(NASA, 2021)

St. Lucie Transportation Planning Organization

July 1, 2022

St. Lucie TPO Drone Port/Advanced Air Mobility Study Preliminary Review

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Acronyms

AAM	Advanced Air Mobility
ACES	Automated, Connected, Electric, and Shared-Use
ATC	Air Traffic Control
BVLOS	Beyond Visual Line of Sight
CAC	Citizen's Advisory Committee
CFR	Code of Federal Regulations
eVTOL	Electric Vertical Take-off and Landing
FAA	Federal Aviation Administration
GHG	Green House Gas
LCB	Local Coordinating Board for Transportation Disadvantaged
LRTP	Long Range Transportation Plan
NASA	National Aeronautics and Space Administration
OEM	Original Equipment Manufacturer
PBI	Palm Beach International Airport
TCTC	Treasure Coast Transportation Council
UAM	Urban Air Mobility
UAS	Unmanned Aircraft Systems
USDOT	U.S. Department of Transportation

Section 1. Advanced Air Mobility (AAM) Background and Description

- General Background
- Description of AAM Network Elements
- Alignment with the St. Lucie County Long Range Transportation Plan
- Summary of AAM Network Elements

Section 1. AAM Background and Description

1.1 General Background

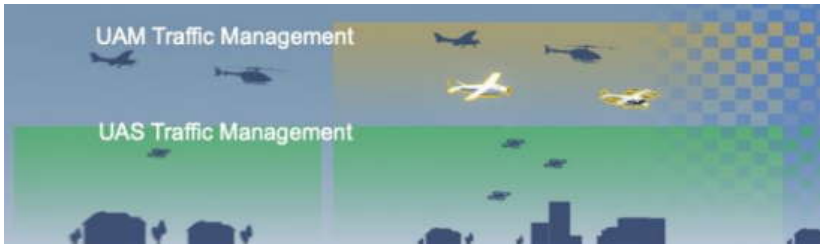

Figure 1-1. NASA Traffic Management Diagram Depicting UAS/UAM Airspace (NASA, 2021)

Urban Air Mobility (UAM), a concept with origins in mid-20th century intra-city helicopter transportation, describes systems utilizing "highly automated aircraft which will operate and transport passengers or cargo at lower altitudes within urban and suburban areas." Advanced Air Mobility (AAM) is an umbrella term which defines a future concept of mobility and of transportation of people and goods. AAM incorporates use cases of urban, suburban and rural transportation using innovative aerial vehicles, such as unmanned aerial vehicles (UAVs) and electric vertical take-off and landing vehicles (eVTOLs). The term AAM is often used interchangeably with Urban Air Mobility (UAM); however, AAM is inclusive of the rural and suburban counterparts whereas UAM mainly focuses on urban connectivity. Unmanned Aircraft Systems (UAS) describes a similar concept focusing primarily on smaller remotely controlled vehicles, what most people would refer to as "drones." AAM/UAM can be seen as a synergy between the automotive industry and civil aviation. Initial UAM passenger operations, most notably helicopter service from New York Airways in New York City, had high operating costs and noise footprints which ultimately ceased operations due to safety concerns from fatal accidents and subsequent bankruptcy; decreasing public interest and negatively influencing public perception of commercial helicopter travel. The advent of electric drone technology revised the interest in UAM through using newer Electric Vertical Takeoff and Landing (eVTOL) vehicles which are more energy efficient and quieter than helicopters. The electrification of eVTOLs allows them to consume energy at a much cheaper rate than helicopters and provided a framework for AAM networks. A gallon of Jet A fuel costs $6.86 on average and the Bell 407, utilized by Blade Aerospace in current helicopter transportation operations in New York City, has a burn rate of 43.2 gallons per hour – leading to a fuel cost of roughly $296/hour (AirNav, 2022). Uber expects direct energy costs for eVTOLs to "come in at roughly $21/flight hour." (Uber, 2016).

eVTOL technology is rapidly developing into reality with roughly 250 companies working on developing this novel technology – signaling a high degree of potential. The impending realization of eVTOL technology has positioned the AAM concept as a potential solution for a multitude of existing transportation bottlenecks and improvement upon current systems, most notably ground traffic congestion and greenhouse gas emissions. Appending an AAM network to existing ground networks has the potential to reduce travel times by 2.6 times (NASA, 2020) – Reducing travel times decreases vehicle congestion, in turn assisting in further decrease of tailpipe and noise emissions. The benefits of AAM are apparent, however a multitude of elements must be used in tandem to effectively implement it.

1.2 Description of AAM Network Elements

Successful AAM networks will integrate eVTOL technology, physical infrastructure (vertiports/heliports, recharging/refueling infrastructure, and utilities, etc.), conceptual infrastructure (airspace corridors and networks, communications arrays, and software), surrounding transit/cargo/transportation networks, and agreement with legislation and liability constraints (Figure 1-2). Initial AAM networks will be built largely around existing helicopter networks, utilizing heliports and helicopter airspace and procedures, while operating eVTOL vehicles and employing minor supporting infrastructure such as electrical charging stations (NASA, 2020). This will allow for a relatively straightforward inception of operations as the physical infrastructure generally already exists, although peripheral infrastructure such as charging stations may present high startup costs. However, given the extensive legal requirements which will need to be met to operate vehicle services over densely populated areas, as well as significantly higher development costs within downtown areas, AAM will most likely begin operating primarily as an option for inter-city cargo and passenger travel between multiple rather than an intra-city option like a city bus system.

