5. Facility Requirements

This chapter presents the airside and landside facility requirements necessary to accommodate existing and forecasted demand, or the anticipated future aircraft operations, at Cape Cod Gateway Airport (HYA or the Airport) in accordance with Federal Aviation Administration (FAA) design criteria and safety standards. The facility requirements are based upon several sources, including the aviation demand forecasts presented in Chapter 4, *Forecasts;* FAA Advisory Circular (AC) 150/5300-13A, *Airport Design;* and 14 Code of Federal Regulations (CFR) Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace.* The findings of this chapter serve as the basis for the formulation of the airside and landside alternatives and future development recommendations for both. The major components of this chapter follow FAA guidance and are listed below:

- Executive Summary of Analysis
- Airside Facility Requirements
- Passenger Terminal Facility Requirements
- Parking and Roadway Access Facility Requirements
- General Aviation and Landside Facility Requirements
- Support Facilities and Utilities
- Facility Requirements Summary

The aviation industry is continuously changing with new aircraft, changing Federal regulations and standards, and changes in airline and general aviation networks. This chapter reviews the existing Airport, compares it to the existing Federal regulations and standards (calendar year 2021), and determines what changes the Airport needs (facility requirements) based on existing and forecast future aircraft operations and Federal regulations and standards. **Appendix F** provides a resource for acronyms and definitions.

5.1. EXECUTIVE SUMMARY OF ANALYSIS

A high-level summary of recommendations can be seen in **Table 5-1**. For a full list of all recommendations, please refer to **Section 5.7** at the end of this chapter.

Table 5-1: Summary of Recommendations

FAA Guideline	Analysis Results and Recommendation	More Details
Airfield Capacity	• Runway 6-24 serves as the current primary visual flight rule (VFR) runway • Runway 15-33 serves as the current primary instrument flight rules (IFR) runway • A secondary C-III runway is justified due to peak season capacity to provide operational flexibility and minimize community impacts • Extend a runway to accommodate more weight Class C aircraft (existing capacity is 12-27% of weight Class C	Section 5.2.1

FAA Guideline	Analysis Results and Recommendation	More Details
	aircraft (weighing 12,500-300,000 pounds) in wet[1] runway pavement conditions)	
Runway Length	• Extend one or both runways to 6,000 - 6,400 feet to meet the needs of both general aviation (GA) and commercial operations (existing Runway 6-24 is 5,425 feet long and Runway 15-33 is 5,253 feet long)	Section 5.2.2
Runway Width	• The current pavement width of Runways 15-33 and 6-24 should remain at 150 feet to accommodate the changing commercial fleet mix	Section 5.2.3
Runway Orientation	• A crosswind runway (Runway 15-33) is justified because Runway 6-24 provides less than standard 95% coverage at 10.5- and 13-knot winds	Section 5.2.5
Runway Safety Areas, Runway Object Free Areas, Runway Protection Zones	• Review alternatives for incremental improvements and enhanced land use controls by the Airport per FAA standards; establish a policy for incremental safety enhancements in future projects	Sections 5.2.6 – 5.2.8
Passenger Terminal Ramp	• Plan for a second aircraft parking position based upon a potential increase in passenger service or changes to the type of aircraft using the terminal, which could trigger reconfiguration	Section 0
Airfield Geometry	• Resolve the areas of non-standard geometry to meet FAA standards as much as practicable	Section 5.2.13
Passenger Terminal Facility	• Expand the existing terminal building to at least 35,000 square feet (SF) to meet existing demand (existing terminal is approximately 30,000 SF) • Plan for up to 55,000 SF to meet demand at 200 peak (design) hour passengers	Section 5.3
Airport Access and Signage	• Conduct Airport signage and access study	Section 5.4.1
Aircraft Hangars	• Identify and set aside land areas to accommodate potential additional individual and conventional hangars as growth and new business interest occurs (estimated 6 individual and 8 conventional hangars)	Section 5.5.1
GA Aircraft Parking Ramps	• Identify and set aside land area to accommodate potential additional aircraft parking ramps as growth occurs (estimated 40,000 - 67,000 SF of additional apron space)	Section 5.5.2
Aviation Fueling	• Plan for an additional Jet A fuel tank to be located in the existing fuel farm area • Provide self-service option for 100LL Avgas fuel • Plan for electric aircraft charging	Section 5.6.1
Aircraft Rescue and Fire Fighting	• Provide housing for all vehicles to maximize their useful life	Sections 5.6.3 and 5.6.4

FAA Guideline	Analysis Results and Recommendation	More Details
(ARFF) / Maintenance/ Snow Removal Equipment (SRE)		

[1] Does not account for snow, ice, or other contamination factors.
Source: McFarland Johnson analysis, 2021.

5.2. AIRSIDE FACILITY REQUIREMENTS

Airside facility requirements address the items that are directly related to the arrival and departure of aircraft, primarily runways and taxiways and their associated safety areas. To assure that all runway and taxiway systems are correctly designed, the FAA has established criteria for use in planning and design of airfield facilities. The selection of appropriate FAA design standards for the development of airfield facilities is based on the characteristics of the most demanding aircraft expected to use an airport or that particular facility at an airport on a regular basis (500 operations per year). Correctly identifying the future aircraft types that will use an airport is particularly important, because the design standards that are selected will establish the physical dimensions of facilities and the separation distances between facilities that will impact airport development for years to come. Use of appropriate standards will ensure that facilities can safely accommodate aircraft using the Airport today, as well as aircraft that are projected to use the Airport in the future.

Airport design standards are set forth in FAA AC 150/5300-13A, *Airport Design*. This document provides criteria for grouping of aircraft into runway design codes (RDC). The RDC consists of a letter representing an aircraft approach category (AAC) which is based on approach speed, a number representing an airplane design group (ADG) which is based on tail height and/or wingspan, and a number representing the visibility minimums associated with the runway (based on corresponding runway visual range (RVR) values in feet). These groupings are presented in Table 5-2.

