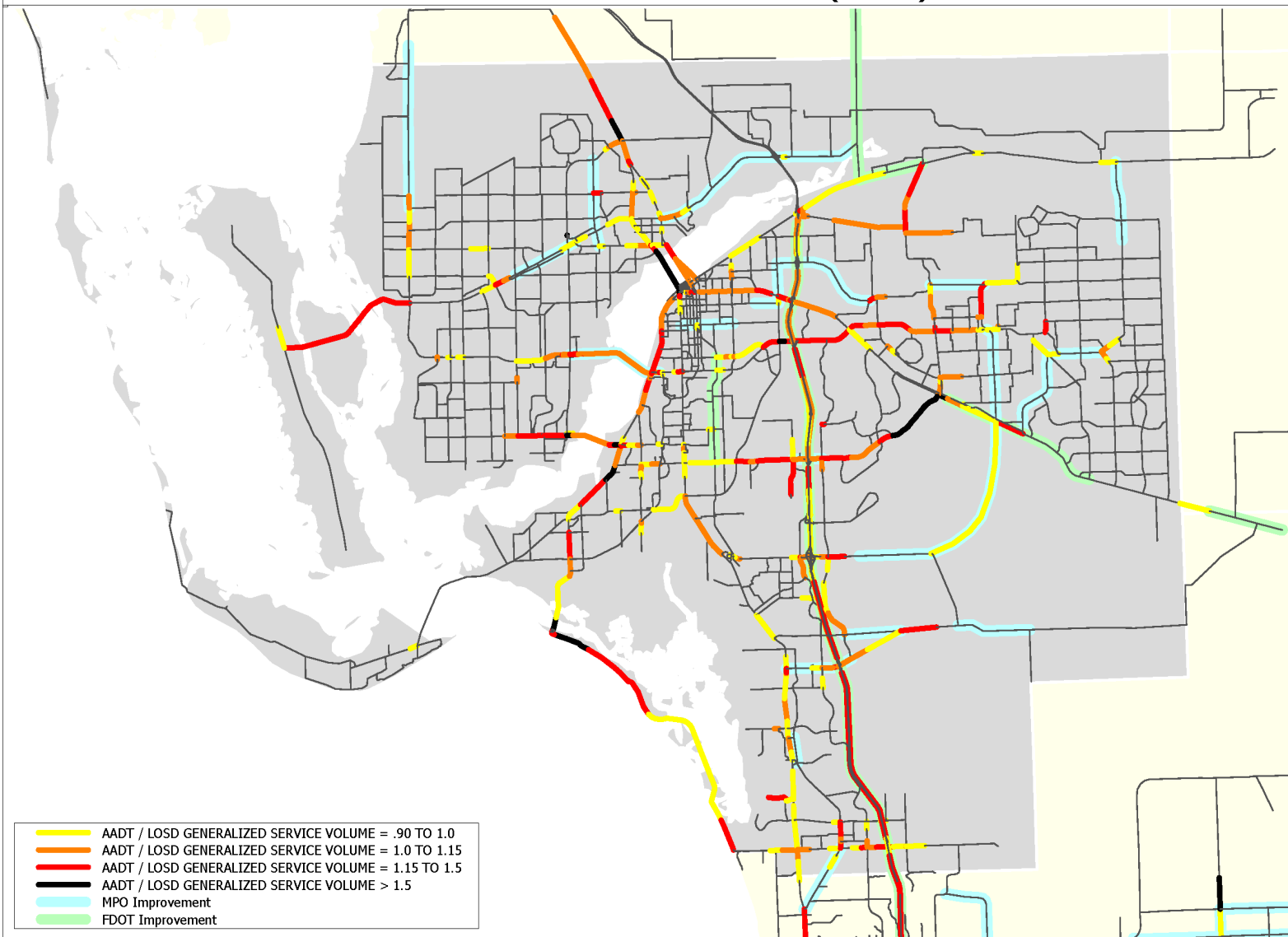# Appendix F
Cost Feasible Plan Development

LEE COUNTY COST FEASIBLE LRTP - ALTERNATIVE 1 IMPROVEMENTS (5-8-20)

—	AADT / LOSD GENERALIZED SERVICE VOLUME = .90 TO 1.0
—	AADT / LOSD GENERALIZED SERVICE VOLUME = 1.0 TO 1.15
—	AADT / LOSD GENERALIZED SERVICE VOLUME = 1.15 TO 1.5
—	AADT / LOSD GENERALIZED SERVICE VOLUME > 1.5
—	MPO Improvement
—	FDOT Improvement

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LEE COUNTY COST FEASIBLE LRTP - ALTERNATIVE 2 IMPROVEMENTS (6-1-20)

