



ADVANCED AIR MOBILITY STUDY

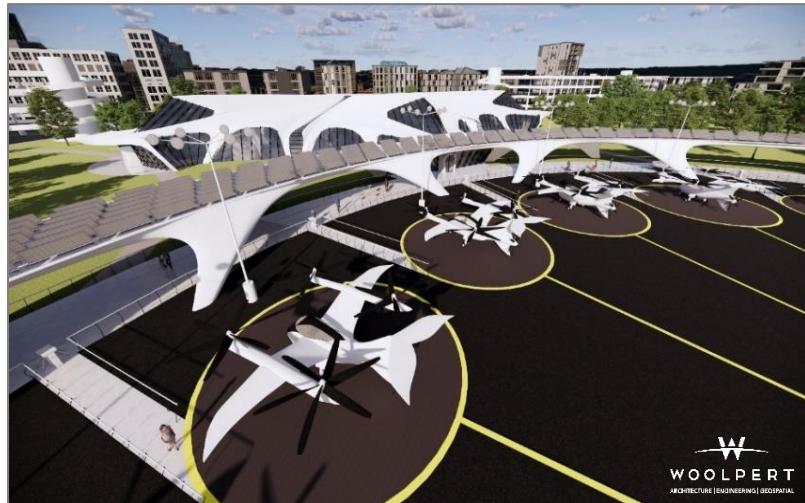
CONCEPTS OF OPERATIONS
(CONOPS)

APRIL 2024

1. Air Metro CONOP

1.1 Introduction

Atlanta is one of the busiest cities in the country with six major interstates traversing it, each exceeding over 80,000 in average annual daily traffic (AADT) pre-Covid. (Georgia Department of Transportation, 2023) Now, however, many people in Atlanta are working from home and commuter traffic has lessened. In September of 2022, the U.S. Census Bureau reported that the number of people primarily working from home in the U.S. tripled between 2019 and 2021 after COVID-19. (U.S. Census Bureau, 2022) Atlanta



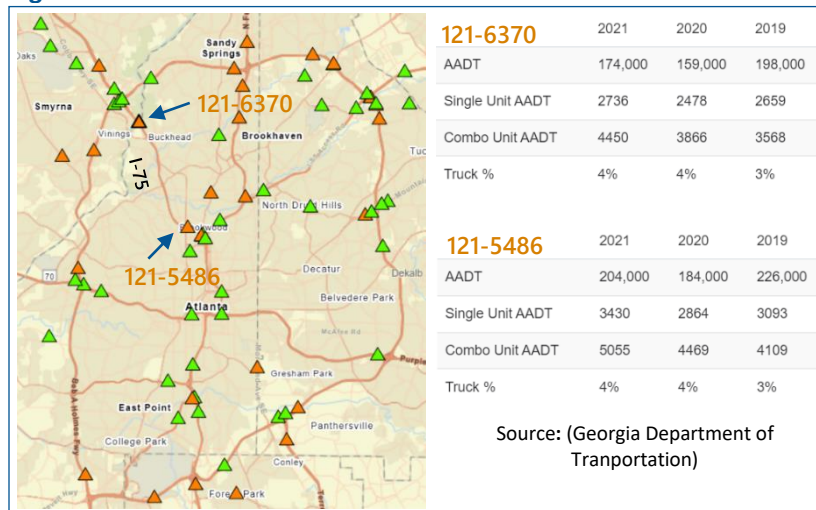
is currently one of the highest remote worker states in the country, falling in 5th place. (Wheatley, 2022) Regardless, the pre-Covid traffic levels (2019) reflect a better picture of what long-term travel demand may be in the Atlanta area, and how the city might benefit from UAM. Unfortunately, only about 3.5% of Atlanta commuters use public transportation now (Donsky, 2019), so convincing them to use urban air mobility (UAM) may require a credible and persuasive public campaign. One of the biggest hurdles will be the first and the last mile, which is the biggest challenge for existing public transportation services now—how does the commuter get to the subway/rail/or bus stop from their origination and vice versa?

1.2 Example Route

A UAM concept of operations (CONOP) for eVTOL aircraft carrying passengers in the Atlanta Metro Area (AIR Metro) would mimic public transit systems today, which typically consist of buses, subways, and light rail. NASA predicts this market to potentially become viable by 2028 and assumes an average of three passengers per trip on pre-determined routes, just like public transit runs today in metropolitan areas. Subways and rail are often the preferred public transit options for commuters because they usually have more direct routes and fewer stops. For an AIR Metro option in Atlanta, the aircraft would operate on a set schedule on a set route in the most congested parts of the city where ground travel is overly burdensome. I-75 between I-285 and I-85 on the northwest side of the city is a logical AIR Metro route for the city. As shown in **Figure 1-1**,

the AADT on I-75 in this area is over

Figure 1-1: AADT on I-75



174,000 (96 percent cars and four percent trucks). Most of these vehicles (approximately 77%) are single occupancy.¹ (Donsky, 2019) This section of interstate does not have a MARTA rail option, so an AIR Metro alternative here is desirable because it would not pull rail commuters from the existing public transportation system.

1.3 Infrastructure needs

Before an AIR Metro route can work on the above-described route, charging infrastructure would be needed. Along this line, the Federal Highway Administration (FHWA) has designated this section of interstate as an alternative fuel corridor, which includes electrical chargers. This may aid in getting the charging infrastructure and capacity needed for eVTOL to the area. (Federal Highway Administration, 2023) There is very little information available on specific OEM charging needs as OEMs are still in the design phases. While charging needs will vary by OEM, Wisk indicates that somewhere in the order of 4,500 kW of dedicated charging capability would be needed to accommodate approximately 100 aircraft operations a day.

Outside of charging infrastructure, the minimum components needed to provide an AIR Metro vertiport along this section of I-75 are a landing area, terminal, and parking. The landing area consists of a touchdown and liftoff area (TLOF) and its associated final approach and takeoff area (FATO) and safety area (SA). The size of the landing area depends on the size of the aircraft, but generally, a 150 ft. by 150 ft. square (22,500 sq. ft. or .52 acres) will accommodate the majority of eVTOL aircraft currently pursuing FAA certification (e.g., Beta, Joby, Lilium). The terminal area and charging station would also require dedicated space.

For comparison purposes, the vertiport in Chicago has one TLOF, three hangars, and an approximately 12,000-square-foot terminal. While the facility has “vertiport” in its name, it, and the others discussed below, were built to FAA heliport standards, which are slightly smaller than vertiport standards. The entire Chicago site is roughly 10 acres. (See **Figure 1-2**).

Figure 1-2: Chicago Vertiport

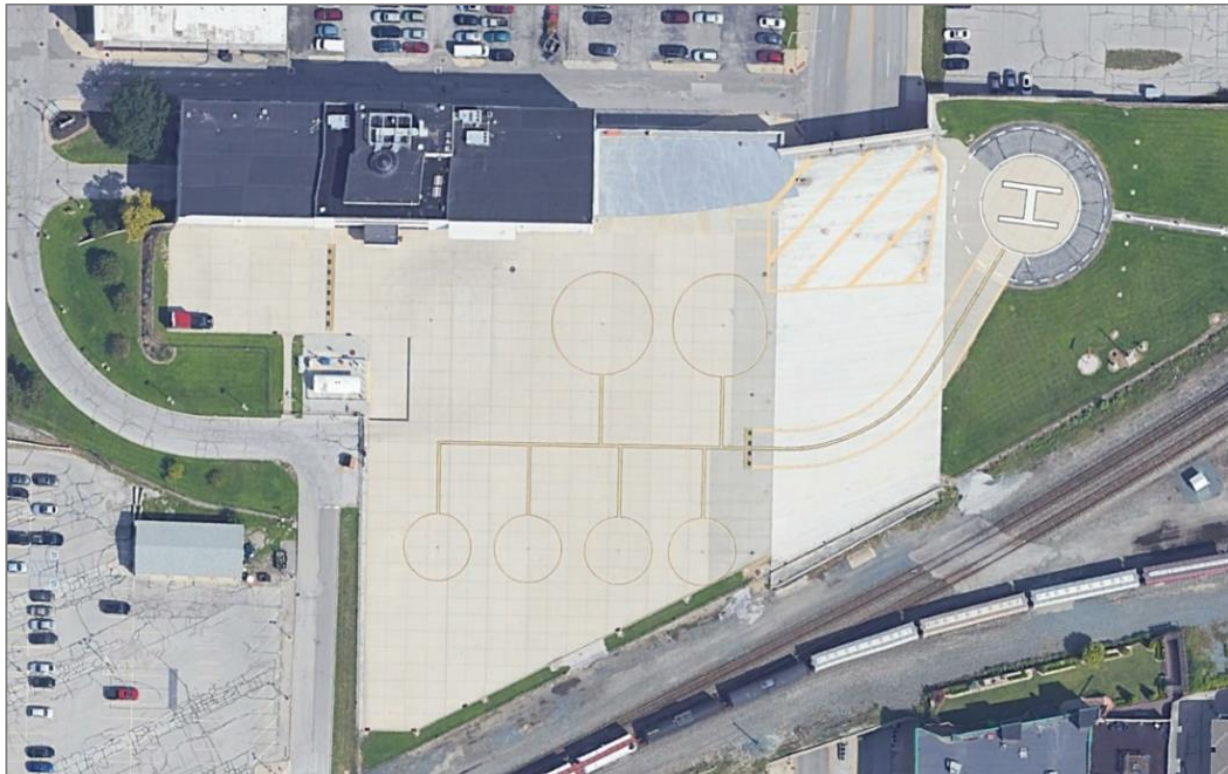


Source: Google Earth, accessed 03/28/23

¹ According to the U.S. Census American Community Survey, approximately 77% of commuters drove alone.

The Indianapolis Downtown Heliport, a public-owned and public-use facility, occupies roughly 210,000 sq. ft. (just under 5 acres) just southwest of the center of the city. It has one TLOF, two hangars, and six parking spots (see **Figure 1-3**).

Figure 1-3: Indianapolis Downtown Heliport



Source: Google Earth, accessed 03/28/23

The Dallas Heliport/Vertiport is a public-use facility with two TLOFs and five parking spaces together which cover roughly 4 acres (see **Figure 1-4**). Given these examples, a vertiport will likely require a minimum of two to three acres for a single TLOF, FATO, SA, parking, terminal area, and charging—more for additional charging stations and TLOFs. Unobstructed ingress and egress will also be needed. The Cumberland Mall would provide an opportunity for such a vertiport for an AIR Metro service on the north side of the I-75 corridor. A second vertiport downtown could be located at one of the MARTA stops, parking garages, or a mall with expansive parking. The challenge will be finding a location big enough to accommodate such an operation.