Table 5-2: Runway Design Code Characteristics

Aircraft Approach Category (AAC)	
Category	**Approach Speed**
A	Approach speed less than 91 knots
B	Approach speed 91 knots or more but less than 121 knots
C	Approach speed 121 knots or more but less than 141 knots
D	Approach speed 141 knots or more but less than 166 knots
E	Approach speed 166 knots or more

Note: 1 knot is equivalent to 1.15078 miles per hour

Airplane Design Group (ADG)	
Group	**Tail Height (feet) (and/or) // Wingspan (feet)**
I	less than 20 // less than 49
II	20 - less than 30 // 49 - less than 79
III	30 - less than 45 // 79 - less than 118
IV	45 - less than 60 // 118 - less than 171
V	60 - less than 66 // 171 - less than 214
VI	66 - less than 80 // 214 - less than 262

Visibility Minimums (VIS)	
RVR (feet)	**Flight Visibility Category**
VIS	Visual Approaches
4000	Lower than 1 statue mile (SM) but not lower than ¾ SM (approach procedure with vertical guidance (APV) greater than or equal to ¾ SM but less than 1 SM)
2400	Lower than 3/4 SM but not lower than 1/2 mile
1600	Lower than 1/2 SM but not lower than 1/4 mile
1200	Lower than 1/4 SM

Source: FAA AC 150/5300-13A, Airport Design.

Review of Chapter 4, *Forecasts*, indicates that the existing and future design aircraft are in the AAC-ADG C-III family of aircraft for airfield dimensional standards. For the purposes of the Airport Layout Plan, specific aircraft need to be designated. The existing design aircraft is the Embraer 190 (E190) and the future design aircraft for the Airport is the Airbus A220 series. Both of these aircraft are designated as AAC-ADG C-III, which is also the same design category as the most demanding business jet aircraft in the general aviation fleet that also regularly use the Airport. The runway length analysis will review the family of C-III aircraft, as aircraft size is not directly commensurate with runway needs.

Not all Airport facilities will be designed to accommodate the most demanding aircraft at the Airport. Certain airside facilities and landside facilities, such as taxiways and general aviation areas that are not intended to serve large aircraft, may be designed to accommodate less demanding aircraft, where necessary, to ensure cost effective development. Designation of the appropriate standards for all proposed development on the Airport is shown on the Airport Layout Plan (ALP).

Airfield facility requirements are covered in this section as follows:

- Airfield Capacity Analysis
- Runway Length
- Runway Width
- Runway Strength
- Runway Orientation
- Runway Safety Areas
- Runway Object Free Areas
- Runway Protection Zones

- Runway Visibility Zones
- Runway Pavement Markings
- Taxiways
- Passenger Terminal Ramp
- Potential Hot Spots and Geometry Requirements
- Airfield Lighting and Signage
- Visual Approach Aids
- Airfield Facility Requirements Summary

5.2.1. Airfield Capacity Analysis

Airfield capacity refers to the ability of an airport to safely accommodate a given level of aviation activity; throughput (or the number of landings and takeoffs) that an airport's runways are able to sustain during periods of high demand. The FAA has prepared several publications and computer programs to assist in the calculation of capacity. This report used the methodologies described in FAA AC 150/5060-5, *Airport Capacity and Delay*. Capacity is described through three terms:

- **Annual service volume (ASV):** A reasonable estimate of an airport's annual capacity. It accounts for differences in runway use, aircraft mix, weather conditions, etc. that would be encountered over a year's time.
- **Visual flight rules (VFR) hourly capacity**: A measure of the maximum number of aircraft operations which can be accommodated on the airport in an hour in visual conditions (cloud ceiling is at least 1,000 feet above ground level (AGL) and visibility is at least three statute miles (SM)).
- **Instrument flight rules (IFR) hourly capacity**. A measure of the maximum number of aircraft operations which can be accommodated on the airport in an hour in instrument conditions (cloud ceiling is at least 500 feet but less than 1,000 feet AGL and visibility is at least one SM but less than three SM).

As demand approaches capacity, individual aircraft delay is increased.

Factors Affecting Capacity

The airfield capacity analysis considers several factors that affect the ability of the Airport to process aviation demand. They include:

- Meteorological Conditions
- Runway/Taxiway Use Configurations
- Runway Utilization
- Aircraft Fleet Mix
- Percent Arriving Aircraft
- Percent Touch-and-Go Operations
- Exit Taxiway Locations
- and Peaking Characteristics.

The following provides information on existing conditions at the Airport for use in capacity calculations. Such data helps formulate the calculations that are used to determine development recommendations that must be implemented to meet that capacity.

Meteorological Conditions

Meteorological conditions specific to the location of an airport not only influence the airfield layout but also affect the use of the runway system. As weather conditions change, airfield capacity can be reduced by low cloud ceilings and visibility. Runway usage will change as the wind speed and direction change, also impacting the capacity of the airfield.

To better understand the impact of deteriorating weather on capacity, a brief synopsis of aviation flying conditions is provided. For the purposes of capacity evaluation, these flying conditions are described as VFR conditions, IFR conditions, and poor visibility and ceiling conditions. Decreasing cloud ceiling and visibility require an increase in aircraft spacing, as mandated by the FAA. This increase in aircraft spacing causes decreases in the frequency at which aircraft can land and depart the airfield over a specified period of time, reducing hourly and annual capacity.

To better understand the impact that inclement weather has on the Airport, climate data from the National Oceanic and Atmospheric Administration (NOAA) was obtained and analyzed to determine the ceiling and visibility characteristics at this site. Based upon this data since 2012, VFR conditions occur at the Airport approximately 81 percent of the time and IFR conditions occur approximately 18 percent of the time. Poor visibility and ceiling conditions are present at the Airport approximately one percent of the time.

Notably, IFR conditions, shown in **Appendix G**, most commonly occur May through July. During IFR conditions, Runway 15 is the favored runway end six months of the year and is also the runway end with the best instrument approach procedures.

Conclusion of Meteorological Conditions: Based on the above data, Runway 15-33 serves as the primary IFR runway and Runway 6-24 serves as the primary VFR runway.