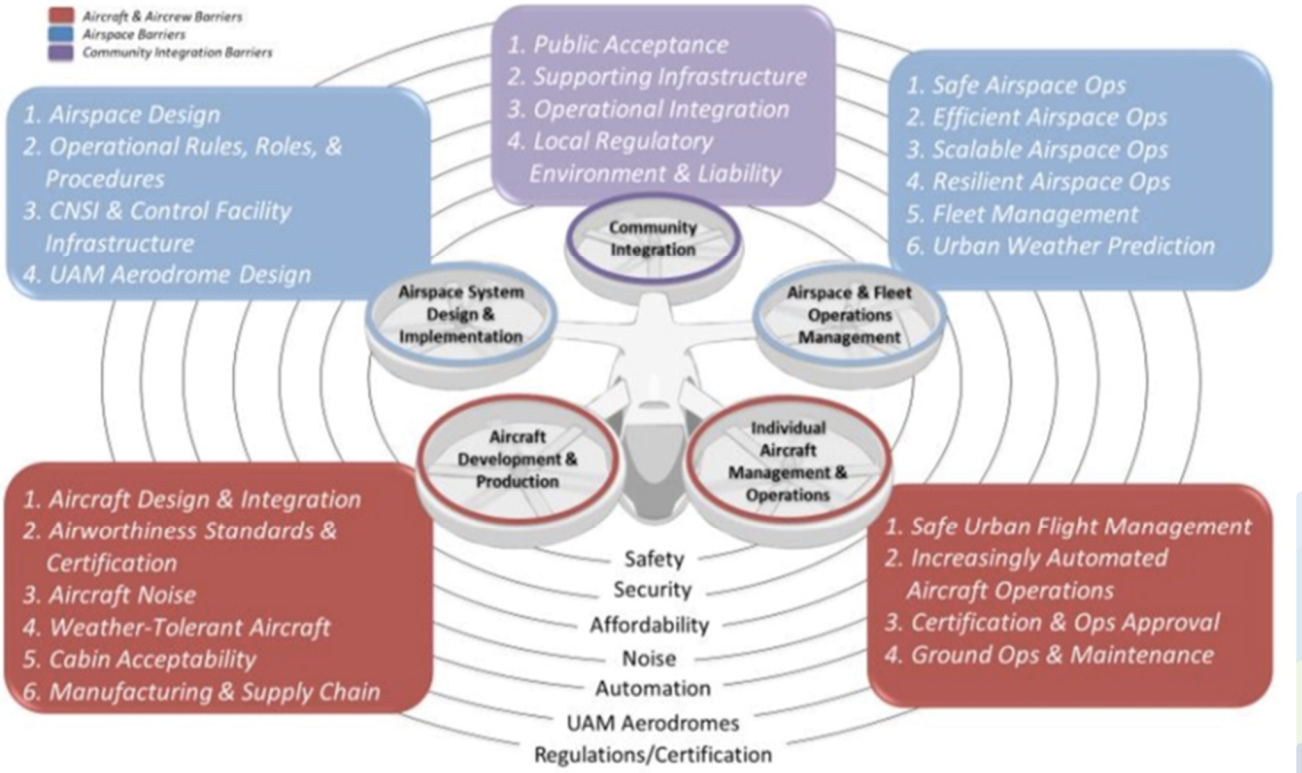

Figure 1-2. Barriers to Entry for AAM Network Creation (NASA, 2021)

Eventually, AAM networks may evolve to have an entirely separate, automated network, vertiports (eVTOL manufacturers are planning to develop their own vertiport infrastructure currently), and fully autonomous eVTOL aircraft lacking the need for a pilot-in-command (PIC). As the technology develops, economies of scale arise, and legislation evolves to accommodate the technology, intra-city AAM travel may also become more viable (FAA, 2020). Most importantly, the development of AAM networks will only be possible with public acceptance. Consumers must trust AAM to be safe, and that the benefits will be worth the costs – in infrastructure development, new legislation, and taxpayer dollars. Given the potential demand, however, the public may be amenable to the development of this new transit medium. Many American cities are growing rapidly (including Port St. Lucie, FL, which the U.S. Census Bureau ranked as the 12th fastest growing city in the

United States) which will add strain to existing ground traffic networks. This will make alternative transportation methods a necessity. AAM may prove to be a high-demand alternative, with projected long-term demand of 20% of all daily work trips in the United States (Booz Allen Hamilton, 2020).

1.3 Alignment with the St. Lucie County Long Range Transportation Plan

Considering its potential to be more cost and energy efficient than traditional methods, providing AAM as an alternative mode of transportation may prove to become a viable strategy for many localities, including St. Lucie County. The AAM concept in many ways aligns with the St. Lucie County Transportation Planning Organization (TPO)'s Long Range Transportation Plan (LRTP). The LRTP outlines several goals for St. Lucie's transportation system by 2045:

- Support Economic Activities
- Provide Travel Choices
- Maintain the Transportation System
- Providing Equitable, Affordable, and Sustainable Urban Mobility
- Improving Safety and Security

The following notes how AAM can support reaching these goals.

Supporting Economic Activities, Providing Travel Choices, and Maintaining the Transportation System

AAM has the potential to support current cargo and transportation networks by reducing congestion from existing and future ground traffic, and to expand such networks by increasing accessibility to areas which may have been more difficult to reach by consumers. For example, a factory located 60 miles outside of downtown Port St. Lucie may take over an hour to drive to considering distance and traffic patterns, but only 15 minutes when utilizing an eVTOL in an AAM network which may reach higher top speeds and does not have to worry about traffic density or road networks (Kasliwal et. al., 2019). This would allow for a more cost-effective transfer of goods to and from the factory. This concept could hold for many locations among the immediate and broader region – allowing for more efficient and expanded cargo transfers between St. Lucie County and communities throughout Florida. This concept can also be applied by understanding AAM as an alternative travel choice - AAM presents a medium to long range alternative to walking, biking, driving, or transit which may prove to be more time and energy efficient. AAM serves multiple passengers (or larger volumes of cargo) at a time, taking vehicles off the road – in turn, reducing stresses on existing road networks while representing a forward-looking investment in St. Lucie County's transportation system.

Provide Equitable, Affordable, and Sustainable Urban Mobility

In its initial stages, AAM would only require existing helicopter infrastructure (heliports, networks, etc.) in addition to charging ports and related utilities. Any location suitable for helicopter transport could then be used for AAM transport – meaning, areas which lack public transportation or ease of access by road may with relative simplicity be served by AAM networks. This may work to improve equitability in St. Lucie's transportation network, while providing a more sustainable transportation option. Evolution in certain technologies, namely electric propulsion, energy storage, and automation, may allow eVTOL aircraft to present as a vehicle option with relatively low chemical and noise emissions.

Contrasting with older VTOL (non-electric) vehicles such as helicopters, which use traditional fossil fuels and have loud rotors, eVTOL aircraft may be charged electrically and use smaller, quieter blades to fly. Although AAM may not be very affordable in initial stages due to high startup costs due to vehicle and infrastructure development and production, "as the technology and infrastructure evolve…trips could become progressively longer, driving down the cost per mile to more affordable levels" (Deloitte, 2020). Essentially, once Original Equipment Manufacturers (OEM) ramp up production of eVTOLs and the networks are built, prices may be driven down significantly, proving AAM networks to be a viable transportation option for the public. AAM could also be used as an automated, efficient solution to regular cargo transportation between fixed or dynamic locations. An eVTOL with a single pilot (or flown by itself) may be able to take more frequent (or easier scheduled) trips than trucks normally could, while utilizing electric power and avoiding unwanted traffic or road delays.

