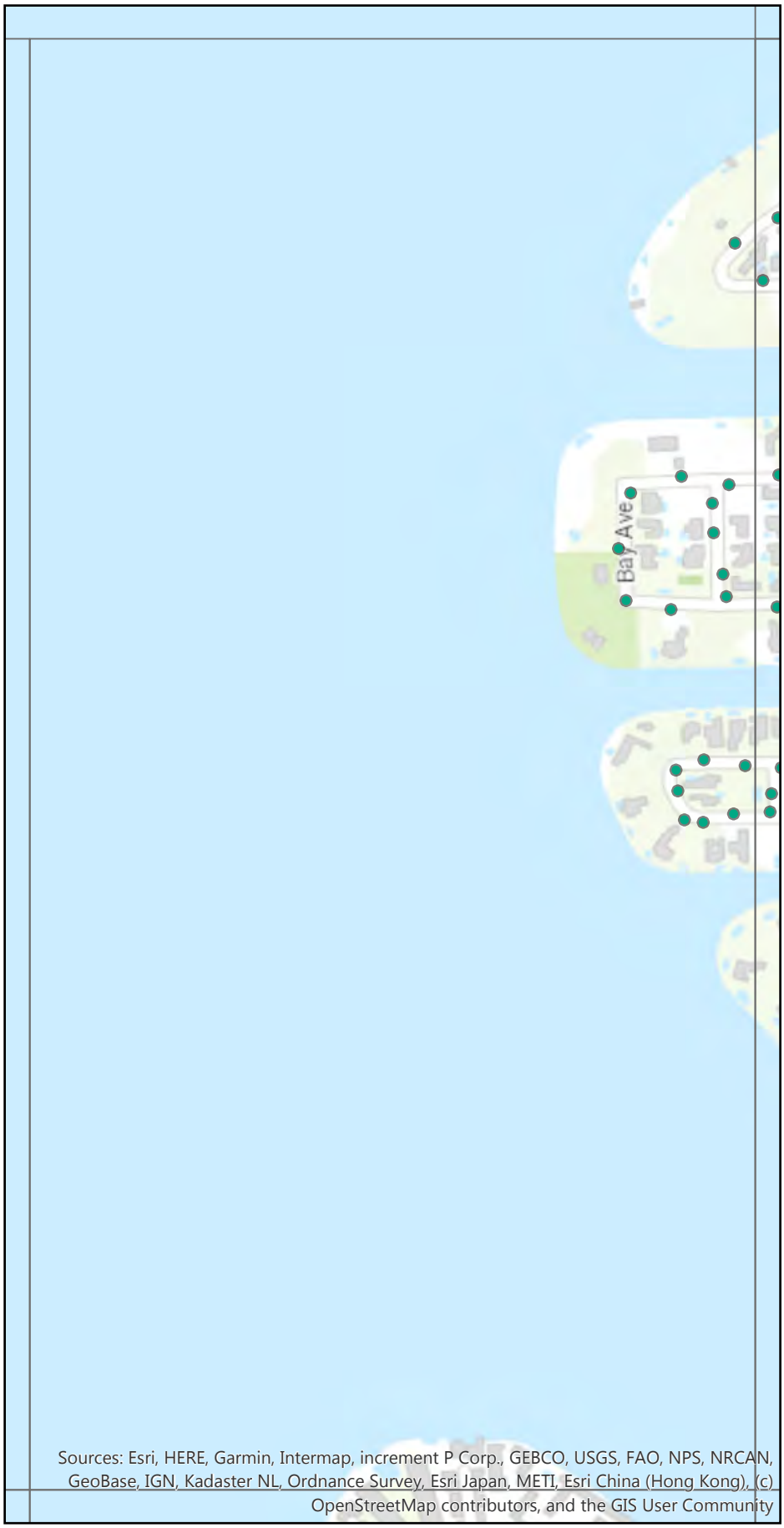

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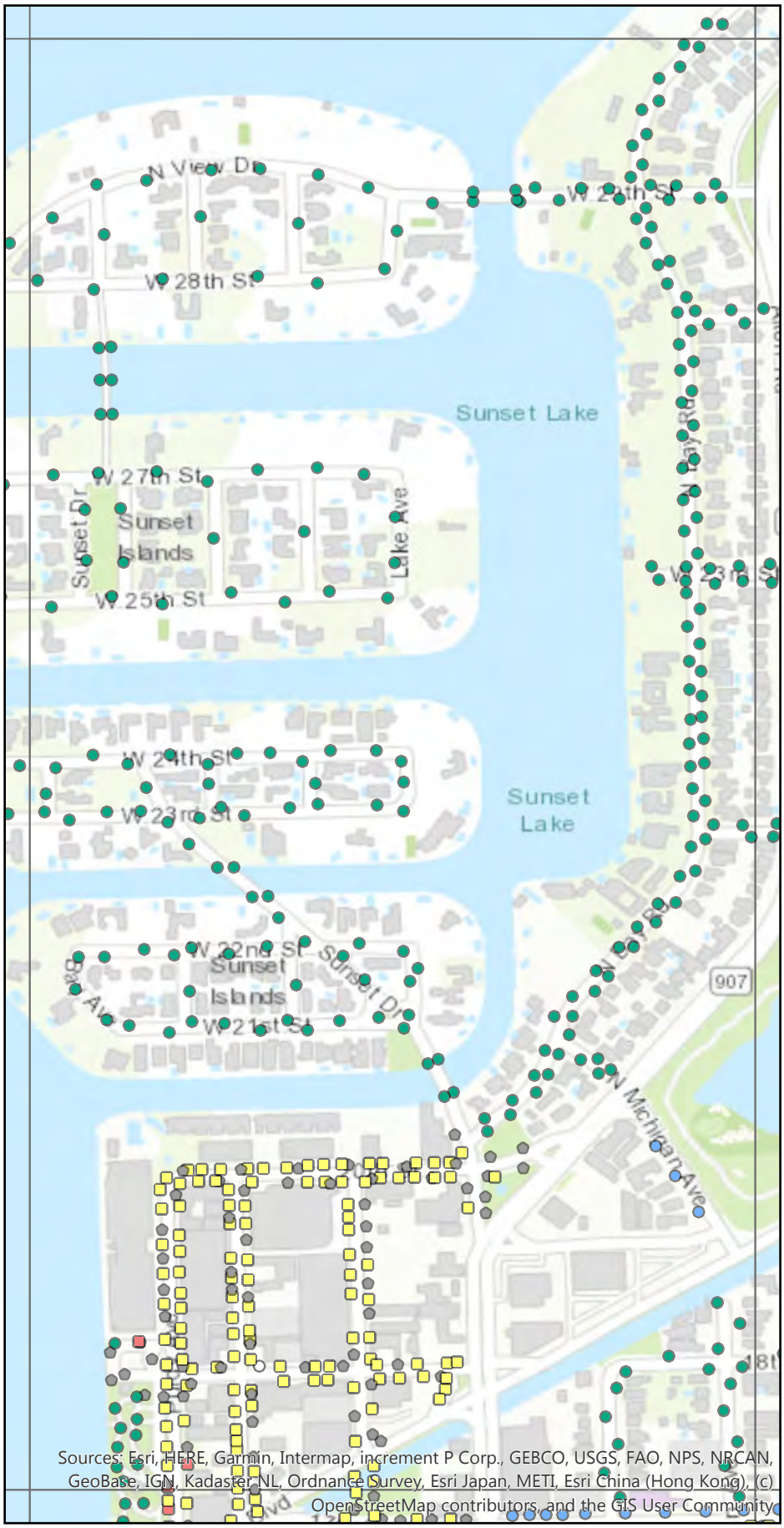

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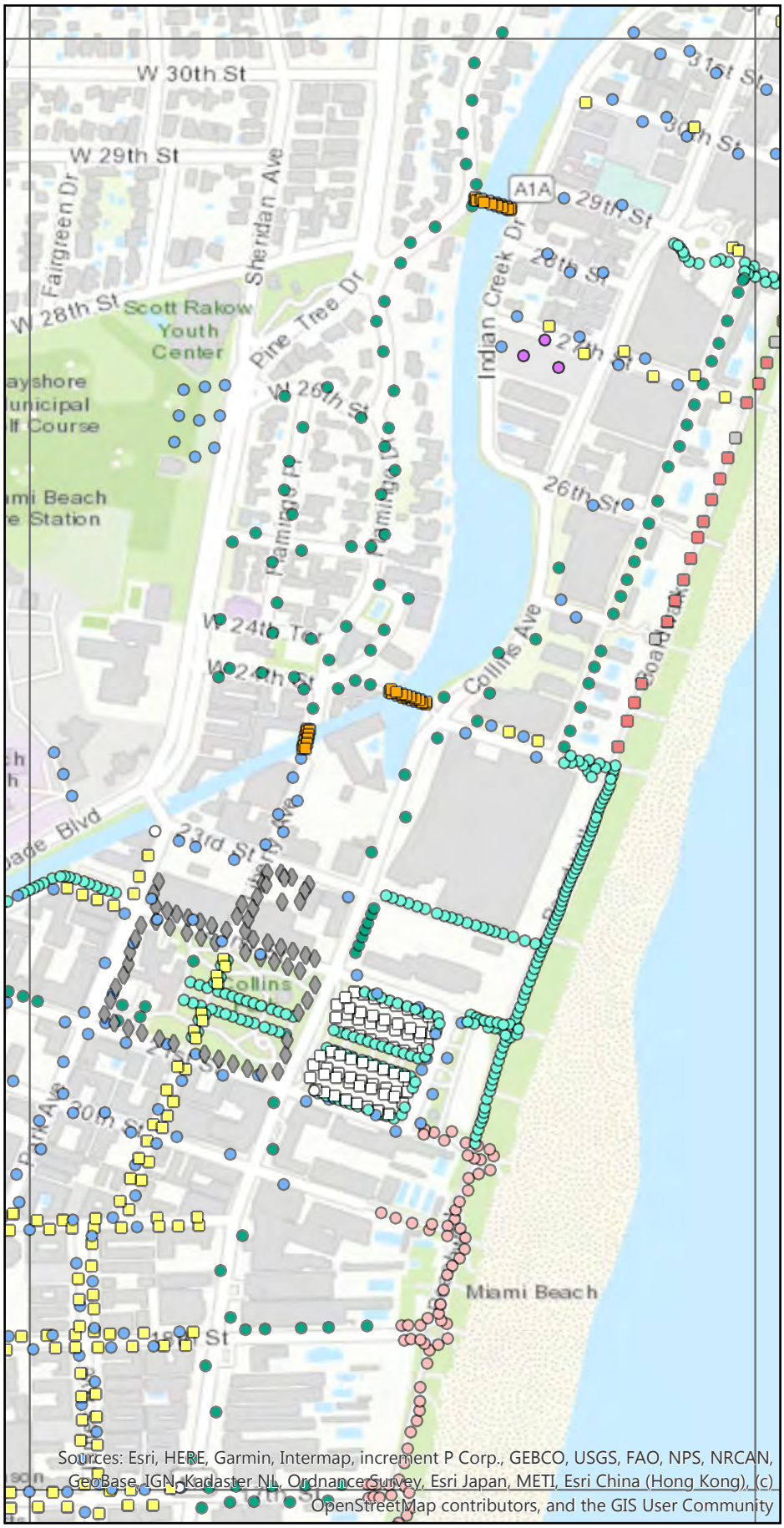

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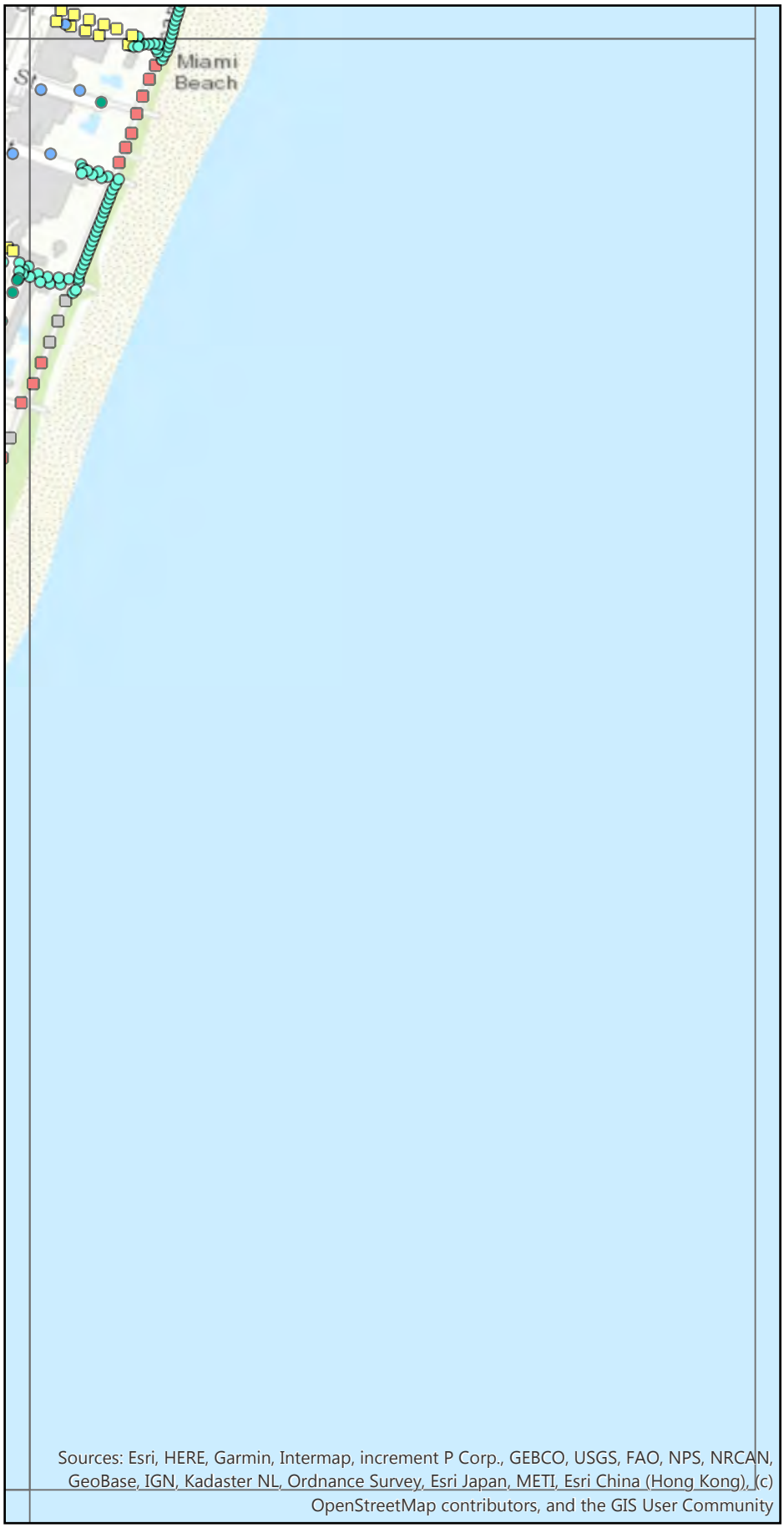

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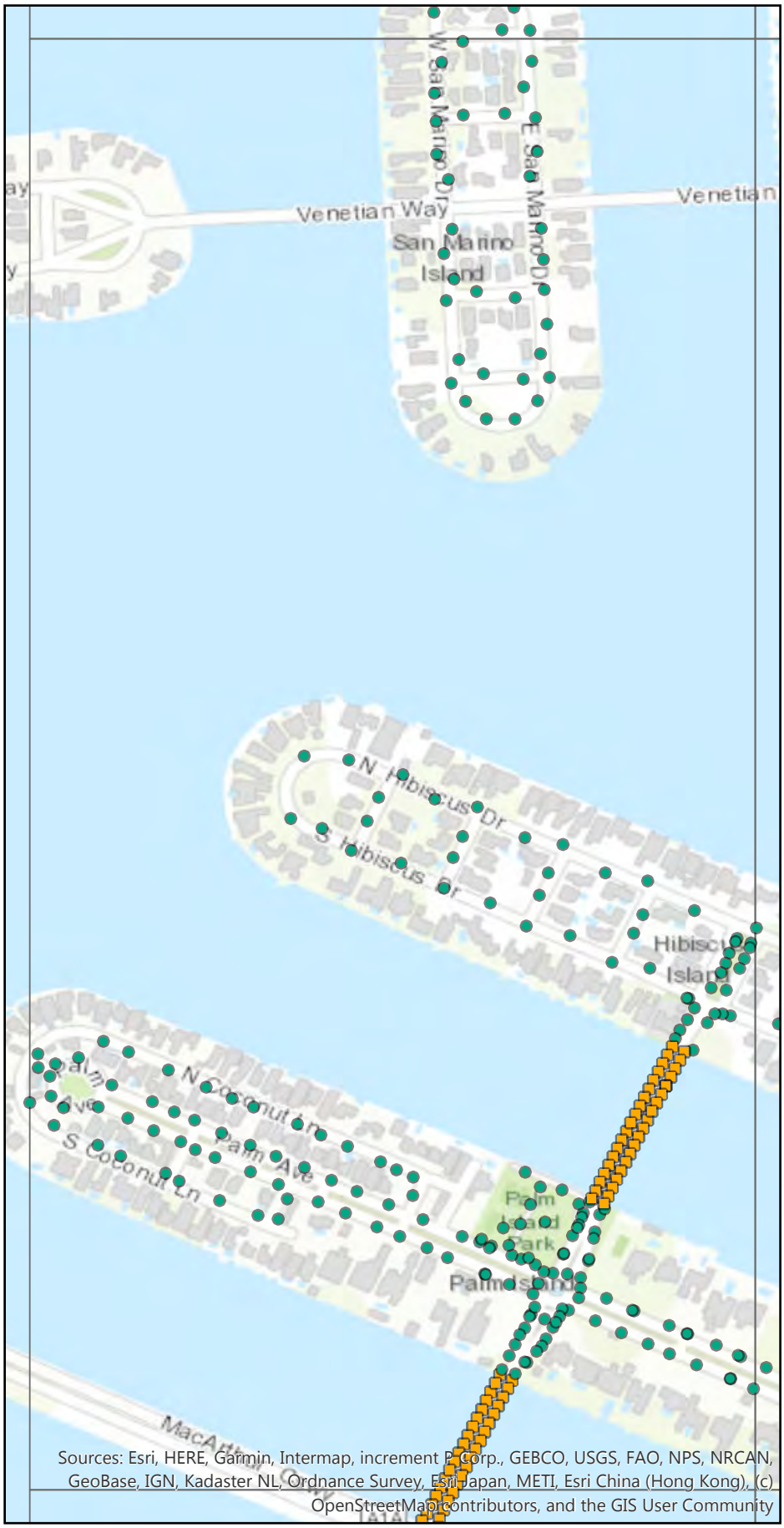

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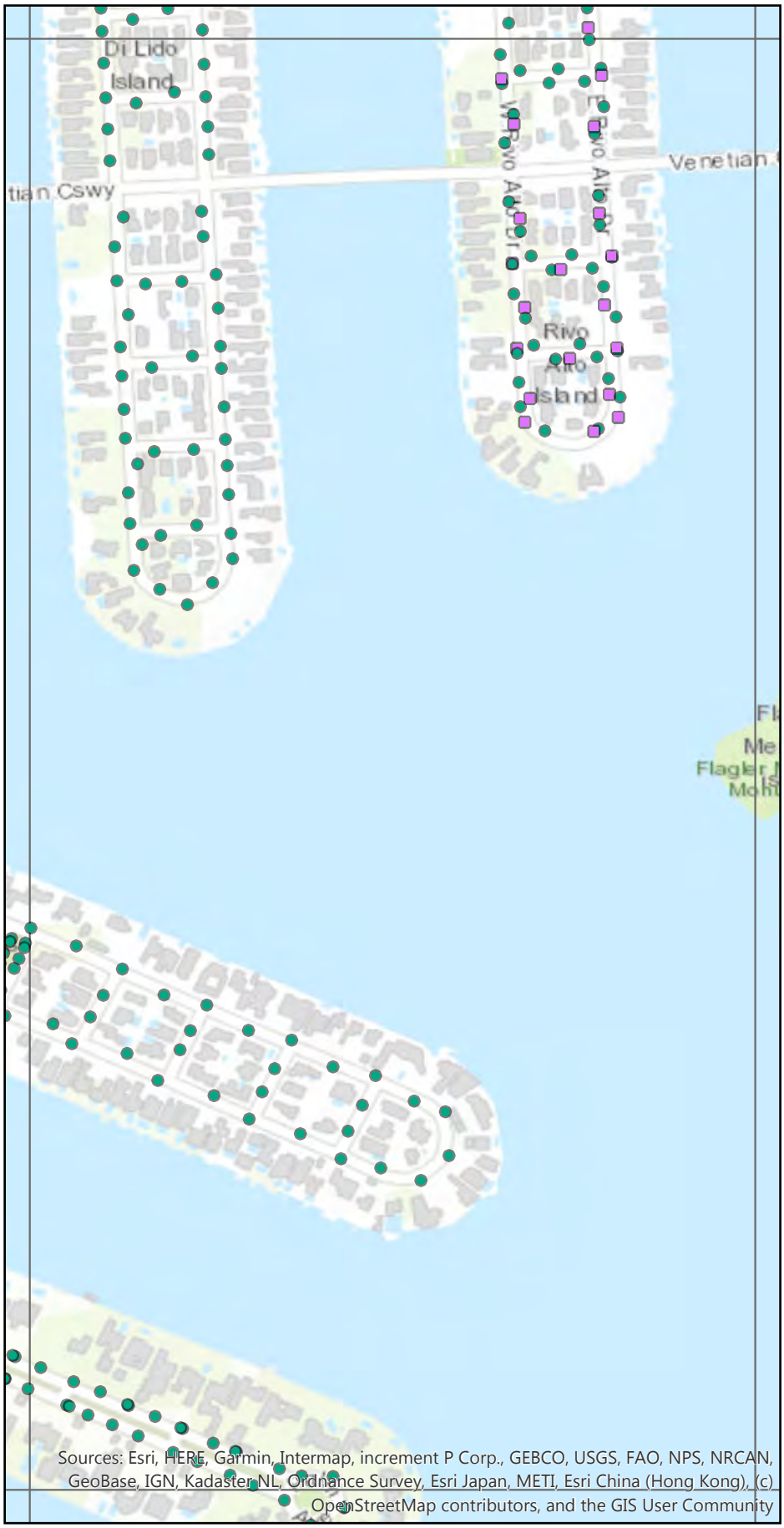

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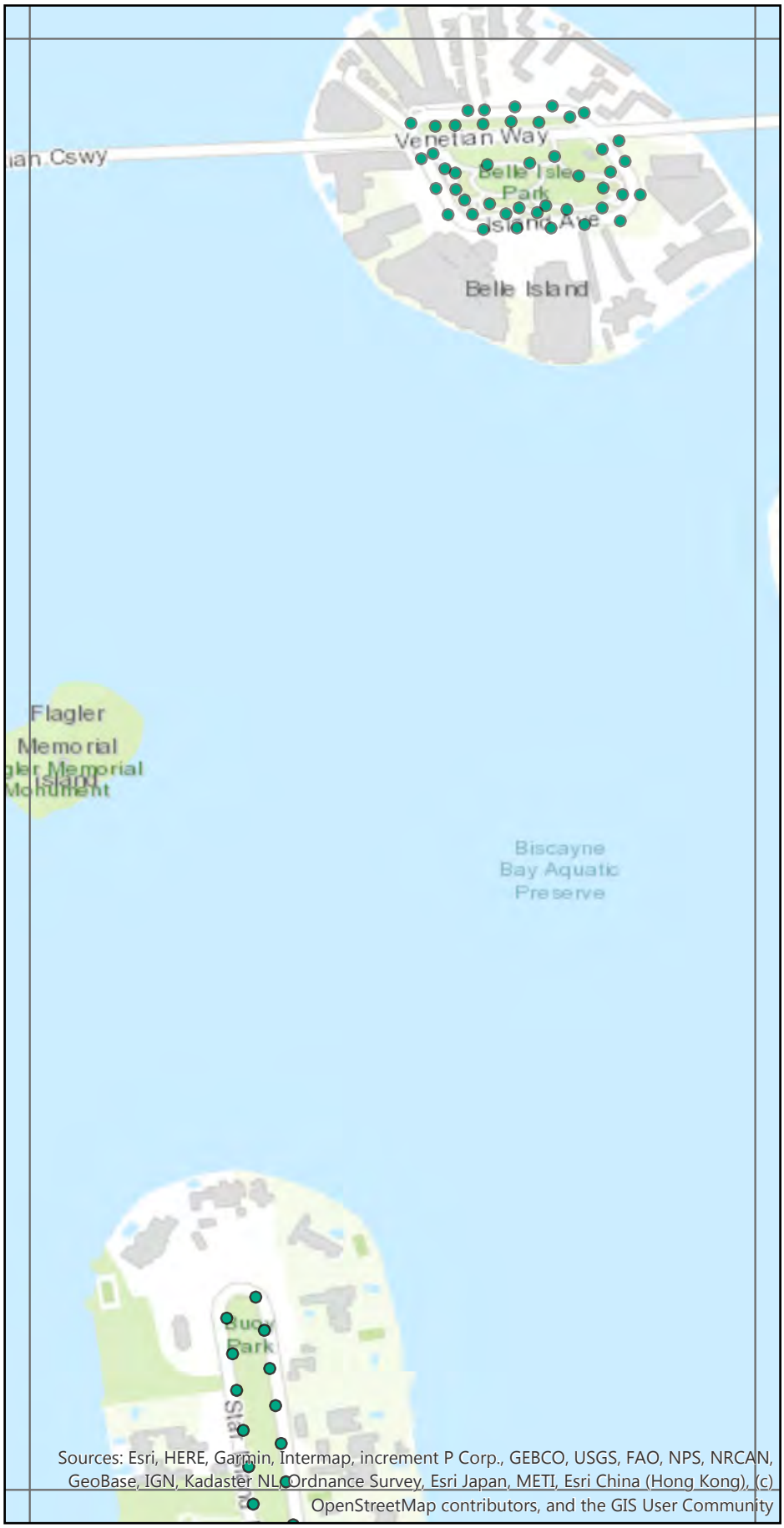