Runway/Taxiway Use Configurations

The configuration of the runway system refers to the number, location, and orientation of the active runway(s), the type and direction of operations, and the flight rules in effect at a particular time. Runway and taxiway configuration is used in conjunction with meteorological conditions to determine capacity. Capacity analyses will typically be run for several wind/weather configurations that are used at an airport to evaluate delays in the various configurations. For instance, an analysis may review:

- Primary runway direction in VFR conditions
- Secondary runway direction in VFR conditions
- Primary runway direction in IFR conditions
- Secondary runway direction in IFR conditions

Even for an airport with a single runway or pair of parallel runways, the runway is likely used in both the primary direction and the opposite or secondary direction, depending on the winds. A reduction in capacity may be due to such things as the inability to land on certain runways in IFR conditions (e.g., converging or intersecting runways) or the extra separation required between arrivals on one runway and departures on a closely spaced parallel runway. Airport configuration and where taxiways are located or connected to those runways, feeds into capacity calculations. Both runways at the Airport have full-length parallel taxiways and stub taxiways, as such; the existing configuration is used to determine existing and future capacity issues.

Runway Utilization

Runway utilization identifies when runways are used, by which aircraft, and in which runway use configuration during what wind/weather conditions. The more usability of runways during certain conditions, the higher the capacity. As discussed in the meteorological conditions section, aircraft generally desire to takeoff and land into the wind. Currently, when winds are calm, both runways are used at the Airport.

Conclusion of Runway Utilization: As shown in **Appendix G**, in all-weather and VFR conditions, winds favor Runway 6-24 in the summer months and Runway 15-33 in the winter months and during IFR conditions. Jet aircraft can typically handle stronger crosswinds than non-jet aircraft.

Aircraft Fleet Mix Index

The capacity of a runway is also dependent upon type and size of aircraft that use it as the mix of smaller to larger aircraft influences the Airport's capacity. Per FAA AC 150/5060-5, aircraft are placed into one of four weight classes (A through D) when conducting capacity analysis. These weight classes are based on the amount of wake vortex created when the aircraft passes through the air. They differ from the categories used in the determination of the AAC. Small aircraft departing behind larger aircraft must hold longer for wake turbulence separation. The greater the separation distance required, the longer the smaller aircraft must wait to depart, the longer the smaller aircraft sits on the runway, the lower the airfield's capacity.

For the purposes of capacity analysis, aircraft weight classes are shown in **Table 5-3.**

Table 5-3: Aircraft Weight Classes

Weight Class	Maximum Takeoff Weight	Aircraft Types
A	Less than or equal to 12,500 lbs.	Small wake turbulence; single engine
B	Less than or equal to 12,500 lbs.	Small wake turbulence; light twin engine
C	Greater than 12,500 lbs. up to 300,000 lbs.	Large wake turbulence; large jet and propeller aircraft
D	Greater than 300,000 lbs.	Heavy wake turbulence; large jet and propeller aircraft

Source: FAA 150/5060-5, Airport Capacity and Delay.

The fleet mix index for an airport is calculated as the percentage of weight Class C aircraft operations, plus three times the percentage of weight Class D operations (percent of C) + (3 x D).

Conclusion of Runway Aircraft Fleet Mix Index: Since there are no weight Class D aircraft forecast to use the Airport, the fleet mix index is equal to the percentage of weight Class C operations. Currently, aircraft fleet mix index is approximately 12 percent in off-peak season and approximately 19 percent during the peak season averaging out to about 14 percent annually.

Percent Arriving Aircraft

The capacity of the runway is also influenced by the percentage of aircraft arriving at the Airport during the peak hour. Arriving aircraft are typically given priority over departing aircraft; arriving aircraft generally require more time to land than departing aircraft need to takeoff. Therefore, the higher the percentage of aircraft arrivals during peak periods of operations, the lower the ASV. Discussions with Airport personnel indicate that operational activity is well balanced between arrivals and departures.

Conclusion of Percent Arriving Aircraft: Arrivals represent 50 percent of operations during the peak period for existing and future conditions.

Percent Touch-and-Go Operations

A touch-and-go operation refers to an aircraft maneuver in which the aircraft performs a normal landing touchdown followed by an immediate takeoff, without stopping or taxiing clear of the runway. A touch-and-go is counted as two operations with minimal runway time, which increases an airport's capacity. These operations are normally associated with training and are included in the local operations figures reported by the air traffic control tower (ATCT). The Airport has restrictions in place that touch-and-go operations are prohibited between 10:00 p.m. and 6:59 a.m. local time unless prior approval is obtained by the airport manager.

Conclusion of Percent Touch-and-Go Operations: Based on historical data from the Airport and the ATCT, touch-and-go operations comprise approximately 10-15 percent of total operations at the Airport. This is anticipated to remain the same within the planning period.

Exit Taxiway Locations

A final factor in analyzing the capacity of a runway system is the ability of an aircraft to exit the runway as efficiently and safely as possible. The location, design, turning radii, and number of exit taxiways affect the length of time (occupancy time) an aircraft remains on the runway. The longer an aircraft remains on the runway, the lower the capacity of that runway.

FAA AC 150/5300-13A provides guidance regarding the number and location of exit taxiways at the Airport based on the aircraft weight class distance to those exit taxiways from the runway threshold as shown in **Table 5-4**.

100 percent of aircraft capacity weight Class A and B and 49 percent of weight Class C aircraft landing on Runway 6 can exit at Runway 24 under dry conditions using the full runway length. This increases for Runway 24 landings to closer to 75 percent of weight Class C aircraft during dry conditions. In wet conditions, less than 27 percent of weight Class C aircraft are supported on Runway 24 and approximately 12 percent of weight Class C aircraft are supported on Runway 6.

Runway 15-33 is the main runway for instrument flight rules or IFR operations. Similar to Runway 6-24, Runway 15-33 can accommodate all weight Class A and B aircraft and up to 75 percent of weight Class C aircraft in dry conditions. In wet conditions, this reduces to approximately 12 percent of weight Class C aircraft.

Table 5-4: Exit Taxiway Cumulative Utilization Percentage

Distance (Feet Threshold to Exit)	Wet Runways			Dry Runways		
	Right and Acute Angle Exits (% of aircraft observed exiting existing runways)			Right Angled Exit (% of aircraft observed exiting existing runways)		
	Aircraft Weight Class			Aircraft Weight Class		
	A	B	C	A	B	C
2,000	60	0	0	84	1	0
2,500	84	1	0	99	10	0
3,500	99	41	0	100	81	2
4,000	100	80	1	100	98	8
4,500	100	97	4	100	100	24
5,000	100	100	12	100	100	49
5,500	100	100	27	100	100	75
6,000	100	100	48	100	100	92

Weight Class A – small, single engine (<12,500 pounds)
Weight Class B – small, twin engine (<12,500 pounds)
Weight Class C – large (12,500 pounds to 300,000 pounds)
Red indicates less than 50 percent of aircraft of that weight class can exit the runway
Sources: FAA AC 150/5300-13A (Table 4-13) and McFarland Johnson, 2020.