Improve Safety and Security

While being held to the same stringent safety standards as existing passenger and cargo aircraft, AAM networks may provide localities with an increased sense of security by expanding the potential for public emergency services to reach areas it may have been costly to do so before. More automation and interconnectedness will allow eVTOL aircraft to be more aware of weather conditions and surrounding traffic or other hazards, minimizing the possibility for pilot error – a leading cause of aircraft accidents. Furthermore, AAM operations will need to adhere to a much wider range of certification standards (Section 2) and oversight than typical vehicle travel which will lead to safe operations going forward.

Figure 1-3. Depiction of eVTOL being Used in Search and Rescue Operations

1.4 Summary of AAM Network Elements

To summarize, AAM networks typically consist of:

- eVTOL aircraft or other automated flying vehicles
- Supporting physical infrastructure
  - Vertiports
  - Charging stations
  - Communications arrays
  - Terminals (for passengers or cargo)
- Planning/operations infrastructure
  - Flight plans/procedures
  - Airspace
  - Communications networks (radio etc.)
  - Integration with existing transportation networks
- Staff
- Pilots (Early maturity level)
- Controllers
- Workers to help facilitate loading and unloading of passengers and/or cargo
- Regulatory Environment
  - Legislative guidance and rules set forth by local, state, and federal governments created to ensure safety and proper accordance with the law

In initial stages AAM networks will likely utilize existing helicopter infrastructure, except for the necessary charging equipment. eVTOLs could fly in existing helicopter airspace, following similar regulations to helicopters and adhering to the same methods of air traffic control and flight procedures.

Section 2. Maturity of AAM Technology

- Introduction and Background
- Regulatory Framework
- AAM Introduced/Enacted Bills in Congress

Section 2. Maturity of AAM Technology

2.1 Introduction and Background

Regulations pertaining to operators, aircraft, airspace, and supporting infrastructure (airport and heliport) have been established to enable safe and efficient operations within the National Airspace System (NAS). Prescribing these regulations is a responsibility of the Federal Aviation Administration (FAA). In addition to the federal regulations, there are state and city-specific rules that pertains to the aviation industry in some regions.

The AAM industry is subject to the same standard of laws that govern the NAS. This means that before AAM aircraft can be deployed in commercial operations at scale, the operators must overcome the regulatory hurdles. These hurdles are further amplified by the disconnect between the current regulations and AAM's envisioned state which introduces innovative and unconventional technologies like automation, beyond visual line of sight (BVLOS) operation, electric powered aircraft, and non-traditional use cases (e.g., package delivery, regional air mobility, etc.) that do not fit into the rules intended for the traditional operators of the NAS. For this reason, civil authorities (such as the FAA), federal agencies (NASA), private operators (Original Equipment Manufacturer), and other AAM stakeholders have been collaborating to collect necessary flight data, develop a roadmap, and reach industry consensus in order to supplement and amend existing regulations to support the realization of AAM while not jeopardizing the safety and consonance of the NAS.

Since commercialization of AAM is dependent on compliance to the existing regulations, it is important to understand the maturity of AAM technology in the scope of the current state of the regulatory framework versus the envisioned state of AAM. Furthermore, this Section familiarizes the St. Lucie TPO members of the public–private collaboration efforts to date.

2.2 Regulatory Framework

Use cases of AAM are subject to different types of existing regulations. The subjectivity of the regulation is dependent on various factors like use cases, aircraft takeoff weight, passengers on board, etc. For example, operators that specialize in drone delivery are more suited for operating under 14 Code of Federal Regulations (CFR) Part 107 – Small Unmanned Aircraft Systems while passenger carrying operator must receive Airworthiness Certificate under 14 CFR Part 21/23 on their aircraft to ensure that the aircraft meets the safety standards. Table 2-1 summarizes the existing regulations that pertain to the distinct use cases. Note that the table doesn't comprise all the regulations that the operators must adhere to but covers the regulations that have the most implications associated with each use case.

Use Cases	Regulations
Cargo Delivery	**14 CFR Part 107** – Small Unmanned Aircraft Systems **14 CFR Part 135** – Operating Requirements
Passenger Transport	**14 CFR Part 21** – Certification Procedures for Products and Articles **14 CFR Part 23** – Airworthiness Standards: Normal Category Airplanes **14 CFR Part 135** – Operating Requirements

Table 2-1. Overview of Existing Regulations and Distinct Use Cases

2.2.1 Regulation and Implications (Cargo Delivery UAS)

14 CFR Part 107 was the first legislation created specifically for commercial drone pilots. Although cargo delivery is permitted under Part 107, the regulation lacks specific guidance and has limitations when the operator intends to deliver heavier cargos on a commercial scale. Below is the list of major implications that are associated with drone delivery under Part 107.

14 CFR Part 107 – Small Unmanned Aircraft Systems

- **Weight Limit**
  According to 14 CFR § 1.1 - General Definitions, "Small Unmanned Aircraft System means an unmanned aircraft weighing less than 55 pounds on takeoff, including everything that is on board or otherwise attached to the aircraft". The weight of the UAS varies but 55 pounds takeoff weight imposes limitations on cargos the operator would be able to deliver through UAS.
- **Airspace Restriction**
  According to 14 CFR 107 § 41 – Operations in Certain Airspace "No Person may operate a small, unmanned aircraft in Class B, Class C, or Class D or within the lateral boundaries of the surface area of Class E airspace designated for an airport unless that person has prior authorization from Air Traffic Control (ATC)." Class B, C, and D airspace is controlled airspace in the vicinity of the airport. The primary purpose of controlled airspace is to ensure safe operations of all participants operating in the vicinity of the airport which generally has heavier air traffic and aircraft maneuvering critical phases of flight (Landing or Take-Off operations).

Figure 2-1 depicts Treasure Coast International Airport and Witham Field Airport's controlled class D airspace. As can be seen, distribution centers located inside the boundaries of the controlled airspace are potentially prohibited from cargo delivery by UAS opportunities under Part 107 without obtaining prior authorization from FAA.