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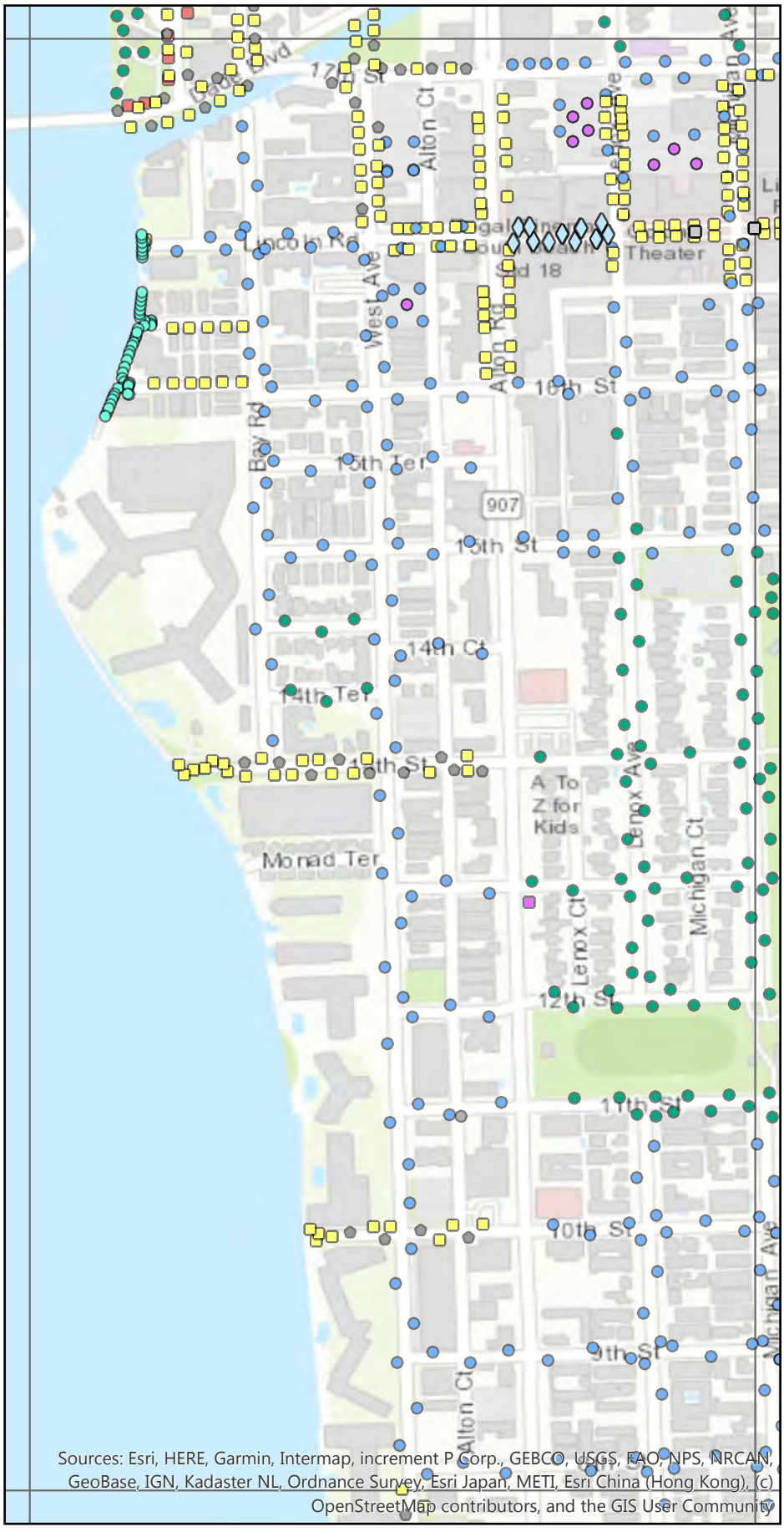

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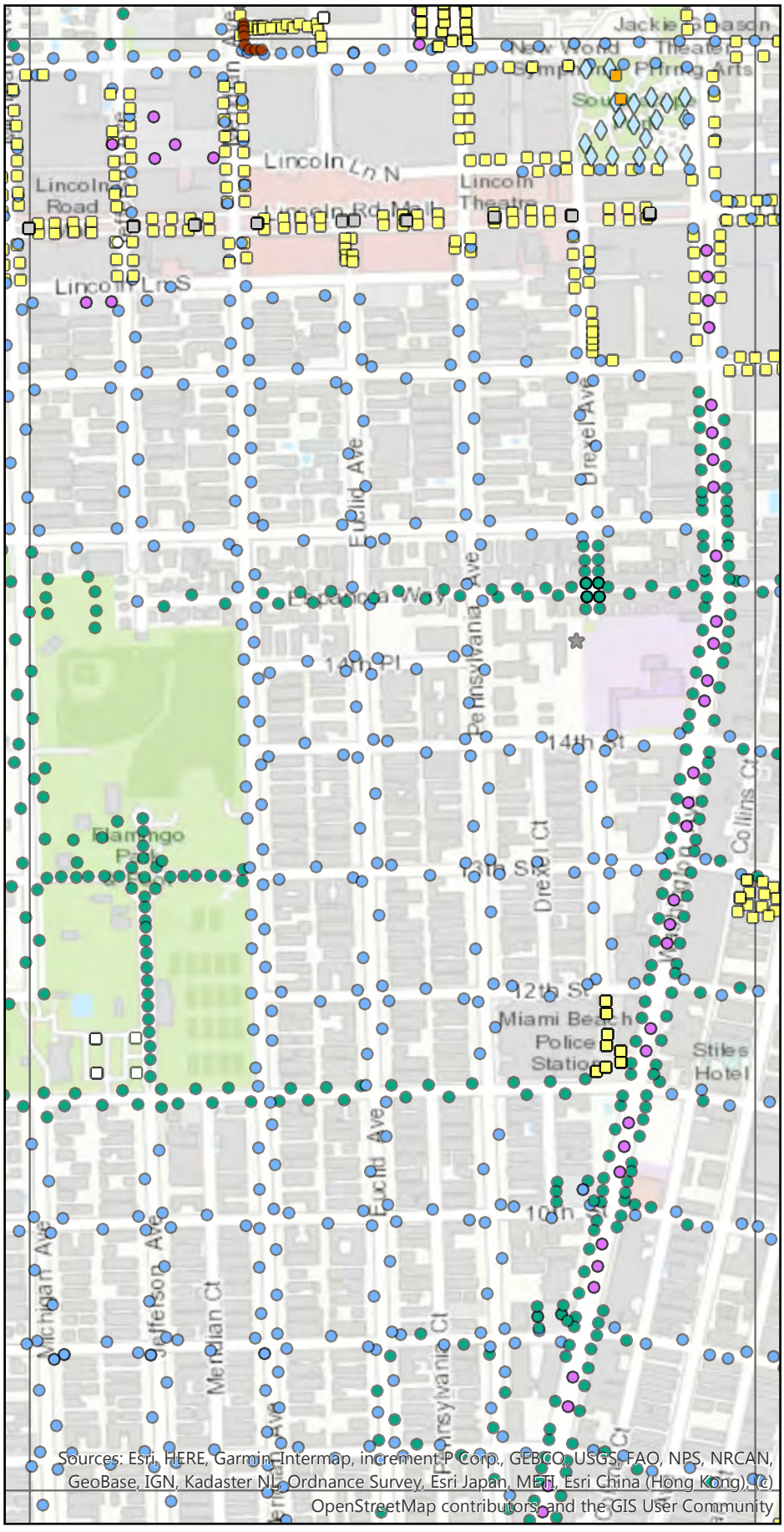

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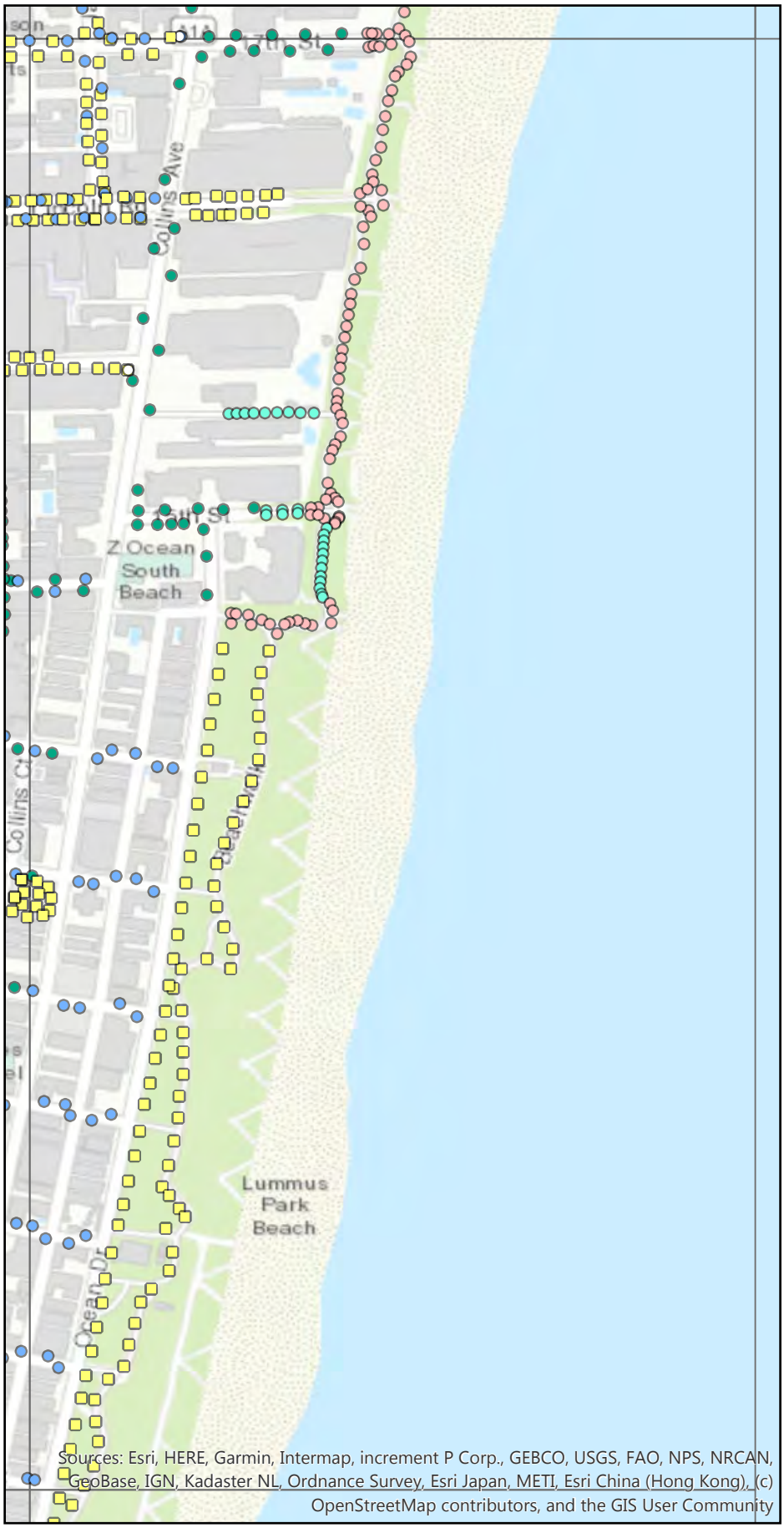

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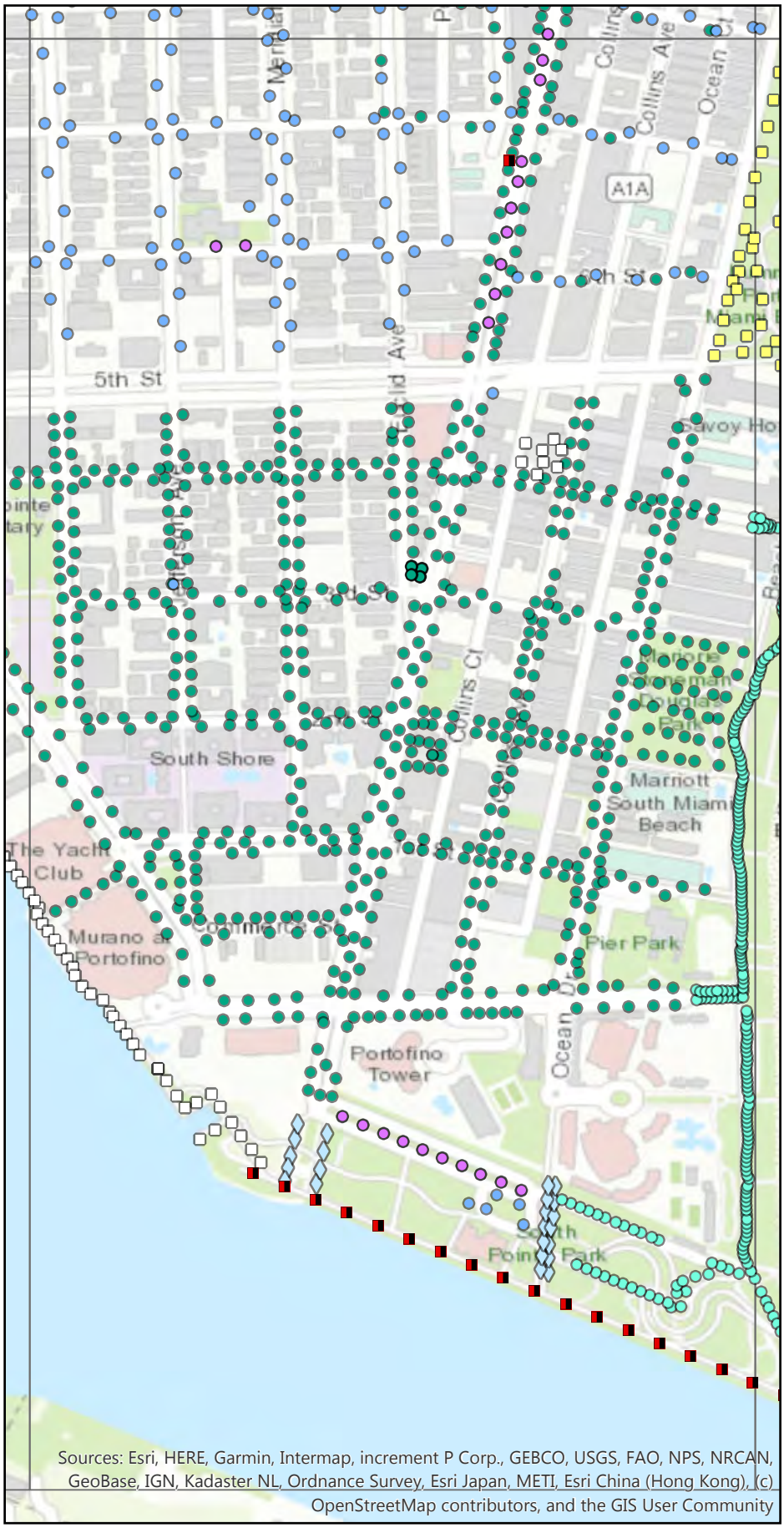

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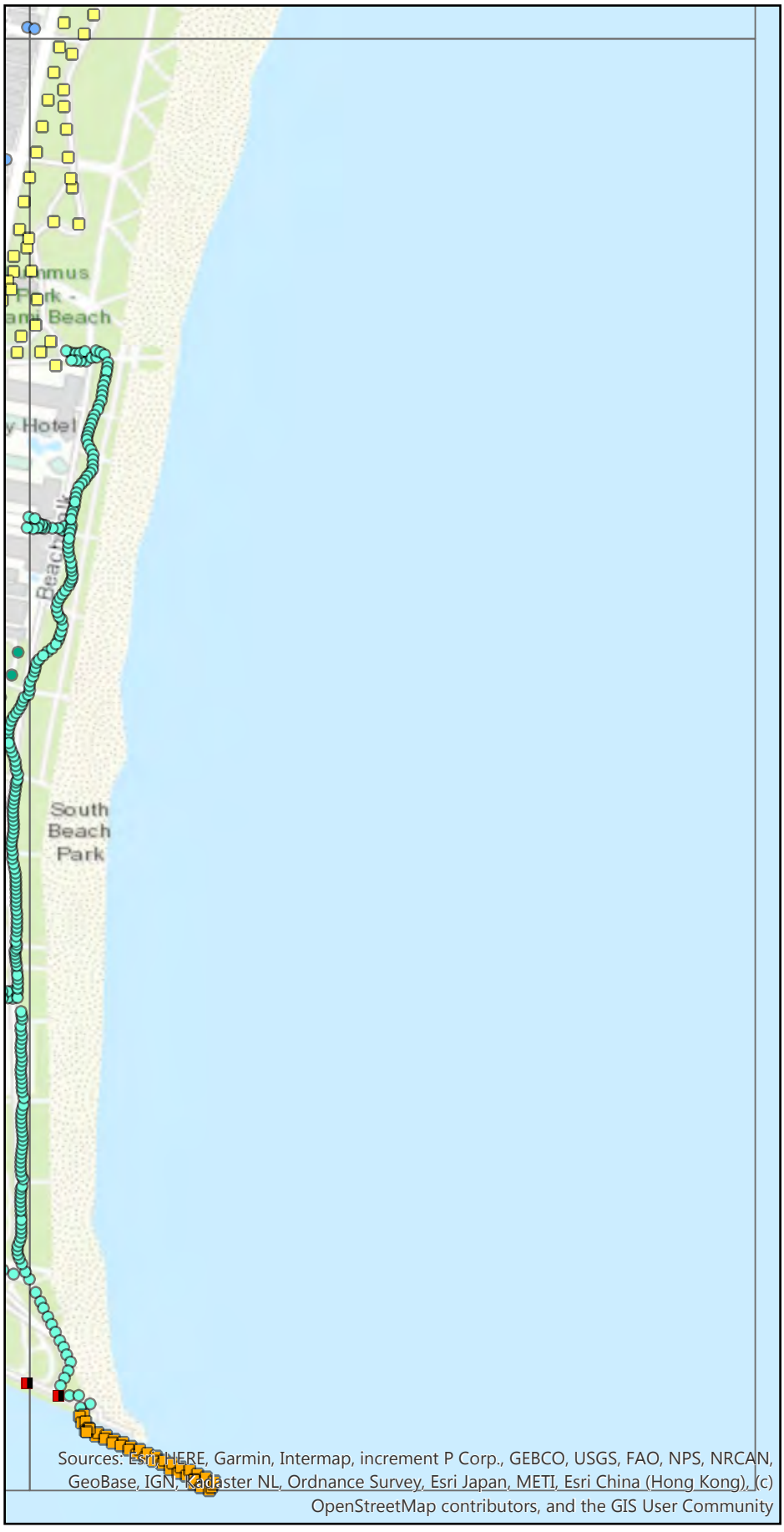

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Appendix B
Miami Beach Citywide Lighting Standards

MIAMIBEACH
RISING
ABOVE

Miami Beach Citywide Lighting Standards

100% Design Submittal

April 2020

City of Miami Beach

Miami Beach Citywide Lighting Standards

Project No: 17178.00
Document Title: Miami Beach Citywide Lighting Standards
Revision: F
Date: April 2020
Client Name: City of Miami Beach, FL

Authors: Barbara Horton and C. Webster Marsh, HLB Lighting Design

Document History and Status

Revision	Date	Description	By
A	8/28/19	75% Submittal - Progress	B. Horton and C.W. Marsh
B	10/11/19	100% Submittal	B. Horton and C.W. Marsh
C	12/06/19	100% Revision	B. Horton and C.W. Marsh
D	12/20/19	100% 2nd Revision	B. Horton and C.W. Marsh
E	1/10/2020	100% 3rd Revision	B. Horton and C.W. Marsh
F	4/29/2020	100% 4th Revision	B. Horton and C.W. Marsh

Contents

Acronyms and Abbreviations

For full definitions please see Appendix A – Technical Terms

ANSI	American National Standard Institute
BUG	Backlight Uplight Glare
CCT	Correlated Color Temperature
CMB	City of Miami Beach
CRI	Color Rendering Index
FDOT	Florida Department of Transportation
FPL	Florida Power and Light
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IoT	Internet of Things
IP	Ingress Protection
LED	Light Emitting Diode
LLF	Light Loss Factor
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
ROW	Right of Way
SSL	Solid State Lighting (e.g. LED)
UL	Underwriter's Laboratory

Background and Purpose

Introduction

Light is transformative. It defines how people see their surrounding environment and how they are seen in it. The Miami Beach Citywide Lighting Standards will serve as a guideline to enhance the community and tourist experience by considering appropriate illumination, safety, long distance visual cues, visual acuity, optical performance, advanced technology, environmental conditions, and maintenance. Following these goals and strategies will position the City of Miami Beach as a world leader in sustainable city lighting and advanced technologies to promote the brand identity and serve the community and visitors.

One of the more critical challenges will be community adoption. Residential streets with pedestrian sidewalk lighting and little to no area street lighting may not see a need for new roadway luminaires. Once a luminaire is submitted for use in a district, a visual mock-up shall be installed to educate stakeholders on industry standards and the overarching goals for the solution. This type of community engagement allows the public to vet solutions, raise questions and concerns, endorse the new design, give ownership of the design to the community it impacts, and hopefully lead to a speedy adoption process.

When considering one-for-one upgrades, care must be taken to evaluate existing conditions and lamp type, lighting quality, fixture optics, pole placement, and pole heights. Once calculations are performed and analyzed, new fixture locations may be required and some existing may need to be removed.

Relative to phasing and commissioning, technology is constantly evolving and changing and the technologies need to stay consistent and compatible throughout the entire scope.

Vision

- Create an opportunity for branding and identity for Miami Beach
- Evaluate visual acuity to enhance safety
- Utilize LED technology to maximize energy efficiency and reduce maintenance
- Employ cutting edge controls, adaptive controls methodologies and two way communication
- Consider environmental conditions: Resiliency, Wildlife and Sky Brightness
- Provide a network for Internet controlled devices throughout the city.

Mission

- To address the variety of needs for existing lighting conditions
- To provide a master plan, maintaining consistency throughout the city
- To upgrade existing lighting poles with modern technology
- To gain the support and solicit feedback from the communities directly affected by the lighting improvements
- To provide a specification guide and standard that can be used on projects to improve the light of the City of Miami Beach
- To improve long-term maintenance and upgrade quality of light

Guiding Principles

Decision making for lighting has many factors and requires a comprehensive list of lighting attributes to develop a lighting solution that meets the needs of the municipality and community.
Prioritizing the needs for each roadway type and district type is paramount to establishing robust lighting strategies for Miami Beach.
Gathering feedback on the scope and design of a project from the stakeholders and community members directly affected.

Guiding Principles

SAFETY

- **Uniformity of 4:1 - 10:1**

Good roadway lighting allows for a co-existence of vehicles, pedestrians, cyclists, and everything else. A basic function of night lighting is to allow all of the road and pedestrian ways to be able to visually survey their immediate surroundings and thus feel secure. People's perception of safety is highly dependent on good vertical illuminance, good uniformity, visual clarity of the surrounding area, minimal glare, good color rendering, and visual hierarchy to support wayfinding.

VISUAL ACUITY

- **Luminances in Appendix F**

Creating visual clarity in the surrounding area works hand in hand with vertical illuminance and uniformity to increase feelings of safety. When surrounding buildings are softly illuminated to provide a visual backdrop and when landscaped areas are conscientiously pruned, it is easy for someone to quickly make a visual assessment of their surroundings and identify an area as safe. This is particularly important along walkways. If only the walkway is illuminated and no vertical illumination in the surrounding environment is provided, it can actually feel uncomfortable to walk there given the feeling of being in a spotlight with no surrounding visual cues. People can instinctively feel that they might be attacked and pulled into a darker surrounding area. Surrounding building interior glow, lighting at entries, supplemental area lighting, and ambient lighting from path and roadway lighting can all contribute to creating good visual clarity.

ENERGY REDUCTION

A combination of energy efficient light sources (LED), proper spacing, interaction between light and site materials, and selective light distribution will lead to an overall efficient project/site. It is important to coordinate with designers and engineers so that all aspects are being thoughtfully selected to ensure the lighting is integrated into the built environment.

COMMUNITY OUTREACH

An important step to consult with the community affected, solicit feedback from community members, and to guide the design to meet the needs of the community.

GLARE

- **BUG Rating of G2 or lower.**

Glare from overly bright or poorly aimed light fixtures can be uncomfortable and can also contribute to people feeling unsafe. If a light fixture is overly glary or aimed in a way that prevents good visual clarity, it can temporarily disable someone's adaptation to the surrounding illuminance and make it difficult to see. Attention should be paid to fixtures with acceptable source and lens brightness, and roadway lighting should never tilt greater than 5% above the horizontal plane to avoid direct view of light sources.
A BUG rating can be used to reduce glare, the IES TM-15-11 has recommended best practices for glare ratings. It is recommended to minimize lighting above 60° to avoid glare, either a G1 or G2 rating at maximum.

COHESION AND CONSISTENCY

- **Pole designs in Appendix C**

In kind with visual clarity, we strive to create a simple cohesion and consistency across the city. By selecting fixtures that are a part of a family, this aids in the predictability of the visual experience. A major benefit to selecting fixtures within a family from one manufacturer leads to easier maintenance as well.

COLOR TEMPERATURE AND CRI

- **CCT of 4000K and CRI of 80**

Color temperature may affect visual acuity and people's sense of space. A cooler color can make people feel safer and more alert, while a warmer color temperature is better for the environment and can make people feel more relaxed. There are many other factors that play into how color temperature affects people, but the temperature is best when consistent but may change based on the application.

Good color rendering can significantly contribute to people's feeling of safety. Some traditional exterior light sources, such as high pressure sodium and older versions of metal halide, have limited color rendering capability and the potential for color shift. Poor color rendering makes the clear differentiation of surface, the identification of cars, or seeing people's clothing and features difficult. State-of-the-art LED sources have the benefit of good color rendering across all parts of the visible spectrum, allowing all colors to be easily detectable and instantly recognizable, even in lower illuminance ranges.

Guiding Principles

BRANDING

Branding shall be signage, luminaire and pole finishes, additional decorative only luminaires, or other options that do not affect or go against the Miami Beach Citywide Lighting Standards.

MAINTENANCE

- **L70 of 100,000 minimum**
- **Replace fixtures at L70**

The adoption of LED technology has significantly increased the lifetimes of exterior lighting systems. With fewer failures and the added benefit of not having to relamp or replace fixtures nearly as often, labor and maintenance costs are reduced. When fixture selections are based off of particular families or manufacturers, the familiarities with maintaining those fixtures will keep labor costs down, too.