Distances from runway thresholds to exit taxiway centerlines are shown in **Table 5-5.**

Table 5-5: Taxiway Exit Distances

	Runway 6	Runway 24	Runway 15	Runway 33
Taxiway A	N/A	5,333’	5,060’	5,060’
Taxiway A1	N/A	N/A	1,120’	3,980’
Taxiway B	3,180’	1,840’	5,060’	N/A
Taxiway C	4,970’	N/A	4,040’	1,060’
Taxiway C1	3,180’	1,840’	N/A	N/A
Taxiway D	1,460’	3,560’	2,870’	2,230’
Taxiway E	N/A	N/A	N/A	N/A

Source: McFarland Johnson, 2021.

Taxiway E was excluded from this list as aircraft would only utilize this taxiway to enter the run-up pit and not use Taxiway E as an exit taxiway.

Conclusion of Exit Taxiway Analysis: Longer runway lengths and the extension and reconfiguration of their associated taxiways, would allow the Airport to accommodate a larger percentage of weight Class C aircraft, especially in wet

PLANNING CONSIDERATION

During wet runway conditions, FAA capacity calculations suggest that only 12 percent of aircraft within weight Class C can be accommodated. With a runway extension to 6,000 feet, the Airport would be able to accommodate approximately 48 percent of weight Class C aircraft.

conditions. FAA traditional runway length recommendations can be found in **Section 5.2.2**. Full-length parallel taxiways to both Runways 6-24 and 15-33 are provided, which allows aircraft to exit the runway efficiently. The Airport can accommodate 12-27 percent of weight Class C aircraft in wet conditions.

Peaking Characteristics

Airline peak periods are defined in terms of peak hour operations and peak hour enplanements. GA peak periods are defined in terms of peak month and peak hour operations, with a focus on the number of aircraft accommodated on the ramp(s) at any given time.

In addition to peaking characteristics described for airline and GA activity, peaking characteristics are also influenced by annual events that occur at an airport or in the vicinity of an airport that affect air travel, vehicle, and/or aircraft parking, etc. For the purposes of this capacity calculation, the seasonality of this airport was taken into consideration.

Conclusion of Peaking Characteristics: Peak season is during the summer months (June, July, and August) and represents approximately 35 percent of annual flights. Each one of the summer months can be the peak month any given year.

Capacity Calculations

With the existing information outlined above and FAA capacity guidance, the following summarizes the key capacity analysis elements that were used for the hourly and annual capacity calculations for the Airport:

- Runway 15-33 serves as the primary IFR runway and Runway 6-24 serves as the primary VFR runway.
- In all-weather and VFR conditions, winds favor Runway 6-24 in the summer months and Runway 15-33 in the winter months and during IFR conditions.
- Aircraft fleet mix index is approximately 12 percent in off-peak season and approximately 19 percent during the peak season averaging out to about 14 percent annually.
- Arrivals represent 50 percent of operations during the peak period for existing and future conditions.
- Touch-and-go operations comprise approximately 10-15 percent of total operations at the Airport. This is anticipated to remain the same within the planning period.
- Full-length parallel taxiways to both Runways 6-24 and 15-33 are provided, which allows aircraft to exit the runway efficiently. The Airport can accommodate 12-27 percent of weight Class C aircraft in wet conditions.
- The Airport has two runway ends equipped with an ILS and necessary ATC facilities to carry out operations in a radar environment.
- There are no airspace limitations affecting runway use.[1]

FAA AC 150/5060-5 provides guidance used to calculate airfield capacity and provide planning estimates on hourly airfield capacity under both VFR and IFR conditions, which are the theoretical

[1] Airspace limitations include local Class B airspace, military airspace, etc. This does not apply at the Airport.

maximum number of aircraft operations (takeoffs and landings) that can take place on the runway system in one hour under those conditions, respectively. The various capacity elements are then consolidated into a single figure, the Airport Service Volume (ASV) for the Airport. The ASV is the theoretical maximum number of aircraft operations that the Airport can support over the course of a year.

Because characteristics of airports vary so widely, guidance in FAA AC 150/5060-5 is provided for different types of airports, from large commercial service hubs, to small single runway facilities. FAA guidance recommends that planning for capacity enhancement should begin when capacity reaches the 60 percent level.

Based on the data collected in the previous sections, using FAA guidance for runway utilization during different wind conditions and guidance from the Airport Cooperative Research Program (ACRP) Report 29, *Evaluating Airfield Capacity*, it was determined that during IFR conditions in the peak season, the Airport is approaching 80 percent of peak hour capacity and is anticipated to exceed 80 percent within the planning period as shown in **Table 5-6**. **Table 5-6** shows the results of the two runways peak/off-peak blended ASV calculation described below.

Table 5-6: Summary of Peak/Off-Peak Blended Capacities and Comparison to Operations

Year	Demand (Operations)		Capacity (Operations)			Percent Peak Hour (Operations)		Percent ASV
	Annual	Peak Hour	ASV	Hourly VFR	Hourly IFR	VFR	IFR	
2019	67,350	44	153,481	87	56	50.4%	78.6%	43.9%
2025	67,219	42	153,481	87	56	48.1%	75.0%	43.8%
2030	68,804	43	153,481	87	56	49.2%	76.8%	44.8%
2040	73,001	46	153,481	87	56	52.7%	82.1%	47.6%

Source: McFarland Johnson Analysis, 2020.

Because it was determined that during IFR conditions in the peak season, the Airport is approaching 80 percent of peak hour capacity, different annual capacities were reviewed for an appropriate assessment of the Airport's unique situation.

Single-Runway Peak Season ASV: If there were only a single runway available and operations reflected the peak season (June, July, and August) demand all year round, the ASV would be approximately 123,000 annual operations. This would result in approximately 69 percent capacity of ASV. Therefore, with capacity over 60 percent, a secondary runway at C-III designation is justified, which the Airport has.

Two Runways Peak Season ASV: During the peak season, operations reached approximately 65 percent of peak season ASV in 2019 and is forecast to reach 72 percent of peak season ASV by 2040. Therefore, with capacity over 60 percent, runway capacity enhancement should begin.