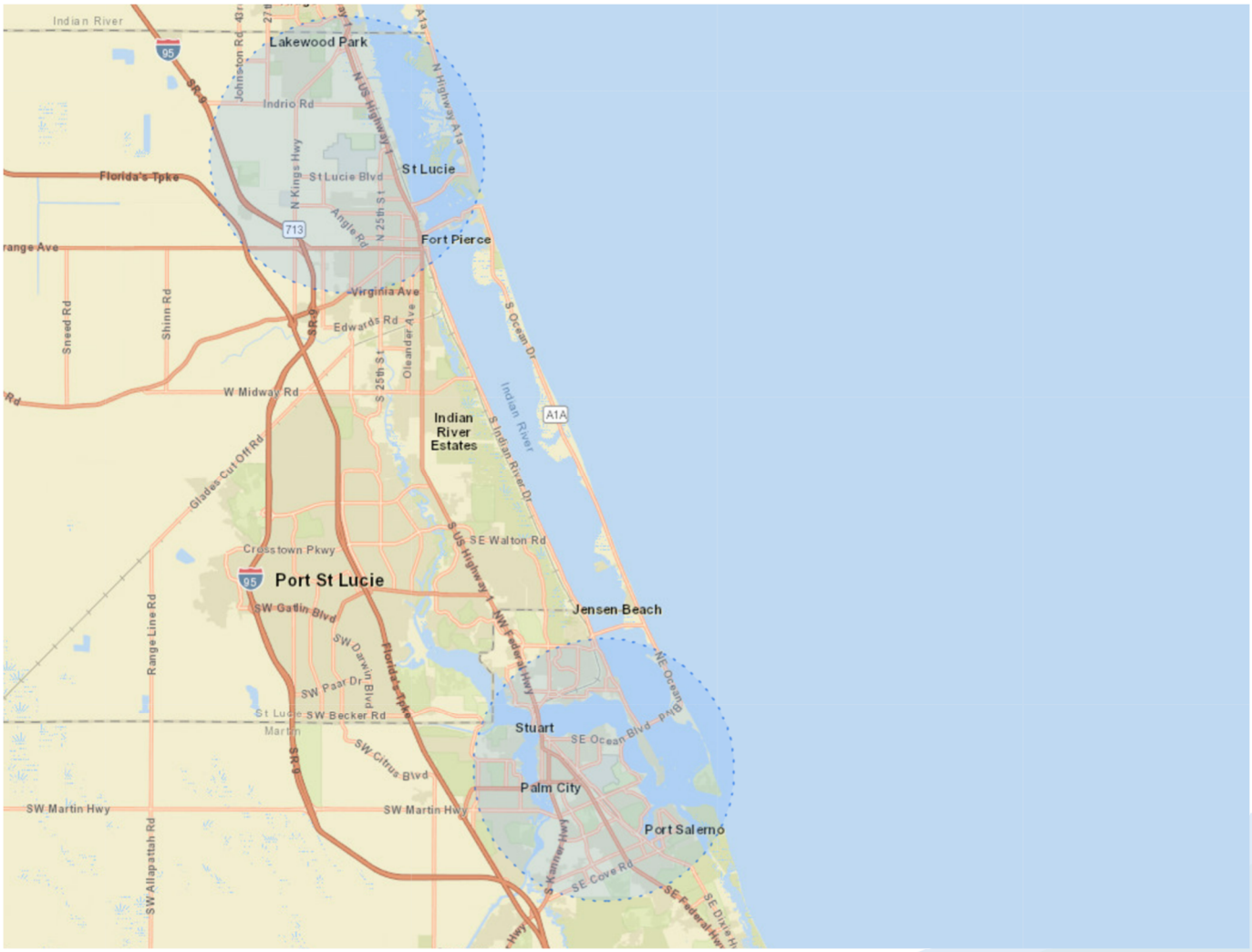

Figure 2-1. Airspace of St. Lucie County

- **Line of Sight Operations**
  According to 14 CFR 107 § 31 – Visual Line of Sight Aircraft Operation, a Remote Pilot must operate the UAS "(a) with vision that is unaided by any device other than corrective lenses, the remote pilot in command, the visual observer (if one is used), and the person manipulating the flight control of the small, unmanned aircraft system must be able to see the unmanned aircraft throughout the entire flight." The regulation limits beyond visual line of sight operations for UAS operators which significantly limits the distance that the drone will be able to deliver to ensure unobstructed vision of the drone.
- **One Pilot per Drone**
  According to the FAA's operating requirements for Part 107, "You cannot be a pilot or visual observer for more than one drone operation at a time". The idea of one operator serving one customer per flight may be financially inefficient when compared to the traditional ground-based delivery services.

2.2.2 Efforts and Advancements (Cargo Delivery UAS)

The implications above demonstrate the disconnect between the existing regulations and the proposed use cases for UAS. For this reason, federal programs have been established for UAS operators, public agencies, and other stakeholders to collaborate to test and evaluate the integration of cargo delivery by UAS into the NAS. Below are the federal programs to date.

UAS Integration Pilot Program (2017-2020)

FAA's UAS Integration Pilot Program (IPP) began in 2017 to bring state, local, and tribal governments together with private sector entities, such as UAS operators or manufacturers, to test and evaluate the integration of civil and public drone operations into the national airspace system. The program is assisting the U.S. Department of Transportation (USDOT) and FAA craft new rules that support core complex low-altitude operations by:

Figure 2-2. FAA IPP (FAA, 2019)

- Identifying ways to balance local and national interests related to drone integration
- Improving communications with local, state, and tribal jurisdictions
- Addressing security and privacy risks
- Accelerating the approval of operations that currently require special authorizations

The main purpose of the program was to evaluate a host of operational concepts, including night operations, flights over people and beyond the pilot's line of sight, package delivery, detect-and-avoid technologies and the reliability and security of data links between pilot and aircraft.

Through the UAS IPP Program, FAA shared the relevant data and lessons learned with the appropriate policymakers and regulatory teams within the FAA and DOT to inform regulations, policy, and guidance. The FAA concluded the UAS IPP on October 25, 2020 as mandated by statute and decided to continue the partnerships and progress it made under the IPP to continue to address remaining challenges through a new program called BEYOND on October 26, 2020. (FAA, 2020)

FAA BEYOND (2020 - Current)

The main objective of the FAA BEYOND program is:

- Beyond Visual Line of Sight (BVLOS) operations that are repeatable, scalable, and economically viable with specific emphasis on infrastructure inspection, public operations, and small package delivery.
- Leveraging industry operations to better analyze and quantify the societal and economic benefits of UAS operations.
- Focusing on community engagement efforts to collect, analyze and address community concerns.