Legend:
- AADT / LOSD GENERALIZED SERVICE VOLUME = .90 TO 1.0
- AADT / LOSD GENERALIZED SERVICE VOLUME = 1.0 TO 1.15
- AADT / LOSD GENERALIZED SERVICE VOLUME = 1.15 TO 1.5
- AADT / LOSD GENERALIZED SERVICE VOLUME > 1.5
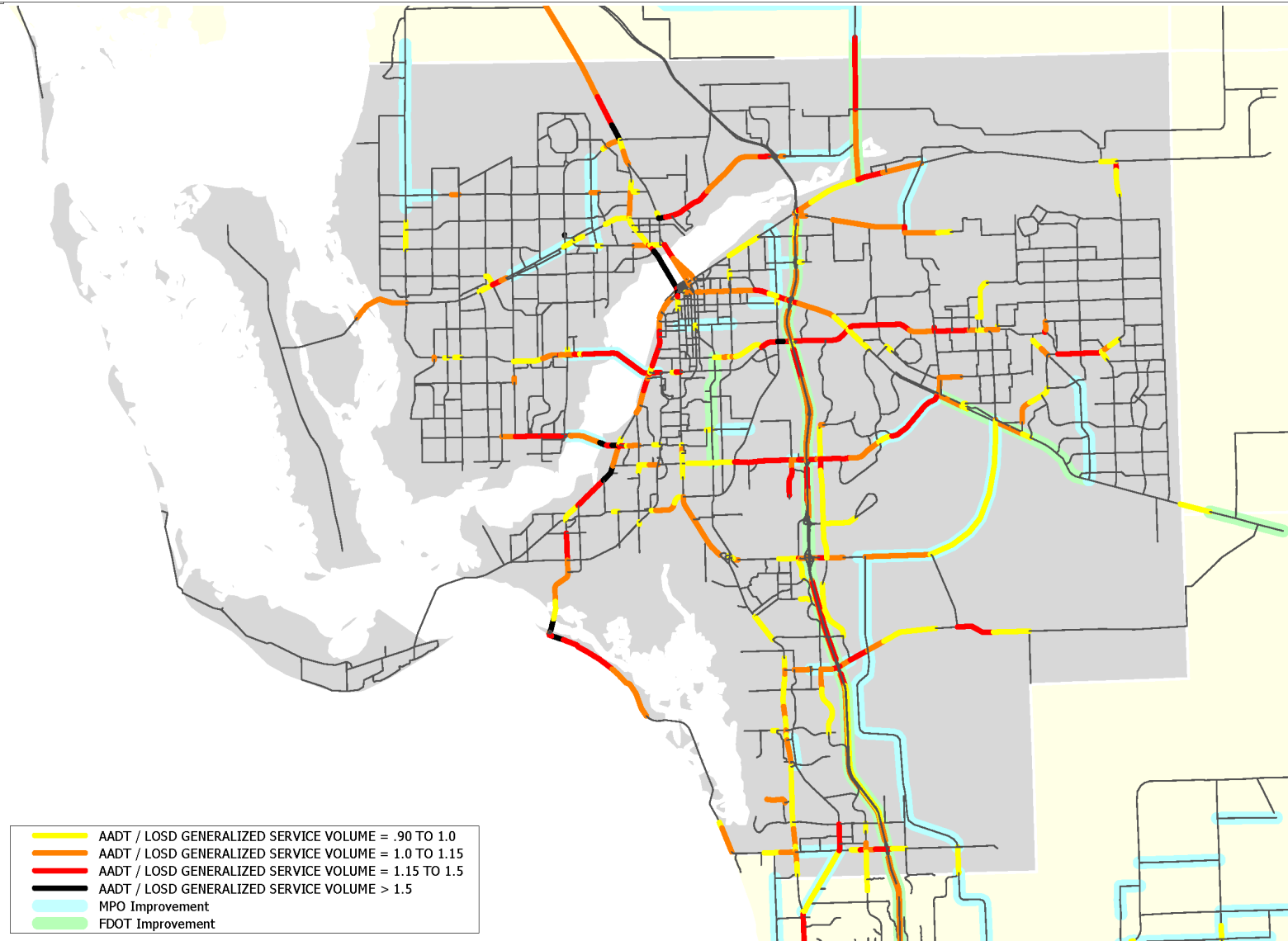- MPO Improvement
- FDOT Improvement

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LEE COUNTY COST FEASIBLE LRTP - ALTERNATIVE 3 IMPROVEMENTS (7-1-20)

Legend:
- AADT / LOSD GENERALIZED SERVICE VOLUME = .90 TO 1.0
- AADT / LOSD GENERALIZED SERVICE VOLUME = 1.0 TO 1.15
- AADT / LOSD GENERALIZED SERVICE VOLUME = 1.15 TO 1.5
- AADT / LOSD GENERALIZED SERVICE VOLUME > 1.5
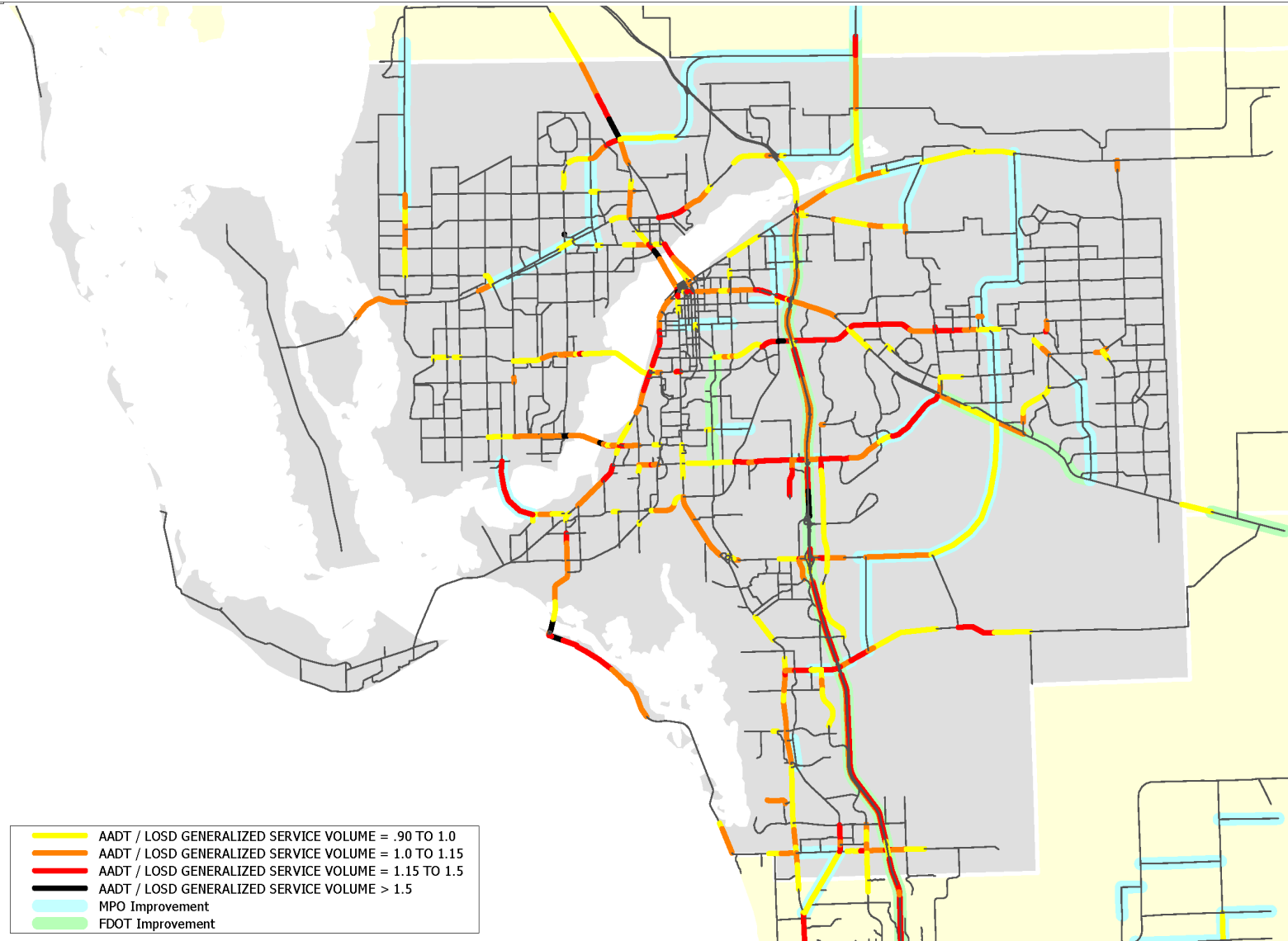- MPO Improvement
- FDOT Improvement