ENVIRONMENTAL FACTORS

- **BUG rating of U0 and B2 or less**
- **Amber light around habitats**

The rapid growth of urban environments often leads to a changed perception of our night sky, mainly due to uncontrolled outdoor lighting. Light pollution, including sky glow, glare, light trespass, and energy waste should be taken into consideration when designing a quality lighting system. Using proper optics, specifying shielding devices and glare accessories, and aiming fixtures within the intended area aids in an efficient and environmentally conscious lighting system. Wildlife can also be negatively affected, and care should be taken to specify glare-free fixtures and utilize robust controls strategies to dim or extinguish lights when not in use. Declining populations in sea turtles, migratory birds, and even insects are occurring because of poorly controlled and executed lighting systems.

A BUG rating can be used to reduce sky glow, the best option is to use luminaires with a rating of U0 which minimizes uplight to an undetectable level. A BUG rating of B1 or B2 minimizes lighting trespass onto properties or habitats, but may still require shielding to prevent trespass completely.

ADAPTIVE AND INTELLIGENT CONTROLS

- **Sensors: Occupancy, daylight, sound/wind**
- **Timeclock control**

Adaptive and intelligent controls provide customizable and strategic lighting to meet the needs of each community. Daylight and occupancy sensors, energy monitoring and reduction, and time-management systems are great examples of systems. Lighting controls can be used to change lighting intensity to meet the needs of the space based on proximity to important wildlife or natural areas, time of day, weather, adjacent ambient lighting, and current occupancy of the roads.

ECONOMIC DRIVER

- **Adjusting intensity in response to sensors**
- **100% ROI by end of life**
- **Light Loss Factor of 0.9**

The opportunity to move to LED and smart technology offers communities a wide variety of beneficial options to decrease cost and increase revenue. Options such as: metering parking, community branding, maintenance cost reduction, electricity cost reduction, citywide data mining, and increased community awareness of safety. Lighting controls in outdoor lighting systems reduce the number of operating hours, lower maintenance costs, and increase energy savings.

LUMINAIRE STYLE

Any new luminaires need to be provided with a marine grade and salt spray rating as specified in Appendix B.

Pole height from base of pole to top of pole/luminaire range shall be between:

- **12 feet and 16 feet in residential and coastal communities**
- **20 feet and 25 feet in commercial communities**

Pole heights shall be defined by the community having jurisdiction so long as it meets the other criteria in the Miami Beach Citywide Lighting Standards.

Executive Summary

The standards and specifications set forth in this document shall be included in the Publics Works Manual upon adoption of the document and will be updated pursuant to the Public Works Department's administrative process.

This report covers the City of Miami Beach citywide lighting standards for illumination of all city owned lighting, including: luminaires, poles, and controls, located within the Miami Beach right of way. Specifications on luminaires, poles, and controls can be found in Appendix B - Luminaire and Controls General Specifications.

The Miami Beach Citywide Lighting Standards will coordinate with the tree master plan and any other master plans that affect the performance and placement of luminaires.

This standard does not include the following:
1. Infrastructure specific standards that affect the design and function of roadways.
2. Power and Electrical specific standards that affect the design and layout of power feeding the luminaires, other than how it will be controlled.
3. Engineering specific standards that affect structural or electrical needs by code or condition.
4. Aesthetic lighting standards for applications such as facade, street pole decoration, or bridge lighting.

Districts and Zones

This report utilizes three categories of functional districts within the City of Miami Beach, distinguished by function: Residential, Commercial, and Coastal These districts would be divided into all possible roadway conditions as sub-categories, based on ANSI/IES RP-8-18 roadway standards as shown in Miami Beach Citywide Lighting Standards Appendix F Page 2. Pedestrian traffic will be classified by the Florida Department of Transportation Level of Service model as shown in Appendix F Page 3.

This report also utilizes Specialty Zones that are unique and have standards in addition to their district.

Roadway functional districts shall be defined every 2,000 linear feet of contiguous road. Roadways that can be categorized by different Functional Districts, do not exceed 2,000 feet, and cannot be categorized as Coastal shall be designed to the district requirements with the higher luminance requirements. Roadways that can be categorized as coastal shall be designed to coastal requirements.

Functional Districts
- Residential - Roadways that provide access to single family dwelling units.
- Commercial - Roadways that provide access to commercially zoned structures and multi-family dwellings.
- Coastal - Roadways that are within line of sight of beaches or waterways or that provide access to structures that are adjacent to beaches or waterways.

Roadway Conditions, Type
- Major
- Collector
- Local

Roadway Conditions, Pedestrian Traffic
- High
- Medium
- Low

Specialty Zones
- Specialty Design Zones
- Lincoln Road
- Public Parking
- Other Specialty Lighting Zones

Retrofit Luminaires

Retrofit Luminaires that preserve the look of the original luminaire and replace luminaires 1-for-1, but do not replace poles, must be capable of meeting the same requirements as specified in the Miami Beach Citywide Lighting Standards. The City of Miami Beach has multiple types of existing luminaires, but retrofits in the style that are full cutoff, have low BUG ratings, and have good CRI are available and so retrofits should not be exempt to these standards. Lighting controls must also be provided for new retrofit luminaires, as specified herein.

House shield accessories and controls for custom applications may be necessary to meet the requirements of the roadway.

New Lighting Performance Specifications

Introduction

The new lighting performance specifications shall be used to provide guidance to the city, but shall also conform to the specifications in Appendix B of this document and any city ordinances that may supersede this document. These specifications have been created to ensure a positive and consistent lighting design throughout the City of Miami Beach and the city has considered a variety of options prior to creating these specifications. The below specifications shall apply to all districts:

Roadway, Pedestrian Way, and Veiling Luminance Values

If not in conflict with specifications listed in each district, the luminance values of roadways and pedestrian ways shall conform to or exceed the most up-to-date IES standards as defined in RP-8. At the time of this report, RP-8-18 is the most up-to-date version, but it shall be up to the agency responsible for the calculation reports to identify the most up-to-date version.

Color Rendering Index (CRI)

The color rendering of the luminaires shall conform to the standards established by IES in ANSI/IES TM-30-18 to ensure a minimum CRI of 80.

Correlated Color Temperature (CCT)

The correlated color temperature rendering of the luminaires shall be 4000K, unless otherwise specified herein.

Return on Investment (ROI)

The return on investment shall be implemented for limited budget reasons and shall allow the City of Miami Beach to recover the entire cost of the project through energy reduction implemented by the luminaires upgraded to newer technology. When replacing installed before the implementation of the Miami Beach Citywide Lighting Standards, the cost of materials for the project must be recovered by the predicted lifetime of the components.

Field Replaceable Components

Luminaires installed shall implement field replaceable components for easy maintenance and upgrades. Field replaceable components shall be removable by city employees without risk of damaged or voiding the luminaire warranty. This specification shall also apply to controls components as specified here-in.

Wildlife/Turtles

Wildlife and Sea Turtle districts shall have special lighting considerations. Habitat districts shall be identified by the Florida Fish and Wildlife Conservation Commission and an Independent Environmental Lighting Impacts Consultant. These districts shall employ the most current recommended lighting design methods to protect the wildlife while providing adequate illumination for roadway and pedestrian way safety.

New Lighting - Residential Neighborhoods

Luminaire Specifications- Disclaimer

Specifications

The specifications in the Miami Beach Citywide Lighting Standards are to be used to ensure consistency in roadway luminances, color temperature, luminaire style, controls protocol, and the overall lighting design for the city. Manufacturers shall provide components such as: lenses, house-side shields, output, and different lighting distributions to meet design criteria specified. Independent Lighting Designers or Engineers may specify lighting and accessories in addition to, but not in lieu of these specifications.

Performance Specification, Residential

- The color temperature of the luminaires shall be 4000K and conform to the industry best practices established by IES in ANSI/IES LM-80-15 and a 4-step MacAdam ellipse, as defined in Appendix A (A1-3), to ensure consistency from luminaire to luminaire.
  - A color temperature of 3000K may be used if prior written approval is given by the City of Miami Beach.
- Shall meet the design criteria of using the right light in the right place at the right time. Must be conscious of light trespass onto property and into homes. Luminaires shall utilize beam control, shielding, and cutoff angles to achieve best practices for minimizing glare and trespass.
- Lighting shall employ a full cut-off optic with accessories such as house-side shields to avoid trespass and limit sky glow.

New Lighting - Commercial Neighborhoods

Luminaire Specifications- Disclaimer

Specifications

The specifications in the Miami Beach Citywide Lighting Standards are to be used to ensure consistency in roadway luminances, color temperature, luminaire style, controls protocol, and the overall lighting design for the city. Manufacturers shall provide components such as: lenses, house-side shields, output, and different lighting distributions to meet design criteria specified. Independent Lighting Designers or Engineers may specify lighting and accessories in addition to, but not in lieu of these specifications.

Performance Specification, Commercial

- The color temperature of the luminaires shall be 4000K and conform to the industry best practices established by IES in ANSI/IES LM-80-15 and a 4-step MacAdam ellipse, as defined in Appendix A (A1-3), to ensure consistency from luminaire to luminaire.
- Lighting shall employ a full cut-off optic with accessories such as house-side shields to avoid trespass and limit sky glow.

New Lighting - Coastal Neighborhoods

Luminaire Specifications- Disclaimer

Specifications

The specifications in the Miami Beach Citywide Lighting Standards are to be used to ensure consistency in roadway luminances, color temperature, luminaire style, controls protocol, and the overall lighting design for the city. Manufacturers shall provide components such as: lenses, house-side shields, output, and different lighting distributions to meet design criteria specified. Independent Lighting Designers or Engineers may specify lighting and accessories in addition to, but not in lieu of these specifications.

Performance Specification, Coastal

- Wildlife and Sea Turtle districts shall have special lighting considerations. Habitat districts shall be identified by the Florida Fish and Wildlife Conservation Commission and an Independent Environmental Lighting Impacts Consultant. These districts shall employ the most current recommended lighting design methods to protect the wildlife while providing adequate illumination for roadway and pedestrian way safety.
- Lighting for coastal areas shall provide an environmentally conscious illumination that does not over-illuminate spaces or increase sky-glow but also provides pathfinding to pedestrian ways.
- Lighting shall employ a full cut-off optic with accessories such as house-side shields to avoid trespass into and visibility from habitats.
    - A habitat is defined as: A sandy beach in a Sea Turtle Lighting District adjoining the waters of the Atlantic Ocean, the Gulf of Mexico, and the Straits of Florida, including all inlet shorelines of those beaches.
- Lighting shall employ warm colored illumination of a long wavelength amber that is at minimum 560 nanometers.
- Lighting shall employ a limited number of luminaires to meet minimum foot-candles as necessary to meet federal, state, and local requirements for each area.
- Where lighting is required adjacent to habitat areas, lighting shall employ long wavelength colored low illumination that is shielded, that does not affect nearby habitats. Shielding shall be mounted to prevent lighting from trespassing onto and visibility from habitat areas.
- New roadway luminaires that are in Sea Turtle Lighting Districts and are within line of sight of the beach shall meet the following criteria:
    - Shall be at a height no greater than 12’-0” or at a height agreed upon by the Florida Fish and Wildlife Conservation Commission and an Independent Environmental Lighting Impacts Consultant.
    - Shall have an angle of illuminance that cannot be seen from any part of the habitat.
    - Shall not provide a cumulative illuminance greater than 0.1 FC at the boundary to the habitat.
    - Shall employ a long wavelength amber illumination that is at minimum 560 nanometers.
    - Minimize adding additional lights unless for safety. Justification for additional lighting under the argument of safety must be reviewed and approved by an Independent Road Safety Consultant in consultation with the Florida Fish and Wildlife Conservation Commission.
    - Use the lowest acceptable illumination levels.
    - Keep mounting height low, if possible without additional lighting.
    - Provide buffer zones, where possible.
    - All roadway lighting shall adhere to any and all guidance provided by FDOT.

- All standards listed above were written in coordination with the Florida Fish and Wildlife Conservation Commission “FWRI Technical Report TR-2, Version 2” and shall not supersede direction or recommendations from the Florida Fish and Wildlife Conservation Commission.

New Lighting - Specialty Lighting Zones

Explanation

These zones have been identified as unique and therefore require additional standards. Each zone may include multiple districts, but shall still adhere to the Miami Beach Citywide Lighting Standards.

Performance Specification, Specialty Design Zones

Zones that utilize an independent lighting designer or engineer may deviate from these standards in appearance with City approval. Alternate designs must still meet the performance criteria.

Performance Specification, Lincoln Road

Lincoln Road Improvements began in 2016 and cover the pedestrian mall starting at the intersection of Lincoln Road and Lenox Avenue and ending at the intersection of Washington Avenue and Lincoln Road. This zone shall be considered a special zone and any additional lighting within this area shall align with the improvements already being implemented. Adjacent zones shall adopt the Miami Beach Citywide Lighting Standards as specified herein.

Performance Specification, Public Parking

Areas designated to Public Parking lots or structures shall be considered a special zone and any additional lighting within these areas shall align with the City of Miami Beach lighting ordinance Ord. No. 98-3108, § 7(F), 1-21-98 as shown below:

> Adequate lighting shall be provided. The lighting shall be arranged and installed to minimize glare on property in a residential district. Parking facilities shall be illuminated from one-half hour after sunset to one-half hour before sunrise at the levels specified below with a uniformity ratio of 10:1:

Use	Minimum Illumination (FC)
Residential lots	0.4
Commercial lots	
Small (5—10 spaces)	0.4
Medium (11—99 spaces)	0.6
Large (100+ spaces)	0.9

Additionally, consideration should be given to Public Parking structures where lighting may be in line of sight to Coastal districts, even from long distances. Luminaires and lighting within line of sight to Coastal districts shall comply with the requirements in the Coastal districts and consult with the Florida Fish and Wildlife Conservation Commission.

Other Specialty Lighting Zones

Information for these zones has been provided in the Urban Lighting Report. See Appendix E for a map and design criteria for of these zones.

- Hospital District
- Mixed-Use Entertainment District
- Town Center Area
- Open Space and Parks
- Convention Center District
- City Hall / City Services
- Oceanfront Environmental

Calculation Report Criteria

Roadway Calculation Reports

All Roadway Calculation Reports shall follow IES Recommended Practice RP-8-18 Chapter 3, show documents verifying compliance with the standards herein, and utilize 90% of initial output for Light Loss Factor (LLF of 0.9). Documents shall show the following information:

Calculation Summary for Roadway and Sidewalks

- Average Luminance cd/m^2
- Average Illuminance fc
- Uniformity Ratio $^{Average}/_{Minimum}$
- Uniformity Ratio $^{Maximum}/_{Minimum}$
- Veiling Luminance Ratio
- Mounting Heights (grade to source of light)

Photometry and IES Files

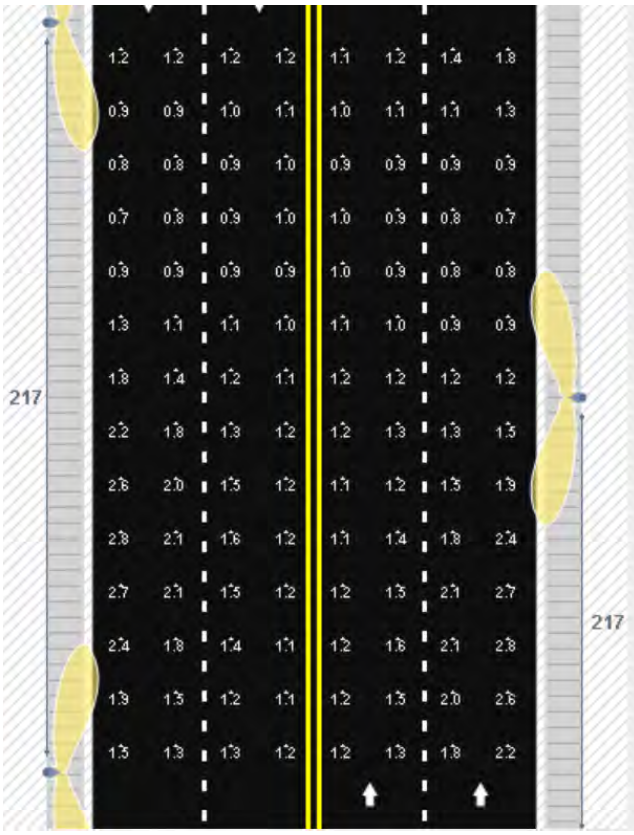
- An IES file shall be prepared in compliance with ANSI/IES LM-63-02/R08 and the following information shall be provided with the Roadway Calculation Report for each Luminaire used in the calculations:
- Test Number
- Test Lab
- Test Date
- Test Method
- Issue Date
- Manufacturer
- Exact Luminaire Part Number
- The Following Information as Shown in the IES File
    - Number of Lamps
    - Lumens to Lamps
    - Multiplier
    - Number of Vertical Angles
    - Number of Horizontal Angels
    - Photometric Type
    - Units Type
    - Width
    - Length
    - Height

Commissioning Summary for Typical Roadway and Sidewalks

- Commissioning Agency
- Commissioning Date
- Commissioning Method
- Measured Luminance
- Measured Illuminance, this can be in lieu of Measured Luminance, if properly measured and converted to Luminance per guidelines in RP-8-18.
- Mounting Heights (grade to source of light)

Calculation Report Tables

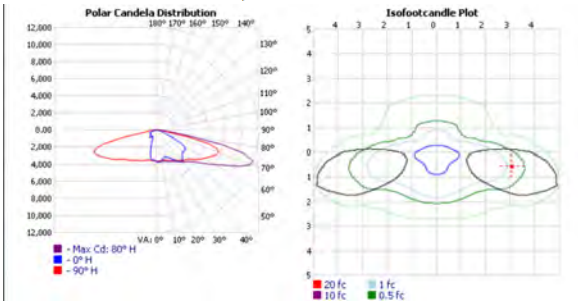
Table 5-2.1 - Example Calculation Report



Spacing		217 feet		
Quantity		10		
		Left	Right	
Roadway Luminance				
Average	[0.6]	1.4	1.4	cd/m²
Max		2.8	2.8	cd/m²
Min		0.8	0.8	cd/m²
Ave/Min	[3.5]	1.8	1.8	
Max/Min	[6]	3.8	3.8	
Lv Ratio	[0.3]	0.3	0.3	
STV		3.3	3.3	
Roadway Illuminance				
Average	[-]	1.7	1.7	fc
Max		3.5	3.5	fc
Min	[-]	0.9	0.9	fc
Ave/Min	[-]	1.9	1.9	
Max/Min		3.8	3.8	
Sidewalk Illuminance				
Average		1.6	1.6	fc
Ave/Min		2.3	2.4	
Ev Min		0.2	0.2	fc
Bikelane Illuminance				
Average		--	--	fc
Ave/Min		--	--	
Ev Min		--	--	fc

Table 5-2.2 - Example Photometry and IES File Report

TEST #:	ISF 34786P42
TEST LAB:	SCALED PHOTOMETRY
TEST DATE:	5/31/2017
CATALOG:	ATB2 40BLEDE10 XXXXX R2 3K
DESCRIPTION:	ATB2 SERIES LED 1000MA TYPE 2 3000K CCT
SERIES:	AUTOBAHN ATB2
LAMP CATALOG:	LED
LAMP:	LED ARRAY
LAMP OUTPUT:	TOTAL LUMINAIRE LUMENS: 15565, ABSOLUTE PHOTOMETRY *
BALLAST / DRIVER:	LED DRIVER, LED DRIVER
INPUT WATTAGE:	133
LUMINOUS OPENING:	RECTANGLE W/LUMINOUS SIDES (L: 5.4", W: 9.6", H: 0.36")
MAX CD:	11,909.0 AT HORIZONTAL: 80°, VERTICAL: 72.5°
ROADWAY CLASS:	MEDIUM, TYPE II



Controls Performance Specifications

Central Intelligence

The lighting controls for the City of Miami Beach shall utilize a central control intelligence that utilizes a dedicated location for the lighting controls central processor for housing and shelter. Gateways to repeat signal from the central processor shall not be capable of overriding signal sent by the central processor. Each device on the system shall be visible and controllable in real-time on the central processor display. Luminaires shall be fully energized at all times to provide power to controls devices which shall switch or dim luminaires as designed.

Integration and Ongoing Development

The lighting controls for the City of Miami Beach shall utilize a non-proprietary and open protocol to allow ongoing improvements for the foreseeable future. An integrator shall be retained by every contractor providing intelligent luminaire controls, the integrator shall be capable of integrating new lighting controls into the intelligent lighting controls systems specified here-in.

Daylight Responsive Controls

The lighting controls shall be capable of adjusting the luminaire's output from off to 100% intensity in response to the presence or absence of daylight.

Inter-Communication Occupancy Controls

The lighting controls shall be capable of gradually dimming the luminaire's output from low to full intensity in response to the presence or absence of pedestrians, vehicles, or other forms of occupancy on the pedestrian ways or roadways. Luminaires shall be able to communicate with each other to provide full illumination for the luminaire directly above the occupant and the luminaires immediately adjacent to the occupant, but keep all other luminaires at the low dimmed state. The lighting shall follow the occupant as it moves along the illuminated way and gradually dim up or down to provide an efficient and safe illumination. Intensity levels are specified in Appendix E.

Internet Enabled Luminaires

The lighting controls devices mounted directly to luminaires shall be capable of communicating with the central intelligence and other controls devices within the vicinity and shall also be able to control the luminaire directly in response to commands from the central intelligence. Luminaire shall be able to report the following: Driver failure, LED failure, pole knocked over, loss of power, communication failure, auxiliary devices not working, end of LED life.

Maintained Illuminance Controls

The lighting controls shall be capable of maintaining a set point illuminance level directly below the luminaire.

Other Unspecified Controls

The lighting controls shall be capable of adapting to the surrounding environment in sound, wind, and other environmental criteria essential but not specific to lighting. The luminaire shall be capable of responding to any of the sensors connected to the lighting controls system.

Auxiliary Controls Ports

The lighting controls shall have expanded capacity, per luminaire, through unused non-proprietary auxiliary controls ports. Provide at minimum, (2) ports per fixture.

Controls Performance by District

Intelligent Luminaire Controls Specifications- Disclaimer

Specifications
The lighting controls needs for the City of Miami Beach shall be a flexible system that is easy to add or remove devices, as needed by the city. The specifications in this report for controls shall be adhered to for consistency in roadway luminances, color temperature, luminaire style, controls protocol, and the overall lighting design for the city.

Additional components shall include: photosensors, occupancy sensors, dimmers, sound detection, wind sensors, and safety beacons.

Performance Specification, Residential

- The City of Miami Beach will provide controls that meet the controls sequence as specified in Appendix E. Residential districts may change the sequence after installation to meet the needs of their specific roadways. Lighting controls manufacturer shall be consulted for any revisions to the controls sequence.

Performance Specification, Commercial

- The City of Miami Beach will provide controls that meet the controls sequence as specified in Appendix E. Commercial districts may change the sequence after installation to meet the needs of their specific roadways. Lighting controls manufacturer shall be consulted for any revisions to the controls sequence.

Performance Specification, Coastal

- Lighting controls implemented in Coastal districts shall comply with all Citywide Standards. Amber luminaires shall be compatible with lighting controls specified and shall provide flicker-free illumination at dimmed states.

Performance Specification, Specialty Lighting Zones

- The lighting controls of Specialty Lighting Zones that utilize an independent lighting designer or engineer may deviate from these standards in appearance with City approval. Alternate controls designs must still meet the performance criteria.

Intelligent Luminaire Controls Report Criteria

Lighting Control Report

All Intelligent Luminaire Controls Reports shall comply with the strictest standards for the controls protocol and cybersecurity and shall show documents verifying compliance with the standards here-in. Documents shall show the following information:

Report of Compliance, for Each Device

- ANSI Standards
- ASTM Standards
- FCC Standards
- IEC Standards
- IEEE Standards
- IP Rating
- NEC Standards
- NEMA Standards
- NRTL Standards
- UL and/or ETL Standards

Report of Functionality

- Wired Maximum Distance
- Wireless Maximum Distance, Line of Sight
- Communications Frequencies
- Frequency Rates and Bandwidth

Report of Compatibility

- Tested as Compatible Devices, Interfaces, and Luminaires
- Report of tested applications or proof of concept showing compliance with the Miami Beach Citywide Lighting Standards and functional testing
- Evidence that all devices in the control system meet cybersecurity standards as required by the Design Lights Consortium (DLC) listing for Networked Lighting Controls Qualified Products List. This shall be applied to the most up-to-date version, presence on an older listing and absence on the latest listing is disqualifying.

Commissioning Summary for Typical Controls

- Commissioning Agency
- Commissioning Date
- Commissioning Method
- Functional Testing Results
    - Sensor detection range
    - Sensor response time and timeout duration
    - Sensor field measured set points
    - Communication signal strength to nearest repeating device
    - Ping time to Central Intelligence

Appendix A
Technical Terms

Appendix A - Technical Terms

Aesthetics
Luminaires that are visually pleasing, even when off during the day and may take into account surrounding historic architecture.

Branding
Using light poles for signage or distinguishing a community through aesthetics.

BUG Rating
A BUG rating is used to identify intensity and directionality of light provided by a roadway luminaire. It is used to minimize backlight (B0-5), uplight (U0-5), and glare (G0-5). A lower number in each category is preferable but not always warranted to the application, but a U0 rating should be observed if sky glow is to be reduced.

CCT (Correlated Color Temperature)
How warm or cold a white source of light appears. Common CCT's in exterior applications are 3000K (warm) or lower for residential or parks. To ensure consistent color between fixtures, CCT should also have a 4-step or smaller binning.

CRI (Color Rendering Index)
How accurately the light reveals colors when compared to daylight. A high CRI (80 or higher) is necessary for tasks that require higher accuracy of color such as in store fronts or sports centers, otherwise lower CRI may be better suited.

Digital Lumen Management
Compensates for diminished lumens over time to maintain illumination levels. Fixtures use an integral sensor to maintain a set level of output and increases the lifespan of the fixture, in some cases adding 15 or more years to the fixture. This also reduces initial energy consumption of the fixture.

Dynamic Color Change
Color is useful to create a sense of place and attract pedestrian traffic, to tell a civic story, facilitate event/seasonal celebrations, or create an interactive social hub. There is a lot of creativity and community engagement that can come from dynamically controlled colored light.

Ease of Maintenance
How easy it is to fix or replace a broken fixture or to re-adjust the aiming.