Figure 1-4: Dallas Heliport/Vertiport



Source: Google Earth, accessed 03/28/23

1.4 Capacity

The capacity of a minimally built vertiport will be limited. The passenger throughput will depend on several variables including the number of passengers the aircraft can carry and the battery charging time needed. The seats available for sale on eVTOL aircraft vary. Lilium’s eVTOL jet has six passenger seats while the BETA Technologies Alia-250 can carry five people, and the Archer Midnight and the Joby can each carry four passengers. The unconstrained throughput of a touchdown lift-off area (TLOF) is expected to be between approximately four and eight full aircraft turns (one arrival and one departure) per hour in VMC with a pilot on board.² This does not factor in eVTOL charging times, which have the potential to be a bottleneck in operations and reduce maximum throughput. If each aircraft is fully loaded on each flight, the maximum unconstrained throughput of a TLOF will be between 32 to 96 passengers (see **Table 1-1**) depending on the

² Woolpert has built a capacity model for touchdown lift-off area (TLOF) occupancy time that was combined with probabilistic techniques to simulate 20,000 operations. The results suggest that the expected unconstrained throughput of a TLOF is between 4.1 and 8.3 full turns per hour.

aircraft used and the number of turns per hour achieved. The average of all the scenarios for a fully loaded aircraft is 4.75 seats occupied and a total of 57 passengers per hour at six turns per hour.

Table 1-1: Anticipated Maximum Unconstrained Passenger (Pax) Throughput of 1 TLOF with Aircraft at Full Capacity

AIRCRAFT	Pax. Seats	Pax Throughput with		
		4 turns/hr.	6 turns/hr.	8 turns/hr.
Lilium	6	48	72	96
Beta	5	40	60	80
Archer	4	32	48	64
Joby	4	32	48	64
Average	4.75	38	57	76

Source: Woolpert, Respective OEMs

1.5 Congestion reduction

I-75 is a high-capacity interstate highway consisting of 10 divided lanes with two of those lanes dedicated for high-occupancy vehicles. Recalling that the AADT of I-75 in this area is at or more than 166,814 cars (96 percent of 174,000 total) and 77 percent of the cars are single occupancy, we can roughly compute the number of cars that will be removed from the road with a two vertiport situation—one for the origination of the trip and one for the destination. Keep in mind this would be an absolute best-case scenario with the assumptions that each car has no more than two passengers and there are no constraints to the operation (e.g., charging and weather). In this best-case, unconstrained scenario we can estimate that an average of 44 cars will be removed from I-75 per hour. If we also assume AIR Metro will operate for 12 hours a day and the traffic will spread out equally over that time frame, we can estimate that a total average of 527 cars per vertiport will be removed from that segment of the road daily with a reduction in the AADT of .32 percent. (See **Table 1-2.**) For the two vertiport AIR Metro scenario a total average of 1054 cars are removed with a reduction in the AADT of .32 percent. Each scenario requires maximum commuter participation and uniformly distributed traffic, and people rarely act this way in real life, but for projection purposes, it provides a best-case outlook.

Table 1-2: Best Case Scenario Vehicle Reduction on Road per Vertiport in Unconstrained Environment and Visual Meteorological Conditions

AIRCRAFT	Pax. Seats	Pax Throughput @ 6 turns/hr.	Car Trips Removed Per Hour Per Vertiport	Car Trips Removed During 12 Service Hrs. Per Vertiport	Best Case % AADT Reduction Per Vertiport
Lilium	6	72	55	665	0.40%
Beta	5	60	46	554	0.33%
Archer	4	48	37	444	0.27%
Joby	4	48	37	444	0.27%
Average	4.75	57	44	527	0.32%

Source: Woolpert, Respective OEMs

Following this line of thinking, multiple vertiports with multiple TLOFs would need to be built in abundance to make an impact on the AADT on the commuter roads of Atlanta. If a single TLOF vertiport needs two to three acres, Atlanta’s vertiport system would require a lot of land.

1.6 Forecast

Forecasting the potential use of a form of transportation that has never existed before is arduous at best. Because of its novel design, no aircraft has been certified to date. The price to purchase has not been established nor has the price to operate. Insurance costs and ticket prices are unknown for the multiple models as is the public’s willingness to accept and use them. The forecast provided here is based on predictions made by NASA. NASA is leading the charge on AAM and UAM, and as a result, has made projections regarding several aspects of the emerging industry. The agency estimates the AIR Metro market to become profitable around 2028 with approximately 4,100 aircraft performing 130 million trips, and by 2030 it could have 23,000 aircraft performing 740 million trips. (NASA, 2018, p. 5) Under their study, the aircraft would have an average of three passengers per trip, which is lower than the best-case average of 4.75 shown in **Table 1-2** above. NASA describes each MSA as having 100-300 vertiports, all located in high-traffic areas handling 3-6 aircraft at a time and having charging stations and aircraft service capabilities.

According to the U.S. Census Bureau, approximately 286.5 million people were living in metropolitan statistical areas (MSA) in 2021 with Atlanta’s portion of that being 2.145 percent. A simple forecast can be made for the Atlanta area by applying this percentage to the NASA forecast described in the previous paragraph. Using this method, Atlanta could anticipate 88 aircraft and almost 2.8 million flights by 2028 with an increase of over fivefold by 2030. (See **Table 1-3**).

Table 1-3: NASA AIR Metro Projections and Atlanta’s Share by Population

NASA AIR Metro Concept: 3 pax. per plane flying 10–70-mile trips on pre-determined routes at scheduled times to/from 100-300 vertiports per MSA		
YEAR	2028	2030
NASA Aircraft Estimate	4,100	23,000
<i>Atlanta’s Share @ 2.145%</i>	88	493
NASA Trips Estimate	130,000,000	740,000,000
<i>Atlanta’s Share @ 2.145%</i>	2,788,500	15,873,000

Sources: (NASA, 2018), (U.S. Census Bureau, Population Division, 2022), Woolpert

The number of stand-alone TLOFs needed to accommodate NASA’s forecast using the previously discussed six turns per hour (or 12 flights) unconstrained estimate would be 53; however, this is a best-case scenario with all the traffic spread out equally over a 12-hour period, in visual meteorological conditions, and with no restrictions (e.g., charging time, maintenance issues, wind conditions), which does not happen in the real world. NASA’s prediction of 100-300 vertiports is highly probable when constraints are added to the mix. Cutting our TLOF turns in half or adding surge times for morning and evening commutes could easily add another 100 TLOFs into the equation to produce the same throughput. While adding more TLOFs and more chargers will produce economies of scale and increase capacity, there will always be some type of constraint on the operation.

1.7 Summary

An AIR Metro CONOP in Atlanta would carry passengers and operate on a set schedule on a set route in the most congested parts of the city where ground travel is overly burdensome. I-75 between I-285 and I-85 on the northwest side of the city is a logical AIR Metro route for the city. The AADT on I-75 in this area is over 174,000 and there is no MARTA rail option for commuters. Two vertiports would be needed, one at each end of the route. The minimum infrastructure needed at each vertiport includes charging infrastructure, a TLOF

with its associated FATO and SA, a terminal, and parking. At a minimum, this would require at least two to three acres of land, more for multiple TLOFs. The capacity of a minimally built vertiport will be limited and is estimated to be between approximately 38 to 76 passengers per hour in very optimal conditions without taking charging times into account. This assumes on average each aircraft carries 4.75 passengers and the operations are equally spread out over a 12-hour window. In these optimal conditions, one route with two vertiports could reduce congestion on this segment of I-75 by roughly 530 cars.

At the national level, NASA predicts AIR Metro passenger trips to reach 750 million by 2030. Atlanta's estimated share of this could be approximately 2.79 million trips. The city could easily need over 100 vertiports to accommodate such demand were it to materialize.

2. Masters Golf Tournament Special Event CONOP

2.1 Introduction

Special events, particularly sporting events can provide a unique opportunity to showcase AAM to a large audience of potential users. Special events generally bring large numbers of spectators into a concentrated area over the course of three to seven days. The State of Georgia is no stranger to the spotlight of the national stage when it comes to hosting special sporting events. The City of Atlanta was selected as the host city for the 1996 Summer Olympic Games where Georgia welcomed more than 2 million visitors from across the world. Additionally, Atlanta has hosted the National Collegiate Athletic Association’s (NCAA) Men’s Basketball Final Four and Championship in 1977, 2002, 2007, and 2013, with more than 51,000 fans attending the final game; Major League Baseball’s (MLB) All-Star Game in 2000 and the 2021 World Series whose three-game attendance total was more than 120,000 attendees; National Football League’s (NFL) Super Bowl Championship in 1993, 1999 and most recently in 2019. Georgia has also been selected, as one of 16 cities, to host the 2026 Fédération Internationale de Football Association’s (FIFA) World Cup Soccer tournament matches.



Photo Credit: DWJ Enterprises, LLC

Estimated attendance figures for significant sporting events held in Georgia are listed below in **Table 2-1**. Since 1934, Augusta National Golf Club in Augusta has been host to the Masters Golf Tournament. The tournament is one of four major championships in men’s professional golf and is the first of the four contested each year. It is unique among the major championships in that the tournament is contested each year at the same location. Attendance figures and other economic impact information for the golf tournament are not released by the Augusta National Golf Club. However, other sources consistently estimate the daily attendance for the practice rounds held Monday through Wednesday at 50,000 patrons and daily attendance for the tournament rounds held Thursday through Sunday at 40,000 patrons, for a total attendance of 310,000.

Table 2-1: Georgia Special Sporting Events Estimated Attendance

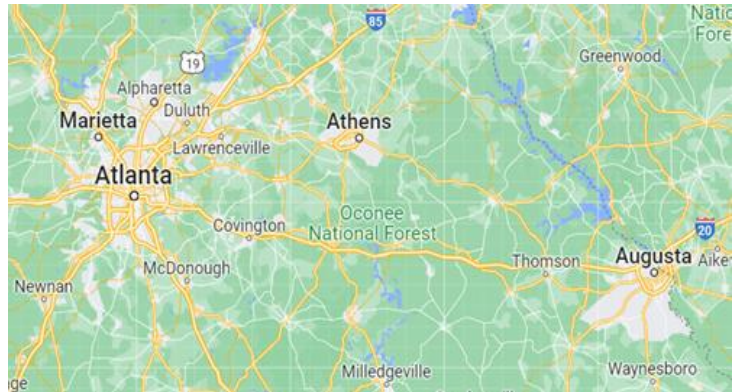
Year	Event	Est. Attendance
Annually	Masters Golf Tournament	310,000
2021	Major League Baseball World Series	123,552
2019	National Football League Super Bowl LIII	70,081
2018	College Football National Championship	77,430
2013	NCAA Final Four Basketball Championship	51,323
1996	Summer Olympic Games	2 million

Source: River Street Group, LLC

2.2 Example Route

A concept of operations (CONOP) for a special event eVTOL operation carrying passengers from the Atlanta metropolitan region to Augusta was analyzed. The route studied is proposed to originate from the Covington Municipal Airport (KCVC) with a landing destination at the Daniel Field Airport (KDNL) in Augusta. Daniel Field was selected as the destination airport due to its 3.7-mile proximity to Augusta National Golf Club. A review of satellite imagery of the area on and adjacent to Augusta National Golf Club did not currently reveal areas sufficient in size to facilitate an eVTOL landing area. Additionally, the Augusta Regional Airport at Bush Field could readily serve as a destination for this CONOP but was removed from further analysis due to its extended proximity to the event venue, at approximately 11.9 miles.