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LEE COUNTY COST FEASIBLE LRTP - ALTERNATIVE 4 IMPROVEMENTS (8-1-20)

▬	AADT / LOSD GENERALIZED SERVICE VOLUME = .90 TO 1.0
▬	AADT / LOSD GENERALIZED SERVICE VOLUME = 1.0 TO 1.15
▬	AADT / LOSD GENERALIZED SERVICE VOLUME = 1.15 TO 1.5
▬	AADT / LOSD GENERALIZED SERVICE VOLUME > 1.5
▬	MPO Improvement
▬	FDOT Improvement

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LEE COUNTY COST FEASIBLE LRTP - ALTERNATIVE 4 IMPROVEMENTS WITH 35% CAV (8-1-20)

Legend:
- AADT / LOSD GENERALIZED SERVICE VOLUME = .90 TO 1.0
- AADT / LOSD GENERALIZED SERVICE VOLUME = 1.0 TO 1.15
- AADT / LOSD GENERALIZED SERVICE VOLUME = 1.15 TO 1.5
- AADT / LOSD GENERALIZED SERVICE VOLUME > 1.5
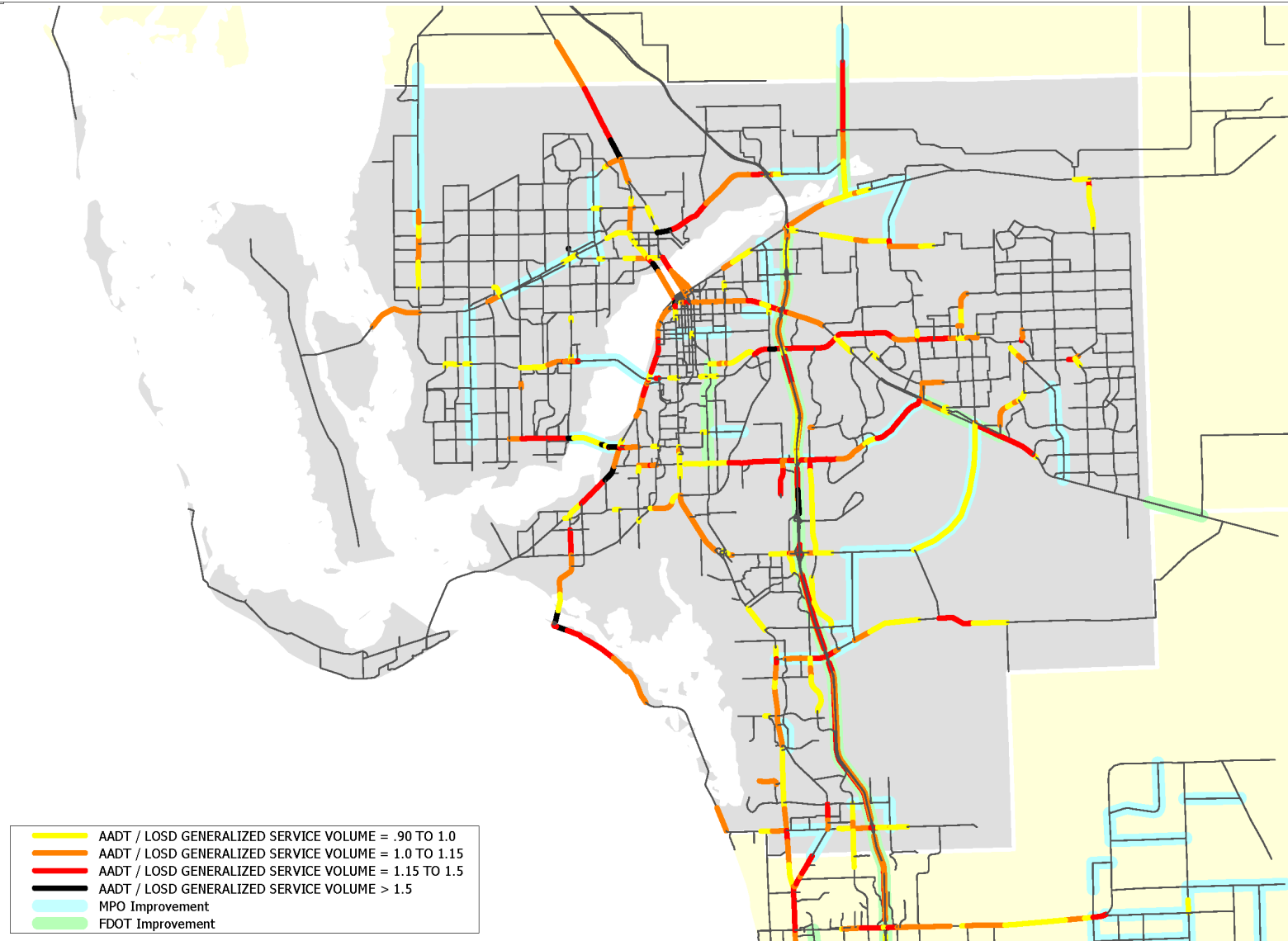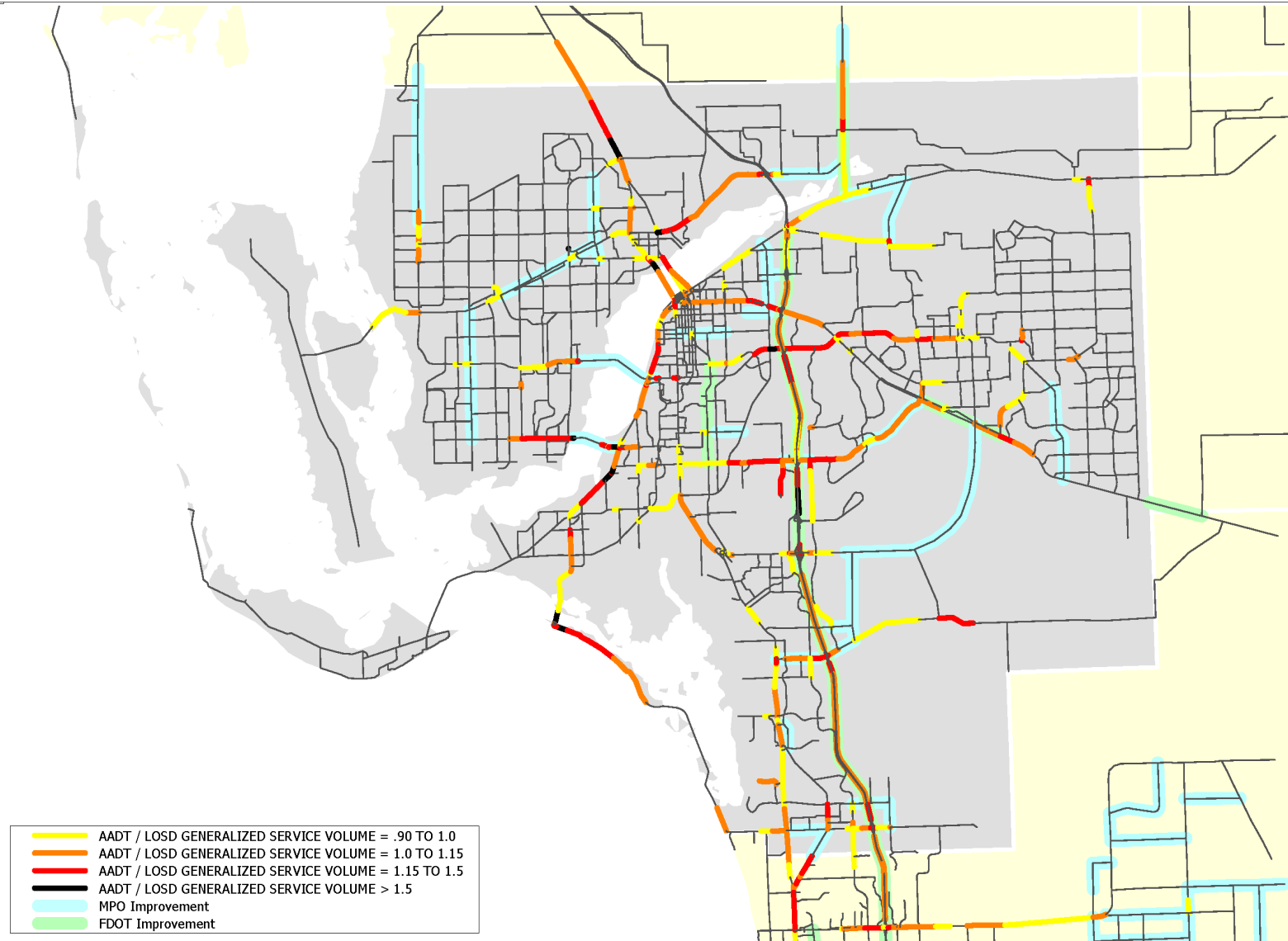- MPO Improvement
- FDOT Improvement