Economic Driver
Improving light in areas may bring more street traffic to under-served neighborhoods or light poles can provide technology for paid parking where it wasn't before.

Efficiency
How much energy the luminaire consumes to produce its light. Shown as lumens per watt (lm/W), a higher lumen number will increase efficiency. 100lm/W or higher is a good efficiency for a LED.

Energy Reduction
Modern design techniques strive to reduce energy consumption with fewer poles and more efficient LED modules and more adaptive controls.

Environmental Considerations
Providing for all aspects of code compliance with resiliency, wild life, and tropical conditions. Modern equipment can be rated to withstand harsh environments without compromising the aesthetics.

Glare Control
How the luminaire controls glare. Can be achieved with a glare shield or specialized optics.

IES LM-80-15
A standard used to ensure consistent and accurate measurements of LEDs. Luminaire manufacturers must provide a report that uses this standard for measurements. This report will be used to meet specification requirements as described in Appendix B.

Illuminance
Measures light incident on a point or surface, defined as luminous flux per unit are incident on a point or surface; measured in foot-candles (fc) or (lm/ft^2) and lux (lm/m^2). A mathematical conversion from Luminance to Illuminance is not recommended and should be avoided unless measuring Illuminance is impossible.

IOT
Internet of Things refers to the ability to connect anything to the Internet so that it can be controlled and monitored remotely.

Controls / Adaptive Controls
Dynamic sensors for motion and daylight sensing increase or decrease illumination, can be used to monitor asset maintenance as needed among other features, and can collect traffic data for roadway optimization.
Life and Warranty
LED fixtures lose intensity over time and are recommended to be replace at 70% of intensity, known as L70. A good L70 is 100,000 hours of use or 23 years of 12 hours operation per day.
Luminance
The magnitude of light energy emitted from a surface per unit area in a given direction; measured in candela per meter squared (cd/m^2). A mathematical conversion from Illuminance to Luminance is not recommended and should be avoided unless measuring Luminance is impossible.
Light Loss Factor (LLF)
A prediction of luminaire performance after heavy use, typically as a percentage of initial output.
Maintenance
With intelligent controls response time can be improved with instant feedback monitoring and safety can be maintained by quickly identifying and repairing unresponsive equipment or poor lighting conditions.
MacAdam Ellipse
A region on a chromaticity diagram, in which all colors are indistinguishable. This metric is used during LED binning to ensure consistency of color across multiple diodes and luminaires.
Off Roadway Luminance Compensation
Automated light output control for the luminaires to be able to adapt brightness to adjacent luminances. This provides easier programming/re-programming and allows a better transition when driving on streets with high contrast areas. Luminaires will be able to conserve energy by adapting to adjacent luminances when there is a change to a lower intensity.
Optical Control
Control that the luminaire has over the light and where it is projected. Can completely cut off light from a specific direction or guide it in a different direction. Good optical control is important to avoid trespass, glare, and other undesirable illumination.
Photo-voltaic Cells (Solar Power)
Continues to be of interest but the form factor, limitations on locations/conflicts with available light, reliability, and the cost of long term maintenance are limiting on its widespread usage. Currently, large solar arrays (Utility-Scale Solar Farms) are the best recommended practice for any solar energy collection.
Return on Investment (ROI)
Many intelligent lighting controls systems are designed to reduce unnecessary energy consumption and can pay for themselves in energy savings over time. An energy audit to compare how much energy is consumed with how much would be saved can reveal how soon the project can repay the money spent in the form of an ROI report.
Safety
With sufficient vertical and horizontal illumination lighting can provide safe conditions for people, cars, and objects to co-exist.
Uniformity Ratio
The contrast between the brightest lit area to the darkest area. A good ratio is where the average illumination of the area is at most 3 times brighter than the darkest area, but specific recommendations are included in this report.
Various Technology Integration
Modern lighting poles can incorporate technology into the architectural design and improve the overall aesthetic. Technology can include but is not limited to: 5G, Control Mesh, Wi-Fi, IOT, Cameras, Speakers, Charging Stations, Parking Metering, Security Stations, Gunshot Detection, Digital Signage, and Inclement Weather Detection.
Visual Acuity
The ability to have clarity and sharpness of vision, which needs different light levels to achieve based on the task and environment.
Way-finding
The use of a combination of lighting and signage to guide vehicles, pedestrians, and all others in a safe and orderly manner.
Wildlife Lighting Certified
Lighting specially designed for areas with sensitive ecosystems. Darkness is the best option for these areas, but where illumination must be provided, certified luminaires should be installed to standards by the Florida Fish and Wildlife Conservation Commission and the U.S. Fish and Wildlife Service.

Appendix B
Luminaire General Specifications

1. GENERAL

1.1 SUMMARY

1.1.1 Included in the Work of this Section are labor, materials, and appurtenances required to complete the Work of this Section, as specified herein, as required by job conditions, or as indicated on drawings. The scope of this section includes general requirements for luminaires and their components, coordination, quality assurances, submittals, and general responsibility for a complete job.

1.2 DEFINITIONS

1.2.1 In this specification, the term “City” includes the Architect, Interior Designer, Landscape Architect, Construction Manager, Owner’s representative and/or the Lighting Specifier, together or individually.

1.2.2 The term “luminaires” refers to lighting fixtures with their integrated light sources and all other components, except for lighting controls.

1.2.3 The use of the word “Approved” shall not extend the City’s responsibilities beyond that as defined in the General Conditions.

1.3 GENERAL REQUIREMENTS

1.3.1 Provide labor, materials, and equipment for the installation of roadway luminaires, lighting equipment, control wiring, and sources as shown on the drawings, specified herein, and in the Miami Beach Citywide Lighting Standards. Luminaires shall be securely attached to poles as specified.

1.3.2 Refer to architectural drawings for locations, dimensions and details, and electrical documents for quantities. Check and verify dimensions and details on drawings before proceeding with the Work. Report any inconsistencies or discrepancies. Should it appear that the Work intended is not sufficiently detailed or explained on the drawings or in the specifications, apply for further drawings or explanations, as may be necessary. Conform to these explanations in the work. If any question arises about the true meaning of the drawings or specifications, provide timely and written questions before proceeding. Under no circumstances shall any request for extra compensation be honored where the basis of claim is such a clarification. In no case submit a bid or proceed on any Work with uncertainty. The intention of this specification and the accompanying or applicable drawings is to provide a job complete in every respect. Contractor is responsible for this result.

1.4 COORDINATION

1.4.1 Luminaire locations and mounting heights as indicated on the electrical drawings are generalized and approximate. Carefully verify locations and mounting heights with City standards,

and other reference data prior to installation. Although the location of equipment included in the Work of this Section may be shown on the Contract Drawings in a certain place, actual construction may disclose that the location for the Work does not make its position easily and quickly accessible. In such cases, provide timely and written notification of this situation before installing this Work, and comply with installation directions.

1.4.2 Clearly indicate the Work to be performed by other trades' contractors, and the materials that are adjacent to or abutting the Work of this Section. Coordinate as required. Schedule the Work to prevent Work of this Section being damaged by other construction operations. Remove and replace Work so damaged at no cost to the project. Coordinate and schedule the Work of this Section with the Work of other Sections and Utility Companies so that there shall be no delay in the proper installation and completion of any part of each respective Work. Construction Work shall proceed in its natural sequence without unnecessary delay caused by the Work of this Section.

1.4.3 Coordinate with other contractors regarding attachment to or openings in the materials of other trades as needed.

1.4.4 Arrange the installation in proper relation to other Work and with architectural finishes so that it shall harmonize in service and appearance and so that there shall be no interference with the Work of others, including interference in location.

1.4.5 Where a catalog number and a narrative or pictorial description are provided, follow the specified catalog numbers and narrative. Provide timely requests for clarification to specification as needed.

1.4.6 Become familiarized with all equipment listed in the luminaire schedule and take responsibility for the successful completion of the entire lighting installation.

1.4.7 Verify compatibility of supply voltage indicated on electrical drawings with voltage specified for each luminaire prior to release. Provide timely and written notification of any and all discrepancies.

1.5 QUALITY ASSURANCES

1.5.1 Contractor shall comply with the General Requirements related to Quality Control, in addition to the provisions herein.

1.5.2 Manufacturers listed herein, shall be assumed capable of supplying the listed luminaires unless exceptions are set forth in their quotations. Provide timely and written notification of any such exceptions. Acceptable manufacturers are listed in the luminaire schedule. Acceptable manufacturers shall be capable of providing proof of satisfactory production of luminaires of the type and quality shown for a period of at least five years.

1.5.3

1.5.4 **Statement of Application:**

1. By commencing the Work of this Section, the Contractor assumes overall responsibility, as a part of the warranty of the Work, to ensure that assemblies, components and parts shown or required within the Work of this Section, comply with the Contract Documents.
2. Warranty: In addition to any warranties required by the General Requirements, the Contractor of the Work of this section shall:
   a. For a period of one year after Owner's initial acceptance and establishment of the beginning date of the warranty period, and at no additional cost, promptly provide and install replacements for luminaires or components thereof which are defective in materials or workmanship under normal operating conditions, except for sources; or successfully repair installed equipment at the job site. For any time during the warranty period that luminaires are not fully functional due to defects in materials or workmanship, provide or pay for and install and remove suitable and adequate temporary luminaires. Warrant replacement luminaires or components to be free of defects in workmanship or materials for a period of one year following replacement, and replace any defective replacements.
   b. Contractor shall not be held responsible for acts of vandalism or for abnormal or accidental abuse of the luminaires or their components occurring after the beginning of the warranty period, nor shall Contractor be held responsible for deleterious effects caused by maintenance procedures performed without the concurrence of Contractor.

1.5.5 **Equipment Compatibility:**

1. For all similar luminaire types, provide sources, control gears and other components fabricated or supplied by a single manufacturer, to simplify maintenance and replacement of equipment.
2. Luminaire details shown may be modified by the manufacturer provided all of the following conditions have been met:
   a. Luminaire performance is equal or improved.
   b. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved.
   c. Cost to the City is reduced or equal.
   d. No conformance to codes has been compromised.
   e. No performance criteria for specified ratings has been compromised.
   f. Modifications have been reviewed and approved in writing.

1.5.6 **Regulatory Agencies:**

1. Provide luminaires constructed, wired and installed in compliance with the current edition of applicable city, state and national codes. Provide luminaires conforming to or exceeding Underwriters Laboratories (UL) standards, and to provisions of applicable codes which exceed those standards.
3. For any category of luminaire tested by any of the following labs, provide luminaires listed and labeled by an independent Nationally Recognized Testing Laboratory (NRTL) such as UL, ETL, CSA, MET.
4. In addition, provide luminaires which conform to additional regulations necessary to obtain approval for use of specified luminaires in locations shown. Use only electrical components listed by the above NRTLs.

1.5.7 Recognized Standards: Luminaires shall comply with all applicable standards including but not limited to the following organizations.

1. Underwriters Laboratories (UL) / Intertek (ETL) / Canadian Standards Organization - US (CSA-US)
2. National Electrical Code (NEC)
3. International Dark Sky Association (IDA)
4. Illuminating Engineering Society (IES)
5. American Society for Testing and Materials (ASTM)
6. American National Standards Institute (ANSI)
7. National Electrical Manufacturers Association (NEMA)
8. International Electrotechnical Commission (IEC)
9. National Electrical Safety Code (IEEE C2)
10. Americans with Disabilities Act (ADA)
11. Design Lights Consortium (DLC)

1.6 SUBMITTALS

1.6.1 **General:**

1. For all submittals, provide documents proving that luminaires meet criteria listed within the report.
2. For standard catalog items with no modifications, submit catalog cut sheets prepared by the manufacturer which clearly show all elements to be supplied and all corresponding product data (including sources, manufacturer and model number of control gears, and other components, as well as voltage; accessories, options and any miscellaneous items detailed in the written description of the specification.) If cut sheet shows more than one (1) luminaire type, all non-applicable information shall be crossed out.
3. For custom luminaires or modified luminaires submit a layout drawing prepared by the manufacturer showing all details of construction, dimensions, source layout, if applicable, mounting hardware or components, power locations, remote control gears, finishes and list of materials. Drawings must be to scale. Provide manufacturer with field dimensions where required. If accessories are required, drawings shall indicate relative position or adjacent vertical surface.
4. When components are indicated as contractor supplied or specified (i.e. remote power supplies, remote control gears housings, NEMA enclosures, etc.), Provide submittals for components in conjunction with the luminaire submittal.
5. Provide submittals with luminaire installation instruction sheets.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

1.7.1 Luminaires and their component elements shall be delivered to the Department of Public Works' designated site or building factory-assembled and wired to the greatest extent practical, in strict accordance with the approved shop drawings, certificates and catalogue cuts, and shall be handled in a careful manner to avoid damage.

1.7.2 Exposed finishes shall be protected during fabrication, transport, storage and handling. Delivered materials shall be identical to the approved samples. Materials which become damaged shall be repaired and/or replaced as directed.

1.7.3 Luminaires shall be stored under cover, above the ground, in clean, dry areas, and shall be tagged and/or marked as to type and location.

1.7.4 Delivered luminaires shall include wiring, sockets, control gears, shielding, channels, lenses and other parts and appurtenances necessary for luminaire installation of each luminaire type.

2. PRODUCTS

2.1 SUMMARY

2.1.1 Provide materials, equipment, appurtenances and workmanship for the Work of this Section conforming to the highest commercial standards, as specified and indicated on the drawings. Make luminaire parts and components not specifically identified or indicated on the drawings, of materials most appropriate to their use or function, and resistant to corrosion and to thermal and mechanical stresses encountered in the normal application and function of the luminaires.

2.1.2 Named manufacturers, when listed in the luminaire schedule, are representative of an adequate level of quality and reputation, and are allowed to submit a product, provided that they are capable of satisfying the provisions of the specifications in every respect. This does not mean that any standard product provided by that manufacturer is automatically qualified. Manufacturers not on this list may be proposed during the substitution period if they can substantiate that their product meets every particular of the relevant specification, and are of comparable quality, experience and reputation. Any submitted product may be rejected without explanation.

2.2 MARKING OF LUMINAIRES

2.2.1 Luminaires shall be equipped with markings showing safety specifications, construction safeguards, and minimum resistance to hazard sources operation under fault conditions. Marking shall include manufacturer/distributor's name, related voltage or voltage range, rated wattage, light output, optical distribution and rated frequency. LED luminaires not suitable for dimming control are required to indicate this clearly in installation instructions or package labeling. Mark luminaires with replaceable sources according to proper source type. Provide markings that are clear and that are located to be readily visible to service personnel, but invisible from normal viewing angles when sources are in place.

2.3 MATERIALS AND FABRICATION

2.3.1 Provide luminaires completely factory-assembled and wired and equipped with necessary sockets, control gears, wiring, shielding, reflectors, channels, lenses, and other parts and appurtenances necessary.

2.3.2 Use only completely concealed hardware, unless otherwise noted. Latching of luminaire door frames shall be unobtrusive. Make luminaire free from light leaks by the inherent design of the luminaire body and frame. Bond gaskets, when used, to the luminaire body. Weld power supply support studs, socket saddle studs and reflector support studs to luminaire body.

2.3.3 Construct luminaires with the minimum number of joints. Make unexposed joints by approved method such as welding, brazing, screwing or bolting. Soldered joints are not acceptable.

2.3.4 Provide metallic cast or extruded parts of luminaires that are close grained, sound, and free from imperfections or discoloration. Provide cast or extruded parts that are rigid, true to pattern, and of ample weight and thickness. Provide cast or extruded parts that are properly fitted, filed, ground, and buffed finished surfaces and joints free of imperfections. Make thickness on cast parts not less than 1/8in (3mm).

2.3.5 Provide marine grade copper material, low copper content, with salt spray ASTM B117.

2.3.6 **Wiring:**

1. Provide luminaire wiring between sources, lamp-holders and associated operating and starting equipment in compliance with UL 1570 and NEC, UL 8750 for LED's.
2. Make connections of wires to terminals of sources, lamp-holders and other accessories in a neat and workmanlike manner and which are electrically and mechanically secure, with no loose strands protruding. Provide of the appropriate amount of wires extending to or from the terminals of a source, lamp-holder or other accessory. These wires shall not be in excess of the number which the accessory is designed to accommodate.

2.3.7 All luminaires shall be UL/ETL/CSA-US listed, “Wet Location” rated at a minimum, with greater protection as appropriate or required by code for the application.

2.3.8 All luminaires, poles, sensors, and its components are to be applicable for the environment in Coastal Districts.

2.4 Sources

2.4.1 **General:**

1. Provide electric sources as required, during construction, including sources for luminaires provided by others.
2. Submit catalogue cuts of all sources to be used in the Work, along with the shop drawing submittal.

2.4.2 **Solid State Lighting / Light Emitting Diode (LED) Light Sources and Luminaires:**

1. General:
   a. Luminaire manufacturer shall have a minimum of five (5) years’ experience in the manufacture and design of LED products and systems and no less than one hundred (100) North American installations.
   b. Unless otherwise specified, luminaire fabrication shall integrate all LED light sources and power/data supplies fabricated by a single manufacturer to ensure compatibility.
   c. All components peripheral devices, integrated photosensors, occupancy sensors, controllers, even if manufactured or provided by others, shall be the responsibility of a single entity, the luminaire manufacturer. All components shall perform successfully as a complete system. Integrated controls shall be programmed on-site to operate as described in by the City standards.
   d. Provide submittals as described herein.
   e. Include all components necessary for a complete installation. Provide all power supplies, synchronizers, data cables, and data terminators for a complete working system.
   f. All white light LED sources within the same luminaire type shall be within four (4) MacAdam ellipses/steps of each other.
   g. All LED sources used in the LED luminaire shall be of proven quality from established and reputable LED manufacturers and shall have been fabricated within 12 months before installation per the date code on the module.
2. Replacement and Spares:
   a. Manufacturer shall provide written guarantee of the following:
      (i) Manufacturer’s LED system or equivalent system will be available for ten (10) years: Manufacturer will provide exact replacement parts, complete replacement luminaires, or provide upgraded parts that are designed to fit into the original luminaire and provide equivalent distribution and lumen output to the original, without any negative consequences.
      (ii) Manufacturer will keep record of original chromaticity coordinates for each LED module and have replacement modules or luminaires from within four (4) MacAdam Ellipses/ steps of the same coordinates available.
      (iii) Manufacturer will keep an inventory or ability to supply replacement parts or complete fixtures within two (2) weeks for component parts or the standard lead time of the original fixture for a complete fixture for

duration of warranty period.

b. All luminaires and control system devices shall be replaceable in the field as specified in the Luminaire Schedule and Miami Beach Citywide Lighting Standards.
c. System shall carry a full warranty for a minimum of three (3) years from the date of shipment (or longer if required by the project). Manufacturer shall be responsible for a cost of labor and shipping as agreed between parties, to replace any component of the system that fails within the warranty period.

3. Products and Components – Performance
   a. LED luminaires and components shall be approved by an NRTL facility such as UL, ETL or CSA/US.
   b. For applicable fixtures: all products included in system shall use Mil-Std 810F, Random Vibration 7.698g as a minimum standard. In installations subject to vibration, luminaire shall be installed with vibration isolation hardware to sufficiently dampen vibrations.
   c. All LED components shall be mercury and lead-free.
   d. All manufacturing processes and electronic materials shall conform to the requirements of the European Union's Restriction on the Use of Hazardous Substances in Electrical and Electronics Equipment (RoHS) Directive, 2002/95/EC.
   e. LEDs shall comply with ANSI/NEMA/ANSLG C78.377-2008 – Specifications for the Chromaticity of Solid-State Lighting Products. Color shall remain stable throughout the life of the source. The chromaticity of the installed product shall match IES LM-80 data showing that the LED's do not shift more than .005 DuV from an approved sample or submitted documentation.
   f. LEDs testing shall be performed in accordance with IES LM-80 - Approved Method for Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
   g. LEDs shall have a minimum rated source life of 100,000 hours or as specified in the Luminaire Schedule. LED "rated source life" shall be determined per IES TM-21 - Projecting Long Term Lumen Maintenance of LED Light Sources based on LM-80 test data. Calculated lifetimes not exceeding testing hours per TM-21 are not accepted.
   h. Luminaire assembly shall include a method of dissipating heat to prevent degradation of source life, electronic equipment, or lenses. LED luminaire housing shall be designed to transfer heat from the LED board to the outside environment. Luminaire housing shall have no negative impact on life of components. High power LED luminaires shall be thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware
   i. Luminaire shall be tested and suitable to operate under a minimum of two (2) case temperatures: 55°C (131°F) and 85°C (185°F) and a relative humidity under 95%.
   j. Manufacturer shall supply in writing a range of permissible operating temperatures and relative humidity levels in which system will perform optimally. LEDs shall be adequately protected from moisture or dust per IP66 rating.
   k. All hardwired power connections to LED luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed, shorted or otherwise mis-wired during the installation process.
   l. For data wiring/cabling, provide pinout information for non-proprietary connectors specified herein.
   m. LEDs shall not be overdriven beyond their specified nominal voltage and current.
   n. Color-changing luminaires utilizing alternating color LED chips shall use an equal combination of each color of LED and shall be compatible with Miami Beach Citywide Lighting Standards.

o. Manufacturer shall be able to provide supporting documentation of the product meeting third party regulatory compliance.
p. Manufacturer shall ensure that products undergo and successfully meet appropriate design and manufactured testing including Design Failure Mode & Effects Analysis, Process Failure Mode & Effects Analysis, Environmental Engineering Considerations and Laboratory Tests, IEC standards and UL/CE testing.
q. Manufacturer shall provide Luminaire Efficacy (lm/W), total luminous flux (lumens), luminous intensity (candelas), chromaticity coordinates, CCT and CRI. Optical performance, polar diagrams, and relevant luminance and illuminance photometric data. Provide data in IES file format in accordance with testing standards IES LM-79-08 and IES LM-82-12, based on test results from an independent Nationally Recognized Testing Laboratory or National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory.
r. All color characteristics, CCT, CRI, Color Fidelity, CIE Chromaticity Coordinates shall be consistent across the entire dimming range.
s. Luminaires shall have less than 30% flicker at frequencies of 200Hz or below at 100% and 20% light output and/or meet IEEE standard PAR 1789.

4. LED Power Supplies/ Drivers:
   a. LED drivers shall have a minimum 50,000 hour published life while operating at maximum case temperature and 65 percent non-condensing relative humidity.
   b. LED drivers shall have THD no more than 20% with 0.9 power factor.
5. Driver shall be Sound Rated A+.
6. Driver shall be > 90% efficient at full load across all input voltages.
7. Digital LED Control and Communication – Performance
   a. LED luminaires shall be network controllable via digital control.
   b. Each LED luminaire and/or node shall have the capability to be set to a unique and individual address. Address shall be selectable through onboard switches or by an external hardware or software method.
   c. LED luminaire shall be compatible with lighting control system specified herein.
   d. Provide interface with minimum of 2 auxiliary contacts.

2.5 RATED LOCATION LUMINAIRES

2.5.1 General:

1. Provide luminaires designed and manufactured specifically for “wet-rated” location service. Components, including nuts, bolts, rivets, springs, and similar parts shall be made of materials of effective corrosion resistance, or of materials which have been subjected to finishing treatment which will assure such resistance.
2. Provide anodized aluminum for aluminum parts of exterior luminaires that are not specified as requiring a painted finish.
3. All luminaires shall be constructed according to UL procedures, and listed by UL ETL or CSA-US for the appropriate category.

2.5.2 **Wet Location:**

1. In addition to the requirements of paragraph, above, wet location luminaires shall meet or exceed the following criteria:
   a. Hermetically sealed.
   a. Provide metal parts of luminaires, which are specified as requiring painting, for use in wet locations, which are painted with suitable weather and/or moisture resisting qualities.
   b. Provide luminaires for use outdoors, or in areas designated as wet locations, which are suitably and effectively gasketed to prevent access of moisture into electrical components or enclosing diffusers, lenses or globes.
   c. Luminaires shall be UL, ETL or CSA-US listed for wet locations.
   d. Luminaires shall have an IP66 wet location rating.

3. EXECUTION

3.1 SUMMARY

3.1.1 Install luminaires complete with light sources, as indicated, and with equipment, materials, parts, attachments, devices, aligner and filler clips, hardware, poles, channels, frames and brackets necessary to make a safe, complete, and fully operative installation.

3.1.2 Coordinate with other trades as appropriate to properly interface installation of luminaires with other work.

3.1.3 Reject and do not install blemished, damaged, or unsatisfactory luminaires. Replace imperfect or unsatisfactory luminaires, if installed, as directed.

3.1.4 All luminaires, poles, sensors, and its components are to be rated to endure the conditions in Coastal Districts and shall be installed to maintain the ratings.

3.1.5 Set luminaires, when installed, to be true, and free of light leaks, warps, dents, or other irregularities. No light leaks are permitted from any visible part or joint of the luminaires. Install luminaires plumb, square, and level at site as agreed upon by engineer, in alignment with adjacent luminaires, and secure in accordance with manufacturers' directions and approved shop drawings.

3.1.6 Provide finish for all exposed parts or trims as specified. If not indicated, provide a finish as directed.

3.1.7 Mount luminaires at heights and locations indicated on the Contract Drawings, or as required by City. Mounting heights specified or indicated are to be to the top of each luminaire, unless otherwise noted. Obtain approval of the exact mounting for luminaires on the job before ordering is commenced and, where applicable, after coordinating with the type, style, and pattern of the surface being installed.

3.1.8 Ground non-current-carrying parts of electrical equipment in accordance with UL and NEC provisions.

3.1.9 Upon completion of installation of luminaires, and after circuits have been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then re-test to demonstrate compliance. Otherwise, remove and replace with new units, and proceed with re-testing. Coordinate all test times and requirements with the City.

1. Test all wiring with an insulation testing instrument, both before and after connection of luminaires and equipment. The minimum resistance shall be 250,000 ohms.

3.1.10 Upon completion of the installation, the luminaires and lighting equipment shall be in first class operating order and free from defects in condition and finish. At time of final inspection, all luminaires and equipment shall be clean, fully lamped, and be complete with required lenses or diffusers, reflectors, shields or other components necessary for the function of the luminaires. Any reflectors, lenses, diffusers, shields or other parts damaged prior to the final inspection shall be replaced prior to inspection.

3.1.11 Luminaires and sources that are part of the Work of this section shall not be used for work lights during construction. Provide adequate portable or temporary lighting for construction.