Figure 2-1: Example eVTOL Route from Atlanta to Augusta



Source: Google Maps, accessed 06/21/23.

For this special event, aircraft would operate on a daily schedule set by the operator and consistent with consumer demand. The flight distance between the KCVC and KDNL is approximately 107 nautical miles. As shown in **Table 2-2** below, the anticipated ranges and speeds of various eVTOL aircraft currently in the design and certification phase are listed. While no aircraft are currently FAA certified and ranges and operational data are still estimated by the manufacturers, three of the six manufacturers listed - BETA, Lilium, and Joby - estimate sufficient aircraft range, from 250-150 miles, to complete a flight on this route. Utilizing the lowest estimated speed of 170 miles per hour, from the three manufacturers with a range greater than or equal to 150 miles, the 107 nautical mile flight would take approximately 40 minutes. The average driving time between the Covington Airport and Augusta National Golf Course is approximately one hour and forty minutes for the 111-mile trip.

Table 2-2: eVTOL Manufacturers' Estimated Aircraft Ranges and Speeds

	BETA	Lilium	Joby	Wisk	Archer	Volocopter
Estimated Range	250 miles	155 miles	150 miles	90 miles	50-100 miles	60 miles
Estimated Speed	170 mph	175 mph	200 mph	138 mph	150 mph	69 mph

Source: Respective OEMs

2.3 Infrastructure needs

In facilitating a special event eVTOL route to the Masters Golf Tournament, from Covington to Augusta, utilizing existing general aviation airports, minimal infrastructure would be needed as landing areas, staging areas, and facilities currently exist. The Covington Municipal Airport currently has a 6,000 x 100-foot asphalt runway with a full parallel taxiway, instrument approach procedures, an AWOS-IIIPT weather observation/reporting station, a 100,000 sq. ft. north apron area, an 80,000 sq. ft. south apron area, terminal building, and vehicle parking. **Figure 2-2** below provides an aerial view of the Covington Municipal Airport complex. Daniel Field Airport in Augusta has two asphalt runways with the primary runway measuring 4,002 x 100 feet. It also has full parallel taxiways for both runways, an ASOS weather observation/reporting station,

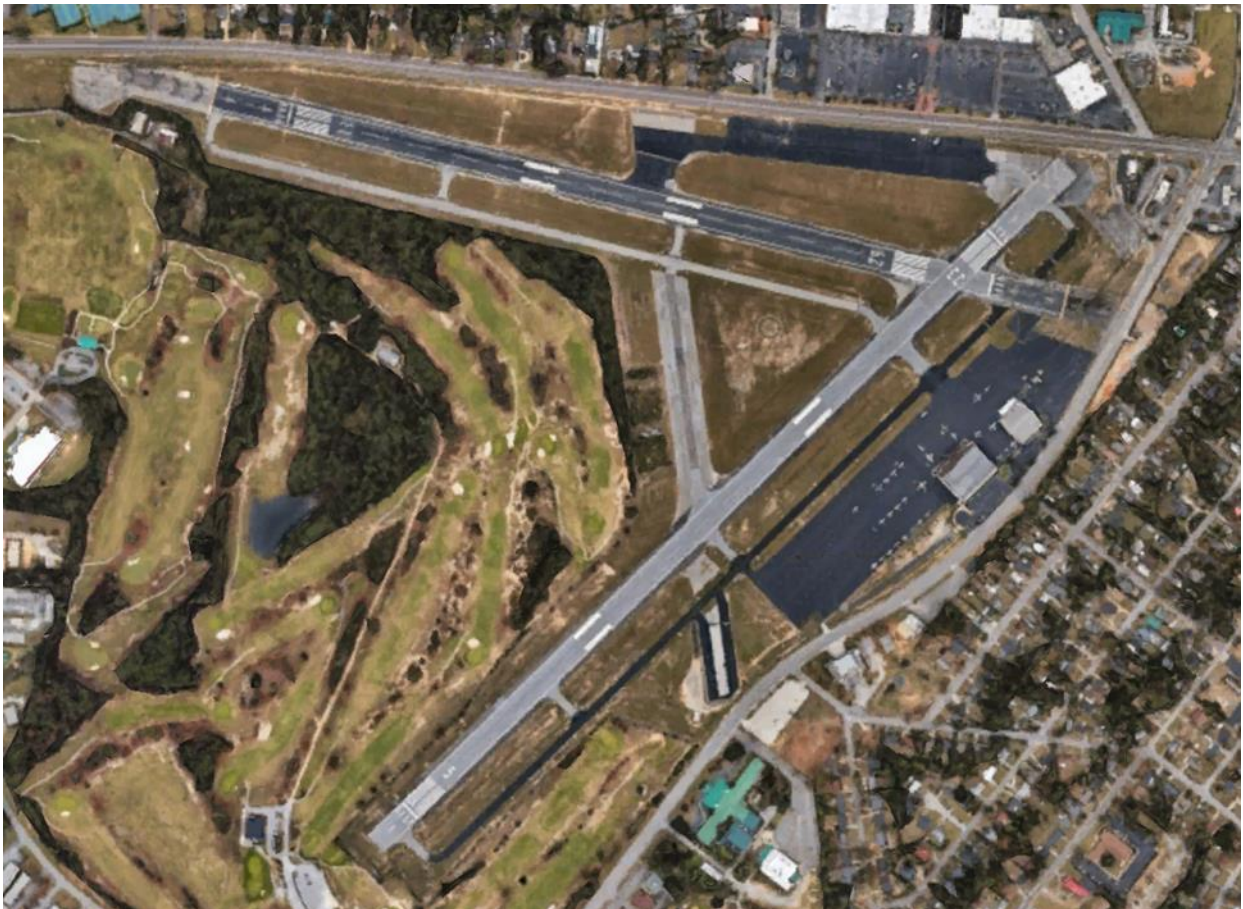
more than 630,000 sq. ft. of apron areas, and a terminal building. **Figure 2-3** below provides an aerial view of the Daniel Field Airport complex. Aircraft charging infrastructure would need to be installed at both the Covington Municipal Airport and Daniel Field Airport. As OEMs are still in the design phase, little information is currently available on specific OEM charging requirements. While charging needs will vary by OEM, Wisk indicates that somewhere in the order of 4,500 kW of dedicated charging capability would be needed to accommodate approximately 100 aircraft operations a day.

Figure 2-2: Covington Municipal Airport



Source: Google Earth, accessed 06/2/23

Figure 2-3: Daniel Field Airport, Augusta, GA



Source: Google Earth, accessed 06/2/23

2.4 Capacity

The utilization of existing airport infrastructure for the origination and destination points for this CONOP eases operational capacity considerations associated with the utilization of touchdown lift-off areas (TLOF) at a vertiport. It also provides the opportunity for eVTOL aircraft to take off and land in horizontal flight which extends battery resources. Passenger throughput will depend on variables including the number of passengers the aircraft can carry and the battery charging time needed. The seats available for sale on eVTOL aircraft vary. Lilium’s eVTOL jet has six passenger seats while the BETA Technologies Alia-250 has five, and the Archer Midnight and the Joby can each carry four passengers. As a worst-case scenario, this CONOP assumed the use of one TLOF. The unconstrained throughput of one touchdown lift-off area (TLOF) is expected to be between approximately four and eight full aircraft turns, with one arrival and one departure, per hour in Visual Meteorological Conditions (VMC) with a pilot on board.³ This does not factor in eVTOL charging times, which have the potential to impact operations and reduce maximum throughput. If each aircraft is fully loaded on each flight, the maximum unconstrained throughput of a TLOF will be between 32 to 96 passengers (see **Table 2-3**) depending on the aircraft used and the number of turns per hour achieved. The average of all the scenarios for a fully loaded aircraft is 4.75 seats occupied and a total of 57 passengers per hour at six turns per hour.

Table 2-3: Anticipated Maximum Unconstrained Passenger Throughput of 1 TLOF with Aircraft at Full Capacity

AIRCRAFT	Pax. Seats	Pax Throughput with		
		4 turns/hr.	6 turns/hr.	8 turns/hr.
Lilium	6	48	72	96
Beta	5	40	60	80
Archer	4	32	48	64
Joby	4	32	48	64
Average	4.75	38	57	76

Source: Woolpert, Respective OEMs

2.5 Congestion reduction

Interstate 20 (I-20) spans 202 miles across Georgia and is the primary west-to-east corridor from Tallapoosa at the Alabama state line to Augusta at the South Carolina state line. The interstate has 10 lanes with an HOV-2 lane in each direction in the metropolitan Atlanta area. It also has six lanes from Exit 24 at Villa Rica to Exit 93 at Covington and Exit 195 at Wheeler Road to Exit 200 at River Watch Parkway in Augusta. The remaining interstate is four lanes. The City of Covington is approximately 111 driving miles from Augusta traveling along I-20. By reviewing the average daily traffic along the I-20 corridor from Covington to Atlanta and the potential number of passengers an eVTOL operation could accommodate during Masters Week we can estimate the number of cars that could be removed from the highway, thereby reducing congestion.

³ Woolpert has built a capacity model for touchdown lift-off area (TLOF) occupancy time that was combined with probabilistic techniques to simulate 20,000 operations. The results suggest that the expected unconstrained throughput of a TLOF is between 4.1 and 8.3 full turns per hour.

An analysis of the average annual daily traffic (AADT), from the Georgia Department of Transportation’s public traffic database, along I-20 between Covington and Augusta was conducted. Data collected for the 2019 traffic on I-20 midway between Atlanta and Augusta is listed below in **Table 2-4**. Data collected for the 2023 traffic on I-20 midway between Atlanta and Augusta is listed below in **Table 2-5**. The 2019 data was used for comparison as this was the last pre-Covid traffic numbers with full attendance at the Masters and indicated an average increase of about 7,300 ADT during Masters Week. This increase was confirmed by reviewing ADT along the same route one month before and one month after Masters Week in 2019.