Figure 2-3. FAA BEYOND Program (FAA, 2021)

Through the two federal programs (IPP and BEYOND), FAA focused on addressing implications associated with Part 107 Regulations by allowing the UAS operators to operate under Title 14 CFR Part 135 - Air Carrier Operator Certification rules to streamline the UAS integration. Ultimately, this decision allowed the UAS operators to obtain Part 135 certifications to be exempt from the weight limit, BVLOS allow the UAS operators with Part 135 certification to be exempt from the limitations of the Part 107 rules. (FAA, 2021)

14 CFR Part 135 – Air Carrier and Operator Certification

Participants in these programs are among the first to prove their concepts, including package delivery by drone through part 135 air carrier certification. Part 135 certification is the only path for small drones to carry the property of another for compensation beyond visual line of sight. As participants in these programs move to prove their concepts, they must use FAA's existing Part 135 certification process, some of which FAA has adapted for drone operations by granting exemptions for rules that don't apply to drones, such as the requirement to carry the flight manuals on board the aircraft. (FAA, 2022)

Limited number of AAM companies have attained Part 135 Certificate to date, and FAA is working with six additional Part 135 air carrier certifications that have been submitted by the operators. Companies who have attained Part 135 Standard Air Carrier Certificate are:

- **Wing Aviation, LLC, Subsidiary of Alphabet Inc.** received Part 135 standard air carrier certificate for the drone operations in October 2019. Currently Wing Aviation is participating in the Integration IPP by delivering food and over-the counter pharmaceuticals directly to homes in Christiansburg, VA. (Wing, 2022).
- **UPS Flight Forward, Inc.** received Part 135 certificate in September 2019 and delivers medical supplies and prescription medicine. The delivery is explicitly operating under Part 107 regulation and with Visual Line of Sight even though the company has the permission to operate BVLOS under the Part 135 Certificate (FAA, 2021).
- **Amazon Prime Air** received Part 135 Certificate in August 2020. Amazon mentioned that "Prime Air fleet isn't ready to immediately deploy package deliveries at scale, and it's actively flying and testing the technology" (CNBC, 2020).

2.2.3 Regulation and Implications (AAM Passenger Carrying Aircraft)

When compared to the delivery UAS, passenger carrying aircraft must go through more rigorous process to be deployed at a commercial scale. For the aircraft to be deployed, they must receive FAA's official authorization (Airworthiness Certification). However, receiving an Airworthiness Certification for a new aircraft takes a considerable time and may be prolonged if the AAM aircraft introduce new technologies and unique flight characteristics.

Airworthiness Certification

Certification is how the FAA manages risk through safety assurance. It provides the FAA confidence that a proposed product or operation will meet FAA safety expectations to protect the public. 14 CFR Part 21 defines three certifications: type, production, and airworthiness:

- **Type certification** is the approval of the design of the aircraft and all component parts (including propellers, engines, control stations, etc.). It signifies the design is in compliance with applicable airworthiness, noise, fuel venting, and exhaust emissions standards. Most of the AAM OEMs are in this phase.

- **Production Certification** is the approval to manufacture duplicate products under an FAA-approved type design. It signifies that an organization and its personnel, facilities, and quality system can produce a product or article that conforms to its approved design.

- **Airworthiness Certification** is the FAA's official authorization allowing for the operation of a type certificated aircraft. A standard airworthiness certificate allows the aircraft to be operated and used with the most minimal restrictions and for compensation and hire. Because type certification is a prerequisite for a standard airworthiness certificate, most UAS do not currently meet the requirements for a standard airworthiness certificate.

In addition to the Airworthiness Certification, AAM companies must receive Air Carrier and Operator Certification (14 CFR Part 135) to provide commercial services and transport passengers However, fundamental differences in the proposed technology and operations compared to the traditional aircraft have to potential to delay the certification process for the AAM companies that are designing a new aircraft. For this reason, FAA, NASA, OEM, and other industry stakeholders have made significant efforts to close the regulatory gap and efficiently certify the aircraft without jeopardizing FAA's safety standards (FAA, 2021).

2.2.4 Efforts and Advancements (AAM Passenger Carrying Aircraft)

Like drone delivery, federal programs have been established to support the certification of passenger carrying aircraft. Below are the major federal programs to date.

FAA/NASA National Campaign

FAA/NASA AAM National Campaign has been established to support the collection of necessary flight data from the participating OEMs to accurately determine the certification requirements for the newly proposed aircraft. According to NASA, the first stage of the will take place between July and November 2020 and, as the name states, focus on developmental testing. NASA will conduct full field tests in urban environments of US-developed aircraft and will include airspace operations management services to explore architectures and technologies needed to support future safety and scalability of UAM operations. Participants selected for the developmental testing will have the opportunity to fly at NASA's Armstrong Flight Research Center, or a range of their choice, and participate in collaborative airspace operations. The evaluation includes all elements of UAM operations under a variety of weather, traffic and contingency conditions.

During the tests, NASA and government partners will record a wide array of flight data, including acoustics, vehicle fight performance, charging, pre-departure scheduling, etc. That information will be provided to the FAA to help determine vehicle certification requirements and, for some data such as acoustics, back to the participating companies for their benefit (NASA, 2021).

Aside from FAA, NASA, and OEMs, other industry stakeholders are participating in the campaign to support the integration of AAM. Five local and state governments have signed Space Act Agreements to consider how emerging vehicles can be integrated into their transportation plans including:

- Massachusetts Department of Transportation
- Minnesota Department of Transportation
- The North Central Texas Council of Governments
- The Ohio Unmanned Aircraft Systems Center of the Ohio Department of Transportation
- The City of Orlando, Florida

Progress of Passenger Carrying AAM Companies

As of June 2022, no companies have received the airworthiness certification on their proposed aircraft. Most companies are still working to receive the type certificate and proposing to begin commercial operation with limited service around 2024 or 2025.

Which region will initially host AAM service is dependent on various factors such as consumer demand towards AAM, geographical advantages for the supply side, local municipal's support for integration of AAM into their transportation network, etc.