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AADT / LOSD GENERALIZED SERVICE VOLUME = .90 TO 1.0
AADT / LOSD GENERALIZED SERVICE VOLUME = 1.0 TO 1.15
AADT / LOSD GENERALIZED SERVICE VOLUME = 1.15 TO 1.5
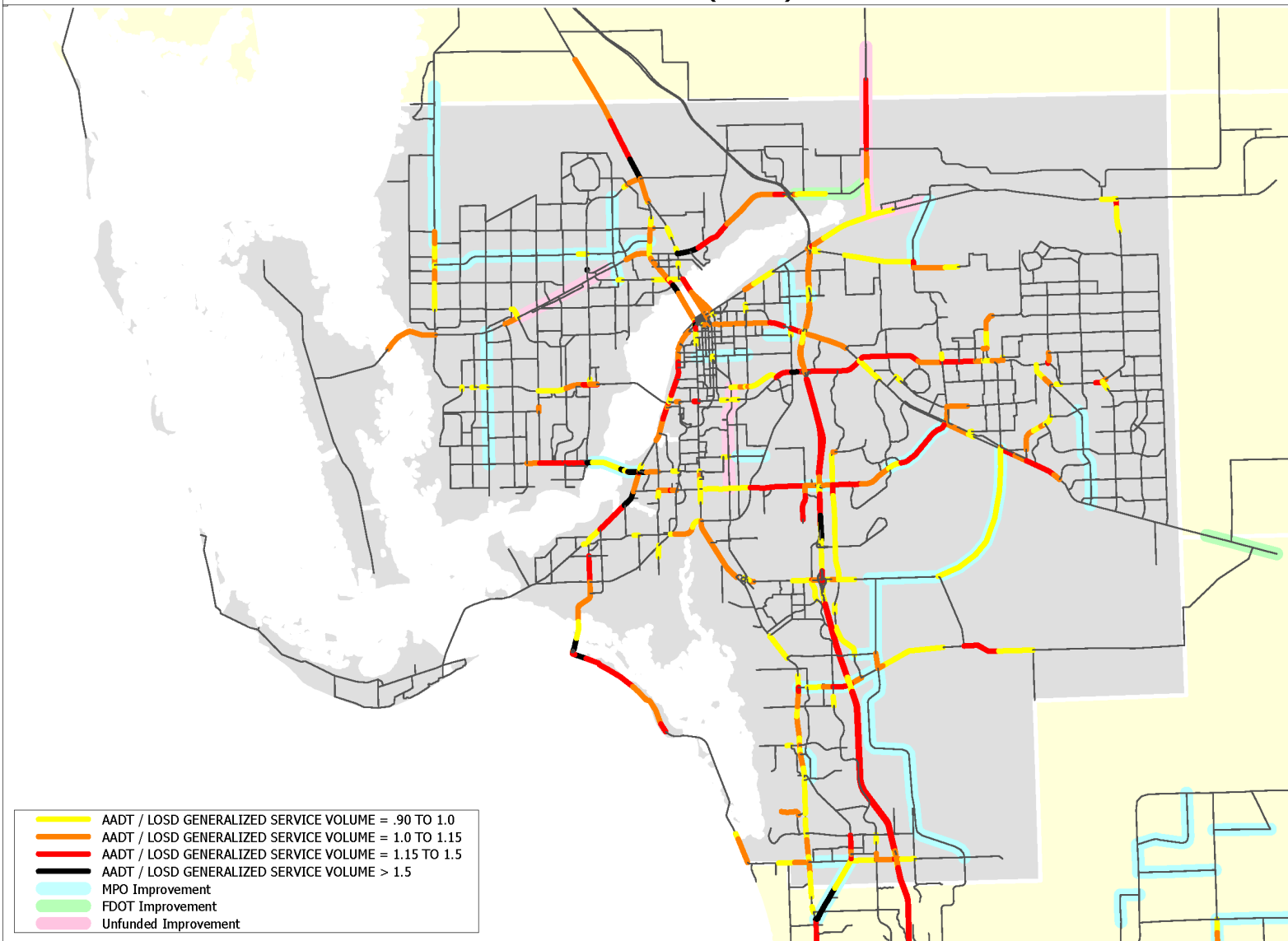AADT / LOSD GENERALIZED SERVICE VOLUME > 1.5
MPO Improvement
FDOT Improvement
Unfunded Improvement