The 2023 data was reviewed for the 7 days during the Masters Golf Tournament and practice rounds and a week in the month prior to and a week in the month following the event, to confirm traffic trends along the route. For the week of the Master’s in 2023, there were approximately 6,000 to 14,500 additional vehicle ADTs on I-20 from the Covington area to Augusta. In 2023, the average ADT increase per day is 11,800 for a total of 82,400 additional vehicle trips for the week. This number was up from approximately 7,300 additional vehicle ADT and 51,200 vehicle trips for the week on the same route in 2019, the last pre-Covid year.

Table 2-4: 2019 Traffic on I-20 midway between Atlanta and Augusta

	Monday 4/8/19	Tuesday 4/9/19	Wednesday 4/10/19	Thursday 4/11/19	Friday 4/12/19	Saturday 4/13/19	Sunday 4/14/19	Totals
Masters Week	34,700	33,000	35,600	37,600	46,800	38,300	42,800	268,800
1 month prior to Masters Week	25,900	24,300	25,000	28,600	37,300	29,400	35,900	203,400
% Increase Masters Week	34%	36%	42%	31%	25%	30%	19%	31%
1 month after Masters Week	26,800	25,000	26,800	32,100	40,500	31,300	37,500	220,000
% Increase Masters Week	29%	32%	33%	17%	16%	22%	14%	23%
Avg. ADT outside Masters Week	26,350	24,650	25,900	30,350	38,900	30,350	36,700	213,200
ADT Increase Masters Week	8,350	8,350	9,700	7,250	7,900	7,950	6,100	55,600

Source: Georgia DOT public traffic database, accessed 6/2/23.

Table 2-5: 2023 Traffic on I-20 midway between Atlanta and Augusta

	Monday 4/3/23	Tuesday 4/4/23	Wednesday 4/5/23	Thursday 4/6/23	Friday 4/7/23	Saturday 4/8/23	Sunday 4/9/23	Totals
Masters Week	38,000	37,100	40,100	43,800	49,800	36,400	45,200	290,400
1 month prior to Masters Week	26,100	22,900	25,700	28,400	35,600	30,300	33,800	202,800
% Increase Masters Week	46%	62%	56%	54%	40%	20%	34%	45%
1 month after Masters Week	29,300	23,600	25,400	30,700	38,300	30,200	35,700	213,200
% Increase Masters Week	30%	57%	58%	43%	30%	21%	27%	38%
Avg. ADT outside Masters Week	27,700	23,250	25,550	29,550	36,950	30,250	34,750	208,000
ADT Increase Masters Week	10,300	13,850	14,550	14,250	12,850	6,150	10,450	82,400

Source: Georgia DOT public traffic database, accessed 6/2/23.

In estimating congestion reduction, a best-case scenario assumes that each car traveling to the Masters Golf Tournament has no more than two passengers and there are no constraints to the eVTOL operation (e.g., charging and weather). In the best-case, unconstrained scenario we can estimate that an average of 44 cars will be removed from I-20 per hour. If we also assume the Masters CONOP will operate for 12 hours a day, from 6 a.m. to noon and 3 p.m. to 9 p.m., and the traffic will be spread out equally during that time frame, we can estimate that a total average of 527 cars will be removed from that segment of I-20 daily with a reduction in the AADT of 0.18% percent. (See **Table 2-6.**) This best-case scenario requires maximum patron participation and uniformly distributed traffic.

Table 2-6: Best Case Scenario Vehicle Reduction on Road per Vertipoint in Unconstrained Environment and Visual Meteorological Conditions

AIRCRAFT	Pax. Seats	Pax Throughput @ 6 turns/hr.	Car Trips Removed Per Hour Per Vertipoint	Car Trips Removed During 12 Service Hrs. Per Vertipoint	Best Case % AADT Reduction Per Vertipoint
Lilium	6	72	55	665	.23%
Beta	5	60	46	554	.19%
Archer	4	48	37	444	.15%
Joby	4	48	37	444	.15%
Average	4.75	57	44	527	.18%

Source: River Street Group, LLC, Woolpert, Respective OEMs

The estimated 527 AADT reduction described above is not likely to make a noticeable difference in the Level of Service along I-20 during Masters Week but is not insignificant when all impacts such as reduced traffic and parking needs are considered as a whole. The reduction in traffic could be compounded in the future if the service is successful.

2.6 Forecast

In this early stage of the advancement of AAM, as eVTOL aircraft manufacturers continue their certification efforts, historical operational and market data is not available to aid in forecasting. The total number of patrons who attend the Masters Tournament annually is estimated at 310,000 by sporting news outlets, which includes 50,000 each day for the three practice rounds and 40,000 each day for the four days of the tournament. Augusta National Golf Club has a long-standing policy of not releasing attendance data.

Potential users of this CONOP would likely come from Masters attendees who have traditionally driven to the Masters or utilized traditional aircraft and flown into Daniel Field Airport or Augusta Bush Field from the Atlanta metropolitan area. As stated earlier, in 2023, the average ADT increase per day is 11,800 for a total of 82,400 vehicle trips for the week. Assuming two passengers per vehicle, 164,800 users could potentially utilize the Masters CONOP.

Table 2-7 below provides 2023 flights operated under Instrument Flight Rules (IFR) from Atlanta’s four busiest general aviation airports, including DeKalb-Peachtree Airport, Fulton County Executive Airport-Brown Field, Cobb County International Airport and the Gwinnett County Airport-Briscoe Field. IFR operations are recorded by the FAA and accessible in their Traffic Flow Management System Counts database. These numbers do not account for flights to Daniel Field and Augusta Regional Airport that are conducted under Visual Flight Rules (VFR), but do provide some insight into operations into the Augusta area during Masters Week. **Table 2-8** provides 2019 IFR flight data for these airports and was used for comparison purposes as this was the last pre-COVID IFR flight data with full attendance at the Masters.

The 2023 data was reviewed for the 7 days during the Masters Tournament and practice rounds and a week in the month prior to and a week in the month following the event, to confirm IFR flight trends along the route. For the week of the Masters Tournament in 2023, there were 94 IFR flights from metro Atlanta airports to Augusta. This number was approximately 25% less than the 124 IFR flights from the same airports in 2019. Assuming three passengers per aircraft for the 94 flights conducted in 2023 from the Atlanta metro area general aviation airports to Augusta, it would yield 282 additional potential passengers for this CONOP.

Table 2-7: 2023 IFR Flights to Augusta from Atlanta Metro Area Airports during Masters Week

	Dekalb Peachtree Airport	Fulton County Executive Airport	Cobb County Int'l Airport	Gwinnett County Airport
Daniel Field Airport	24	18	3	1
Augusta Regional Airport	37	6	4	1
Total 2023 Masters Flights	61	24	7	2
Total Flights March 5-11, 2023	7	1	0	1
Total Flights May 7-13, 2023	10	5	3	2

Source: FAA Traffic Flow Management System Counts Database, Accessed 6/27/23.

Table 2-8: 2019 IFR Flights to Augusta from Atlanta Metro Area Airports during Masters Week

	Dekalb Peachtree Airport	Fulton County Executive Airport	Cobb County Int'l Airport	Gwinnett County Airport
Daniel Field Airport	57	5	6	1
Augusta Regional Airport	42	8	3	2
Total 2019 Masters Flights	99	13	9	3
Total Flights March 3-9, 2023	17	3	0	1
Total Flights May	18	6	0	0

Source: FAA Traffic Flow Management System Counts Database, Accessed 6/27/23.

Aircraft Enplanement data from Augusta Regional Airport at Bush Field reports that during April 2022, the last year of available data, the airport recorded 32,116 passenger enplanements and 29,819 passenger deplanements. 2019 passenger enplanement and deplanement data were reviewed for comparison purposes as this was the last pre-COVID IFR flight data with full attendance at the Masters. 2019 passenger enplanements were 38,935 and passenger deplanements were 37,541. It is noted that the 2023 passenger enplanements and deplanements are lower than the numbers recorded in 2019 by 17.5% and 20.5% respectively.

In summarizing historical data analyzed for vehicle trips along I-20, metro Atlanta general aviation airport flights and deplaned passengers at Augusta Regional Airport, it is estimated that there are approximately 165,800 potential passengers for this Masters CONOP. 164,800 potential passengers could be generated from individuals who have historically driven to the Masters Golf Tournament and 282 potential passengers could be generated from individuals who have previously utilized traditional general aviation flights. Due to data collection methods, it was not possible to determine if deplaning passengers at Augusta Regional Airport-Bush Field originated in the metro Atlanta region and could be candidate passengers for this CONOP.

According to Destination Augusta, a 501(c)(6) corporation responsible for promoting travel and tourism in the Augusta area, hotel and motel revenue generated during the month of April is historically three times greater than any other month of the year. For the lodging nights April 2-8, 2023, hotel and motel revenue totaled \$18,466,609 and was 11.5% higher than the previous year. The 2023 average daily hotel/motel room rate was \$479.79. AirDNA, a commercial provider of vacation rental data and analytics to Destination Augusta, reports that during the 2023 Masters Week, the average daily rate for short-term rentals was \$820, a 14.5% increase from 2022 rates. Although cost data for an eVTOL flight is not available for this CONOP, the cost of nightly lodging in Augusta during Masters Week could be a potential driver for additional passengers for this CONOP.

2.7 Summary

A special event CONOP for the Masters Golf Tournament would carry passengers and operate on a set schedule from the Covington Municipal Airport to Daniel Field Airport in Augusta. The route would cover 107 nautical miles and flight time is estimated at approximately 40 minutes. Utilizing two existing airports as takeoff and landing areas or touchdown and liftoff areas for eVTOL operations would minimize the infrastructure required to bring this CONOP into service. Specifically, charging facilities for eVTOL aircraft would need to be added and available for use at both airports.

When analyzing the capacity potential, passenger throughput will depend on variables including the number of passengers the aircraft can carry and the battery charging time needed. The passenger throughput for the CONOP is estimated to be between approximately 38 to 76 passengers per hour in optimal conditions without taking aircraft charging times into account. This assumes on average each aircraft carries 4.75 passengers and the operations are equally spread over a 12-hour window. In these optimal conditions, this CONOP could potentially reduce congestion on this segment of I-20 by approximately 527 cars, with a reduction in the AADT of 0.18% percent.

It is estimated there are approximately 165,800 potential passengers for this CONOP. 164,800 potential passengers could be generated from individuals who have historically driven to the Masters Golf Tournament and 282 potential passengers could be generated from individuals who have previously utilized traditional general aviation flights to the Augusta area airports.

Given Georgia's historically desirable location for large-scale sporting events, it is likely that this CONOP could be modified for future events such as the 2026 World Cup Soccer tournament being hosted in Atlanta. Additionally, other CONOPs could be developed to transport an annually estimated 3.5 million fans of Major League Baseball's Atlanta Braves to their 80 home games each year at Truist Park in Cobb County.