Two Runways Peak/Off-Peak Blend ASV: This capacity calculation includes seasonal variations. These figures indicate that the Airport is currently operating at 44 percent ASV. The utilization of the airfield is expected to climb to approximately 48 percent of ASV by 2040. One important thing to note is the IFR hourly capacity since it exceeds the 60 and 80 percent FAA thresholds within the planning period. Peak hour occurs during the busy summer months, when IFR conditions are at their highest. **Table 5-6** above presents a summary of the blended airfield capacity calculations compared to the current and forecast level of activity.

Summary and Recommendation for Airfield Capacity

PLANNING CONSIDERATION

Runway 15-33 is a justified and eligible secondary runway at C-III standards based on summer-time peak season capacity.

A runway extension should be considered for one or both runways, because in wet conditions, both runways can accommodate only 12-27 percent of weight Class C aircraft. Planning for capacity enhancement measures should be considered for the primary IFR runway, which is Runway 15-33. Runway 15-33 is justified as an AAC-ADG C-III Secondary Runway for capacity for the following reasons:

- The Airport exceeds the FAA threshold of 60 percent of its single runway peak season ASV, which justifies Runway 15-33 as a secondary runway.
- The top three months of IFR conditions are May (27 percent), June (25 percent), and July (21 percent), which are during the peak summer season or shoulder season (May and September). Due to prevailing winds, Runway 15 is the most favored runway end or in the favored runway use configuration for a combined ten months of the year. Therefore, Runway 15-33 is primary IFR runway.
- Runway 15 has the best instrument approach to the Airport by providing the lowest approach visibility and ceiling minimums. Therefore, Runway 15-33 is primary IFR runway.
- IFR peak hour operations were 79 percent in 2019 and are forecast to exceed 82 percent during the planning period. It is imperative Runway 15-33 remains the primary IFR runway.

5.2.2. Runway Length

A wide variety of aircraft use the Airport daily. These aircraft, both large and small, have different runway requirements. In some cases, smaller or older aircraft may require more runway length than larger aircraft with more efficient engines. A significant number of factors go into determining aircraft performance and the runway requirements that must be met for an aircraft to use a particular runway. These include (but are not limited to):

- **Airport elevation**: The higher the airport elevation, the lower the air density, which translates to less air circulating through the engine resulting in less power. The higher the airport elevation, the longer a runway needs to be.
- **Aircraft weight**: The heavier an aircraft, the longer it takes to take off or slow down. This means the heavier an aircraft (with more passengers, luggage, cargo, and/or fuel – also known as payload), the longer a runway needs to be. Aircraft flying longer distances (stage lengths) require more fuel, which results in heavier aircraft weight and longer runway needs.
- **Temperature**: The higher the temperature, the lower the air density, which means lower combustion and power for engines and lower drag over the wings. This means that the higher the temperature, the more runway length is needed.

- **Longitudinal slope of the runway**: If the runway slopes up, it takes longer for aircraft to take off. Similarly, if a runway slopes down, it takes longer for an aircraft to land.
- **Runway condition (dry/wet/icy/contaminated)**: A dry, clean runway is the best for landing. During rain, snow, ice, sand, dust, or other contamination, there is less traction between the wheels and the runway pavement, which results in longer runway length needed for takeoff and landing.

The FAA has published FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*, to assist in the determination of the required runway length for both the primary and crosswind runways. For airports accommodating aircraft greater than 12,500 pounds (i.e. a King Air turboprop), there are two methodologies identified. Airports that are regularly served by aircraft greater than 60,000 pounds (such as this Airport); the AC suggests using the requirements of the individually most demanding aircraft that meets the critical use threshold. In order to ensure a thorough analysis to validate the need for a longer runway, this Master Plan reviewed ***both*** methodologies and considered ***each*** of the individual aircraft greater than 60,000 pounds that regularly use the Airport to determine adequate runway length ranges based on AC methodologies.

Aircraft Weighing Between 12,500 and 60,000 Pounds (General Aviation)

For airports with predominately GA activity, the FAA has created a series of figures consisting of different groups and operating characteristics of a fleet of GA jet aircraft within the 12,500- to 60,000-pound weight class. Furthermore, these figures depict the requirements associated with operating at 60 percent useful load (the difference between maximum allowable gross weight and the operating empty weight) and 90 percent useful load. These figures are depicted in **Figure 5-1**, **Figure 5-2**, **Figure 5-3**, and **Figure 5-4**.

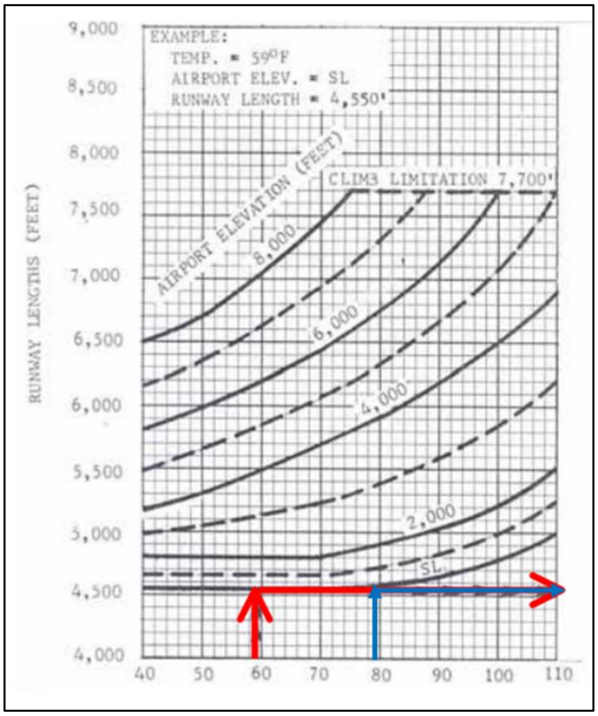
A two-week sampling of flights during the month of February (typically one of the slower months at the Airport) 2021, found there were multiple daily departures to destinations over 1,000 nautical miles (NM) from the Airport including Bozeman, Montana (2,043 NM); Houston, Texas (1,624 NM); and West Palm Beach, Florida (1,174 NM). Aircraft operating at these ranges would likely be operating closer to 90 percent of their useful load as opposed to 60 percent useful load.