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LEE COUNTY COST FEASIBLE LRTP - ALTERNATIVE 5 IMPROVEMENTS WITH 35% CAV (9-1-20)

▬	AADT / LOSD GENERALIZED SERVICE VOLUME = .90 TO 1.0
▬	AADT / LOSD GENERALIZED SERVICE VOLUME = 1.0 TO 1.15
▬	AADT / LOSD GENERALIZED SERVICE VOLUME = 1.15 TO 1.5
▬	AADT / LOSD GENERALIZED SERVICE VOLUME > 1.5
▬	MPO Improvement
▬	FDOT Improvement
▬	Unfunded Improvement

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LEE COUNTY COST FEASIBLE LRTP - ALTERNATIVE 6 IMPROVEMENTS (10-1-20)

▬	AADT / LOSD GENERALIZED SERVICE VOLUME = .90 TO 1.0
▬	AADT / LOSD GENERALIZED SERVICE VOLUME = 1.0 TO 1.15
▬	AADT / LOSD GENERALIZED SERVICE VOLUME = 1.15 TO 1.5
▬	AADT / LOSD GENERALIZED SERVICE VOLUME > 1.5
▬	MPO Improvement
▬	FDOT Improvement
▬	Unfunded Improvement

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LEE COUNTY COST FEASIBLE LRTP - ALTERNATIVE 6 IMPROVEMENTS WITH 35% CAV (10-1-20)
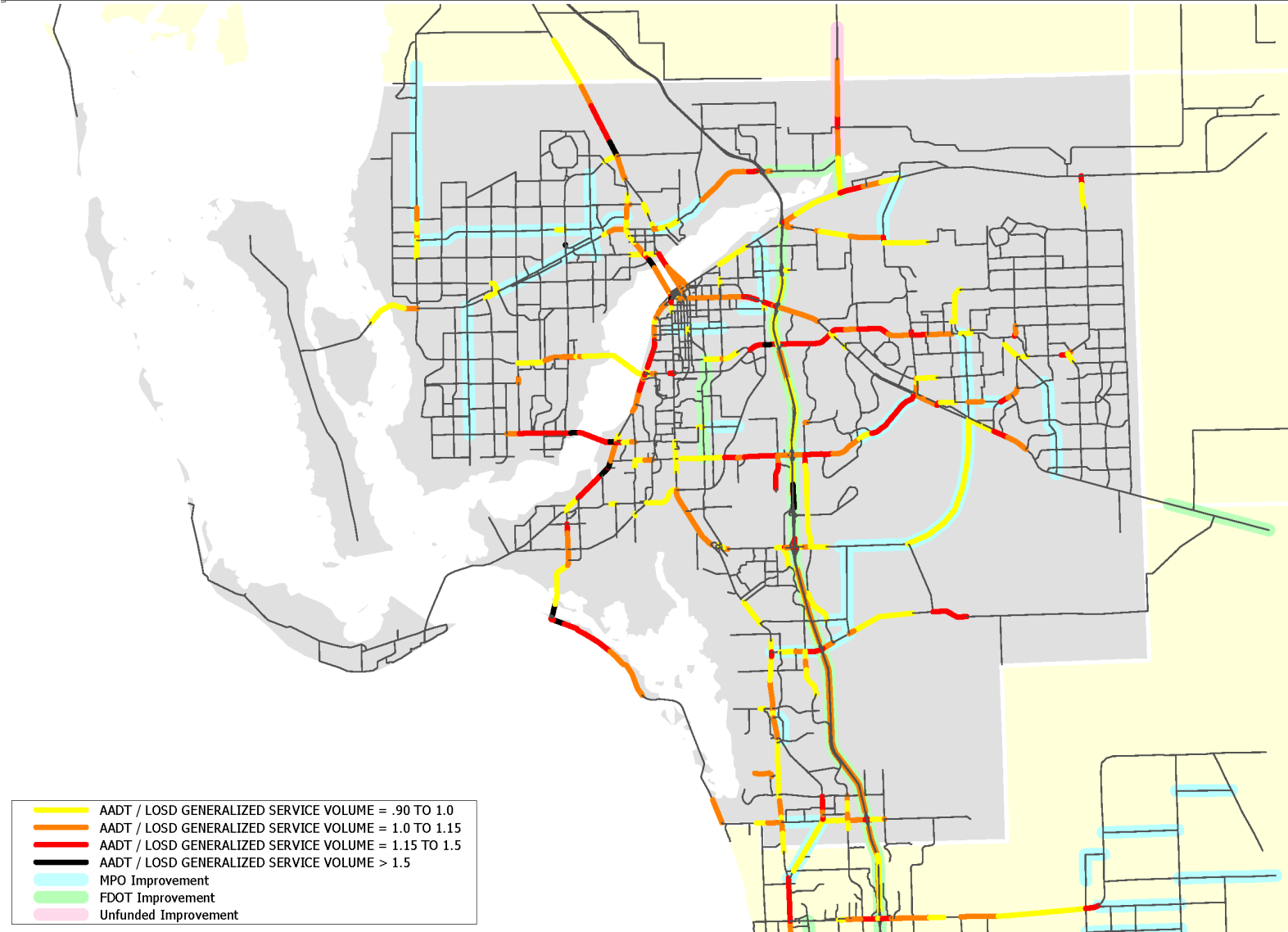
Legend:
- AADT / LOSD GENERALIZED SERVICE VOLUME = .90 TO 1.0
- AADT / LOSD GENERALIZED SERVICE VOLUME = 1.0 TO 1.15
- AADT / LOSD GENERALIZED SERVICE VOLUME = 1.15 TO 1.5
- AADT / LOSD GENERALIZED SERVICE VOLUME > 1.5