3. Air Rural CONOP

3.1 Introduction

Historically, young adults have migrated out of rural areas while older adults have migrated into rural retirement destinations. However, many people moved to non-metropolitan areas during the COVID-19 pandemic in search of areas with less population density as COVID-19 infection rates increased. (Davis, Rupasingha, Cromartie, & Sanderes, 2022, p. 5) The overall population in rural areas took a dramatic upswing during 2020-2021. In 2021, 20 percent of the population in rural America was 65 years and older for the first time in history, compared with 16 percent of the metro population. (Davis, Rupasingha, Cromartie, & Sanderes, 2022, p. 7)



Most of Georgia is made up of rural areas. This non-urban land supports many industries and provides affordable quality-of-life options for more than one out of every five Georgians. As such, the health and prosperity of rural Georgia are vital to all Georgians, urban and non-urban alike, because it plays a strategic part in the overall economy supporting agriculture, manufacturing, distribution, and tourism. Records from the Georgia Department of Transportation show that a disproportionate number of fatalities occur on rural roads. (GDOT 2021 Statewide Strategic Transportation Plan, 2021, p. 12) With almost one-fourth of personal vehicle miles traveled in Georgia occurring on rural roadways, “maintaining and enhancing a transportation system that connects all corners of Georgia will boost opportunities for all communities and businesses in the State.” (1 p. 12)

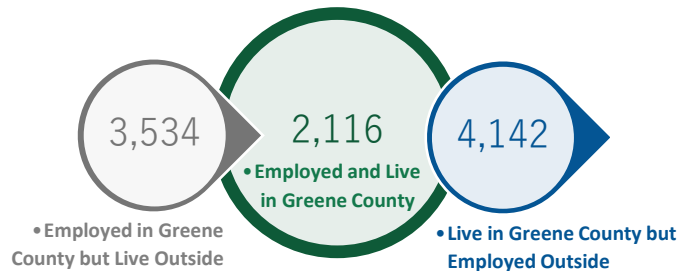
Transportation in Georgia, like all of America, is changing. Most of this change is happening in urban areas where travel distances are shorter but take longer than in rural areas where congestion is minor. Uber and Lyft are challenging traditional taxis, electric scooters are taking the place of walking, and electric car ownership is growing. Rural America is less affected by many of these changes because of less congestion. However, rural residents also have their travel challenges when commuting to work and accessing provisions and services. Rural commuters already face transportation challenges in Georgia, and with the growing attraction of rural destinations for getaways and retirement, transportation issues will continue to grow in the state’s countryside. Rural commuter air mobility may help overcome some of these problems by lessening the challenges of distance and improving the connectivity of rural communities.

3.2 Example Route

An AIR Rural CONOP for eVTOL aircraft carrying passengers would act like an “air taxi” and act as an alternative to rental cars, ride-share, buses, and personal vehicles. Schedules are not predetermined—rides are given on demand like existing ride-sharing and taxi companies today. NASA predicts that the air taxi market will not gain any footing until 2030 at which time it will likely be limited to “concentrated areas of high-net-worth individuals and business” (NASA, 2018, p. 6). The agency also indicates that for the air taxi concept to work in large volume, there would need to be a very large density of vertiports, similar to the AIR Metro CONOP.

An example route for AIR Rural could include Greene County, which is about equidistance between Atlanta and Augusta. Like most non-urban areas, it has a small labor shed with more people leaving the county for work than are employed and live in the county. (See **Figure 3-1.**) There are roughly 20,500 jobs within a 30-

Figure 3-1: Greene County Labor Shed



Source: (Power, 2022, p. 2)

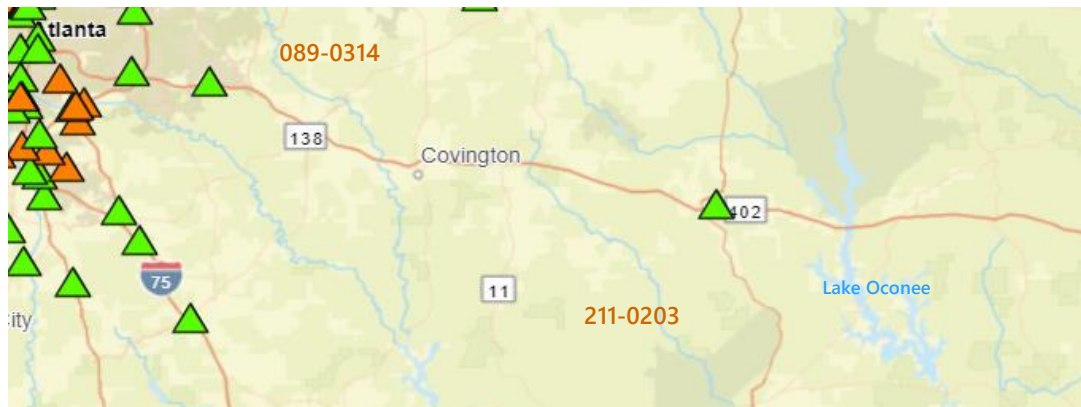
minute drive of Greensboro, the county seat, but a workforce of over 24,600. (Georgia Power, 2023, p. 1), which results in a net surplus of workers.

Greene County is home to Lake Oconee, a 19,000-acre lake built by Georgia Power in 1979 when Wallace Dam was erected on the Oconee River. (Greene County Georgia Economic Development, 2022) The area has six championship golf courses while the lake supports water skiing, wakeboarding, boating, fishing, and swimming. The projected annual number of users of recreational facilities at Lake Oconee in 2030 is 699,369. (Georgia Power, 2016, p. 89) The lake has attracted many tourists interested in a weekend destination, a summer lake house, or a retirement location. Because of its rural nature, attractiveness as a vacation and recreation destination, and proximity to Atlanta and Augusta, it may support an AIR Rural CONOP.

An AIR Rural connection from Atlanta International Airport to a site near the Ritz Carlton Hotel could accommodate guests and tourists to the hotel and Lake Oconee. It could also accommodate weekend getaways for residents living near the Atlanta Airport and commuters working in one area and living in the other. The same could be said for connecting Lake Oconee to Augusta.

Commutes to or from Atlanta would likely be conducted partly on I-20/SR 402. **Figure 3-2** shows that the Annual Average Daily Traffic (AADT) on I-20 just east of I-285 is 143,000 (89 percent cars and 11 percent trucks). Farther east on I-20 just past U.S. 441, the AADT shrinks to 33,500 (77 percent cars and 23 percent trucks). Commutes to or from Augusta would also likely be conducted partly on I-20/SR 402. **Figure 3-3** Error! Reference source not found. shows that the AADT on I-20 between Augusta and SR 441 is 29,800 143,000 (74 percent cars and 26 percent trucks).

Figure 3-2: AADT on I-20 East of I-285



089-0314	2021	2020	2019	211-0203	2021	2020	2019
AADT	143,000	135,000	146,000	AADT	33,500	29,200	33,300
Single Unit AADT	3803	3496	3337	Single Unit AADT	844	678	717
Combo Unit AADT	11433	10473	10264	Combo Unit AADT	6699	5994	6276
Truck %	11%	10%	9%	Truck %	23%	23%	21%

Source: (Georgia Department of Transportation, 2023)

Figure 3-3: AADT on I-20 between Augusta and SR 441



265-0163	2021	2020	2019
AADT	28,900	25,400	29,800
Single Unit AADT	696	612	636
Combo Unit AADT	6866	6037	6295
Truck %	26%	26%	23%

Source: (Georgia Department of Transportation, 2023)

As a reference, the distance from Atlanta International and Augusta Regional Airports to several Greene County locations is shown in **Table 3-1**.

Table 3-1: Road Distance from Atlanta International Airport to various Greene County Locations

LOCATION	Ritz Carlton	Greensboro	Gold Club at Cuscowilla	Sanding Creek Sporting Grounds	Greene County Airport
Atlanta International Airport	88 miles	79 miles	82 miles	87 miles	82 miles
Augusta Regional Airport	90 miles	82 miles	91 miles	83 miles	78 miles

Source: Google Earth

A review of several OEM aircraft data indicates these distances will be in the range of some but not all eVTOL aircraft. **Table 3-2** shows the anticipated ranges of various eVTOL aircraft currently in the design and certification phase. While no aircraft are certified yet and exact ranges are still unknown, some of these aircraft should have no problem serving a Lake Oconee/Atlanta/Augusta route.

Table 3-2: Anticipated Range of Early eVTOLs

Maximum Range	<i>BETA</i>	<i>Lilium</i>	<i>Joby</i>	<i>Wisk</i>	<i>Archer</i>	<i>Volocopter</i>
Miles	250	155	150	90	50-100	60

Source: Respective OEMs

3.3 Infrastructure needs

An AIR Rural CONOP would require charging infrastructure. While charging needs will vary by OEM, NASA’s eVTOL Electrical Infrastructure Study for UAM Aircraft assumes 600 kW will future-proof charging needs. Augusta Regional Airport recently installed a charging system designed by BETA that supports 350kW, which will charge their ALIA eVTOL along with several other aircraft.

Outside of charging infrastructure, the minimum components needed to provide an AIR Rural vertiport are a landing area and parking. Since these are on-demand flights, full terminal amenities are not needed. The landing area consists of a touchdown and liftoff area (TLOF) and its associated final approach and takeoff area (FATO) and safety area (SA). The size of the landing area depends on the size of the aircraft but generally, a 150 ft. by 150 ft. square (22,500 sq. ft. or .52 acres) will accommodate the majority of eVTOL aircraft currently pursuing FAA certification (e.g., Beta, Joby, Lilium). An aircraft charging station already exists at Augusta’s airport so if the airport were used as one of the vertiports, additional infrastructure would likely not be needed. Two more vertiports would be needed somewhere near Atlanta International Airport and Lake Oconee. These locations would also likely need charging capability for the aircraft to make the next leg of the flight given the distances between all three areas.

3.4 Capacity

The capacity of a minimally built vertiport is described in Section 1.4 of the AIR Metro CONOP. The passenger throughput will depend on several things including the number of passengers the aircraft can carry and the battery charging time needed. The seats available for sale on eVTOL aircraft vary. Lilium’s eVTOL jet has six passenger seats while the BETA Technologies Alia-250 can carry five people, and the Archer Midnight and the Joby have four passengers, with an average of 4.75 for all of them. However, NASA predicts that air taxi trips will likely be conducted with fewer passengers per flight than those on predetermined schedules serving intra-

metropolitan areas. (NASA, 2018, p. 5) NASA predicts one passenger per aircraft, but for the AIR Rural CONOP two passengers have been used because of the recreational nature of the route.