2.3 AAM Introduced/Enacted Bills in Congress

United States Congress has been introducing/enacting various bills to support the realization of AAM. Below are bills that have passed Senate or only the House of Representative to date:

- **Advanced Air Mobility Coordination and Leadership Act** (S.516) Passed Senate on 03/23/2022

  This bill directs the Department of Transportation to establish an AAM interagency working group to plan and coordinate efforts related to the safety, infrastructure, physical security, cybersecurity, and federal investment necessary to bolster the AAM ecosystem, particularly passenger-carrying aircraft, in the United States. AAM refers to an air transportation system that moves people and cargo between places using new aircraft designs that are integrated into existing airspace operations as well as operated in local, regional, intraregional, rural, and urban environments. (S.516, 2022)

- **Drone Infrastructure Inspection Grant Act** (H.R. 5315) Introduced in House of Representatives on 04/28/2022

  The Drone Infrastructure Inspection Grant Act, introduced by Representatives Greg Stanton (D-AZ-9) and Garret Graves (R-LA-6), authorizes a grant program to state, local, and tribal governments to purchase drones for infrastructure inspection purposes and to community colleges/universities to support drone education and workforce training programs. NASAO urged House Transportation and Infrastructure Committee members to vote in favor of the bill at the committee's mark up.

- **Advanced Aviation Infrastructure Modernization Act** (H.R. 6270) Passed House of Representatives on 06/13/2022

  The Advanced Aviation Infrastructure Modernization Act, introduced by Representatives Rick Larsen (D-WA-2), Garret Graves (R-LA-6), and Dina Titus (D-NV-1), authorizes a grant program to state, local, and tribal governments, transit agencies, port authorities, and metropolitan planning organizations to plan the infrastructure needed to facilitate AAM operations and construction for public use vertiports. NASAO is a key supporter of this bill.

- **National Center for the Advancement of Aviation Act** (H.R. 3482) Introduced in House of Representatives on 05/25/2021

  The National Center for the Advancement of Aviation Act, introduced by Representative Andre Carson (D-IN-7) and the late Don Young (R-AK-At Large), establishes a national, independent forum to facilitate collaboration and cooperation between all sectors of aviation and aerospace to coordinate, promote, and support the future of aviation. The House bill is a companion to the Senate version (S.1752) introduced in May 2021 by Senators Jim Inhofe (R-OK) and Tammy Duckworth (D-IL). Last year, NASAO joined a coalition of aviation stakeholders to send a joint letter of support for the bill.

Section 3. Use Cases of AAM

- Use Cases Overview
- Passenger Transportation
- Cargo and Commodity Transportation
- Public Service/Emergency Operations

Section 3. Use Cases of AAM

3.1 Use Cases Overview

Prior sections have described the current state of the regulatory environment surrounding AAM and have provided a high-level overview of the AAM concept. This section provides a more detailed outline of potential use cases for AAM within the context of St. Lucie County to give the TPO a better understanding of the benefits and shortcomings of this emerging technology.

AAM use cases can be sorted into three distinct categories:

- Passenger Transportation
- Cargo and Commodity Transportation
- Public Service/Emergency Operations

By looking at St. Lucie County's passenger flows, transportation methods, and demographic trends, alongside an analysis of the LRTP and other planning materials, these three overarching use cases were used to create a framework which allowed for the suggestion of use cases more specific to St. Lucie County. These use cases are not recommendations, which are outside of the scope of this paper.

3.2 Passenger Transportation

2019 Data from the U.S. Census Bureau and Bureau of Labor and Statistics (aggregated and presented by Data USA) gives context to the state of demographics and transportation in St. Lucie County. Residents of St. Lucie County primarily use personal vehicles to commute – 79.8% of commuters reported using cars to get to work every day in 2019. The average commute time for St. Lucie County residents in 2019 was 26 minutes one way, however roughly 3.6% of residents logged commutes which were 90 minutes each way daily. Commute times will continue to rise naturally as traffic increases due to St. Lucie County's rapid growth (Table 3-1). In lieu of extensive investment into developing alternative transportation methods to account for this increase, vehicle congestion will continue to grow.

	Total Population	Total Employment
2015	292,362	108,097
2045	525,100	190,247
Total Growth	**232,738**	**82,150**
Percent Growth	**79.61%**	**75.99%**

Table 3-1. Predicted Population Growth in St. Lucie County (St. Lucie TPO LRTP, 2021)

Given many commuters reporting long commuting times, and a high degree of reliability by the public on personal vehicles, there may be opportunity for AAM to alleviate burdensome travel times and the continued onset of greenhouse gas (GHG) emissions that come with the usage of gas-powered vehicles. For environmental considerations especially, utilizing eVTOLs as an alternate transportation method presents a possibility for improvement. GHG emissions from transportation accounted for 27% of total emissions in the United States in 2020, with over 70% of those coming from light-duty vehicles (cars) and medium/heavy duty trucks (EPA, 2022). The LRTP projects a total population increase in St. Lucie County of 232,738 between 2015 and 2045, and a total employment increase in the county of 82,150 jobs (Table 3-1). As more people live and work in St. Lucie County, more of these vehicles will be on the roads – increasing traffic congestion and emissions. AAM networks may be used to combat the higher emissions stemming from these increases, as eVTOL travel at many distances provide lower emissions than gas-powered vehicles and at distances of 62 miles or greater "Emissions tied to the eVTOL were 52% lower than gasoline vehicles and 6% lower than battery-electric vehicles" (Kasliwal et. al., 2021). This does not even mention noise emissions, which are expected to be remarkably low for new eVTOL technology.

Assuming the population of St. Lucie County grows at this projected rate of almost 80% in the next 30 years, providing the community – many of whom may have moved from other areas in Florida or the United States – with greater access to longer distance areas will become important. As the Treasure Coast Airport still lacks commercial authorization, the closest major airport, Palm Beach International, lies roughly an hour's drive away from the lower part of St. Lucie County. Utilizing an AAM network between those two cities alone would allow for easy access to Palm Beach County and PBI for St. Lucie County residents, allowing for road trips that may have taken over 90 minutes by car to be cut by 80% each way (Kasliwal et. al., 2021). On a broader scale, connecting St. Lucie County to the rest of Florida would provide residents with a higher degree of travel flexibility.