- MPO Improvement
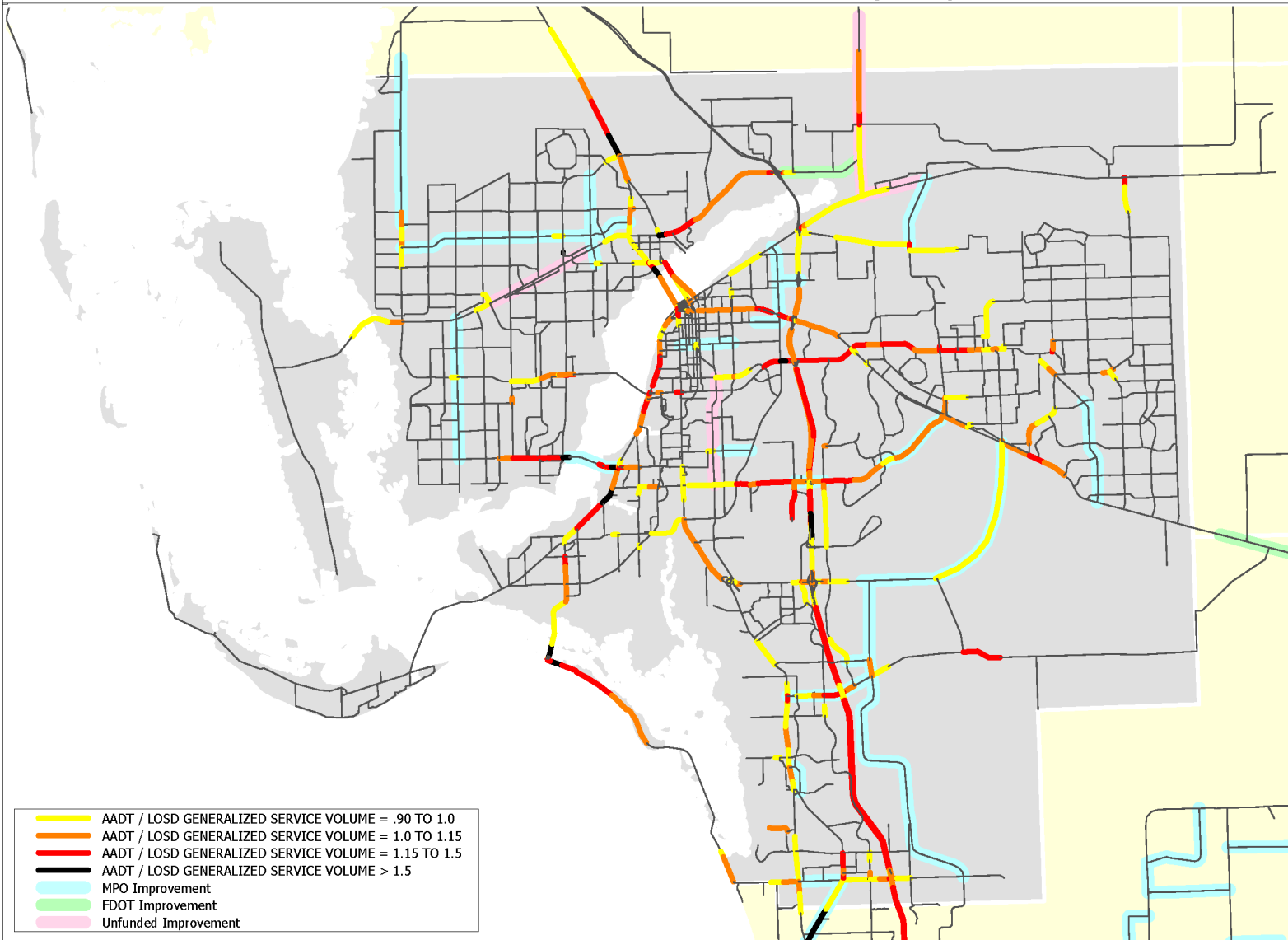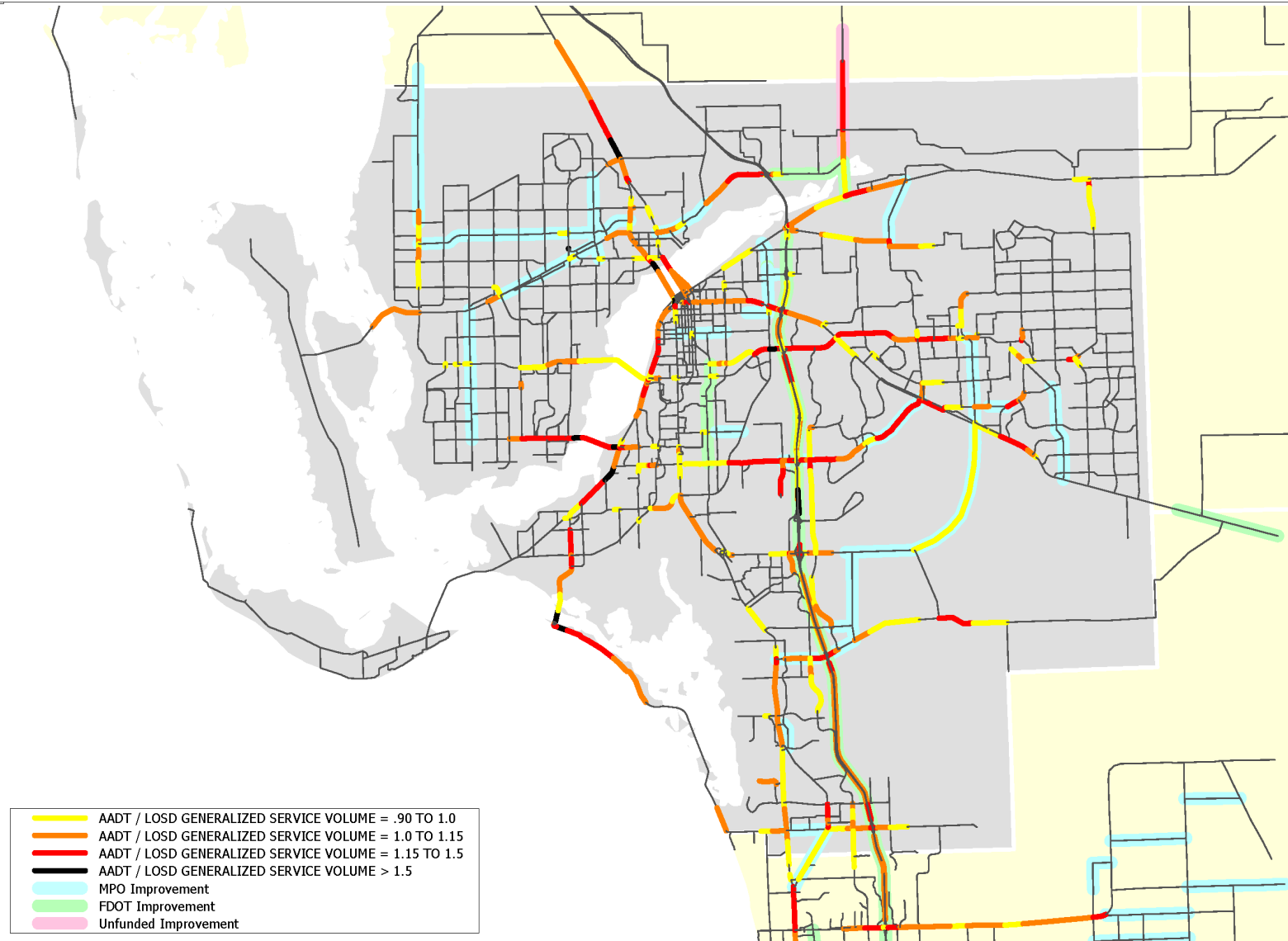- FDOT Improvement
- Unfunded Improvement

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LEE COUNTY MPO
METROPOLITAN PLANNING ORGANIZATION

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Connected and Automated Vehicles White Paper

PURPOSE

In light of emerging technologies and State legislative guidance (Appendix 1), Metropolitan Planning Organizations/Transportation Planning Organizations (MPO/TPO) must address the potential effects of Connected and Automated Vehicles (CAV) in developing their 2045 Long- Range Transportation Plan (LRTP) updates. Development of the District 1 Regional Planning Model D1RPM is currently underway by the Florida Department of Transportation (FDOT) District 1 with MPO/TPO alternative testing scheduled for completion prior to the adoption of the MPO/TPO LRTPs in 2020-2021. The purpose of this white paper is to explore the potential effects of level 2 and level 3 CAV on traffic forecasting in developing the new 2015-2045 (D1RPM) and explain steps the District is taking to assist the MPO/TPOs in addressing these new requirements.