Virtually all of the aircraft identified in the 75 percent of the GA fleet in AC 150/5325-4B use the Airport regularly. Aircraft identified in the 100 percent of the GA fleet such as the Bombardier Challenger 600/601/603/604, Dassault Falcon 900/2000, and Lear 45/55/60 also frequent the Airport, with aircraft within this family using the Airport daily.

Based on the data collected with the vast majority of the GA fleet (family of aircraft) using the Airport daily, the range of runway need was identified as follows:

- Average of 100 percent of GA fleet carrying 60-90 percent useful load (**Figure 5-3** and **Figure 5-4**): **6,200-foot runway length identified**.
- Average of 90 percent useful load of aircraft representing 75-100 percent of the fleet (**Figure 5-2** and **Figure 5-4**): **6,700-foot runway length identified**.
- The resulting requirement is a range of approximately **6,200 to 6,700-foot runway length identified**.

Figure 5-1: **General Aviation Fleet 12,500-60,000 pounds, 75% of fleet at 60% Useful Load**



LEGEND:

FAA Sample Analysis

HYA Resulting Analysis

NOTES:

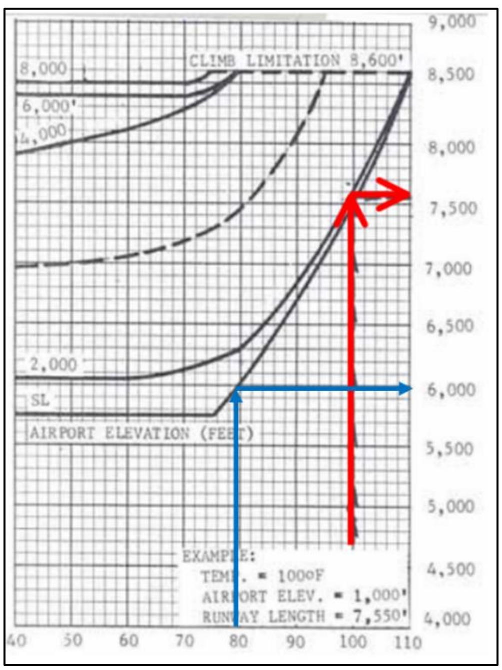
1.) Mean Daily Maximum Temperature = **79.9° F** occurring in July.

2.) Runway Length required for 75% of fleet at 60% useful load = **4,500 feet**

3.) Airport Elevation: **54.1 feet**

Sources: AC 150/5325-4B; NOAA NCDC 1981-2010 Climate Normals temperature data (Avg. Temp of Hottest Month = July – 79.9°F); McFarland Johnson analysis, 2021.

Figure 5-2: **General Aviation Fleet 12,500-60,000 pounds, 75% of fleet at 90% Useful Load**



LEGEND:

FAA Sample Analysis

HYA Resulting Analysis

NOTES:

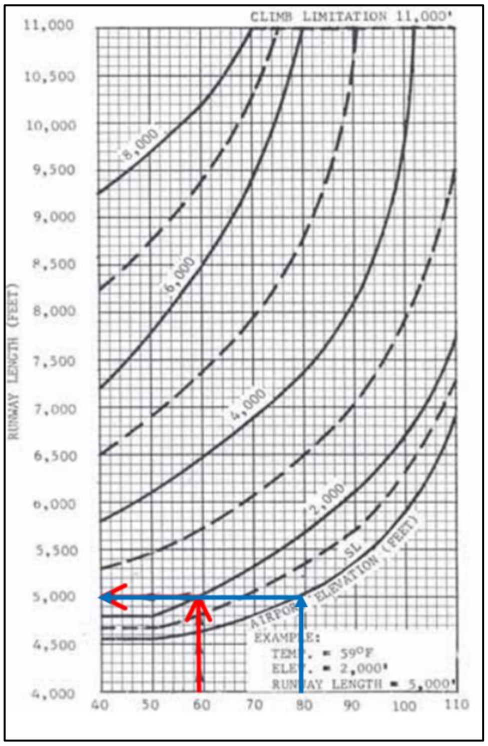
1.) Mean Daily Maximum Temperature = **79.9° F** occurring in July.

2.) Runway Length required for 75% of fleet at 90% useful load = **6,000 feet**

3.) Airport Elevation: **54.1 feet**

Sources: AC 150/5325-4B; NOAA NCDC 1981-2010 Climate Normals temperature data (Avg. Temp of Hottest Month = July – 79.9°F); McFarland Johnson analysis, 2021.

Figure 5-3: General Aviation Fleet 12,500-60,000 pounds, 100% of fleet at 60% Useful Load



LEGEND:

FAA Sample Analysis

HYA Resulting Analysis

NOTES:

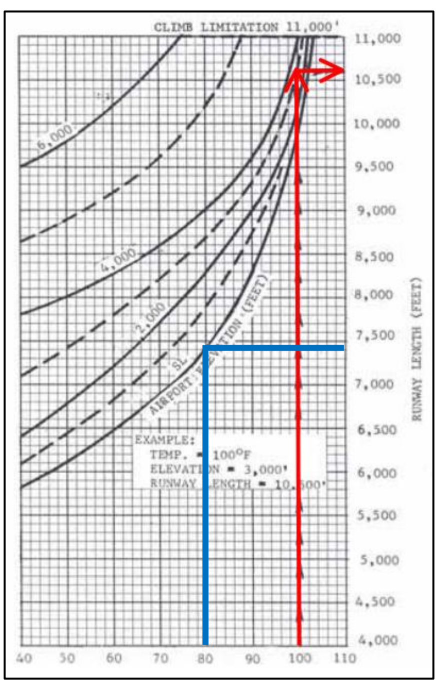
1.) Mean Daily Maximum Temperature = **79.9° F** occurring in July.

2.) Runway Length required for 75% of fleet at 90% useful load = **5,000 feet**

3.) Airport Elevation: **54.1 feet**

Sources: AC 150/5325-4B; NOAA NCDC 1981-2010 Climate Normals temperature data (Avg. Temp of Hottest Month = July – 79.9°F); McFarland Johnson analysis, 2021.

Figure 5-4: General Aviation Fleet 12,500-60,000 pounds, 100% of fleet at 90% Useful Load



LEGEND:

FAA Sample Analysis

HYA Resulting Analysis

NOTES:

1.) Mean daily Maximum Temperature = **79.9° F** occurring in July.

