# Circuit Analysis

Per previous coordination with ODOT and CPP, the following approach was determined for CCG3A lighting infrastructure improvements:

1. Existing high mast lighting (for infrastructure installed in 2010 or later) will be used in the Central Interchange area to the extent feasible. Asymmetric distributions for new high mast lighting will be considered where advantageous.
2. Any existing lighting infrastructure in the Central Interchange area installed prior to 2010 will be removed or replaced.
3. Lighting between East 22nd Street and Carnegie Avenue Overpasses is proposed to be low mast, supplemented with conventional wall packs.
4. High mast towers north of Carnegie Avenue will generally remain unless impacted.
5. Local street lighting will comply with CPP standards. East 14th Street (where not in conflict with the future CCG3B project), East 18th Street, and East 22nd Street will be shoeboxes on fiberglass poles with underground conduit. All other CPP lighting will be luminaires with 8' arms on wood poles. Segments of luminaires with 8' arms on wood poles shall have overhead wiring except when running overtop of bridges 13 and 14, where conduit shall be used to pass wiring under the bridge decks and/or in the parapets.
6. The shared use path and pedestrian corridor being installed along East 22nd Street and the north side of Midtown Connector will comply with ODOT standards for illuminance criteria and CPP standards for installation. Lighting will be shoeboxes on fiberglass poles with underground conduit.
7. CPP is responsible for any necessary circuit design for luminaires with 8' arms on wood poles with overhead wiring on Carnegie Avenue, Cedar Avenue, Midtown Connector, and Central Avenue Connector (generally all project locations where primary poles are being relocated and the lighting is secondary to the primary poles). The CCG3A project is responsible for furnishing and installing the wood poles and luminaires with 8' arms in these locations.
    a. CPP will be responsible for making connections between relocated/new poles and transformers.
8. The CCG3A Project is responsible for the light poles on the Carnegie bridge, which will be powered from conduit in the parapet also installed by the project. CPP will be responsible for connecting these lights to the overhead circuitry for the lights on either side of the bridge.
9. The CCG3A project is responsible for bronze shoebox on fiberglass poles with underground conduit along E. 22nd Street, E. 14th Street north of Ramp B6, and E. 18th Street, as well as luminaires with 8' arms on wood poles with overhead wiring on E. 14th Street south of Ramp B6. The CCG3A project is also responsible for bronze shoebox on fiberglass poles with underground conduit for pedestrian and shared pathway applications along East 22nd Street and Midtown Connector. The project will take care of circuit design and layout for these poles.
10. CPP will provide new poles with transformers, and CPP staff will perform actual connection(s) to the existing CPP infrastructure.

Michael Baker International (MBI) developed a preliminary lighting layout for both the ODOT freeway/ramps as well as the City of Cleveland local street and pedestrian lighting that are part of the project. Details and results from the photometric analysis for the ODOT freeway/ramp lighting are included in the ODOT photometric analysis memo as well as ***Exhibit D-CCG3A Photometric Analysis-***

***ODOT Infrastructure*.** Details and results from the photometric analysis for the City of Cleveland local street and pedestrian lighting are included in the city street and pedestrian photometric analysis memo as well as ***Exhibit A-CCG3A Photometric Analysis-City Streets*** and ***Exhibit B-CCG3A Photometric Analysis-E 22nd St and Midtown Connector Corridor***. Once the lighting layout was developed, power sources were located and circuits designed for the proposed local street and pedestrian lighting and ODOT freeway/ramp lighting. Control center placement and circuit layout and design for the ODOT freeway/ramp lighting was performed in accordance with the ODOT TEM and communication with District staff. Transformer and (where necessary) control center placement and circuit layout and design for the local street lighting was performed in accordance with guidance provided by Cleveland Public Power (CPP) and the ODOT TEM.

## Circuit Analysis: ODOT Freeway/Ramp Lighting

The existing ODOT lighting within the CCG3A project limits is powered by two 480 volt-two wire control centers, control center B, located along the southern edge of the Hilton Garden Inn parking lot and control center A, located south of the intersection between Central Avenue and East 19th Street. To upgrade the corridor to 3-wire circuits, these control centers are being replaced as part of the project. Also, to remove conflicts with the proposed realignment of I-90 and promote ease of access for maintenance, the proposed control centers will be relocated. Control center B's replacement will be located in the proposed median between E. 14th Street Northbound and E. 18th Street and designated as Control Center "CN" (CC-CN) due to its near proximity to the proposed Central Avenue Connector. CC-CN will power the ODOT lighting encompassing the southern and western regions of the CCG3A project. Control center A's replacement will be located east of Ramp A1 just south of where it connects to Carnegie Avenue and designated as Control Center "CR" (CC-CR) due to its near proximity to Carnegie Avenue. CC-CR will power the eastern region of the CCG3A project. Both locations are outside of clear zone criteria specified in ODOT L&D Vol. 1 Figure 600-1 and provide pull-off access for ODOT maintenance vehicles (the grass median between E. 14th Street and E. 18th Street for CC-CN and the grass behind the guardrail along the eastern edge of shoulder of Ramp A1 for control center CC-CR).