The unconstrained throughput of a touchdown lift-off area (TLOF) is expected to be between approximately four and eight full aircraft turns (one arrival and one departure) per hour in VMC with a pilot on board.⁴ This does not factor in eVTOL charging times, which have the potential to be a bottleneck in operations and reduce maximum throughput. If each aircraft is fully loaded on each flight, the maximum unconstrained throughput of a TLOF will be between 8 to 64 passengers per hour depending on the number of passengers on each flight and the number of turns accomplished per hour (see **Table 3-3**).

Table 3-3: Anticipated Maximum Unconstrained Passenger (Pax) Throughput of 1 TLOF with Aircraft at Full Capacity

Pax.	Pax. Throughput with		
	4 turns/hr.	6 turns/hr.	8 turns/hr.
1	8	12	16
2	16	24	32
3	24	36	48
4	32	48	64

Source: Woolpert

3.5 Congestion reduction

I-20/SR 402 is a four-lane divided highway that should be able to accommodate the existing traffic shown in **Figure 3-2** and **Figure 3-3** without noticeable congestion. An AIR Rural CONOP will likely not impact congestion on the highway as most rural congestion is located on local roads. Studies conducted by the Federal Highway Administration (FHWA) and the National Center for Transportation Research identified seven primary causes of traffic congestion in small urban and rural areas: traffic incidents, work zones, environmental conditions, fluctuations in normal traffic, special events, traffic control devices, and physical bottlenecks. (Michalaka, et al., 2022, p. 47) A survey conducted specifically in rural areas across the southeastern U.S. identified day-to-day peak-hour traffic and special events/tourism as the two highest contributors to traffic congestion. (Michalaka, et al., 2022, p. 45) An AIR Rural CONOP would reduce congestion for transient travelers boarding eVTOL at Augusta or Atlanta airports because they would be able to avoid the local reasons for congestion.

For traffic congestion experienced by residents in Greene County, an analysis of cars removed per flight has been performed for each of the passenger case scenarios in **Table 3-4**. This analysis assumes that 77 percent of the cars removed are single occupancy. (Donsky, 2019)

Table 3-4: Vehicle Reduction on Road Per Flight

Pax. Seats	Car Trips Removed Per Flight
1	0.77
2	1.54

⁴ Woolpert has built a capacity model for touchdown lift-off area (TLOF) occupancy time that was combined with probabilistic techniques to simulate 20,000 operations. The results suggest that the expected unconstrained throughput of a TLOF is between 4.1 and 8.3 full turns per hour.

Pax. Seats	Car Trips Removed Per Flight
3	2.31
4	2.08

Source: Woolpert

3.6 Forecast

Forecasting the potential use of a new form of transportation is difficult. While aircraft exist, the eVTOL is a new type of aircraft and none have been certified to date. The price to purchase has not been established nor has the price to operate. Insurance costs and ticket prices are unknown for the multiple models as is the public’s willingness to accept and use them. NASA estimates most air taxi flights will be 10 to 70 miles (NASA, 2018, p. 18), just slightly less than our AIR Rural example route. The agency also believes only localized or niche market scenarios have the potential for profitability by 2030, and that this initial market will serve businesses and wealthy individuals, which is a reason why Lake Oconee was chosen for this AIR Rural CONOP.

Forecasts of AIR Rural are made based on the projected usage of Lake Oconee in 2030 (Georgia Power, 2016) and the estimated labor market for Greene County in that same year (Georgia Power, 2023). (See Section 1.2 for a discussion on Greene County’s labor shed.) Note that historically the Greene County population has grown at an average annual growth rate of 1.589% over the last decade. (Greene County Economic Development) This growth rate has been applied to both the workforce leaving Greene County for jobs and those coming into the county for jobs to arrive at 2030 estimates, which is the first year NASA believes air taxis will have a market, albeit limited to concentrated areas of high-net-worth individuals and businesses.

Table 3-5 below shows the projected usage of an AIR Rural CONOP based on capturing 1%, 2.5%, 5%, and 10% of the projected usage of Lake Oconee recreational facilities and commuters entering or exiting the county for work.

Table 3-5: Potential AIR Rural CONOP Usage

2030 Projected Annual Use of Lake Oconee Recreational Facilities				699,369	
	Percentage of users captured	1%	2.5%	5%	10%
	Annual Pax.	6,994	17,484	34,968	69,937
Source:	(Georgia Power, 2016, p. 89); Woolpert				
2030 Projected Residents Living Outside County but Working Inside				4,137	
	Percentage of users captured	1%	2.5%	5%	10%
	Annual Pax.	41	103	207	414
Source:	(Georgia Power, 2023, p. 2); (Greene County Economic Development); Woolpert				
2030 Projected Residents Living Outside County but Working Inside				4,773	

	Percentage of users captured	1%	2.5%	5%	10%
	Annual Pax.	48	119	239	477
Source:	(Georgia Power, 2023, p. 2); (Greene County Economic Development); Woolpert				
Total Annual Pax. Forecasted					
	Percentage of users captured	1%	2.5%	5%	10%
	Annual Pax.	7,083	17,707	35,414	70,828

Source: Woolpert

3.7 Summary

An AIR Rural CONOP in Georgia carrying passengers would act like an “air taxi” and would replace rental cars, rideshare, buses, and personal vehicles. Schedules would not be predetermined, but rather, rides would be given on demand like existing ride-sharing or taxi companies today. An example route for AIR Rural includes Greene County (Lake Oconee) and Atlanta and Augusta. Some traffic from both the Atlanta area and the Augusta area flows to and from Greene County. Greene County is a potential AIR Rural route because it has six championship golf courses and is home to Lake Oconee, which supports water skiing, wakeboarding, boating, fishing, swimming, and numerous high-priced homes. Landing areas would be needed in all three locations. Augusta’s airport has recently installed a charging system designed by BETA that supports 350kW, which could be the location of one landing area.

By 2030, NASA predicts air taxi service will be limited to concentrated areas of high-net-worth individuals and businesses. (NASA, 2018, p. 6) Based on this assumption, the projected use of the Greene County/Atlanta/Augusta AIR Rural route in 2030 could range roughly from 7,000 to 70,000 passengers depending on the percentage of users of the Lake Oconee and workforce entering or exiting the county is captured by the service.

4. Regional Air Mobility CONOP Connecting Hartsfield-Jackson Int’l Airport

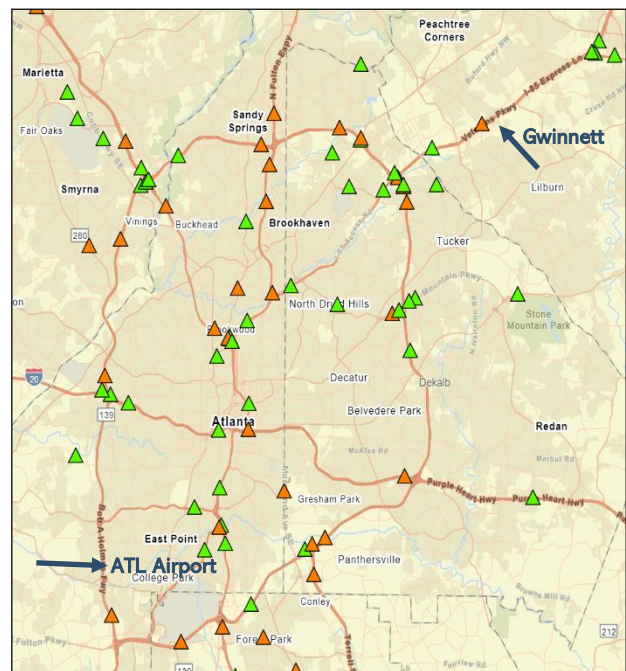
4.1 Introduction

In 2022 Atlanta was identified as the eighth-largest metropolitan area in the nation with more than five million residents, according to the U.S. Census Bureau. Multiple studies have identified the Atlanta metro region as having some of the worst traffic congestion and bottlenecks in the nation. A 2023 study *Top 100 Truck Bottlenecks* (Institute, 2023), released by the American Transportation Research Institute, identified the I-85 at I-285 interchange in northeast Atlanta as the fourth most congested in the United States. Five interstate corridors in Atlanta were ranked in the top 20 nationally, with the I-285 at State Route 400 and I-75 at I-285 ranking 14th and 18th respectively. The traffic congestion along the I-85 corridor in the northeast Atlanta metro region in Gwinnett County makes travel to Atlanta’s Hartsfield-Jackson International Airport located south of downtown Atlanta in Fulton County difficult.

According to Airports Council International, in 2022 Hartsfield-Jackson Atlanta International Airport (ATL) topped the list as the world’s busiest airport with more than 93.7 million passengers flying through Atlanta (Bates, 2023). This is nearly a 24 percent increase over the 75.7 million passengers who traveled through Atlanta in 2021. Atlanta’s 2022 passenger numbers are still 15 percent below 2019 traffic, indicating that air travel continues to be in recovery mode.

In a report released by McKinsey & Company, *Final Approach: How Airports Can Prepare for Advanced Air Mobility* (Company, 2021), they predict airports are likely to be at the center of the Advanced Air Mobility (AAM) revolution. They cite the fact that more than two-thirds of the 25 largest AAM companies are targeting airports among their initial markets. They attribute the interest from the AAM companies to the currently congested links between airports and the urban areas they serve, basic airfield infrastructure is already constructed, and customers on AAM flights could save up to 40 to 60 percent of the time currently spent traveling to the airport from urban and suburban origination points.

Figure 4-1: eVTOL Route from Gwinnett County to ATL Airport



Source: Georgia DOT public traffic database, accessed 6/2/23.

4.2 Example Route

A concept of operations (CONOP) for a Regional Air Mobility route from suburban Gwinnett County to ATL was analyzed. According to the Georgia Department of Transportation’s public traffic database (Georgia Department of Transportation, 2023) for 2023, along I-85 in Gwinnett County north of I-285, the average annual daily traffic (AADT) is 305,000 vehicles (See **Figure 4-1.**) This section of interstate in Gwinnett County does not have Metropolitan Atlanta Rapid Transit Authority (MARTA) rail service, as MARTA currently only serves Fulton, DeKalb, and Clayton County. The lack of MARTA service in Gwinnett County leaves residents with few options other than automobiles to access the ATL airport.

The Gwinnett County Airport – Briscoe Field (KLZU) could serve as a site for initial eVTOL operations to ATL, serving the more than 975,000 county residents. For this CONOP, aircraft would operate on demand or a daily schedule set by the operator and consistent with consumer demand. The flight distance between the KLZU and KATL is approximately 32 nautical miles.