2.) Runway Length required for 75% of fleet at 90% useful load = **7,400 feet**

3.) Airport Elevation: **54.1 feet**

Sources: AC 150/5325-4B; NOAA NCDC 1981-2010 Climate Normals temperature data (Avg. Temp of Hottest Month = July – 79.9°F); McFarland Johnson analysis, 2021.

Aircraft Greater than 60,000 pounds (General Aviation and Commercial)

For commercial facilities like the Airport that are regularly used by aircraft weighing more than 60,000 pounds, FAA AC 150/5325-4B suggests using the requirements of an individual aircraft, typically the most demanding. However, it is also appropriate to look at a family of aircraft using a facility to ensure that you meet the demand for your "typical" fleet and for that reason, this Master Plan considers each of the aircraft within this weight class that regularly use the Airport.

Embraer 190 (Existing User) – Aircraft performance for an E190 varies depending on the weight variant, engine type, and take-off settings used. JetBlue flights are E190 AR[2], so this variant was used for existing and future calculations. For the existing flight to John F. Kennedy International Airport (JFK) at maximum payload (payload is the weight of occupants, cargo, and baggage), runway length information is shown in **Table 5-7**. It is anticipated that longer stage lengths (distance flown) may occur within the planning period. The E190 has conducted over 1,130 operations at the Airport since JetBlue launched service in 2014.

Table 5-7: Runway Length Analysis - Embraer 190 HYA to JFK

Data: The calculation will use the following design conditions:		
a.	Airplane	E190
b.	Mean daily maximum temperature of hottest month at the airport	79.9° Fahrenheit (26.6° C)
c.	Airport elevation	54.1 feet (16.5 m)
d.	Maximum design landing weight	97,003 lbs. (44,000 kg)
e.	Maximum design takeoff weight	114,199 lbs. (51,800 kg)
f.	Maximum difference in runway centerline elevations.	5.2 feet (Runway 6-24) 11.5 feet (Runway 15-33)

Results:	
Standard (MTOW) Runway Length for Takeoff Distance	6,115 feet
HYA-JFK Adjusted Runway Length for Takeoff Distance	5,290 feet

Sources: Embraer 190 Airport Planning Manual; McFarland Johnson analysis, 2021.
Notes: HYA adjusted analysis assumes payload and fuel weights that would be reflective of a typical HYA operation to an airport within the Northeast Corridor (i.e., HYA-JFK).

Additional runway requirement scenarios for longer range flights on the E190 are depicted in **Table 5-13.**

Gulfstream IV/G500 (Existing and Future User) – The Gulfstream G500 (G500) is the representative existing and future GA design aircraft. Aircraft performance for a Gulfstream V varies depending on the weight variant used. Combined with the similar variant, the Gulfstream IV, these aircraft have accounted for over 4,886 operations at the Airport since 2010. A 15 percent contamination

[2] JetBlue Airways Fleet Embraer ERJ-190 Details and Pictures, https://airlinesfleet.com/jetblue-airways-fleet-embraer-erj-190-details-and-pictures/, accessed Oct. 15, 2020.

factor is added to Part 135 operations on takeoff per the AC. Although origin and destination cities have varied, a typical route to/from the Airport ranges up to 1,500 NM. See **Table 5-8**.

Table 5-8: Runway Length Analysis - G500 1,500 NM Flight

Data: The calculation will use the following design conditions:		
a.	Airplane	G500
b.	Mean daily maximum temperature of hottest month at the airport	79.9° Fahrenheit (26.6° C)
c.	Airport elevation	54.1 feet (16.5 m)
d.	Maximum design landing weight	64,350 lbs. (29,189 kg)
e.	Maximum design takeoff weight	79,600 lbs. (36,106 kg)
f.	Maximum difference in runway centerline elevations.	5.2 feet (Runway 6-24) 11.5 feet (Runway 15-33)

Results:	
Standard (MTOW) Runway Length for Takeoff Distance	6,585 feet
HYA + 1,500 NM Adjusted Runway Length for Takeoff Distance	5,265 feet (6,054 feet contaminated)

Sources: Gulfstream G500 Airport Planning Manual; McFarland Johnson analysis, 2021.
Notes: HYA adjusted analysis assumes payload and fuel weights that would be reflective of a typical HYA operation to an airport within a 1,500 NM range.

Bombardier Global 5000/Express (Existing and Future User) - A similar-sized competitor to the Gulfstream V, the Bombardier Global 5000 and Global Express are also frequent Airport users within the 60,000-pound user weight class with over 734 operations at the Airport since 2010. A 15 percent contamination factor is added to Part 135 operations on takeoff per the AC. Although origin and destination cities have varied, a typical route to/from the Airport ranges up to 1,500 NM. See **Table 5-9**.

Table 5-9: Runway Length Analysis - Global 5000/Express 1,500 NM Flight

Data: The calculation will use the following design conditions:		
a.	Airplane	Global Express
b.	Mean daily maximum temperature of hottest month at the airport	79.9° Fahrenheit (26.6° C)
c.	Airport elevation	54.1 feet (16.5 m)
d.	Maximum design landing weight	78,600 lbs. (35,652 kg)
e.	Maximum design takeoff weight	92,500 lbs. (41,957 kg)
f.	Maximum difference in runway centerline elevations.	5.2 feet (Runway 6-24) 11.5 feet (Runway 15-33)

Results:	
Standard (MTOW) Runway Length for Takeoff Distance	6,476 feet
HYA + 1,500 NM Adjusted Runway Length for Takeoff Distance	5,180 feet (5,958 feet contaminated)

Sources: Bombardier Global 5000 Airport Planning Manual; McFarland Johnson analysis, 2021.
Notes: HYA adjusted analysis assumes payload and fuel weights that would be reflective of a typical HYA operation to an airport within a 1,500 NM range.

Airbus A220 (Future User) – Aircraft performance for an Airbus A220 (A220) varies depending on the weight variant used. The longest runway at the Airport (Runway 6-24 at 5,425 feet) accommodates takeoff weights of up to 125,000 pounds in the summer, which does not translate into any useable range due to additional fuel requirements in IFR conditions. For the existing flight to JFK at maximum payload, runway length information is shown in **Table 5-10**. It is anticipated that longer stage/flight lengths may occur within the planning period. Runway length requirements for those are shown in **Table 5-13**. JetBlue began to accept deliveries of the A220 in early 2021 and has publicly stated that this aircraft will replace the E190 on all routes by 2025.