INTRODUCTION

The new automotive technologies addressed in this Appendix include adaptive cruise control, traffic incident warning, and self-parking systems provided by some new car models on the road today. Defined by Society of Automotive Engineers as "levels 2-3 automation", these vehicles are anticipated to provide safer and more efficient travel as their numbers increase and become a significant portion of vehicles on Florida's roadways. For example, the study: *Planning for Cars That Drive Themselves: Metropolitan Planning Organizations, Regional Transportation Plans, and Autonomous Vehicles, Erick Guerra, Journal of Planning Education and Research, 2015,* suggests that by providing safer and more efficient spacing or platooning of vehicles, these CAVs can potentially bring significant increases roadway capacity and reductions in vehicle collisions.

While we may continue to speculate about when fully autonomous vehicles (levels 4 and 5 automation) will become a significant portion of the vehicle mix, it is understood this level of technology has the potential to fundamentally change transportation infrastructure planning, engineering, and operations. It also promises to expand mobility for the very young, the elderly, and the disabled and may substantially lower travel costs for all.

According to the 2018 FDOT report "Guidance for Assessing Planning Impacts and Opportunities of Automated, Connected, Electric and Shared-Use Vehicles (ACES)", level 3 automation may represent 30% to 60% of the vehicle fleet by 2035 (see table A 2-1 in Appendix 3). As previously mentioned, this significant increase could yield an increase in roadway lane capacity. Therefore, our discussion begins by considering the impact this may have on the development and use of the 2045 D1RPM model in District 1.

MODEL PLANNING ELEMENTS

With respect to Travel Demand Forecasting, the FDOT report "*Emerging Technology, Demographic Changes, and Travel Behavior; Trends, Key Parameters, and Scenarios*", FDOT- 2016" proposes several key parameters in modeling CAV technology.

- Capacity of Freeway and Major Arterial Segments associated with reduced headway
- Trip Generation/Generational Effects associated with 0 car households and unlicensed driver mobility

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- Value of In-Vehicle Time (IVT) associated with trip length
- Auto Operating Cost (including Parking Costs)

While data is not yet available to reliably forecast the potential effects of many of these elements, data is available pertaining to potential increases in roadway capacity due to the effects of decreased and consistent vehicle headways, or following distance, of Level 2 and 3 automation which is available on many vehicles today.

D1RPM CAV IMPROVEMENTS

As presented at past Florida Statewide Model Task Force (MTF) meetings, the 2045 D1RPM model under development has been improved to include features that allow for the testing of potential roadway capacity effects of CAV. These features include:

- A *saturation-rate* parameter used to determine the proportion of CAV in the vehicle fleet (currently on a system-wide basis);
- A *lookup table* used to estimate the effects of CAV on roadway capacity based on fleet saturation rate and facility type;
- A *separate trip purpose* designation for CAV;
- *Special-use lanes* which may be designated for exclusive use by CAV resulting in a maximum capacity increase.

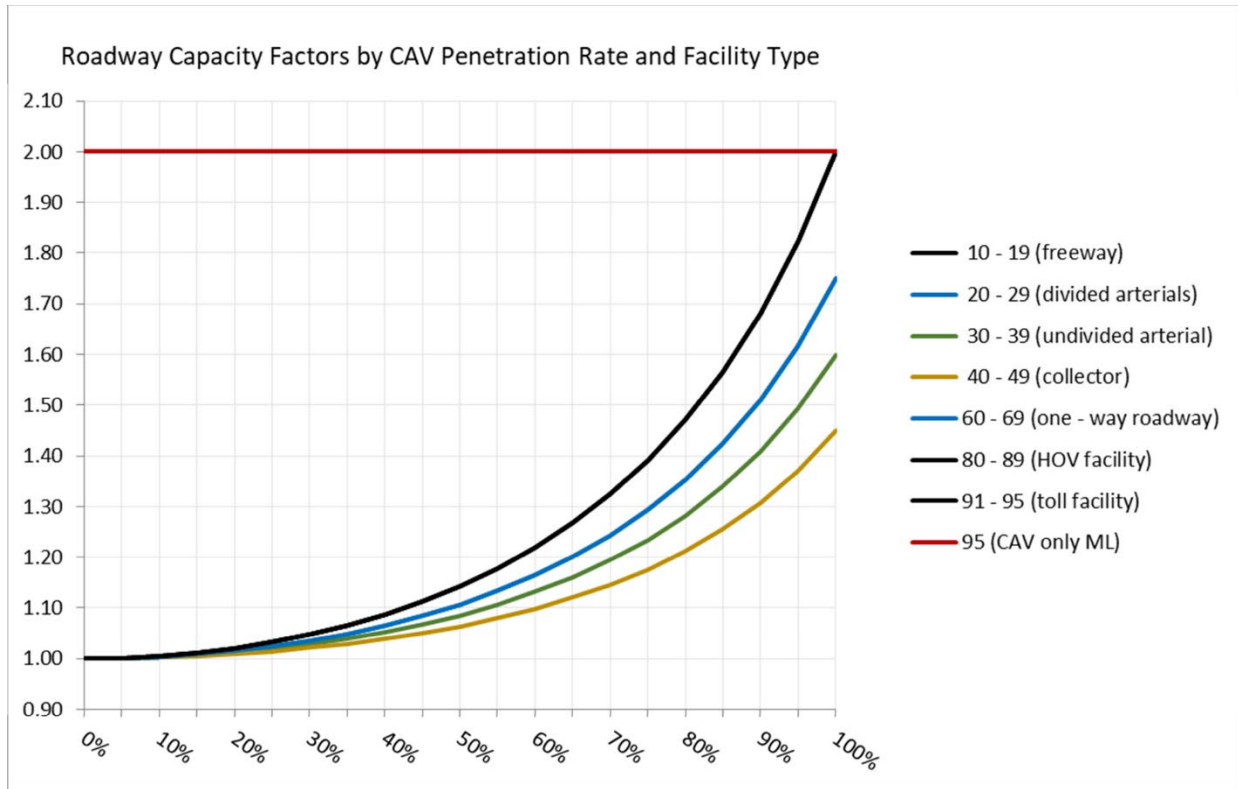A summary of other CAV related improvements to the D1RPM are as follows:

- The Model Network
    - Special-use lanes and ramps have been included in the roadway network on I-4 in Polk County; on I-75 in Sarasota/Manatee County; and on I-75 in Lee and Collier Counties.
    - Link capacity for certain facility types is modified according to the current "*lookup*" table of capacity effects which is in use.
- Auto Occupancy and Mode Choice
    - Vehicle trips are split into two tables for identification of CAV and non-CAV vehicle trips.
- Highway Assignment
    - CAV trips are identified with a special *'linkgroup"* code which enables special-use lanes to be used exclusively by CAV.
- Reporting
    - Model output reports modified to reflect inclusion of CAV.

Figure 1 was developed by District 1 in coordination with Professor Xiaoping (Shaw) Li, PhD with the Center for Urban Transportation Research (CUTR) at the University of South Florida (USF), to reflect his extensive research and field experiments in testing autonomous vehicles. Dr. Li's research provides a reasonable, albeit conservative estimate of the effects of platooning and CAV fleet saturation rates on roadway capacity. Additional data on potential capacity effects are included in Appendix 2.

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Figure 1: CAV Saturation Rates and Facility Types

Roadway Capacity Factors by CAV Penetration Rate and Facility Type

Legend:
- 10 - 19 (freeway)
- 20 - 29 (divided arterials)
- 30 - 39 (undivided arterial)
- 40 - 49 (collector)
- 60 - 69 (one - way roadway)
- 80 - 89 (HOV facility)
- 91 - 95 (toll facility)
- 95 (CAV only ML)

IMPLEMENTATION OF D1RPM CAV CAPABILITIES IN THE MPO/TPO 2045 LRTP UPDATES

In consideration of Federal and State of Florida legislative guidance, FDOT District 1 proposes to assist District MPO/TPOs in the development of their upcoming 2045 LRTP Updates by incorporating these model procedures within the D1RPM, as deemed appropriate, as an initial step in addressing the potential effects of CAV on roadway capacity.

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Appendix 1 – Legislative Guidance

Federal Highway Administration, Section 1430 of the FAST ACT, with respect to Use of Modeling and Simulation Technology, states "*It is the sense of Congress that the Department should utilize, to the fullest and most economically feasible extent practicable, modeling and simulation technology to analyze highway and public transportation projects authorized by this Act to ensure that these projects: (1) will increase transportation capacity and safety, alleviate congestion, and reduce travel time and environmental impacts; and (2) are as cost effective as practicable.*"

Recent CAV legislation available on the FDOT Florida Automated Vehicles site, (automatedfl.com) conveys the following:

Florida HB 7027 Recommends MPOs consider advances in vehicle technology when developing long-range transportation plans and requires FDOT to accommodate advances in vehicle technology when updating the Strategic Intermodal System Plan.

Statute 339.175 – (with respect to Long Range Transportation Plans) directs FDOT to make the most efficient use of existing transportation facilities to relieve vehicular congestions, improve safety, and maximize the mobility of people and goods. Further, it states that such efforts must include, but are not limited to, consideration of infrastructure and technological improvements necessary to accommodate advances in vehicle technology, such as autonomous technology and other developments.

Statute 339.64 (3)(c) – (with respect to Strategic Intermodal System Plan) directs FDOT to coordinate with federal, regional, and local partners, as well as industry representatives, to consider infrastructure and technological improvements necessary to accommodate advances in vehicle technology, such as autonomous technology and other developments, in Strategic Intermodal System facilities.

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Appendix 2 Roadway Capacity Factors by CAV Penetration Rate and Facility Type

D1RPM Lookup Table: Roadway Capacity Factors by CAV Penetration Rate and Facility Type

Facility Type	10-19 (freeway)	20-29 (divided arterials)	30-39 (undivided arterial)	40-49 (collector)	60-69 (one-way roadway)	80-89 (HOV Facility)	91-95 (toll facility)	95 (CAV only ML)
0%	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	2.0000
5%	1.0013	1.0009	1.0008	1.0006	1.0009	1.0013	1.0013	2.0000
10%	1.0050	1.0038	1.0030	1.0023	1.0038	1.0050	1.0050	2.0000
15%	1.0114	1.0085	1.0068	1.0051	1.0085	1.0114	1.0114	2.0000
20%	1.0204	1.0153	1.0122	1.0092	1.0153	1.0204	1.0204	2.0000
25%	1.0323	1.0242	1.0194	1.0145	1.0242	1.0323	1.0323	2.0000
30%	1.0471	1.0353	1.0283	1.0212	1.0353	1.0471	1.0471	2.0000
35%	1.0652	1.0489	1.0391	1.0294	1.0489	1.0652	1.0652	2.0000
40%	1.0870	1.0652	1.0522	1.0391	1.0652	1.0870	1.0870	2.0000
45%	1.1127	1.0845	1.0676	1.0507	1.0845	1.1127	1.1127	2.0000
50%	1.1429	1.1071	1.0857	1.0643	1.1071	1.1429	1.1429	2.0000
55%	1.1782	1.1337	1.1069	1.0802	1.1337	1.1782	1.1782	2.0000
60%	1.2195	1.1646	1.1317	1.0988	1.1646	1.2195	1.2195	2.0000
65%	1.2678	1.2009	1.1607	1.1205	1.2009	1.2678	1.2678	2.0000
70%	1.3245	1.2434	1.1947	1.1460	1.2434	1.3245	1.3245	2.0000
75%	1.3913	1.2935	1.2348	1.1761	1.2935	1.3913	1.3913	2.0000
80%	1.4706	1.3529	1.2824	1.2118	1.3529	1.4706	1.4706	2.0000
85%	1.5656	1.4242	1.3393	1.2545	1.4242	1.5656	1.5656	2.0000
90%	1.6807	1.5105	1.4084	1.3063	1.5105	1.6807	1.6807	2.0000
95%	1.8223	1.6167	1.4934	1.3700	1.6167	1.8223	1.8223	2.0000
100%	2.0000	1.7500	1.6000	1.4500	1.7500	2.0000	2.0000	2.0000

Estimated CAV percentage ranges based on 2018 ACES guidance (Appendix 3)

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Table A2-1 Autonomous Vehicle (AV) Fleet Share by Scenario, 2020-2060

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