Figure 3-1. Lilium's Proposed AAM Network throughout Florida (Lilium, 2021)

On November 11th, 2020, Lilium announced it would be launching its first hub location for AAM travel in Orlando, Florida at the Lake Nona Vertiport with operations starting in 2025. Lilium envisions connecting the entire state of Florida through this vertiport, with Port St. Lucie projected to be a roughly 30-minute eVTOL trip (~90 miles) from takeoff to touchdown (Lilium, 2020). Integrating an eVTOL base in St. Lucie County with Lilium's proposed Lake Nona hub has the potential to expand the county's sphere of influence throughout the entire state – for example, travelers from St. Lucie could reach Jacksonville by eVTOL travel in less than 90 minutes (not including connection time); a car ride between the two areas currently takes roughly 3 to 4 hours. Connecting St. Lucie County residents to Lake Nona also provides access to Orlando International Airport, one of the busiest airports in the United States and a huge international gateway that could increase visitor and business access to St. Lucie County.

eVTOL technology furthermore shows potential in the ecotourism industry, which focuses on bringing tourists to nature destinations while minimizing impact on the environment. eVTOLs (compared to helicopters) generate relatively low environmental or noise emissions, allowing passengers to experience attractions while minimizing impact on nature. Ecotourism attractions in nearby Martin County (Hobe Sound, Blowing Rocks Preserve, and the St. Lucie Inlet Preserve State Park) or further away would then be more accessible and attractive to visit than by car. Nautilus Aviation, an ecotourism startup, plans on deploying a similar concept by flying eVTOL aircraft over the Great Barrier Reef with flights beginning in 2026 (Nautilus Aviation, 2021).

3.3 Cargo and Commodity Transportation

As St. Lucie County begins to position itself as a logistics hub, implementing alternative cargo transportation methods may be necessary. Although eVTOLs cannot individually transfer as much per trip as a typical cargo truck, the frequency with which the vehicles can travel medium to long distances could facilitate the more energy and time efficient transfer of goods. More automation in eVTOLs versus standard trucks or aircraft would allow for easier network planning and scheduling while cargo would be transported at higher speeds over long distances. These automation and efficiency improvements may minimize storage costs and lead times, reducing operational expenses for logistics firms and more quickly bringing goods to consumers. St. Lucie County's centralized location within Florida, the Treasure Coast Airport, and a significant amount of impending private investment in logistics in the county provide many opportunities for AAM cargo operations.

Treasure Coast Airport, sitting on 3,800 acres (larger than Miami International Airport), includes a business park with over 50 companies. AAM operations at the airport would provide for a wider ability for these companies to transfer goods and commuters throughout Florida. Furthermore, pending development of a 245,000-square foot FedEx Ground facility and 1.1 million square foot Amazon fulfillment center in the southern part of St. Lucie County creates further opportunities to expand cargo operations and commerce. Cargo-specific vertiports at Treasure Coast airport or in southern St. Lucie County adjacent to the FedEx/Amazon centers (or both) could assist in providing for this demand while increasing operational and environmental efficiency and reducing the number of delivery vehicles on the road, reducing traffic congestion. eVTOL-based medium to long range AAM cargo operations could also pair with a UAS last-mile delivery venture such as Amazon Prime Air or Zipline to systematically deliver goods to consumers from these distribution centers without the goods ever having to travel on a road. Zipline, an American logistics company, has pioneered delivery of medical supplies by UAS operations by partnering with multiple healthcare providers such as Novant Health and CardinalHealth to distribute PPE, pharmaceuticals, and medical supplies in a fast and efficient manner. Using eVTOLs/AAM to collect medical supplies from more well-supplied areas in the state to then be distributed through UAS operations such as Zipline's presents as another use case of this technology (Zipline, 2021).

Figure 3-2. Conceptual Drawing of Pipistrel's Cargo eVTOL (GPS World, 2020)

3.4 Public Service/Emergency Operation

The most immediate use of AAM technology for public service lies in its potential to assist in air ambulance or search and rescue operations. St. Lucie County is quite susceptible to Hurricane damage – The proximity of so many people living close to the Atlantic Ocean, as well as the low coastal elevations, significantly increases the county's vulnerability. Port St. Lucie is second to only Miami in terms of Hurricane damage risk according to a 2010 Florida State University Study, as it has significant potential for high winds with short return periods (amount of time between significant hurricane-force wind events). Serious damage from hurricanes could leave St. Lucie County residents stranded, injured, or displaced. eVTOL aircraft can travel at long distances with far fewer emissions than helicopters and will most likely be "smarter" by having a degree of automation which allows them to conduct many operations without an active pilot in command – allowing the pilot to conduct physical rescue operations while the eVTOL stabilizes or flies to problem areas. Airborne Motorworks, a firm based in Spokane, WA, has developed a concept eVTOL engineered for medical purposes (Figure 3-3). Integrating a similar technology with St. Lucie County's limited Air Ambulance network for patient transport, medivac, or medical supplies transfer to and from St. Lucie Hospital presents as another potential use case to consider. Since eVTOL vehicles will be able to fly over traffic, response times can be improved significantly over an ambulance or fire truck with cheaper and cleaner power than helicopters.

Figure 3-3. Mockup of Airborne Motorworks' Medivac eVTOL (Motorworks, 2021)

Section 4. Recommendations and Way Forward

- Conclusion and Recommendation
- Roadmap – Way Forward

Section 4. Recommendations and Way Forward

4.1 Conclusion and Recommendation

The preliminary review of AAM shows proposed/expected benefits of (i) alleviating congestion on roads, (ii) reducing GHG emissions, (iii) improving mobility, and (iv) sustained economic growth in the region. These benefits are well-suited with the following aspects of the St. Lucie County region:

- Fast population and economic growth
- Potential for increased road congestion and emissions
- SmartMoves 2045 objective of integrating Autonomous, Connected, Electric, and Shared (ACES) vehicle concepts that makes travel safer and more efficient but most importantly, greatly improve mobility

For these reasons, integration of AAM into St. Lucie's transportation network has the potential to yield a promising result to the county. However, further analyses are required to identify which use cases of AAM have the greatest potential and benefits. Ultimately, the decision of integrating AAM into St. Lucie's future mobility plan lies within its citizens, constituents, and board members of St. Lucie TPO.