As shown in **Table 4-1** below, the anticipated ranges and speeds of various eVTOL aircraft currently in the design and certification phase are listed. While no aircraft are currently FAA certified and ranges and operational data are still estimated by the manufacturers, all six manufacturers listed - BETA, Lilium, Joby, Wisk, Archer, and Volocopter estimate sufficient aircraft range, from 250 to 60 miles, to complete a flight on this route. Utilizing the estimated speed of Beta’s aircraft at 170 miles per hour the flight would take approximately 12 minutes and utilizing Volocopter’s estimated speed of 69 miles per hour the flight would take approximately 28 minutes. The route as depicted in **Figure 4-1** is approximately 33 miles and by car averages approximately one-hour travel time.

Table 4-1: eVTOL Manufacturers’ Estimated Aircraft Ranges and Speeds

	BETA	Lilium	Joby	Wisk	Archer	Volocopter
Estimated Range	250 miles	155 miles	150 miles	90 miles	50-100 miles	60 miles
Estimated Speed	170 mph	175 mph	200 mph	138 mph	150 mph	69 mph

Source: Respective OEMs

Areas adjacent to I-85 along the southern part of Gwinnett County contain dense commercial development and identifying areas suitable for vertiport construction could pose challenges. However, two recent purchases by the Gwinnett County Board of Commissioners along this corridor, a 103-acre site of OFS Brightwave Solutions located off Jimmy Carter Boulevard and I-85, and a 75-acre site of the Gwinnett Place Mall, located off Pleasant Hill Road at the I-85 interchange, could provide potential areas to explore for new vertiports for this CONOP. New vertiports constructed in these general areas could provide alternative origination and destination points for this CONOP and serve to expand and further connect Gwinnett County’s transportation network to the metro Atlanta region.

4.3 Infrastructure needs

In facilitating an eVTOL route from Gwinnett County to Atlanta’s Hartsfield-Jackson International Airport necessary infrastructure will need to be installed. In Gwinnett County to operate the route from the Gwinnett County Airport would require minimal infrastructure, as landing areas, staging areas, and facilities to serve aircraft currently exist at both airports. **Figure 4-2** below provides an aerial view of the Gwinnett County Airport complex. The Gwinnett County Airport currently has a 6,000 x 100-foot asphalt runway with a full parallel taxiway, instrument approach procedures, an AWOS-IIIPT weather observation/reporting station, more than 340,000 sq. ft. of apron area on the north side of the airport, terminal buildings and vehicle parking.

Figure 4-3 below provides an aerial view of the Hartsfield-Jackson Atlanta International Airport which has: five runways with the longest being 12,390 x 150 feet and the shortest at 9,000 x 150 feet; parallel taxiways for all runways; an ASOS weather observation/reporting station, more than 300,000 sq. ft. of apron areas adjacent to a single fixed-based operator, general aviation FBO terminal building and vehicle parking.

Aircraft charging infrastructure would need to be installed at both airports. As with traditional airport operations, first and last-mile connectivity will be important for eVTOL operations at ATL. The location of these operations should be considered and optimized relative to the proximity to passenger terminal facilities.

Figure 4-2: Gwinnett County Airport



Source: Google Earth, accessed 6/2/23

Figure 4-3: Hartsfield-Jackson Atlanta International Airport



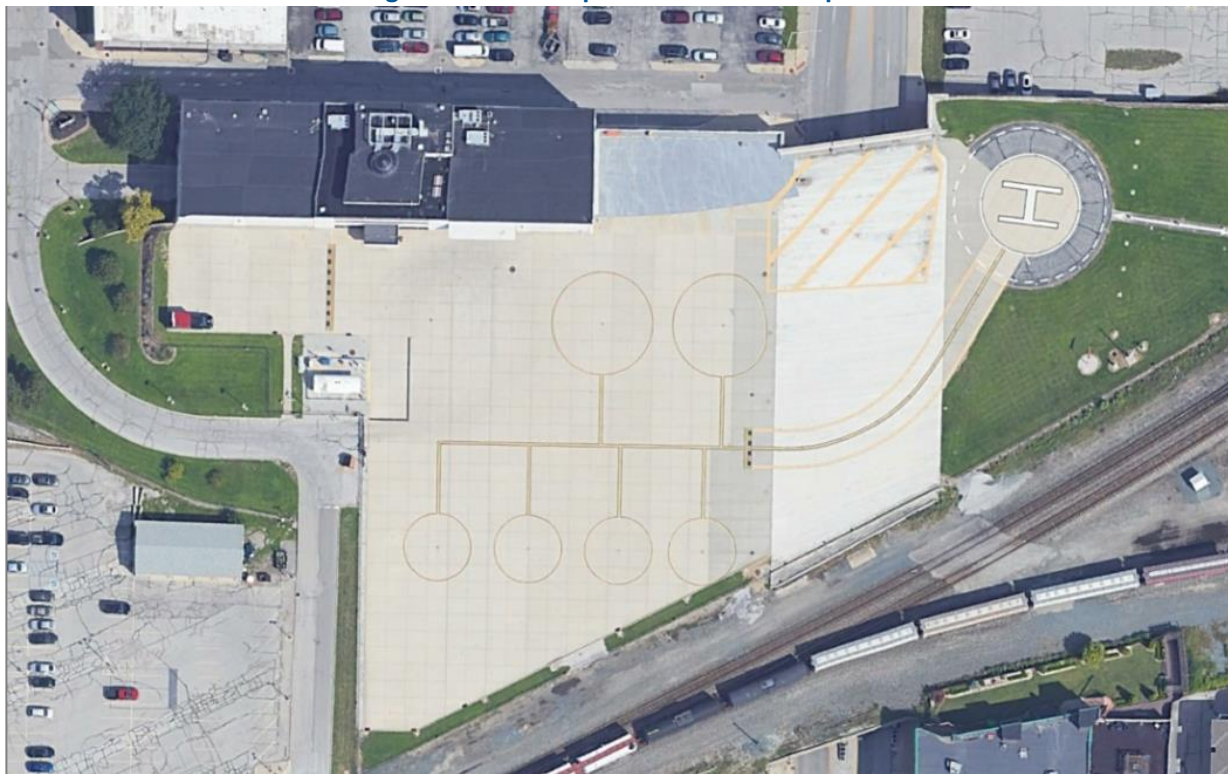
Source: Google Earth, accessed 6/2/23

For a Regional Air Metro CONOP route to operate from greenfield sites in Gwinnett County, close to I-85, a vertiport with adequate charging infrastructure would need to be constructed. The Federal Highway Administration (FHWA) has designated this section of Interstate I-85 as an “alternative fuel corridor”, which supports the installation of electric vehicle charging, hydrogen, propane, and natural gas fueling infrastructure at strategic locations along the nation’s major highways. This FHWA initiative may aid in accelerating the growth of charging infrastructure and capacity needed for eVTOL operations in this area (Federal Highway Administration, 2023). There is very little information available on specific OEM charging needs as OEMs are still in the design phases. While charging needs will vary by OEM, Wisk indicates that somewhere in the order of 4,500 kW of dedicated charging capability would be needed to accommodate approximately 100 aircraft operations a day.

Outside of charging infrastructure, the minimum components needed to provide a Regional Air Mobility vertiport along this section of I-85 are a landing area, terminal, and parking. The landing area consists of a touchdown and liftoff area (TLOF) and its associated final approach and takeoff area (FATO) and safety area (SA). The size of the landing area is dependent on the size of the aircraft operating into/out of the facility, but generally, a 150 ft. by 150 ft. area of 22,500 sq. ft. or .52 acres will accommodate the majority of eVTOL aircraft currently pursuing FAA certification, like Beta, Joby, Lilium, Archer, etc. The terminal area and charging station would require additional dedicated space.

Representative examples of existing vertiports include the Indianapolis Downtown Heliport and the Dallas Heliport/Vertiport. The Indianapolis Downtown Heliport, a public-owned and public-use facility, occupies approximately 210,000 sq. ft., just under five acres, southwest of the city center. It has one TLOF, two hangars, and parking for six eVTOL aircraft (see **Figure 4-4.**)

Figure 4-4: Indianapolis Downtown Heliport



Source: Google Earth, accessed 03/28/23

The Dallas Heliport/Vertiport is a public-use facility with two TLOFs and five parking spaces covering approximately four acres. (See **Figure 4-5**). Given these examples, a vertiport will likely require a minimum of two to three acres for a single TLOF, FATO, SA, parking, terminal area, and charging. Unobstructed ingress and egress will be required.

Figure 4-5: Dallas Heliport/Vertiport

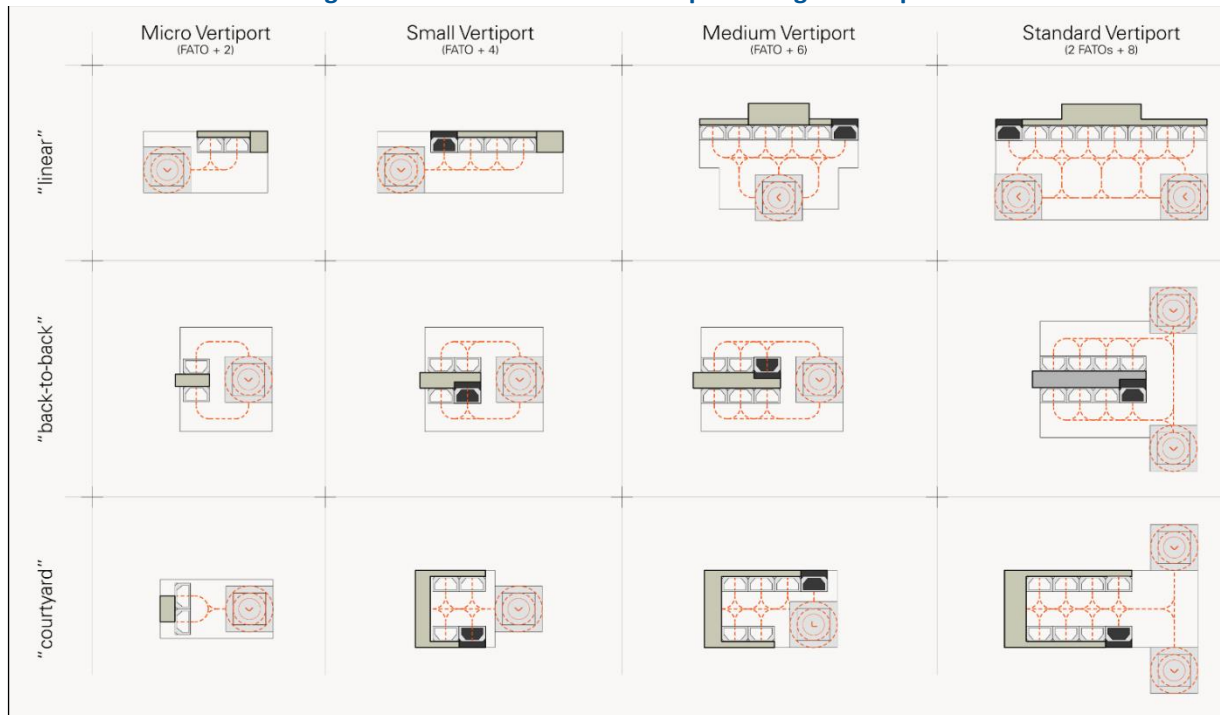


Source: Google Earth, accessed 03/28/23

eVTOL manufacturer Lilium has developed scalable conceptual designs, as depicted in **Figure 4-6**, for its network of vertiports currently under development (Designing a Scalable Vertiport, 2020). Their design is based on a limited set of standardized modules, which they contend make it simpler and more cost-effective to plan a vertiport for a specific site. Their modules can be prefabricated off-site, potentially reducing costs and allowing for more rapid on-site construction.