3.2 POLES

3.3 Delivery, Storage, and Handling

1. Package aluminum poles for shipping according to ASTM B 660.
2. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
3. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below finished grade.
4. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
5. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

3.4 Warranty

1. Special Warranty: Manufacturer agrees to repair or replace components of pole(s) that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.
2. Warranty Period: Five years from date of Substantial Completion.
3. Warranty Period for Corrosion Resistance: Five years from date of Substantial Completion.
4. Warranty Period for Color Retention: Five years from date of Substantial Completion.

3.5 Performance Requirements

1. Shall meet requirements:
   a. AASHTO LTS-6-M for structural and wind load standards.
   b. ASTM A 500/A 500M for steel poles
   c. ASTM B 221 for aluminum poles
   d. ASTM A 123/A 123M for hot dipped galvanized finishes
   e. ASTM A 36/A 36M for structural steel in foundations
2. Shall have an oval handhole 2-1/2” x 5” with secured cover by captive stainless or galvanized steel screws.
3. Shall have hot dipped galvanized steel hardware where not welded.

3.6 Installation

1. This guideline does not include any recommendations or guidelines for the mounting of any luminaires or poles. All installations must be done in coordination with the Florida Building Code and manufacturer provided details.

2. Shall install to manufacturer requirements and materials.
3. Shall maintain code required distances from nearby services above or under ground.
4. Do not mount aluminum poles in contact with earth, concrete, or different metals without proper protection to reduce corrosion.
5. Provide proper grounding as recommended by manufacturer.

3.7 INTELLIGENT LUMINAIRE CONTROLS

3.7.1 Refer to Miami Beach Citywide Lighting Standards Chapter 5 page 2, Chapter 6 pages 1 and 2 for controls performance specification framework.

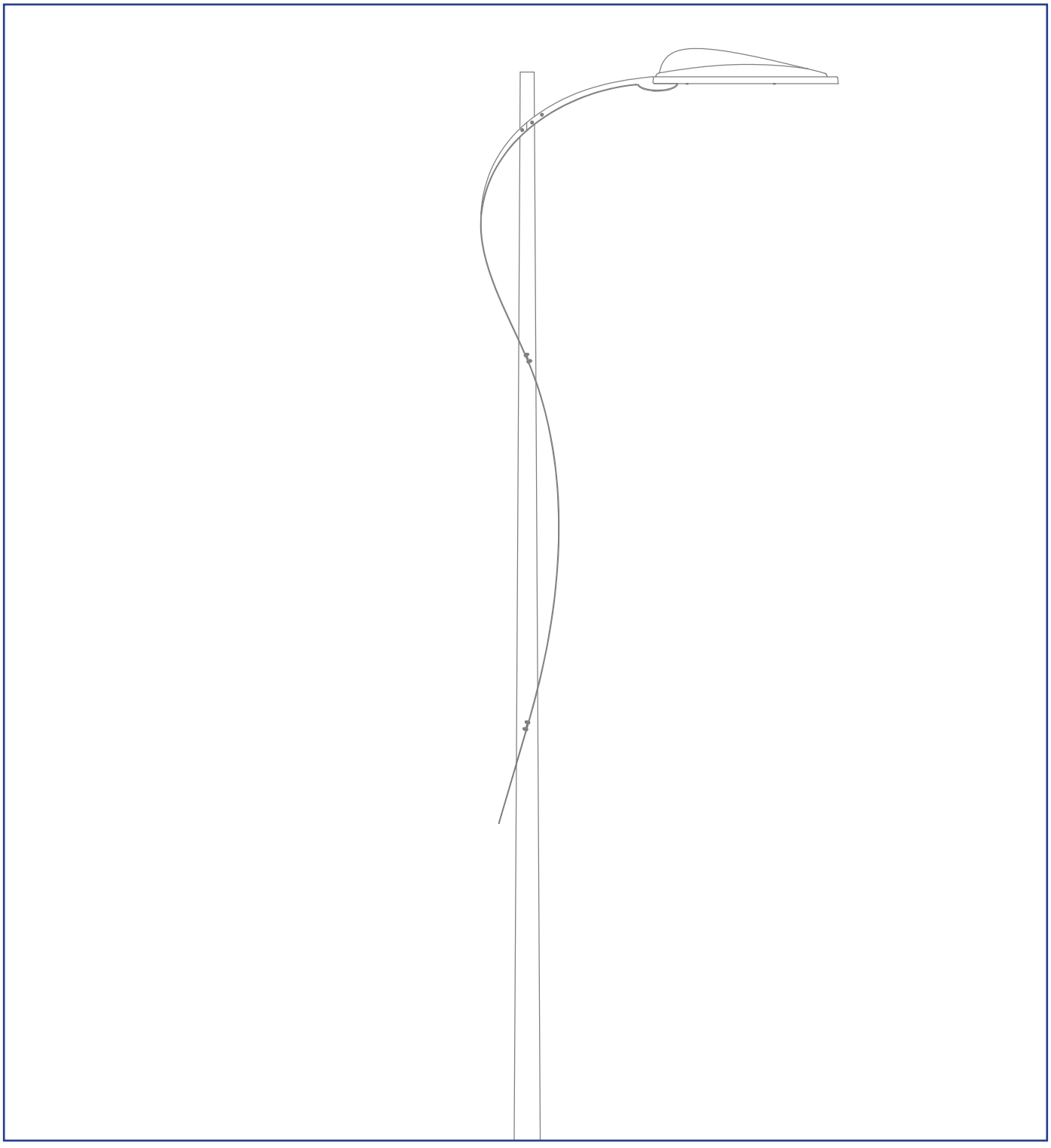
3.8 CALCULATION REPORTS

3.8.1 Refer to Miami Beach Citywide Lighting Standards Chapter 6 page 1 for calculation report specification framework.

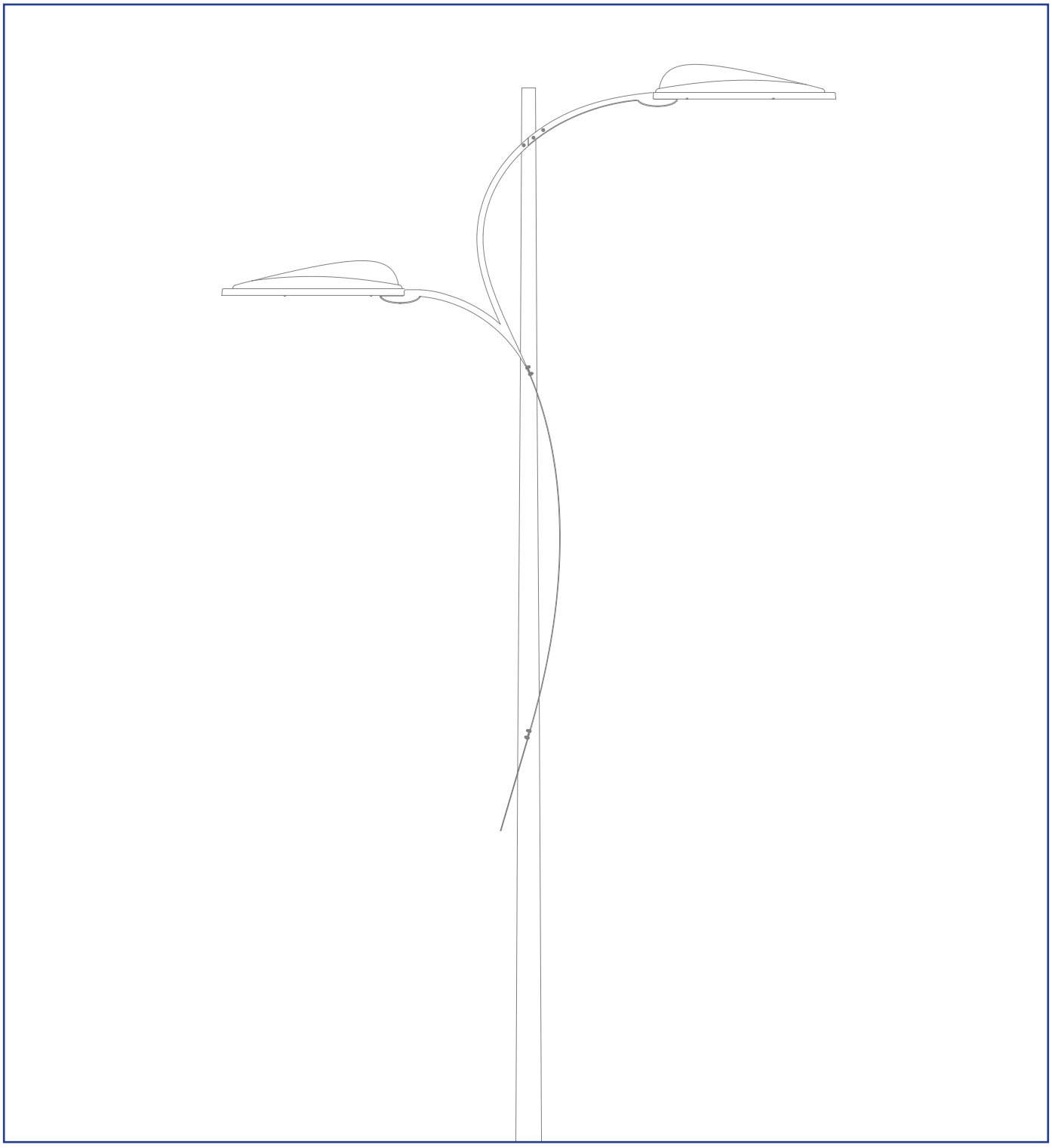
3.9 SAMPLES AND MOCKUPS

3.9.1 Samples and mockups shall be provided at the request of the community for a review period of no less than 3 weeks. Full-scale mockups shall adhere to all parts of the Miami Beach Citywide Lighting Standards, as though they are a complete installation. At the end of the agreed upon duration, mockups shall be completely demolished and removed by the same agency that installed the mockup.

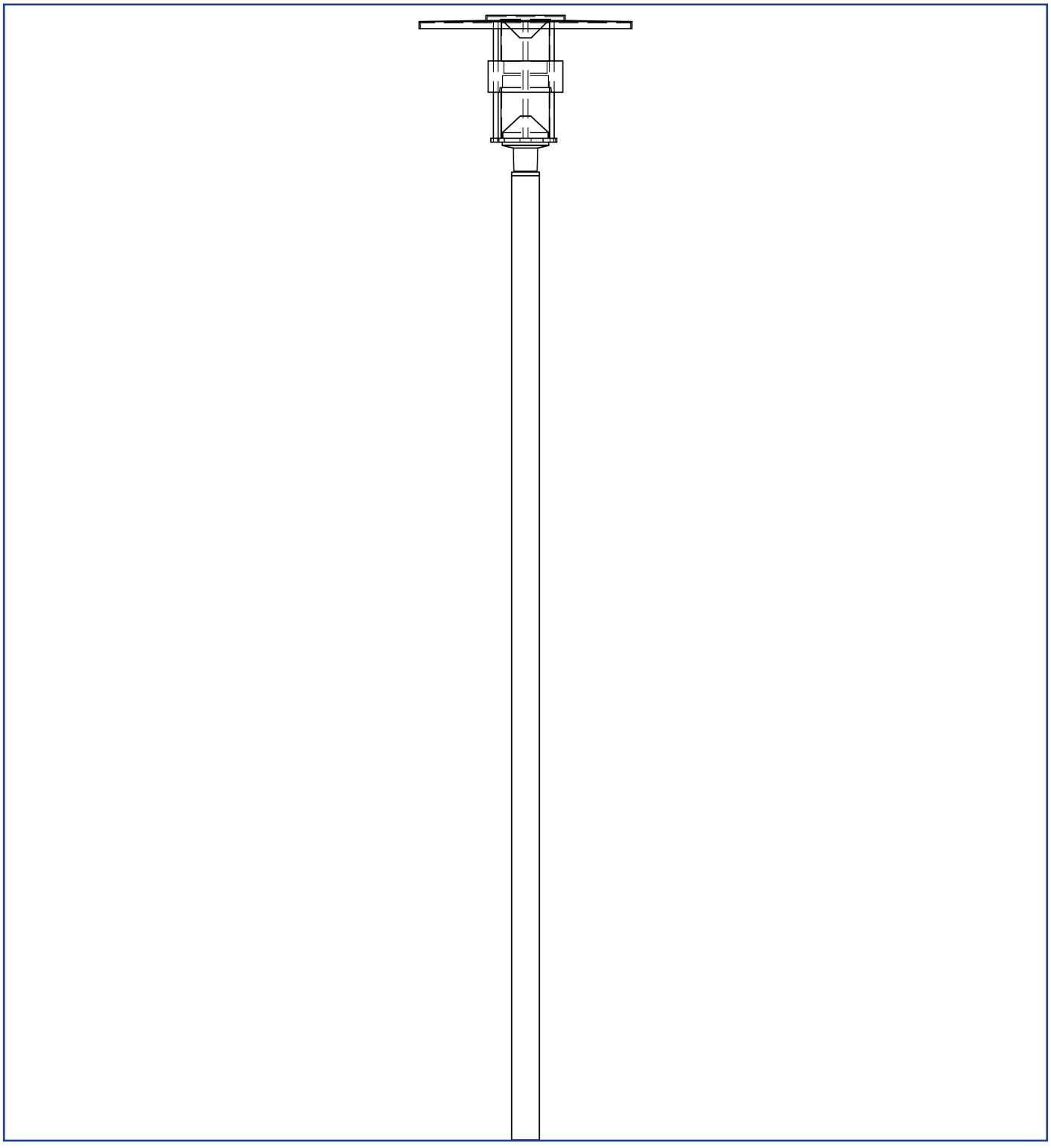
Appendix C
Typical Drawings



Typical A - “Roadway Luminaire” 25’ - 30’ Overall Height

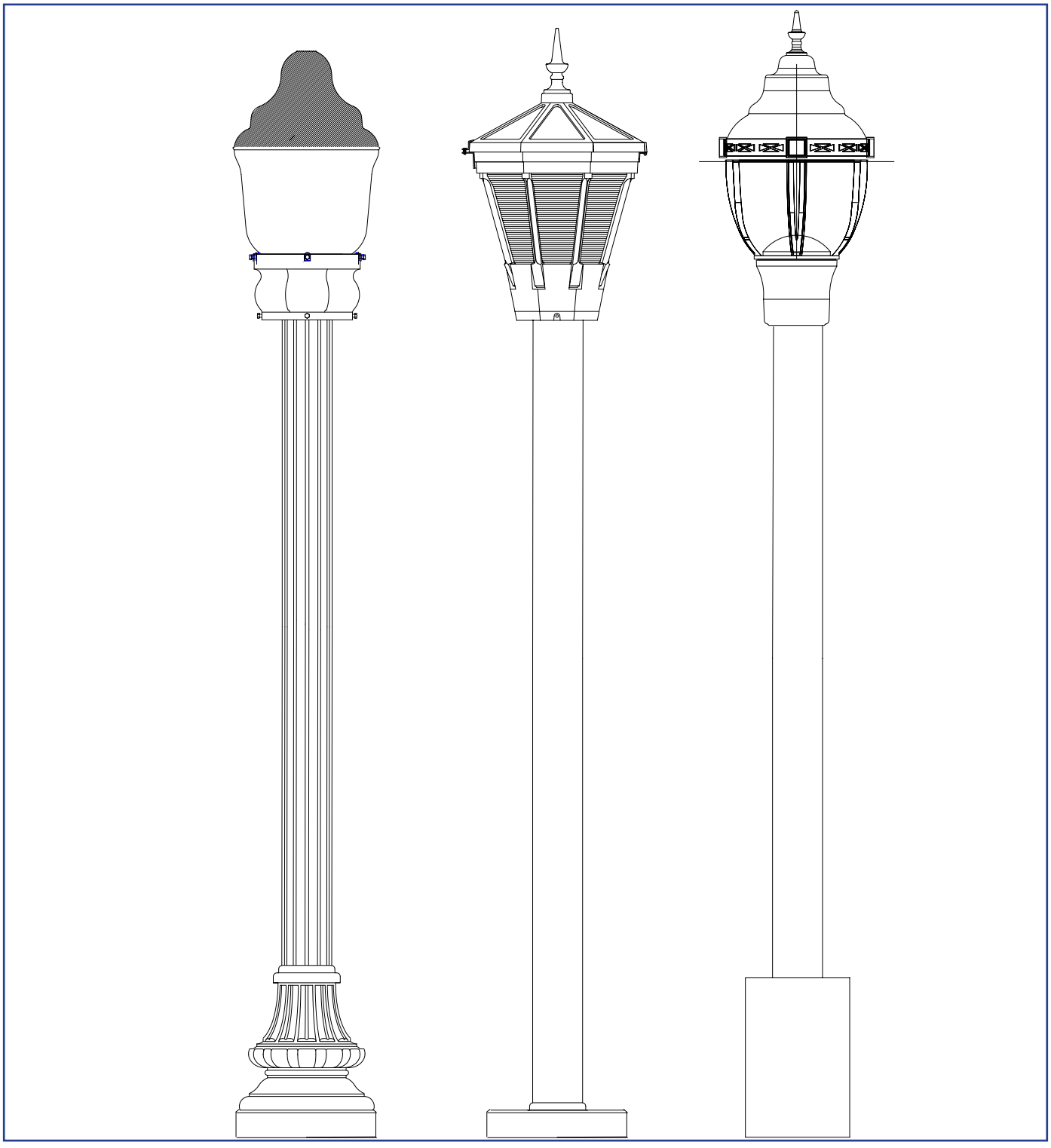


Typical B - “Roadway / Pedestrian Luminaire”
25’ - 30’ Overall Height
12’ - Pedestrian Head



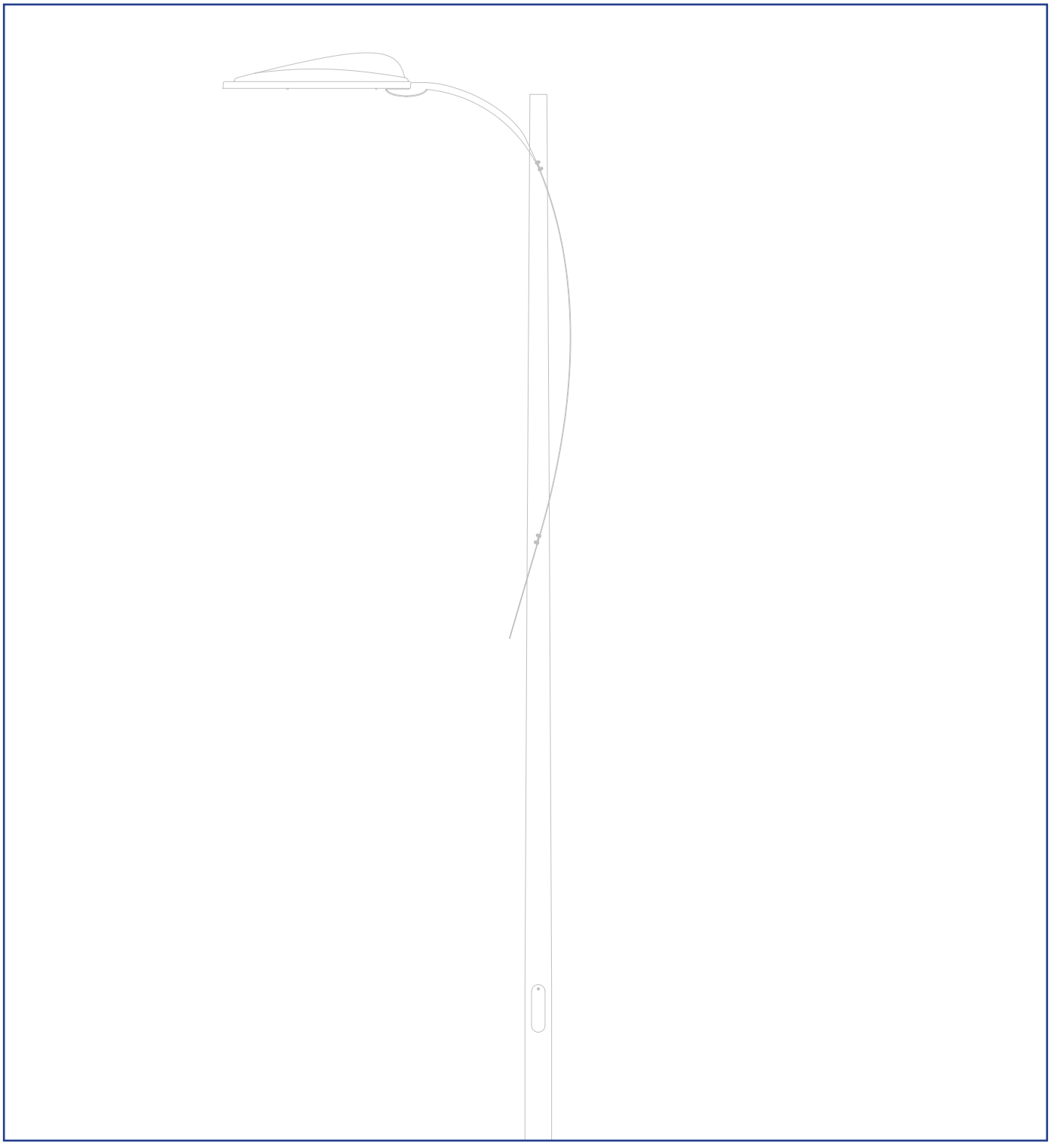
Typical C - “Branded Pedestrian Luminaire” in South Beach 14’ - 16’ Overall Height

Fixture type not approved for use within Coastal Districts.



Typical D - "Pedestrian Luminaires" 14' - 16' Overall Height

Fixture types not approved for use within Coastal Districts.



Typical E - “Turtle-Friendly Luminaire” 12’ Maximum Overall Height

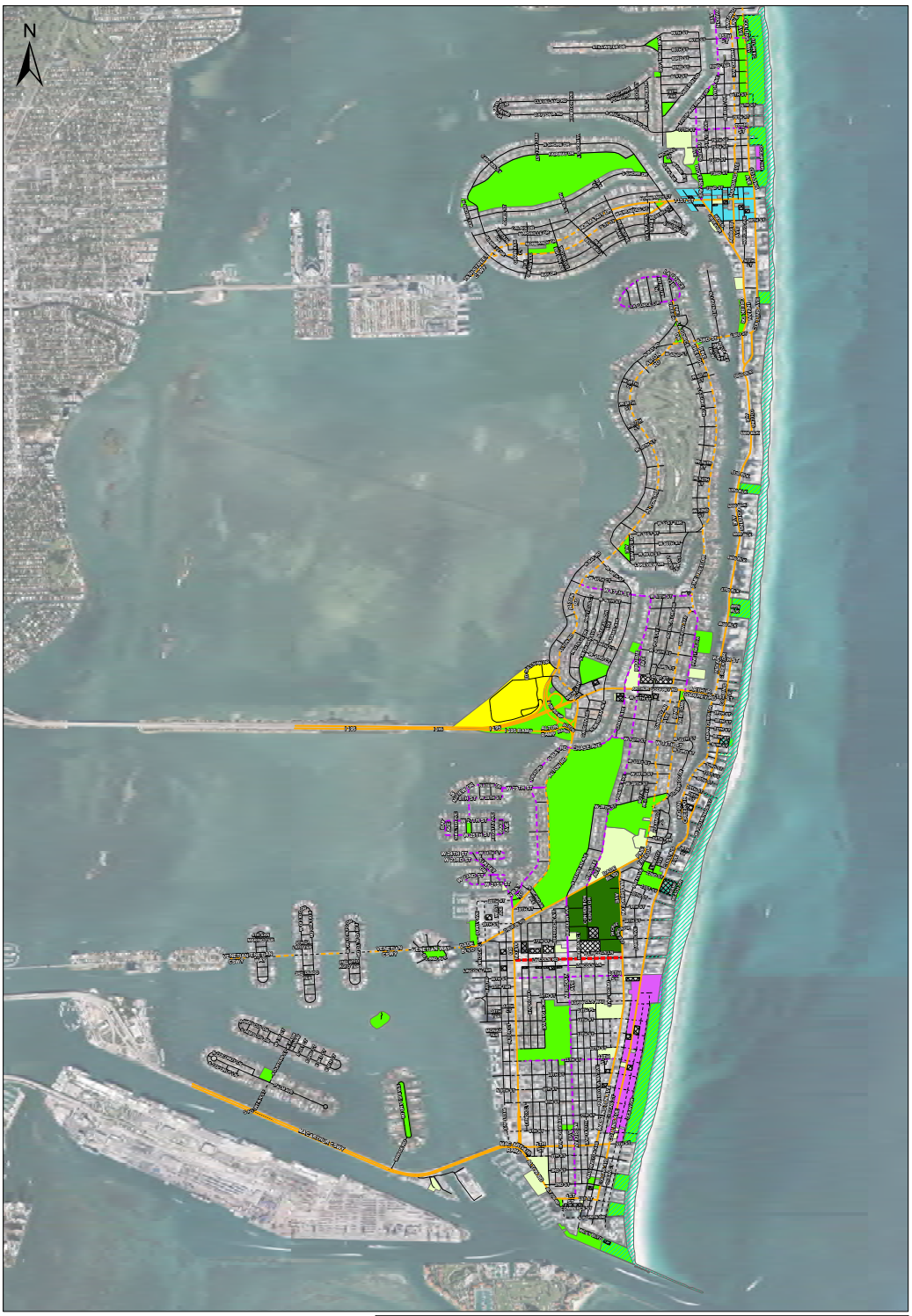
Must be approved by the Florida Fish and Wildlife Conservation Commission
Depending on mounting location, additional shielding may be required.