Furthermore, AAM industry is at infancy when compared to other conventional modes of transportation due to technological and regulatory gaps that must be fulfilled before achieving its proposed benefits. It is recommended that the TPO to stay informed on the developments of the regulations, federal funding opportunities, and AAM advancements within the Florida region (Lilium, UPS Flight Forward, and Amazon Prime Air), and consider participating in the FAA's BEYOND and NASA's AAM National Campaign to identify how emerging vehicles are being integrated into local agencies transportation plan.

The forward-thinking mindset of the TPO board members who want to spearhead the effort of integrating future of mobility into St. Lucie is commendable. For this reason, it is recommended the TPO to consider the following roadmap that is divided in short-term and mid-term opportunities that can be included into the TPO's Unified Planned Work Program (UPWP) to further facilitate the realization of AAM into St. Lucie County.

4.2 Roadmap - Way Forward

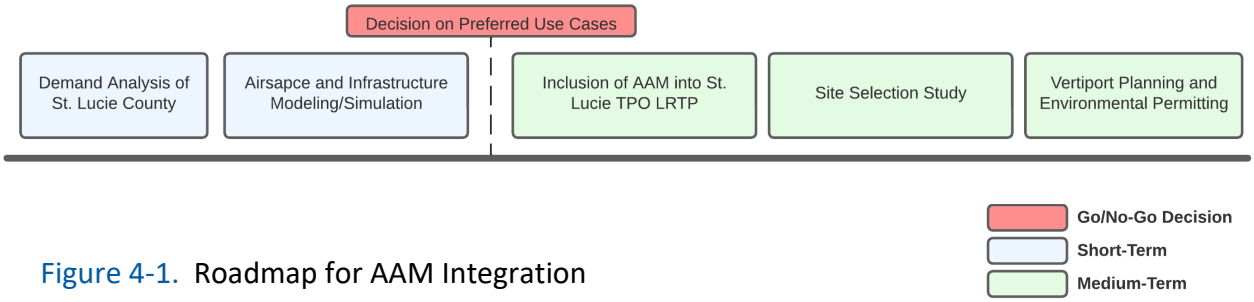

Figure 4-1. Roadmap for AAM Integration

Short-Term

» **Demand Analysis of St. Lucie County to Identify Most Suitable Use Cases**

An in-depth evaluation of local consumer demand for each use cases by analyzing the most current census data available to recommend suitable use cases for St. Lucie. This evaluation will decompose the Concept of Operations of AAM and St. Lucie's LRTP Transportation Goals to establish distinctive input variables to provide a result that is current and relevant to the TPO's objective. Census data will include Average Commute Time to Work, Consumer Expenditure on Transportation, Average Income per Household, Population Density, etc. This work will allow the TPO to further understand the potential and expected demand for each use cases of AAM in the St. Lucie County.

» **Airspace and Infrastructure Modeling/Simulation**

Dependent on a chosen use case(s), a modeling and simulation pipeline to inform the TPO as to the viability of differing scenarios is required. The modeling pipeline generally begins with the creation of one or more airspace models, illustrating how differing design possibilities may interact with existing controlled or uncontrolled airspace. The airspace model(s) are supplemented with air traffic input, generated by research conducted and correspondence with the TPO to determine the system objective and potential scenarios (where are vehicles flying? how frequently? etc.) The models and input are fed into a fast-time simulation software, which simulates movement through the entire network and how externalities such as weather, collision avoidance, or other delay inducing factors impact specific aircraft and the entire network. The software produces metrics for use in data analysis in a comparison between multiple scenarios – delays by location, ride quality, average travel time and more. Finally, the flight tracks generated by the fast-time simulation are exported and combined with data from the initial airspace model to create a visualization component involving a system-wide 3-D

simulation which depicts the aircraft as they move about the system. The provided metrics and analysis along with the visualization component give important context to how a new system or design may impact current operations in St. Lucie County and inform potential planning decisions moving forward and facilitate public input.

» **Decision on Preferred Use Cases of AAM**

Community outreach through a forum and survey session to educate/engage the citizens and assess their preference towards integrating each use cases of AAM into St. Lucie's transportation network. During the outreach, the expected benefits can be highlighted, and potential concerns (noise and privacy) associated with AAM can be discussed. After assessing the citizens preference, findings would be presented to the Citizens Advisory Committee (CAC), Treasure Coast Transportation Council (TCTC), Local Coordinating Board for Transportation Disadvantaged (LCB), and TPO Board for the constituents to reach a consensus on which use cases of AAM could be integrated into St. Lucie's transportation network. It may be appropriate for the TPO to reassess the current state of AAM industry prior to the outreach, giving an opportunity for the TPO to postpone the pursuant of AAM integration if the industry is meeting unexpected delays or citizens of St. Lucie are hesitant towards the AAM integration.

Medium-Term

» **Inclusion of AAM into St. Lucie TPO's Long Range Transportation Plan, SmartMoves 2045 Based on the Findings to Date and Board's Decision**

Integration of AAM into the TPO's upcoming Long Range Transportation Plan (LRTP) based on the findings to date and decision of the board members. This work will update the TPO's previous roadmap for AAM integration into St. Lucie to realign the way forward with the current and expected state of the AAM industry.

» **Site Selection Study for Vertiports/Drone Ports**

Utilize findings of the following to identify vertiport locations:

- Demand Analysis
- Airspace and Infrastructure Modeling/Simulation
- Community Outreach

In addition, conduct the following:

- **Equity Assessment** to provide AAM access to the low-income regions as well as reducing privacy and noise concerns for the non-participants on ground.
- **Local Zoning Ordinance Assessment** to site AAM infrastructures in appropriate zoning codes.
- **Energy Grid Assessment** to identify grids that meets the electric charging demand of AAM aircraft.

- **Airspace Assessment** for the AAM aircraft's approach and departure flight trajectory to avoid parts of airspace that are heavily congested.

The goal is to identify 3-5 suitable locations for AAM infrastructure (vertiport) that ensures supply, demand, safety, and equity.

Vertiport Planning and Environmental Permitting

General aviation airports (those without commercial service) may be suitable for AAM infrastructure. Depending on the result of the site selection study, this work will enable coordination between the TPO and Treasure Coast International Airport and Business Park to update the Airport Layout Plan and Master Plan which is part of the eligibility requirements to secure federal funding for AAM infrastructure at airports in the future. This work will assess and address county's desire to commercialize Treasure Coast Airport by serving AAM operations in the future.

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