In September 2022, the Federal Aviation Administration (FAA) released *Engineering Brief No. 105, Vertiport Design* (Engineering Brief No. 105, Vertiport Design, 2022) It provides specific design guidance for establishing new public and private vertiports, including modification of existing helicopter and airplane landing facilities. Due to the current lack of validated eVTOL aircraft performance data, the FAA has stated, at this time, it is taking a prescriptive and conservative approach with recommendations in the engineering brief and expects further vertiport guidance to evolve into an updated performance-based design standard.

Figure 4-6: Lilium’s Scalable Vertiport Design Concept



Source: Lilium

4.4 Capacity

The capacity of a minimally built vertiport will be limited. The passenger throughput will depend on several variables including the number of passengers the aircraft can carry, and the battery charging time needed. The seats available for sale on eVTOL aircraft vary. Lilium’s eVTOL jet has six passenger seats while the BETA Technologies Alia-250 can carry five people, and the Archer Midnight and the Joby can each carry four passengers. The unconstrained throughput of a touchdown lift-off area (TLOF) is expected to be between approximately four and eight full aircraft turns (one arrival and one departure) per hour in VMC with a pilot on board.⁵ This does not factor in eVTOL charging times, which have the potential to be a bottleneck in operations and reduce maximum throughput. If each aircraft is fully loaded on each flight, the maximum unconstrained throughput of a TLOF will be between 32 to 96 passengers (see **Table 4-2**) depending on the aircraft used and the number of turns per hour achieved. The average of all the scenarios for a fully loaded aircraft is 4.75 seats occupied and a total of 57 passengers per hour at six turns per hour.

⁵ Woolpert has built a capacity model for touchdown lift-off area (TLOF) occupancy time that was combined with probabilistic techniques to simulate 20,000 operations. The results suggest that the expected unconstrained throughput of a TLOF is between 4.1 and 8.3 full turns per hour.

Table 4-2: Anticipated Maximum Unconstrained Passenger (Pax) Throughput of 1 TLOF with Aircraft at Full Capacity

AIRCRAFT	Pax. Seats	Pax Throughput with		
		4 turns/hr.	6 turns/hr.	8 turns/hr.
Lilium	6	48	72	96
Beta	5	40	60	80
Archer	4	32	48	64
Joby	4	32	48	64
Average	4.75	38	57	76

Source: Woolpert, Respective OEMs

4.5 Congestion reduction

I-85 northeast of Atlanta is a high-capacity interstate highway consisting of 10 divided lanes with two dedicated express lanes which are tolled. As previously stated, according to the 2023 study *Top 100 Truck Bottlenecks* (Institute, 2023) released by the American Transportation Research Institute, the interchange at I-85 and I-285 is the fourth most congested interchange in the country with an average speed of 38.1 mph and peak average speed of 28.5 miles per hour. According to the *2022 Global Traffic Scorecard* (Inrix, 2023) produced by the mobility analytics firm Inrix, the typical U.S. driver lost 51 hours to congestion in 2022.

As previously noted, the 2023 AADT of I-85 in this area is approximately 305,000 cars. We can estimate the number of cars that will be removed from the road with a two-vertiport situation—one for the origination of the trip and one for the destination. This would be a best-case scenario with the assumption that each car has no more than two passengers and there are no constraints to the vertiport operation which includes but is not limited to charging and weather.

In this best-case, unconstrained scenario we can estimate that an average of 44 cars will be removed from I-85 per hour. If we also assume the Regional Air Mobility CONOP will operate for 12 hours a day and the traffic will spread out equally over that time frame, we can estimate that a total average of 527 cars per vertiport will be removed from that segment of the road daily with a reduction in the AADT of .17 percent. (See **Table 4-3.**) For the two vertiport Regional Air Mobility CONOP scenario a total average of 1054 cars are removed with a reduction in the AADT of .34 percent. Each scenario requires maximum commuter participation and uniformly distributed traffic.

Table 4-3: Best Case Scenario Vehicle Reduction on Road per Vertiport in Unconstrained Environment and Visual Meteorological Conditions

AIRCRAFT	Pax. Seats	Pax Throughput @ 6 turns/hr.	Car Trips Removed Per Hour Per Vertiport	Car Trips Removed During 12 Service Hrs. Per Vertiport	Best Case % AADT Reduction Per Vertiport
Lilium	6	72	55	665	0.22%
Beta	5	60	46	554	0.18%
Archer	4	48	37	444	0.15%
Joby	4	48	37	444	0.15%
Average	4.75	57	44	527	0.17%

Source: Woolpert, River Street Group, Respective OEMs

The estimated 1054 ADT reduction described above is not likely to make a noticeable difference in the Level of Service along I-85. The reduction in traffic could be compounded in the future if the service is successful and multiple vertiports are in operation.

4.6 Forecast

In this early stage of the advancement of AAM, as eVTOL aircraft manufacturers continue their certification efforts, historical operational, ticket pricing and market data are not available to aid in forecasting. The forecast provided here is based on air taxi and airport shuttle predictions made by the National Aeronautics and Space Administration (NASA) in their 2018 Urban Air Mobility (UAM) Market Study (NASA, 2018). NASA is leading research and analytics on AAM and UAM, and as a result, has made projections regarding aspects of the emerging industry. As summarized in **Table 4-4** below, the administration estimates, that in the near term, the air taxi and airport shuttle market have a combined potential national demand of 55,000 daily trips or 82,000 daily passengers. In an unconstrained best-case scenario, they estimate a potential national demand of 11 million daily trips.

Table 4-4: NASA Air Taxi and Airport Shuttle Projections & Atlanta’s Share by Population

Period	Near Term	Unconstrained
NASA National Daily Aircraft Estimate	4,100	850,000
<i>Atlanta’s Share @ 2.145%</i>	88	18,230
<i>Gwinnett’s Share of Atlanta MSA @ 16%</i>	15	2,900
NASA National Daily Trip Estimate	55,000	11,000,000
<i>Atlanta’s Share @ 2.145%</i>	1,180	235,950
<i>Gwinnett’s Share of Atlanta MSA @ 16%</i>	190	37,750

Sources: (NASA, 2018), (U.S. Census Bureau, Population Division, 2022), River Street Group

According to the U.S. Census Bureau, approximately 286.5 million people were living in metropolitan statistical areas (MSA) in 2021 with Atlanta’s portion of that being 2.145 percent, and Gwinnett County’s share of the Atlanta region’s MSA population is 16 percent as depicted in **Table 4-5** below. (U.S. Census Bureau, Population Division, 2022) We can further refine our forecast for Gwinnett County by applying these percentages to the NASA forecast described in the previous paragraph. Using this methodology, Gwinnett

County could anticipate in a conservative near-term forecast 15 aircraft operating 190 trips daily and in an unconstrained scenario 2,900 aircraft operating 37,750 trips per day. Refer to **Table 4-4** above.

Regional airport travel data from the metropolitan planning organization’s Atlanta Regional Commission and forecasts from the Hartsfield-Jackson Atlanta International Airport were reviewed for this CONOP. The most current data from both agencies, 2008 and 2015 respectively, was deemed too dated to provide meaningful input into the forecast for this CONOP.

The number of stand-alone TLOFs needed to accommodate the adjusted NASA forecast for Gwinnett County, using the previously discussed six turns per hour or 12 flights, would be two in the near term and 263 for the unconstrained estimate. The unconstrained estimate is a best-case scenario with all traffic spread equally over a 12-hour period, in visual meteorological conditions, and with no restrictions, for charging time, maintenance issues, wind conditions, etc.

Table 4-5: 2021 Atlanta Metropolitan Statistical Area (MSA) Estimated Population

<i>County</i>	<i>Est. Population</i>	<i>Percentage of MSA</i>
<i>Fulton</i>	1,062,531	17%
<i>Gwinnett</i>	965,145	16%
<i>Cobb</i>	766,691	12%
<i>DeKalb</i>	759,231	12%
<i>Clayton</i>	297,318	5%
<i>Cherokee</i>	274,839	4%
<i>Forsyth</i>	260,721	4%
<i>Henry</i>	245,023	4%
<i>Douglas</i>	145,628	2%
<i>Fayette</i>	120,681	2%
<i>Rockdale</i>	93,961	2%
<i>Outer Counties in MSA</i>	1,102,893	19%
2021 Total Est. Population	6,143,138	100%

Source: U.S. Census Bureau

4.7 Summary

A Regional Air Mobility CONOP would carry passengers and operate on a set schedule from the Gwinnett County Airport or potential vertiport sites along the I-85 corridor in the northeast Atlanta metropolitan region to the Hartsfield-Jackson Atlanta International Airport. The route is approximately 33 miles and by car takes approximately one hour to travel. By utilizing the fastest and slowest eVTOL aircraft analyzed in this study, flight time for this route would vary from 12 to 28 minutes, respectively. This represents a significant time savings of 52-88% which could be an important factor for potential users.

Utilizing two existing airports as takeoff and landing areas or touchdown and liftoff areas for eVTOL operations would minimize the infrastructure required to bring this CONOP into service. Specifically, charging facilities for eVTOL aircraft would need to be added and available for use at both airports.

When analyzing the capacity potential, passenger throughput will depend on variables including the number of passengers the aircraft can carry and the battery charging time needed. The passenger throughput for the CONOP is estimated to be between approximately 38 to 76 passengers per hour in optimal conditions without taking aircraft charging times into account. This assumes on average each aircraft carries 4.75 passengers and the operations are equally spread over a 12-hour window. In these optimal conditions, this CONOP could potentially reduce congestion on this segment of I-85 by approximately 1054 cars, with a reduction in the AADT of 0.34 percent.

Utilizing NASA's UAM study's national projections and adjusting for state and local population, it is conservatively estimated there are approximately 15 aircraft operating 190 trips daily from two vertiports for this CONOP. In an unconstrained scenario, it is estimated that 2,900 aircraft would operate daily trips from 263 vertiports.

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