Appendix D
References

Reference Summary

Category	City Wide Lighting Standard	Reference
Environmental Factors	BUG Rating of B1 or B2 Minimizes Lighting Trespass BUG Glare Rating Backlight and Up Light Trespass	 Section 1, Page 2 Section 1, Page 3 Section 1, Page 3 Section 4, Pages 2 & 4
Wildlife and Sea Turtle Districts	Use lighting only when necessary. Keep it low in mounting height, keep it shielded so no light is visible from the beach, keep it long wavelength (560nm or longer) during breeding season. Miami Beach ordinance 46-203, Florida Fish and Wildlife Conservation Chapter 62B-55 Model Lighting Ordinance for Marine Turtle Protection and Coastal Construction Control Line (CCL) established by the State of Florida pursuant to F.S. § 161.053.	Section 4, Page 4 Chapter 62B-55*
Calculation Report		Section 5, Pages 1-2
Lighting Control	Bi-level lighting system recommended see section 6 controls performance specification.	Section 6, Page 1
Performance Requirements	Luminaire specifications	Section 4
Color Rendering Index	80 / ANSI TM-30-18 minimum requirement	Section 4, Page 1
Residential Color Temperature	3000K/4000K-ANSI/IES LM-80-15/4 STEP Macadam	Section 4, Page 2
Commercial Color Temperature	4000K-ANSI/IES LM-80-15/4 STEP Macadam	Section 4, Page 3
Luminaire Values	IESNA RP-8-18 or latest	Appendix F, Page 2
Pedestrian Traffic	State of Florida Department of Transportation 2013 Quality/Level of Service Handbook or latest	Appendix F, Page 3
Parking	Miami Beach ordinance 98-3108, § 7(F), 1-21-98	Section 4, Page 5

Appendix E
Lighting Zone Design Matrix and Map



City of Miami Beach Lighting Zones

MIAMIBEACH RISING ABOVE

1 inch = 0.25 miles

0 0.25 0.5 1 Miles

Legend

Corridor Type
- Major - Commercial
- Major - Residential
- Collector - Commercial
- Collector - Residential
- Local - Residential
- Local - Commercial

District
- Hospital District
- Mixed-Use Entertainment District
- Town Center Area
- Open Space and Parks
- Convention Center District
- City Hall/City Services
- Parking - Public

Areas of Interest
- Oceanfront Environmental
- Lincoln Road Pedestrian Mall

Note: Lighting standards specified for districts shall take precedence over corridors which run through these specified districts. The Oceanfront Environmental overlay shall take precedence over all districts and corridors.

JACOBS

LIGHTING ZONE DESIGN MATRIX

Lighting Zone	Average Luminance (cd/m^2)	Average Uniformity Ratio (avg:min)	Maximum Uniformity Ratio (max:min)	Maximum Veiling Luminance Ratio (v,max:avg)	Correlated Color Temperature	New Lighting Specifications (see note 4)	Fixture Type	Controls Sequence
Corridor – Major Commercial	1.2	3:1	5:1	0.3	4000K	Commercial	Roadway	ON = Dusk OFF = Dawn DIM
Corridor – Major Residential	0.6	3.5:1	6:1	0.3	4000K See note 5	Residential	Roadway or Pedestrian (see note 12)	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.
Corridor – Collector Commercial	0.6	3.5:1	6:1	0.4	4000K	Commercial	Roadway	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =11:59pm -4:30am.
Corridor – Collector Residential	0.4	4:1	8:1	0.4	4000K See note 5	Residential	Roadway or Pedestrian (see note 12)	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.
Corridor - Local Commercial	0.6	6:1	10:1	0.4	4000K	Commercial	Roadway	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.
Corridor - Local Residential	0.3	6:1	10:1	0.4	4000K See note 5	Residential	Roadway or Pedestrian (see note 12)	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.
Hospital District	0.6	6:1	10:1	0.4	4000K	Commercial	Roadway	ON = Dusk OFF = Dawn DIM
Mixed-Use Entertainment District	0.9	4:1	4:1	4:1	4000K	Commercial	Roadway or Pedestrian (see note 12)	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =11:59pm -4:30am.
Town Center Area	0.9	4:1	4:1	4:1	4000K	Commercial	Roadway or Pedestrian (see note 12)	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =11:59pm -4:30am.
Open Space and Parks	0.6	6:1	10:1	0.4	4000K	Residential	Pedestrian	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.

LIGHTING ZONE DESIGN MATRIX

Lighting Zone	Average Luminance (cd/m²)	Average Uniformity Ratio (avg:min)	Maximum Uniformity Ratio (max:min)	Maximum Veiling Luminance Ratio (v,max:avg)	Correlated Color Temperature	New Lighting Specifications (see note 4)	Fixture Type	Controls Sequence
Parking	0.4 - 0.9 (per district)	6:1	10:1	0.4	4000K	Residential	Pedestrian	ON = ½ hour after sunset OFF = 2 hours after closing or ½ hour before sunrise DIM OCC =2 hours after closing until dawn
Convention Center District	0.6	6:1	10:1	0.4	4000K	Commercial	Branded	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.
City Hall/City Services	0.6	6:1	10:1	0.4	4000K	Commercial	Pedestrian	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.
Oceanfront Environmental Overlay	0.6	6:1	10:1	0.4	Amber	Coastal	Turtle Friendly (see note 11)	ON = Dusk OFF = Dawn DIM
Lincoln Road Pedestrian Mall	0.9	4:1	4:1	4:1	4000K	Specialty	Branded	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.

Notes:

1. All luminaires to have 80 CRI minimum and full cut off optics.
2. All luminaires to have efficiency of 100lm/W, with L70 of 100,000 hours
3. All luminaires capable of dimming.
4. New Lighting specifications are listed in Section 4 of the Citywide Lighting Standards.
5. See residential specification for options on color temperature.
6. ON refers to when the lights are to be illuminated.
7. OFF refers to when the lights are to not provide illumination but remain energized.
8. DIM refers to when the lights are to dim to maintain a target illuminance. Refer to luminance to illuminance conversion chart for associated foot-candle values.
9. DIM 20% refers to when the lights are to dim to 20% of target illuminance in DIM.
10. OCC refers to when the lights are to fade from the current intensity to 100% over 5 seconds in response to motion sensors. Sensors timeout after 15 seconds and lights fade down to previous intensity over 30 seconds. Controls shall be capable of triggering luminaires in response to traffic 300 hundred feet away on approach. Sensors of adjacent luminaires shall be capable of triggering multiple luminaires on the roadway in response to approaching traffic. Controls shall be field tested by controls manufacturer and adjusted as needed for optimal safety.
11. Fixture should be approved by the Florida Fish and Wildlife Conservation Commission and comply with the coastal lighting specifications.
12. Roadway, Pedestrian, or Roadway/Pedestrian fixture types may be used in these districts.
13. Lighting standards specified for districts shall take precedence over corridors which run through these specified districts. The Oceanfront Environmental overlay shall take precedence over all districts and corridors.

Appendix F
Lighting Standards, Referenced

LIGHTING DESIGN CRITERIA FROM ANSI/IES RP-8-18

Street Classification	Pedestrian Activity Classification*	Average Luminance L_{avg} (cd/m²)	Average Uniformity Ratio L_{avg}/L_{min}	Maximum Uniformity Ratio L_{max}/L_{min}	Maximum Veiling Luminance Ratio $L_{v,max}/L_{avg}$
Major	High	1.2	3.0	5.0	0.3
	Medium	0.9	3.0	5.0	0.3
	Low	0.6	3.5	6.0	0.3
Collector	High	0.8	3.0	5.0	0.4
	Medium	0.6	3.5	6.0	0.4
	Low	0.4	4.0	8.0	0.4
Local	High	0.6	6.0	10.0	0.4
	Medium	0.5	6.0	10.0	0.4
	Low	0.3	6.0	10.0	0.4

Table Notes:

* Pedestrian Activity Classifications are defined in Section 11.3.3.

L_{avg}: Maintained average pavement luminance

L_{min}: Minimum pavement luminance

$L_{v,max}$: Maximum veiling luminance

CLASSIFICATION OF PEDESTRIAN TRAFFIC FROM FLORIDA DOT

PEDESTRIAN LEVEL OF SERVICE SCORE

If pedestrian traffic is not known, a survey shall be performed following these criteria:

Surveyor shall use the most up-to-date version of State of Florida Department of Transportation LOSPLAN software and follow the guidelines as written in the State of Florida Department of Transportation 2013 Quality/ Level of Service Handbook. Newer versions of this handbook will supersede this standard.

LOSPLAN level of service numbers shall be used in the following equation and scores shall be use to define pedestrian classifications listed below.

$$PLOS_f = \sum d_1 (p_1)^2 + \ldots d_n (p_n)^2 / \sum d_1 (p_1) + \ldots d_n (p_n)$$

Where:

$PLOS_f$ = Pedestrian level of service for the facility

d_1 = Length of the first segment

p_1 = Pedestrian level of service score for the first segment

d_n = Length of the last segment

p_n = Pedestrian level of service score for the last segment

Low: Less than or equal to 2.75

Medium: Greater than 2.5 but less than or equal to 4.25

High: Greater than 4.25

LUMINANCE (cd/m²) TO ILLUMINANCE (fc) CONVERSION CHART

Lighting Zone	Average Luminance (cd/m²)	Average Illuminance for R1 pavement (fc)	Average Illuminance for R2 & R3 pavement (fc)	Average Illuminance for R4 pavement (fc)
Corridor – Major Commercial	1.2	1.2	1.8	1.6
Corridor – Major Residential	0.6	0.6	0.9	0.8
Corridor – Collector Commercial	0.6	0.6	0.9	0.8
Corridor – Collector Residential	0.4	0.4	0.6	0.5
Corridor - Local Commercial	0.6	0.6	0.9	0.8
Corridor - Local Residential	0.3	0.3	0.45	0.4
Hospital District	0.6	0.6	0.9	0.8
Mixed-Use Entertainment District	0.9	0.9	1.35	1.2
Town Center Area	0.9	0.9	1.35	1.2
Open Space and Parks	0.6	0.6	0.9	0.8
Parking	0.4 - 0.9 (per district)	0.4 - 0.9 (per district)	0.6-1.35 (per district)	0.53-1.2 (per district)
Convention Center District	0.6	0.6	0.9	0.8
City Hall/City Services	0.6	0.6	0.9	0.8
Oceanfront Environmental Overlay	0.6	0.6	0.9	0.8
Lincoln Road Pedestrian Mall	0.9	0.9	1.35	1.2

Notes:

1. Conversions assume 1fc = 10 lux
2. Conversion of each roadway type in foot-candles (fc) are based on IES RP-8-18 Section 11.7.1. The foot-candle numbers are approximations based on roadway reflectances and may not be accurate for all roadway types. The luminance method is the preferred method for lighting of roadways and mathematical conversion should only be used when it is impossible to calculate or measure luminance.
3. R1 Pavement: Mostly diffuse reflectance properties characteristic of Portland cement or asphalt surface with a minimum of 15% of the aggregates composed of artificial brightener aggregates.
4. R2 & R3 Pavement A combination of diffuse and specular reflectances characteristic of asphalt surfaces.
5. R4 Pavement: Mostly specular surface typical of very smooth asphalt texture.

Appendix C
GIS Lighting Zones Map

City of Miami Beach Lighting Zones

MIAMIBEACH RISING ABOVE

1 inch = 0.25 miles

0 0.25 0.5 1 Miles

Legend

Corridor Type

- Major - Commercial
- Major - Residential
- Collector - Commercial
- Collector - Residential
- Local - Residential
- Local - Commercial

District

- Hospital District
- Mixed-Use Entertainment District
- Town Center Area
- Open Space and Parks
- Convention Center District
- City Hall/City Services
- Parking - Public

Areas of Interest

- Oceanfront Environmental
- Lincoln Road Pedestrian Mall

Note: Lighting standards specified for districts shall take precedence over corridors which run through these specified districts. The Oceanfront Environmental overlay shall take precedence over all districts and corridors.

JACOBS

Appendix D
Photometric Report

MIAMIBEACH

Citywide Photometric Analysis

2017-119-KB
SMART CITY STREET LIGHTING SYSTEM – DESIGN, BUILD, OPERATE, AND MAINTAIN

PROCUREMENT DEPARTMENT
1755 Meridian Avenue, 3rd Floor
Miami Beach, Florida 33139


MIAMI
BEACH
// CITEMETRIX™ ANALYSIS
citelum
GROUPE EDF

SECTION I

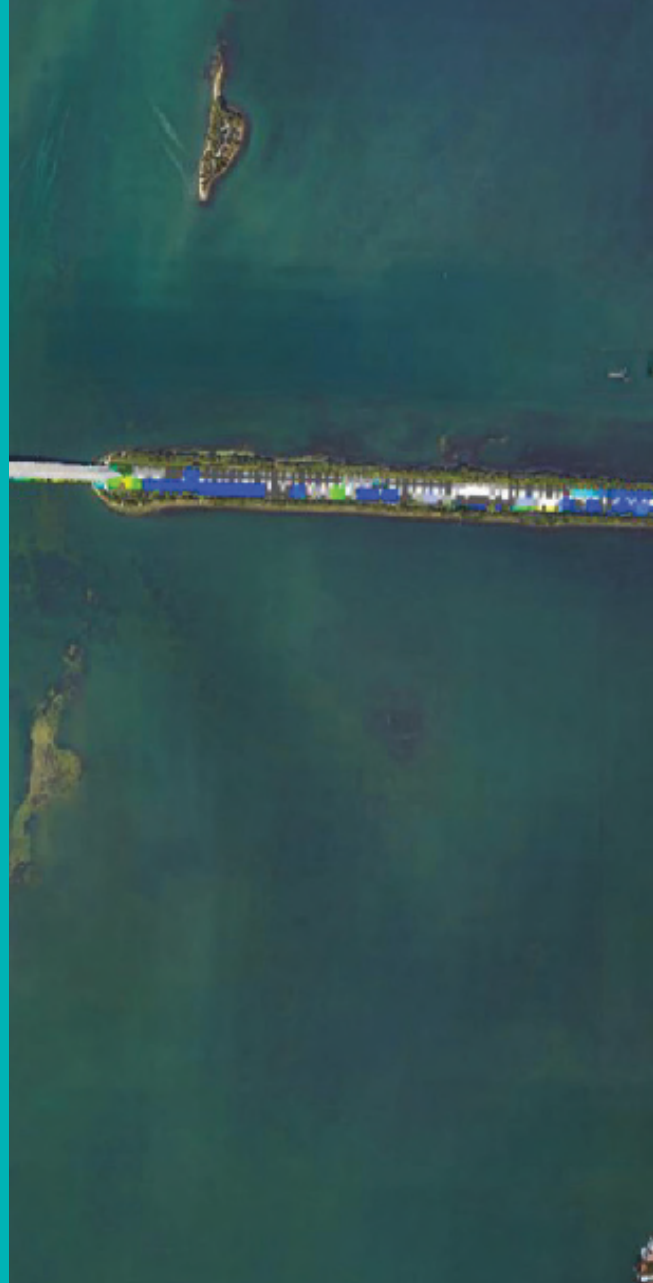
EXECUTIVE SUMMARY
CITEMETRIX™ ANALYSIS

In mid-2015, Citelum approached the City of Miami Beach to propose the preparation of a Lighting Master Plan. The goal of such a plan is to ensure that the City has appropriate and desired lighting levels and lighting uniformity in accordance with its goals for tourism and public safety, among other things. Essentially, **the right light at the right place and the right time.**

Generally, such a process begins with assessing the City's current lighting by conducting a comprehensive inventory and analysis of lighting levels, i.e., a Citemetrix™ Analysis. Since the city has an existing, albeit somewhat dated GIS database of its street lights, it was decided that this database could be utilized for an initial analysis.

Citelum was advised that one of the City's main concerns at present is to analyze the current lighting in the city and assess its adequacy. Citelum was ultimately contracted to perform a photometric analysis of the City's street lights for this purpose.

Citelum sent a team of technicians to perform a city-wide photometric analysis for Miami Beach. Over the course of multiple weeks, the team drove and measured performance of all accessible roadways. This information was then mapped and analyzed by Citelum engineers in order to generate a top level understanding of lighting performance.



MEASUREMENT PROCEDURE

THE PHOTOMETRIC PATROL CAR & MUSE®

Citelum's Citemetrix™ Analysis is performed using our proprietary Computerized Maintenance Management System, MUSE®, and tailor-made smart lighting vehicle, the Photometric Patrol Car. MUSE® provides all software from route design to data integration, and from cross analysis to automatic reports.

The Photometric Patrol Car is equipped with an Illuminance meter (Konica Minolta T10-A), a GPS radio (BU-353) and a Control PC/Laptop. Through a CAN bus interface, the equipment also collects the location and odometer readings directly from the vehicle that are then factored in and recorded to the Control PC running the Photometric Module. LUX meter reading is recorded for every wheel rotation, in this case every 80 cm.

Equipment calibration is performed by external certified laboratories periodically. Additional information on the measurement tools may be found in Appendix C.

SOFTWARE DESCRIPTION

Citelum worked with the City of Miami Beach to gather as much existing data as possible to ensure a successful measurement. This included the GIS layer for street light locations as well as the street centerlines. This data was then imported into the MUSE® GIS platform as the basis for the creation of measurement routes, known as "itineraries." The itineraries are generated as a method to systematically measure all roadway segments in an optimized manner.

After the itinerary segments have been created, patrols are scheduled and they are downloaded to the Control PC. The patrol team consists of a Driver and a Control PC Technician. The Technician acts as a navigator, providing required direction to the Driver to record measurements for each itinerary. The Control PC automatically indicates when the data has been acquired successfully. Also, itineraries are color coded so that roads to be patrolled are easily distinguishable from roads already patrolled. At the end of each patrol, data is reviewed and uploaded to the main database for additional quality control.

ACCESSIBILITY ISSUES

During the data collection of the Citemetrix™ Analysis in Miami Beach, specific street segments were not measured due to accessibility restrictions.

List of Inaccessible Streets:

Española	Drexel Ave.	Meridian Ave.
Lincoln Ave.	Lincoln Ln.	W. 63rd St.
Lincoln Rd.	N. Bay Rd.	34th St.
Lincoln Ct.	14th & Bay Rd.	87th Terrace
Euclid Ave.	Alton Ct.	Atlantic Way & 80th St.

THE PURPOSE OF A CITEMETRIX™ ANALYSIS IS TO TAKE THE FIRST STEP TOWARDS A FULLY DESIGNED LIGHTING MASTER PLAN.

HOW MUCH LIGHT IS THERE?
HOW MUCH LIGHT DOES THERE NEED TO BE?

WHAT IS THE RIGHT LIGHT, FOR THE RIGHT APPLICATION, FOR EVERY LOCATION IN THE CITY OF MIAMI BEACH?

SECTION III

IMPORTATION & EVALUATION
DATA IMPORT / QUALITY ASSURANCE

After an itinerary has been completed, all measurements from that route are sent to the main database for quality assurance and control purposes. After all routes have been completed and quality-checked, reporting can be performed, as described in this report

For Miami Beach, we broke down the roadway segments by roadway type (accompanying chart 3c). The total numbers of segments, and their related distance are reflected in the accompanying chart:

NUMBER OF ROADWAY SEGMENTS (3a)

Roadway Types	*Sections*
COLLECTOR	10
EXPRESSWAY	12
LOCAL	1,775
MAJOR	379
TOTAL	**2176**

DISTANCE BREAKDOWN (MILES) (3c)

MILES OF ROADWAY MEASURED (3b)

Roadway Types	*Distance (Miles)*	*Distance Percentage*
COLLECTOR	1.46	1%
EXPRESSWAY	10.05	6%
LOCAL	124.40	73%
MAJOR	33.59	20%
TOTAL	**169.49**	**100%**

For reporting purposes, all results are segregated by roadway type, and in expressed distance instead of by number of street segments. This provides a better base of measurement, as roadway segments may vary in length.

EVALUATION STANDARDS

After reviewing and providing quality control of the collected data, Citelum was able to begin the evaluation process. Our goal was to evaluate the measurements against accepted lighting standards, identify over lit and under lit areas, and calculate the uniformity of each roadway segment.

In order to evaluate the data collected and compare lighting levels to known standards, Citelum made specific assumptions.

1) **Citelum used the IESNA RP-8 Roadway Lighting standards to set the acceptable lighting level requirements**

2) **Within the RP-8 standard, lighting levels are outlined by roadway type, pavement classification, and pedestrian conflict level.**

    a. Citelum assumed that the roadways measured all have a pavement classification of R2 or R3.

    b. The roadway types defined in the RP-8 vary slightly from the City's roadway type definitions, and therefore, we made the following assumptions:

Miami Beach Roadway Classification Nomenclature	RP-8 Equivalent Nomenclature *(Assumed)*	Pedestrian Conflict Area *(Assumed)*	RP-8 Recommended Illuminance Level (f.c./LUX)	RP-8 Recommended Uniformity Ratio (E_{AVE}/E_{MIN})
INTERSTATE	**EXPRESSWAY**	**LOW**	**0.9/9.0**	**3.0**
ARTERIAL	**MAJOR**	**MEDIUM**	**1.3/13.0**	**3.0**
RAMP	**COLLECTOR**	**MEDIUM**	**0.9/9.0**	**4.0**
RESIDENTIAL	**LOCAL**	**MEDIUM**	**0.7/7.0**	**6.0**
ALLEY	**LOCAL**	**LOW**	**0.4/4.0**	**6.0**
BEACH	**LOCAL**	**HIGH**	**0.9/9.0**	**6.0**

The photometric measurements taken were measured with a greater number of significant figures than normally factored into the RP-8 prescribed standards. Also, based on Citelum's previous experience, it would be highly unlikely to find any roadway segments adhering exactly to the strict standard. Therefore, Citelum included a safety factor to expand the standard values to be a range of values. For Illuminance, we factored in a ± 25% allowable variance from standard and for uniformity, we factored in a ± 20% allowable variance from standard.

SECTION IV

GENERAL FINDINGS
OVERALL SUMMARY

The following values have been analyzed for photometric results:

- **Average lighting levels**
- **Lighting level compliance with standards**
- **Average uniformity**
- **Uniformity compliance with standards**

All results are broken down by roadway types, following the IESNA recommendations.

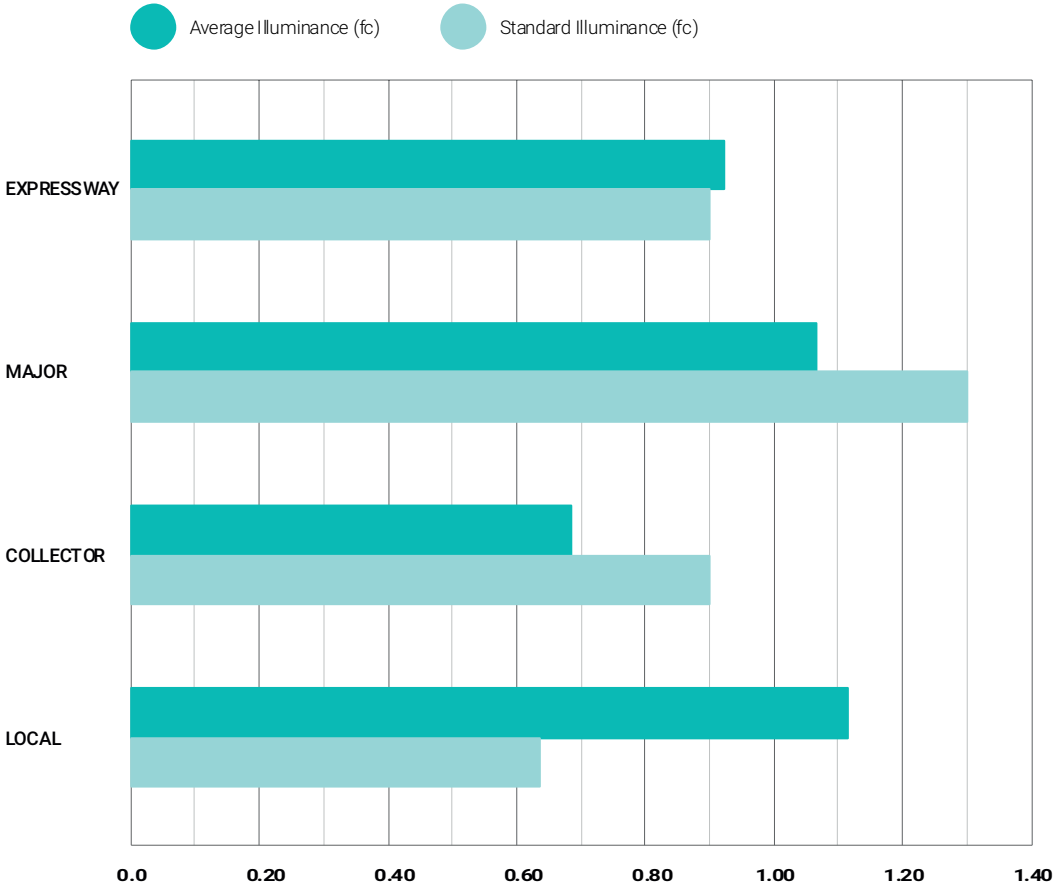
LIGHTING LEVELS *(FULL RESULTS IN APPENDIX A)*

For each roadway segment, the average Illuminance has been calculated based on all measured values for this segment. The full results are available in Appendix A.

Then for each roadway type, the average Illuminance has been calculated and compared to the RP-8 standard values. Results below are displayed in foot-candles (fc), following the IESNA recommendations.

Roadway Types	*Average Illuminance (fc)*	*Standard Illuminance (fc)*
EXPRESSWAY	0.92	0.9
MAJOR	1.07	1.3
COLLECTOR	0.68	0.9
LOCAL	1.11	0.63*

*Standard Illuminance for local roadways can either be 0.4, 0.7 or 0.9 fc based on pedestrian conflict area factor.