Per ODOT TEM section 1140-5.3.2, each ODOT standard control center (specified in ODOT standard construction drawing – SCD – HL-60.31) can have up to six branch circuits with a maximum load of 30 amps. For this project, MBI proposed four circuits on CC-CN. For CC-CR, three circuits were proposed. This number of circuits ensures all circuits have a total circuit load less than 30 amps, meeting ODOT loading criteria for branch circuits. Each circuit on the control centers maintains a voltage drop less than five percent, meeting the criteria specified in ODOT TEM section 1140-5.2.2. For additional detail regarding the layout, loading assumptions for proposed light fixtures, and circuit analysis for circuits proposed on CC-CN, see ***Voltage Drop Calculations-ODOT CC-CN*** and for additional detail regarding the layout, loading assumptions for proposed light fixtures, and circuit analysis for circuits proposed on CC-CR, see ***Voltage Drop Calculations-ODOT CC-CR***.

## Circuit Analysis: City Street Lighting

As discussed above, the CCG3A project is responsible for the circuit layout and design for the bronze shoebox on fiberglass poles with underground conduit along E. 22nd Street, E. 14th Street north of Ramp B6, and E. 18th Street, as well as luminaires with 8' arms on wood poles with overhead wiring on E. 14th Street south of Ramp B6. To power the proposed lighting in these locations, two transformers on wood CPP poles were proposed. Transformer "C" (CC-C) is proposed at the southwest corner of the

E. 18th Street and Carnegie Avenue intersection. CC-C will power the light poles proposed along E. 14th Street and E. 18th Street. Transformer "D" (CC-D) is proposed at the southeast corner of the E. 22nd Street and Carnegie Avenue intersection. CC-D will power the street light poles proposed along E. 22nd Street. CPP confirmed the proposed locations of CC-C and CC-D at the coordination call on April 7, 2022. CPP also confirmed they will install the wood poles and transformers for CC-C and CC-D.

For this project, MBI proposed two circuits on CC-C – one for the proposed luminaires with 8' arms on wood poles with overhead wiring on E. 14th Street south of Ramp B6 and one for the proposed luminaires on fiberglass poles with underground conduit on E. 14th Street north of Ramp B6 and E. 18th Street. The circuits were separated with the intent to simplify replacement of the wood poles with luminaries on fiberglass poles powered by underground cable - matching the proposed lighting with underground conduit on E. 14th Street and E. 18th Street north of Ramp B6 - as part of the CCG3B work. An additional item to note regarding the two circuits on CC-C is the transition between overhead and underground conduit. The connection between overhead and underground conduit occurs one wood pole south of the final proposed wood pole along E. 14th Street (C1-21 rather than C1-22). This is because the northmost wood pole (C1-22) will have to be installed later than most of the wood poles to not conflict with MOT phases 1-7 for the project (during these phases, a temporary connection between E. 14th and Community College is proposed). For CC-D, only one circuit was necessary to provide power to all street lights proposed along E. 22nd Street.

Each circuit on CC-C and CC-D maintains a voltage drop less than five percent, meeting the criteria specified in ODOT TEM section 1140-5.2.2. Also, all circuits have a total circuit load less than 30 amps, meeting ODOT loading criteria for branch circuits specified in ODOT TEM section 1140-5.3.2. For additional detail regarding the layout, loading assumptions for proposed light fixtures, and circuit analysis for circuits proposed on CC-C, see ***Voltage Drop Calculations-CPP CC-C*** and for additional detail regarding the layout, loading assumptions for proposed light fixtures, and circuit analysis for circuits proposed on CC-D, see ***Voltage Drop Calculations-CPP CC-D***.

## Circuit Analysis: Pedestrian and Shared Pathway Lighting

As discussed above, the CCG3A project is responsible for the circuit layout and design for the bronze shoebox on fiberglass poles with underground conduit for pedestrian and shared pathway lighting along E. 22nd Street and the north side of Midtown Connector. Additionally, the CCG3A project is responsible for the circuit layout and design for any aesthetic and landscaping elements on the E. 22nd Street bridge (bridge 13) requiring power; this includes the proposed irrigation system for the planters as well as the proposed art panels on bridge 13. To power the aforementioned items, one transformer on a wood CPP pole was proposed. Transformer "E" (CC-E) is proposed on the North side of Central Avenue just east of the intersection of E. 22nd Street and Central Avenue. The proposed electrical elements will be connected to this transformer via a control center installed by the project to provide metered service to these items.

For this project, MBI proposes 16 circuits on CC-E: two circuits for the pedestrian and shared pathway lights along E. 22nd Street and the north side of Midtown Connector, one circuit for the irrigation of the planters on the E. 22nd bridge (bridge 13), and 13 circuits for the art panels on bridge 13. 13 circuits are necessary for the art panels to maintain a voltage drop less than five percent per ODOT TEM section

1140-5.2.2. To keep all art panels connected to the same power service, a special control panel will be specified for CC-E to accommodate 16 circuits.

Each individual art panel has two 96-watt powerpacks to power the LED lights inside each panel. The art panels are in groups of eleven panels except for the wingwall at the southeast corner of E. 22nd Street and Midtown Connector, which is a group of fourteen panels. Each grouping is on its own circuit to meet the voltage drop requirements. All 16 circuits on the control center maintain a voltage drop less than five percent, meeting the criteria specified in ODOT TEM Section 1140-5.2.2. All circuits will use 20-amp breakers in accordance with the National Electric Code (NEC). For additional detail regarding the layout, loading assumptions for proposed fixtures, and circuit analysis for circuits proposed on CC-E, see ***Voltage Drop Calculations-CC-E.***