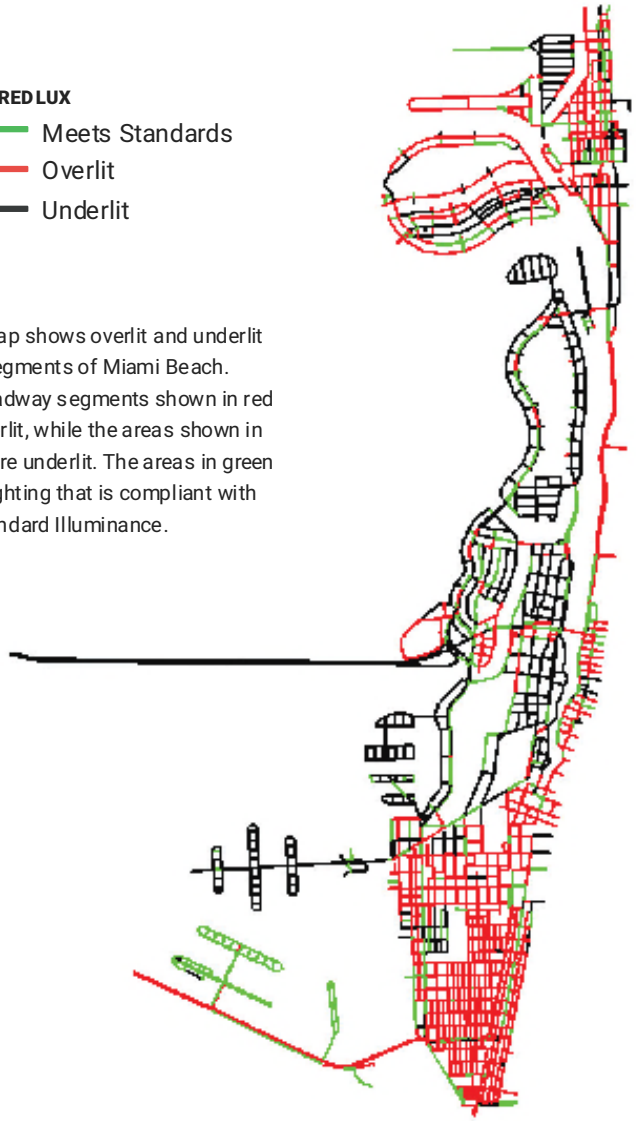


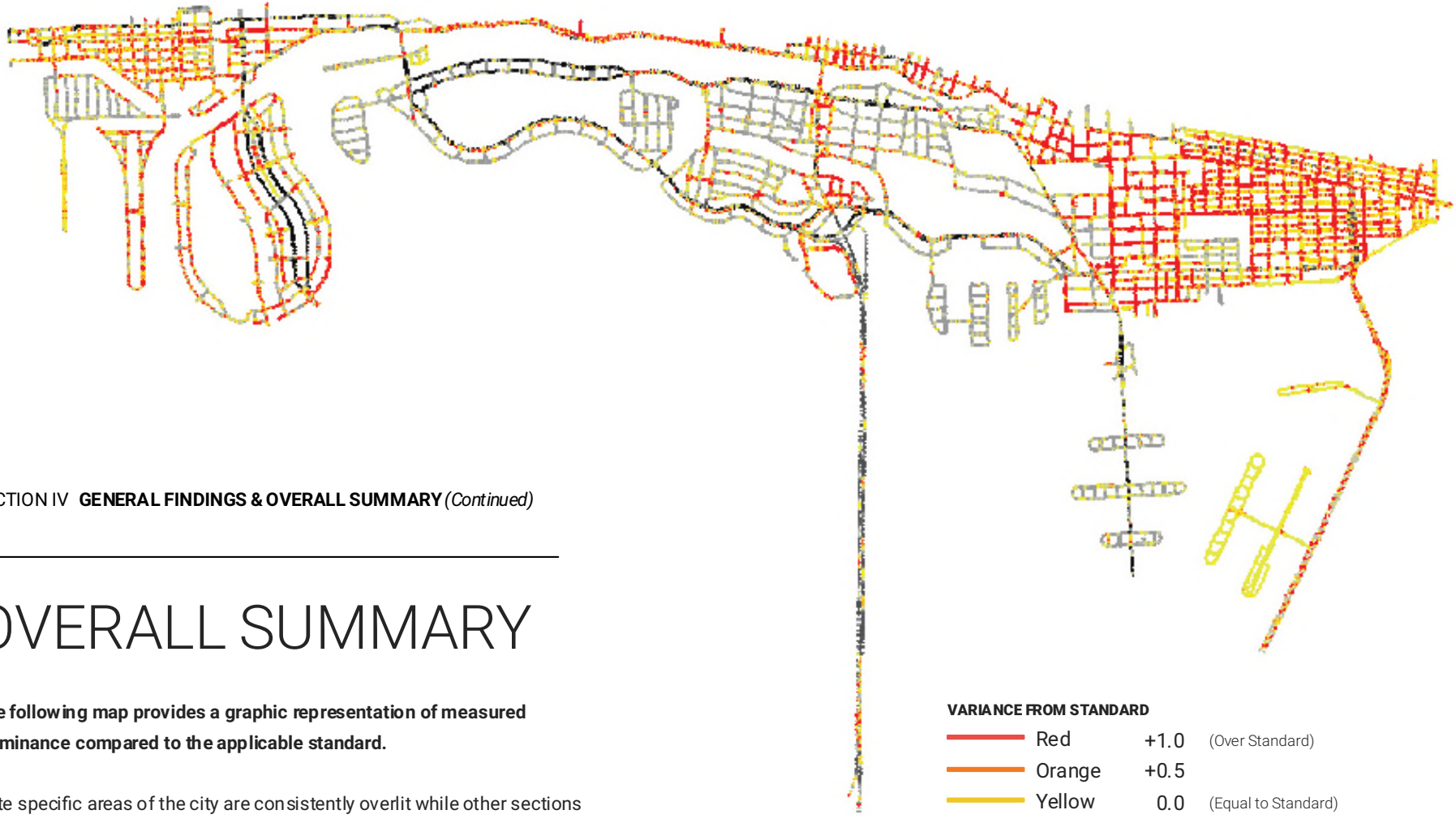
MEASURED LUX

- Meets Standards
- Overlit
- Underlit

RIGHT

This map shows overlit and underlit road segments of Miami Beach. The roadway segments shown in red are overlit, while the areas shown in black are underlit. The areas in green have lighting that is compliant with the standard Illuminance.





SECTION IV **GENERAL FINDINGS & OVERALL SUMMARY** *(Continued)*

OVERALL SUMMARY

The following map provides a graphic representation of measured Illuminance compared to the applicable standard.

Note specific areas of the city are consistently overlit while other sections are lit below standard. Further detail on measurements can be found in subsequent pages of this section.

VARIANCE FROM STANDARD

Red	+1.0	(Over Standard)
Orange	+0.5	
Yellow	0.0	(Equal to Standard)
Grey	-0.5	
Black	-1.0	(Below Standard)

OVERALL SUMMARY

On average, expressway, major and collector roadways are lit below standards. Local roadways, however, are highly above standards on average.

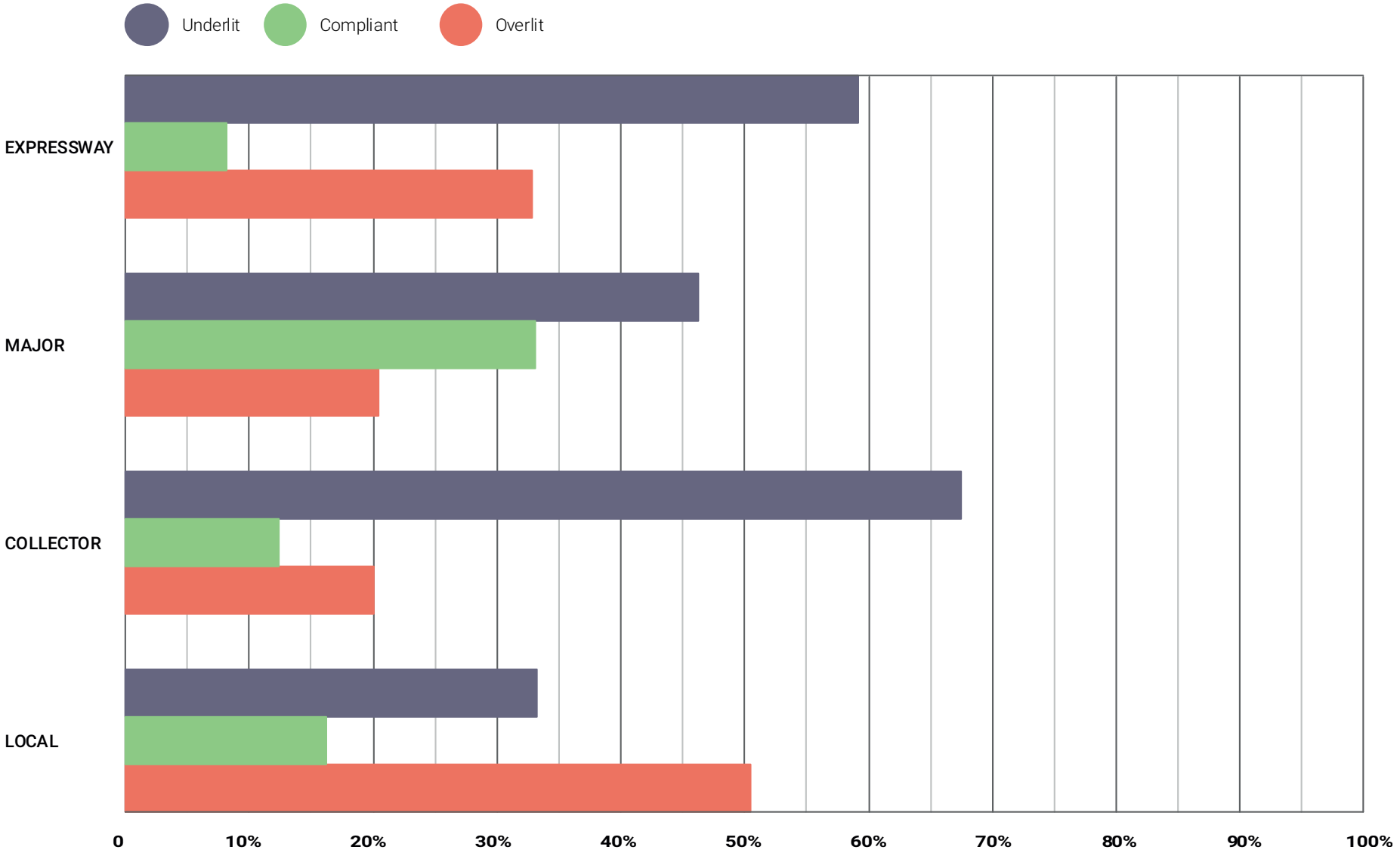
When we break down the results in terms of compliance with standards, a roadway type can appear close to standards, but individual street results are typically overlit or underlit, giving the incorrect impression of averaging near the recommended standards.

When comparing results to recommended standards, the average Illuminance by street segment can be deemed:

- **Compliant with standard (if included in a +/- 25% range)**
- **Underlit**
- **Overlit**

The results below are shown in percentage of the total distance in miles for each one of the four roadway types:

Roadway Type	Underlit	Compliant	Overlit	Grand Total
EXPRESSWAY	59.1%	8.1%	32.8%	100.0%
MAJOR	46.3%	33.1%	20.5%	100.0%
COLLECTOR	67.6%	12.4%	20.0%	100.0%
LOCAL	33.3%	16.2%	50.5%	100.0%
GRAND TOTAL	**37.7%**	**19.0%**	**43.2%**	**100.0%**


Underlit
Compliant
Overlit
EXPRESSWAY
MAJOR
COLLECTOR
LOCAL
0
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

UNIFORMITY

CALCULATING UNIFORMITY

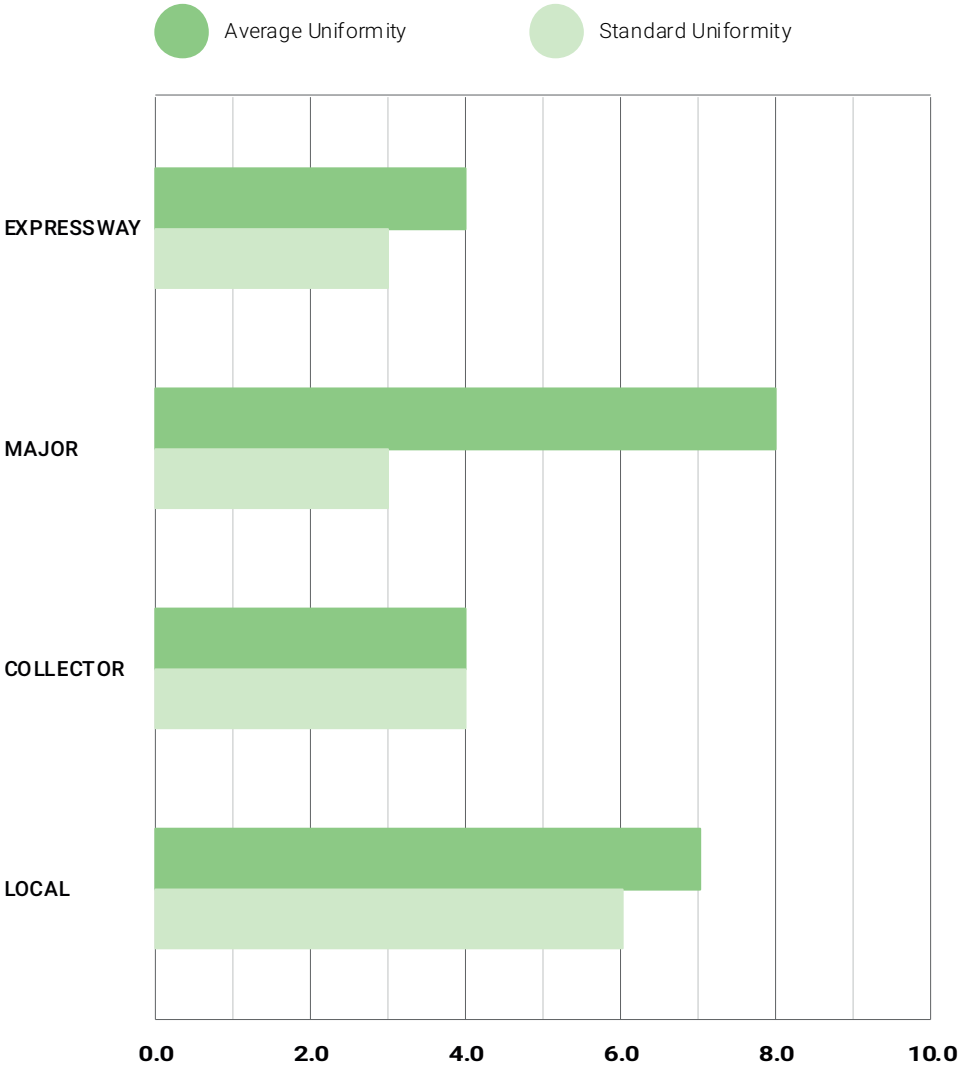
(FULL RESULTS IN APPENDIX B.)

For each roadway segment, the average uniformity has been calculated based on all measured values for this segment, using the following formula:

$$\frac{\text{AVERAGE ILLUMINANCE}}{\text{MINIMUM ILLUMINANCE}}$$

Then for each roadway type, the average uniformity has been calculated and compared to the standard values, following the IESNA recommendations. **The results are below:**

Roadway Types	*Average Uniformity*	*Standard Uniformity*
EXPRESSWAY	4	3
MAJOR	8	3
COLLECTOR	4	4
LOCAL	7	6

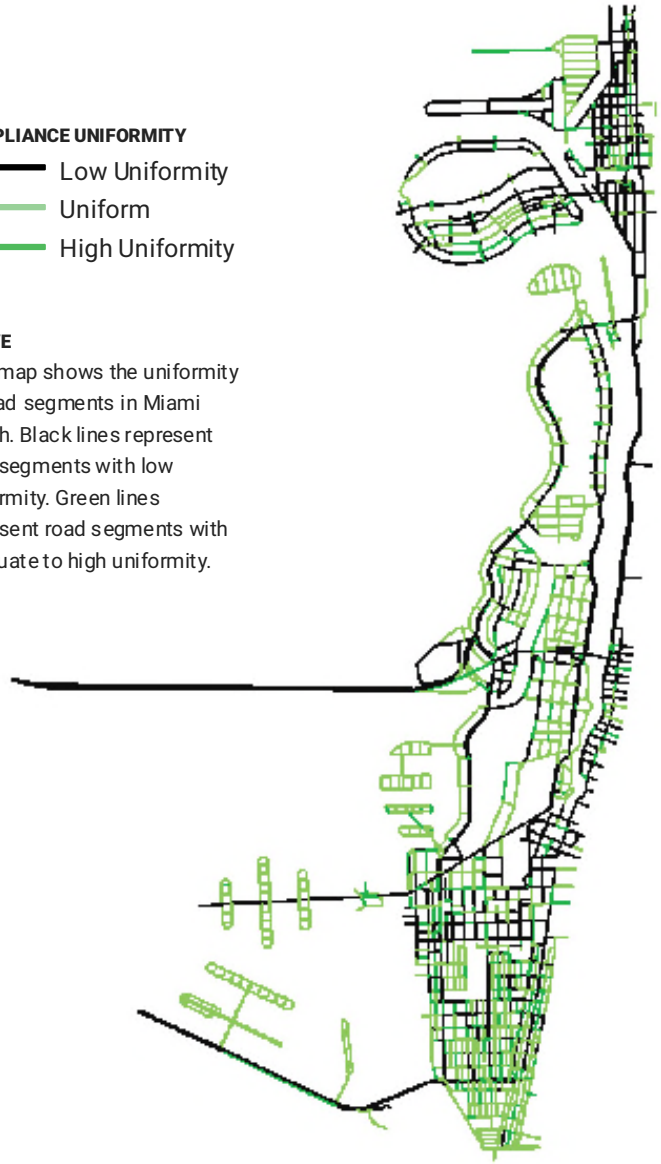


COMPLIANCE UNIFORMITY

Low Uniformity
Uniform
High Uniformity

ABOVE

This map shows the uniformity of road segments in Miami Beach. Black lines represent road segments with low uniformity. Green lines represent road segments with adequate to high uniformity.



UNIFORMITY OVERVIEW

Uniformity is expressed as a ratio of Average Illuminance divided by the Minimum Illuminance, meaning a calculated value of 1 is "perfectly uniform" lighting. Roadways that are not uniform will exhibit bright and dark areas, meaning the ratio between the average and minimum lighting levels will be a larger number.

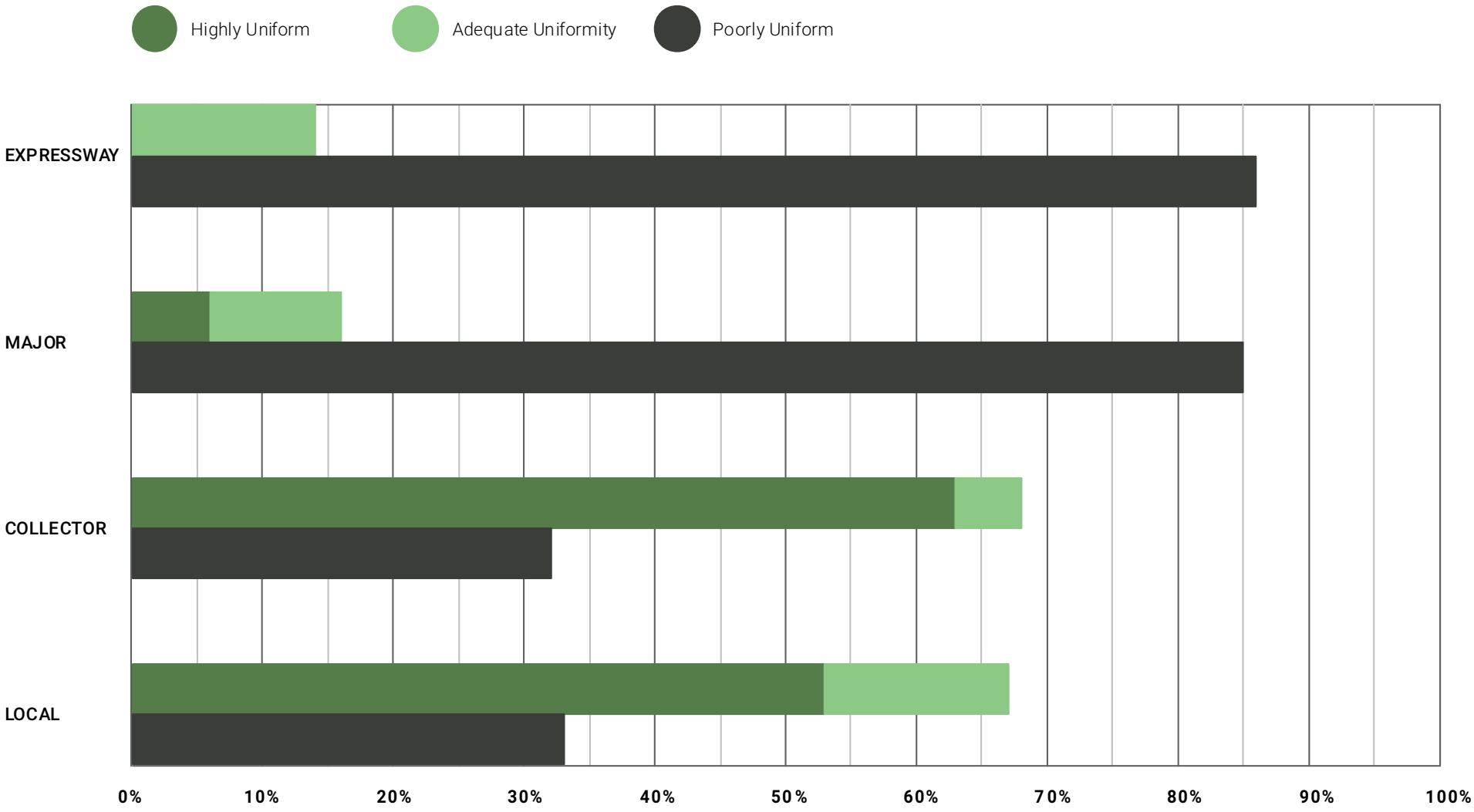
On average, expressways and major roadways exhibit low levels of uniformity (calculated value greater than standard). Both collectors and local roadways are generally uniform or exhibit greater uniformity than required, meaning the ratio is closer to "perfect uniformity" than required.

When comparing results to recommended standards, the average uniformity by street segment can be deemed:

- **Compliant with standard (if included in a +/- 20% range)**
- **High Uniformity (if uniformity is lower than 80% of the standard)**
- **Low Uniformity (if uniformity is higher than 120% of the standard)**

The results below are showed in percentage of the total distance in miles for each one of the four roadway types:

Roadway Type	Low Uniformity	Adequate Uniformity	Highly Uniformity	Grand Total
EXPRESSWAY	86%	14%	0%	100%
MAJOR	85%	10%	6%	100%
COLLECTOR	32%	5%	63%	100%
LOCAL	33%	14%	53%	100%
GRAND TOTAL	**47%**	**13%**	**41%**	**100%**


Highly Uniform
Adequate Uniformity
Poorly Uniform
EXPRESSWAY
MAJOR
COLLECTOR
LOCAL
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

SOUTH

NEIGHBORHOODS INCLUDED

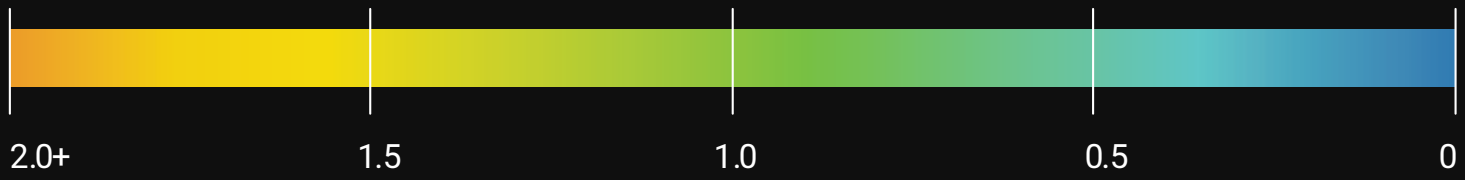
South Point
Flamingo/Lummus
West Avenue
Star Island
Palm Island
Hibiscus Island
Venetian Islands

ILLUMINATION TRENDS

The South of Miami Beach is world renowned tourist destination. Currently, most of the area is brightly lit. While this may be more light than standards require, it could be a strategic choice to over light this area.

One exception is the area west of Flamingo Park, which is considerably darker and lit below standard.

LEGEND



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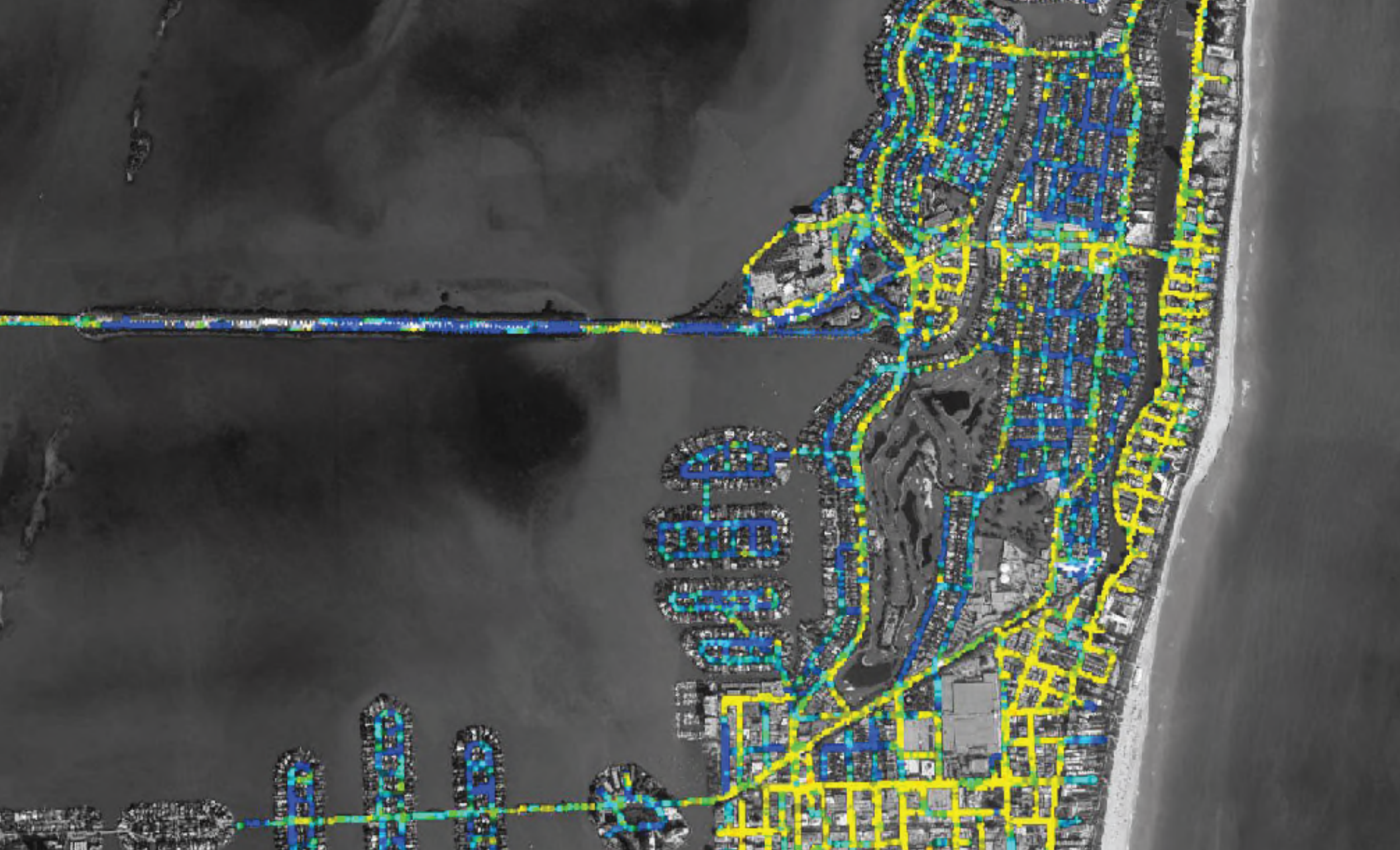


CENTRAL

NEIGHBORHOODS INCLUDED

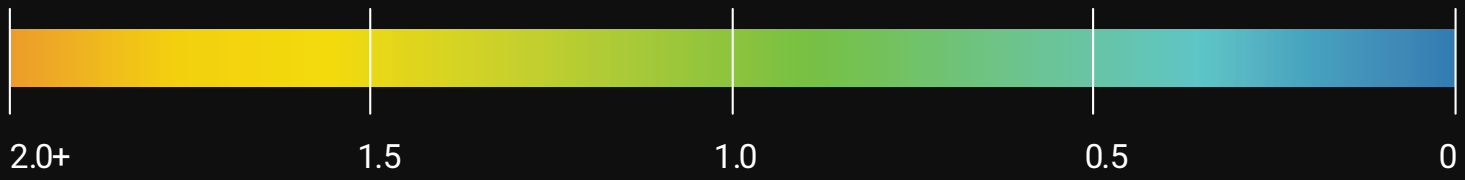
Bayshore
City Center
Ocean Front
Nautilus

ILLUMINATION TRENDS

Central Miami Beach begins the transition from tourist mecca to residential area. With this known, lower lighting levels are seen and accepted. These local roadways are lit slightly below standards.

Major roadways, such as Alton Road or the Julia Tuttle Causeway, while lit to the same level of these residential neighborhoods, require greater levels of lighting and improvements may be required.

LEGEND



(fc)

BISCAYNE BAY

NEIGHBORHOODS INCLUDED

Ocean Front

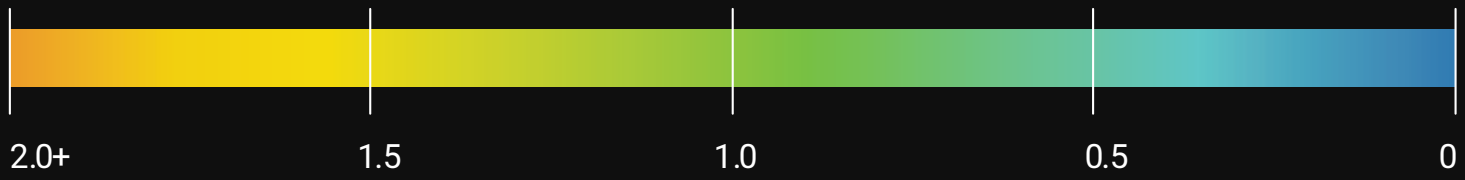
Nautilus

La Gorce

ILLUMINATION TRENDS

Similar to the trends exhibited in central Miami Beach, the area surrounding La Gorce are lit to a lower level, with major streets (Alton Road, W 63rd Street) lit below standards.

LEGEND



(fc)

NORTH

NEIGHBORHOODS INCLUDED

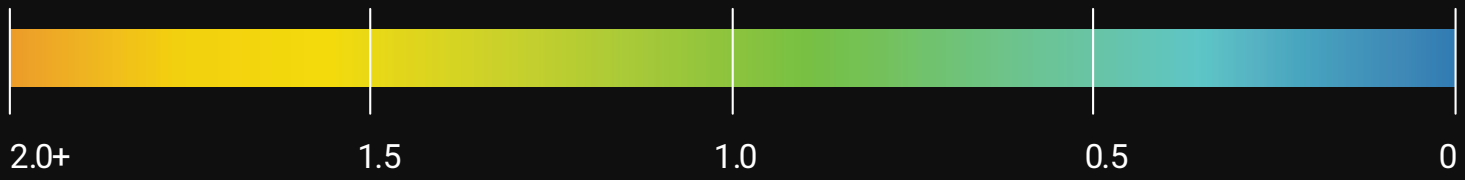
North Shore
Normandy Isle
Normandy Shores
La Gorce
Biscayne Point

ILLUMINATION TRENDS

As the Miami Beach becomes more heavily trafficked in the North, lighting levels increase to those seen in the South portion. Again, this may be a strategic decision by the City.

The major difference is the existence of dark spots within the roadway network. On Collins Ave, poor uniformity leads to dark corners lit below standard. Also, Normandy Drive / 71st Street stand out from the surrounding streets with considerably lower lighting levels.

LEGEND



(fc)

OVERALL ASSESSMENT

In order to assess the overall compliance with standards, Citelum cross referenced the data collected for Illuminance and Uniformity.

The following table shows *(in miles of roadway)* how much of the overall system falls within the assumed acceptable range for Illuminance and Uniformity when compared to standards.

The portions of the data in grey represent the amount of roadway that is underlit, overlit, and/or not uniform.

This information is for all roadway types. The data can be parsed by roadway type, as described further in **Section 6, General Recommendations.**

18.2%

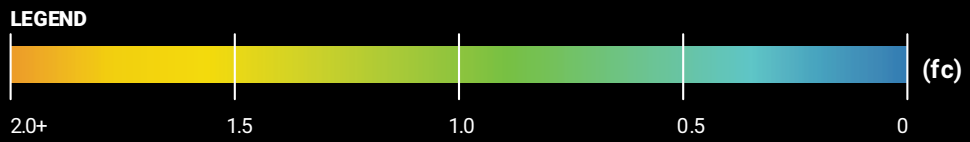
of roadways meet both Illuminance and Uniformity standards

Uniformity	Underlit	Compliant	Overlit	Grand Total
POORLY UNIFORM	17.8	14.0	47.1	79.0
UNIFORM	2.7	9.5	9.2	21.5
HIGHLY UNIFORM	43.4	8.7	16.9	69.0
GRAND TOTAL	**63.9**	**32.3**	**73.3**	**169.5**

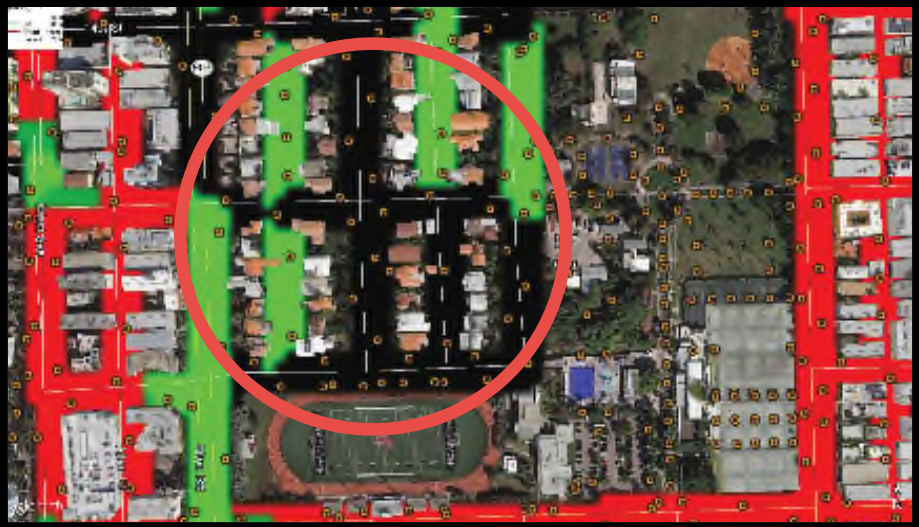
SPECIFIC EXAMPLES - UNDERLIT

This is an example of a very dark/underlit intersection in an area of the city that is mostly underlit. Available street lighting is either not working or obstructed by overgrown trees. Additional maintenance may provide better service in this area. If the City elects to install new LED street lights, properly designed lighting can alleviate these issues.

ILLUMINANCE



OVERLIT - UNDERLIT



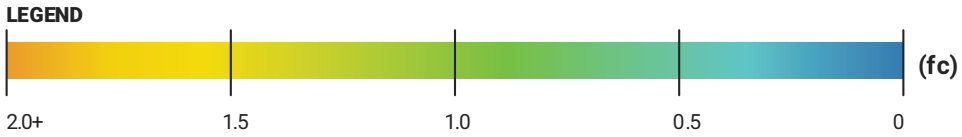
UNDERLIT INTERSECTION

13TH & LENNOX

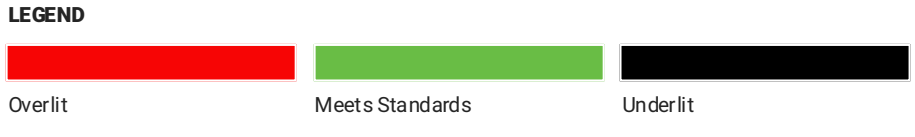
SPECIFIC EXAMPLES - OVERLIT

This shows an example of a technically overlit street. Given the location, land use, and pedestrian movement in the area, the City may elect to keep the lighting of the roadway at an elevated level for safety.

ILLUMINANCE



OVERLIT - UNDERLIT



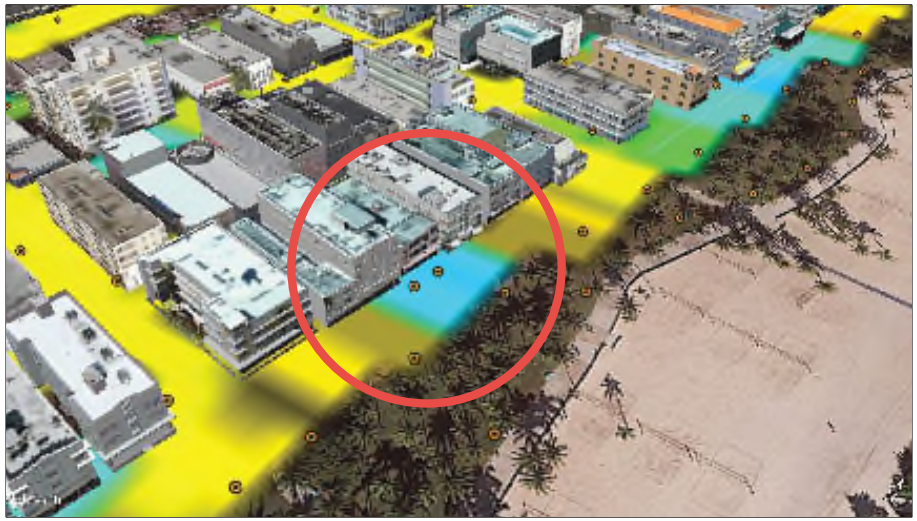
OVERLIT INTERSECTION

WASHINGTON AVE. (BETWEEN 12TH & 13TH)

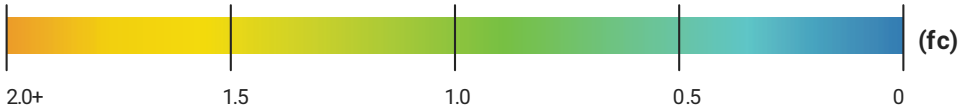
SPECIFIC EXAMPLES - POORLY UNIFORM

This major roadway provides a good example of the importance of uniformity and properly designed lighting. While the lighting level is close to standard, the lighting mid-block is measurably lower *(approximately 1.0 fc)* than the lighting at the intersections. This is most likely caused by the fixture type *(Post Top)* and location *(offset from roadway)* along Ocean Drive as compared to the cobra head fixtures used to illuminate the intersections. This poor uniformity can lead to drivers having issues adjusting their eyes to higher levels of glare when entering brighter spaces. On a roadway with heavy pedestrian traffic, like Ocean Drive, this can lead to safety issues.

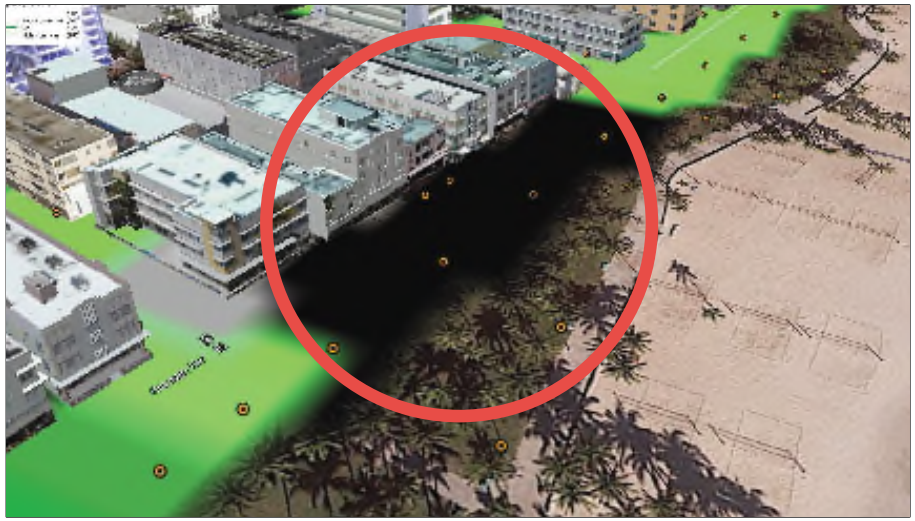
ILLUMINANCE



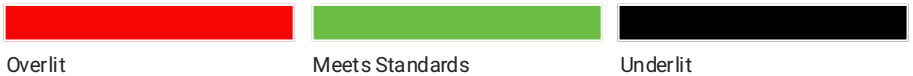
LEGEND

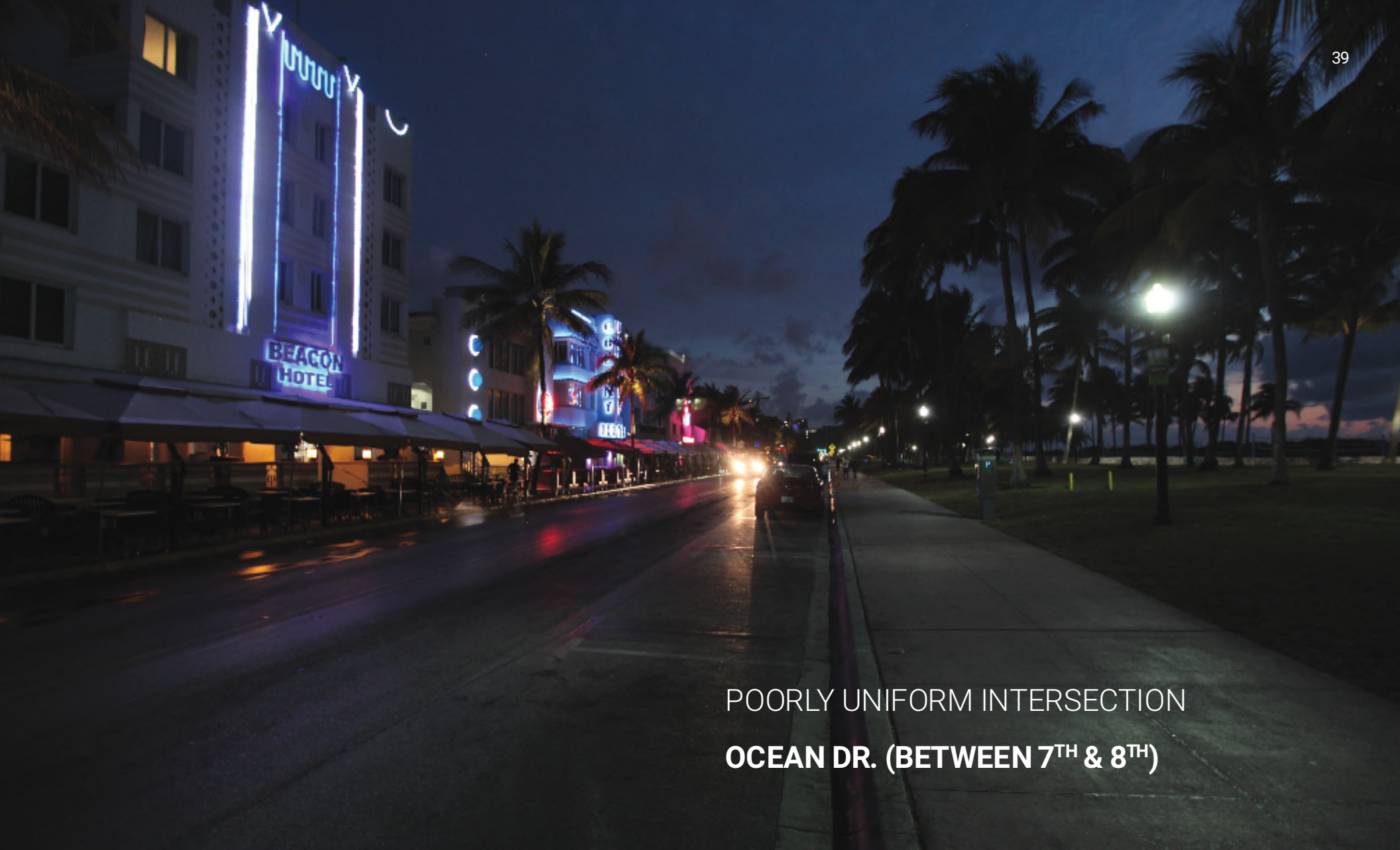


OVERLIT - UNDERLIT



LEGEND





POORLY UNIFORM INTERSECTION

OCEAN DR. (BETWEEN 7TH & 8TH)

SUMMARY

After a thorough review of the lighting conditions in Miami Beach, Citelum has reached a few general conclusions:

1) **Only approximately 18.2% of the roadways** (by mileage) **fall within the assumed acceptable range for Illuminance and Uniformity when compared to standards**

2) **Expressways are either underlit or overlit, but in most cases display low uniformity**

3) **Major roadways can be underlit, compliant or overlit but in most cases the uniformity is low**

4) **The majority of surveyed collectors are underlit, however the uniformity is acceptable**

5) **A variety of issues can be observed on local roadways, with entire sections of the City that are overlit as well as specific underlit streets**

GENERAL RECOMMENDATIONS

Based on these findings, Citelum suggests the following:

1) **The City should update their existing inventory of street lights to account for any information that is more than 5 years out of date**

2) **The City should work with industry to develop a Lighting Master Plan. This plan will define the lighting goals of the City, as performing only to standard may not best the best option for specific regions. For example:**

   a. The City may choose to continue to over light the main tourist and commercial centers of the city

   b. The City should define a desirable lighting level for residential neighborhoods

   c. Working with Police Department and the Emergency Services, the City should identify areas within the city that should be over lit with the goals of crime prevention and increased safety

3) **The City should improve the operation and maintenance services to address street light outages in proactive or preventative manner. This can be accomplished through a robust Computerized Maintenance Management System (CMMS), higher standards for O&M performance through Key Performance Indicators (KPIs), or the introduction of an advanced street light monitoring and control system**

4) **The City could include a remote control system on LED lights, setting a schedule for lighting levels. Specific areas can be kept bright when needed and adjusted during off-peak hours**

5) **The uniformity of street lighting within the City should be improved. This can be accomplished multiple ways:**

   a. The city can investigate the possibility of adding additional street lights where needed and removing extraneous luminaires

   b. The city can investigate upgrading the existing street lights to LED. LED fixtures provide directed light and with proper design (distribution types, low back-light and glare, etc.) uniformity issues can be corrected


citelum
GROUPE EDF

Appendix E
Lighting Zone Design Matrix and Luminance (cd/m²) to Illuminance (fc) Conversion Chart

LIGHTING ZONE DESIGN MATRIX

Lighting Zone	Average Luminance (cd/m²)	Average Uniformity Ratio (avg:min)	Maximum Uniformity Ratio (max:min)	Maximum Veiling Luminance Ratio (v,max:avg)	Correlated Color Temperature	New Lighting Specifications (see note 4)	Fixture Type	Controls Sequence
Corridor – Major Commercial	1.2	3:1	5:1	0.3	4000K	Commercial	Roadway	ON = Dusk OFF = Dawn DIM
Corridor – Major Residential	0.6	3.5:1	6:1	0.3	4000K See note 5	Residential	Roadway or Pedestrian (see note 12)	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.
Corridor – Collector Commercial	0.6	3.5:1	6:1	0.4	4000K	Commercial	Roadway	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =11:59pm -4:30am.
Corridor – Collector Residential	0.4	4:1	8:1	0.4	4000K See note 5	Residential	Roadway or Pedestrian (see note 12)	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.
Corridor - Local Commercial	0.6	6:1	10:1	0.4	4000K	Commercial	Roadway	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.
Corridor - Local Residential	0.3	6:1	10:1	0.4	4000K See note 5	Residential	Roadway or Pedestrian (see note 12)	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.
Hospital District	0.6	6:1	10:1	0.4	4000K	Commercial	Roadway	ON = Dusk OFF = Dawn DIM
Mixed-Use Entertainment District	0.9	4:1	4:1	4:1	4000K	Commercial	Roadway or Pedestrian (see note 12)	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =11:59pm -4:30am.
Town Center Area	0.9	4:1	4:1	4:1	4000K	Commercial	Roadway or Pedestrian (see note 12)	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =11:59pm -4:30am.
Open Space and Parks	0.6	6:1	10:1	0.4	4000K	Residential	Pedestrian	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.

LIGHTING ZONE DESIGN MATRIX

Lighting Zone	Average Luminance (cd/m^2)	Average Uniformity Ratio (avg:min)	Maximum Uniformity Ratio (max:min)	Maximum Veiling Luminance Ratio (v,max:avg)	Correlated Color Temperature	New Lighting Specifications (see note 4)	Fixture Type	Controls Sequence
Parking	0.4 - 0.9 (per district)	6:1	10:1	0.4	4000K	Residential	Pedestrian	ON = ½ hour after sunset OFF = 2 hours after closing or ½ hour before sunrise DIM OCC =2 hours after closing until dawn
Convention Center District	0.6	6:1	10:1	0.4	4000K	Commercial	Branded	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.
City Hall/City Services	0.6	6:1	10:1	0.4	4000K	Commercial	Pedestrian	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.
Oceanfront Environmental Overlay	0.6	6:1	10:1	0.4	Amber	Coastal	Turtle Friendly (see note 11)	ON = Dusk OFF = Dawn DIM
Lincoln Road Pedestrian Mall	0.9	4:1	4:1	4:1	4000K	Specialty	Branded	ON = Dusk OFF = Dawn DIM DIM 20% and OCC =10:00pm -6:00am.

Notes:

1. All luminaires to have 80 CRI minimum and full cut off optics.
2. All luminaires to have efficiency of 100lm/W, with L70 of 100,000 hours
3. All luminaires capable of dimming.
4. New Lighting specifications are listed in Section 4 of the Citywide Lighting Standards.
5. See residential specification for options on color temperature.
6. ON refers to when the lights are to be illuminated.
7. OFF refers to when the lights are to not provide illumination but remain energized.
8. DIM refers to when the lights are to dim to maintain a target illuminance. Refer to luminance to illuminance conversion chart for associated foot-candle values.
9. DIM 20% refers to when the lights are to dim to 20% of target illuminance in DIM.
10. OCC refers to when the lights are to fade from the current intensity to 100% over 5 seconds in response to motion sensors. Sensors timeout after 15 seconds and lights fade down to previous intensity over 30 seconds. Controls shall be capable of triggering luminaires in response to traffic 300 hundred feet away on approach. Sensors of adjacent luminaires shall be capable of triggering multiple luminaires on the roadway in response to approaching traffic. Controls shall be field tested by controls manufacturer and adjusted as needed for optimal safety.
11. Fixture should be approved by the Florida Fish and Wildlife Conservation Commission and comply with the coastal lighting specifications.
12. Roadway, Pedestrian, or Roadway/Pedestrian fixture types may be used in these districts.
13. Lighting standards specified for districts shall take precedence over corridors which run through these specified districts. The Oceanfront Environmental overlay shall take precedence over all districts and corridors.

LUMINANCE (cd/m²) TO ILLUMINANCE (fc) CONVERSION CHART

Lighting Zone	Average Luminance (cd/m²)	Average Illuminance for R1 pavement (fc)	Average Illuminance for R2 & R3 pavement (fc)	Average Illuminance for R4 pavement (fc)
Corridor – Major Commercial	1.2	1.2	1.8	1.6
Corridor – Major Residential	0.6	0.6	0.9	0.8
Corridor – Collector Commercial	0.6	0.6	0.9	0.8
Corridor – Collector Residential	0.4	0.4	0.6	0.5
Corridor - Local Commercial	0.6	0.6	0.9	0.8
Corridor - Local Residential	0.3	0.3	0.45	0.4
Hospital District	0.6	0.6	0.9	0.8
Mixed-Use Entertainment District	0.9	0.9	1.35	1.2
Town Center Area	0.9	0.9	1.35	1.2
Open Space and Parks	0.6	0.6	0.9	0.8
Parking	0.4 - 0.9 (per district)	0.4 - 0.9 (per district)	0.6-1.35 (per district)	0.53-1.2 (per district)
Convention Center District	0.6	0.6	0.9	0.8
City Hall/City Services	0.6	0.6	0.9	0.8
Oceanfront Environmental Overlay	0.6	0.6	0.9	0.8
Lincoln Road Pedestrian Mall	0.9	0.9	1.35	1.2

Notes:

1. Conversions assume 1fc = 10 lux
2. Conversion of each roadway type in foot-candles (fc) are based on IES RP-8-18 Section 11.7.1. The foot-candle numbers are approximations based on roadway reflectances and may not be accurate for all roadway types. The luminance method is the preferred method for lighting of roadways and mathematical conversion should only be used when it is impossible to calculate or measure luminance.
3. R1 Pavement: Mostly diffuse reflectance properties characteristic of Portland cement or asphalt surface with a minimum of 15% of the aggregates composed of artificial brightener aggregates.
4. R2 & R3 Pavement A combination of diffuse and specular reflectances characteristic of asphalt surfaces.
5. R4 Pavement: Mostly specular surface typical of very smooth asphalt texture.