Table 5-10: Runway Length Analysis - A220 HYA to JFK

Data: The calculation will use the following design conditions:		
a.	Airplane	A220
b.	Mean daily maximum temperature of hottest month at the airport	79.9° Fahrenheit (26.6° C)
c.	Airport elevation	54.1 feet (16.5 m)
d.	Maximum design landing weight	129,498 lbs. (58,740 kg)
e.	Maximum design takeoff weight	148,998 lbs. (67,585 kg)
f.	Maximum difference in runway centerline elevations.	5.2 feet (Runway 6-24) 11.5 feet (Runway 15-33)

Results:	
Standard (MTOW) Runway Length for Takeoff Distance	6,200 feet
HYA-JFK Adjusted Runway Length for Takeoff Distance	5,865 feet

Sources: Airbus A220-300 Airport Planning Manual, McFarland Johnson analysis, 2021.
Notes: HYA adjusted analysis assumes payload and fuel weights that would be reflective of a typical HYA operation to an airport within the Northeast Corridor (i.e., HYA-JFK).

Since 2010, there have been nearly 7,000 operations on aircraft over 60,000 pounds. The existing commercial and GA design aircraft are the E190 and Gulfstream V/G500, respectively. The future commercial design aircraft for the Airport is the A220. The existing and proposed design aircraft should be reviewed on an individual basis per FAA AC 150/5325-4B. Additional aircraft were reviewed due to their existing use of the Airport as well as for planning purposes. In the current uncertain times of the COVID-19 pandemic, airlines are retiring portions of their fleet earlier than originally planned. This may result in Airbus A320 (A320) operations at the Airport when the E190 retires, if the A220 aircraft are not already in use for the HYA-JFK route. **Table 5-11** shows the FAA standard runway length analysis for the aircraft identified in this Master Plan at MTOW and MLW, which is consistent with the guidance in the FAA Runway Length AC.

Table 5-11: FAA Standard Runway Length Analysis at MTOW and MLW

	Takeoff (feet)	Landing (feet)
E190 AR (commercial)	6,115 – 8,915	4,655 – 5,175
G500 (GA)[1]	6,585 – 6,585	3,100 – 4,100
Global Express (GA)[2]	5,540 – 6,540	2,670 – 3,670
A220 (commercial)	6,200 – 9,415	4,950 – 5,950
A320 (commercial)	5,515 – 7,515	5,290 – 5,635

[1]This aircraft also represents the GIV and G650 which would be expected to have similar performance.
[2]This aircraft also represents the Global 5000 which would be expected to have similar performance.
Sources: FAA AC 150/5325-4B; Gulfstream GV Planning Manual; Gulfstream.com; GlobalAir.com; Embraer 190 Planning Manual; Airbus A320 Planning Manual; McFarland Johnson analysis, 2021.

Since existing and proposed routes do not necessarily use MTOW and MLW, the following is a more specific analysis of runway length needs at the Airport. As shown in **Table 5-12**, it is anticipated that with the future design aircraft and the existing fleet of GA aircraft already using the facility, the existing runway length will need to increase to accommodate the mix of aircraft.

Table 5-12: HYA-Based Runway Length Analysis

	HYA Adjusted Takeoff Length (feet)
E190 (Commercial HYA-JFK)	5,290
G500 (GA 1,000 NM)[1]	6,054
Global Express (GA 1,000 NM)[2]	5,958
A220 (Commercial HYA-JFK)	5,865
A320 (Commercial HYA-JFK)	6,000

[1]This aircraft also represents the GIV and G650 which would be expected to have similar performance.
[2]This aircraft also represents the Global 5000 which would be expected to have similar performance.
Sources: Embraer 190 Airport Planning Manual; Airbus A220-300 Airport Planning Manual; Airbus A320 Airport Planning Manual; Gulfstream V Planning Manual; Gulfstream.com; GlobalAir.com; McFarland Johnson Analysis, 2020.

Forecast Scenario Considerations

In addition to the aircraft above that represent both existing the future users, this Master Plan considers forecast scenarios as identified in the forecast chapter. These forecast scenarios largely considered regional airline service and/or less than daily ultra-low-cost carriers (ULCCs). The aircraft associated with these scenarios are as follows:

Embraer 175 (Forecast Scenario) – The Embraer 175 (E175) is widely used by regional air carriers operating under brands such as Delta Connection, American Eagle, and United Express. At full load, the aircraft can carry up to 76 passengers, and approximately 5,515 feet or runway would be required for takeoff assuming the aircraft was carrying a payload respective of a short regional flight, such as Washington D.C. which is 350 NM from the Airport. Additional runway requirements are depicted in **Table 5-13**.

Bombardier CRJ-700 (Forecast Scenario) – Similar to the E175, the Bombardier CRJ-700 (CRJ-700) is another popular short- to medium-range twin engine jet in wide use by U.S. regional airline carriers. The CRJ-700 has very similar performance to the E175 and can seat 66-70 passengers in certain configurations. Runway requirements for the CRJ-700 are depicted in **Table 5-13**.

Table 5-13: Forecast Scenario Runway Requirements

Common Origin/Destination Airports	Takeoff (feet)[1]	Landing (feet)[1]
CRJ-700 – Atlanta	5,915	5,980
CRJ-700 – DC	5,215	5,980
E175 – Atlanta	7,615	5,290
E175 – DC	5,515	5,290
E190 – Atlanta	7,665	5,175
E190 – DC	6,315	5,175
A220 – Atlanta	6,365	5,578
A220 – DC	5,965	5,578
A320 – JFK	5,015	5,520
A320 – Orlando	6,015	6,325
A320 – Ft. Myers	6,115	6,383

[1] Distances are shown at sea level and during standard atmospheric conditions. Takeoff distances are longer on a hot, summer day. These are adjusted for runway slope and wet runways.
Sources: CRJ-700 Planning Manual, Embraer 175 Planning Manual, Embraer 190 Planning Manual, Airbus A220 Planning Manual, Dassault Falcon 900 Planning Manual, Jet Advisors (accessed May 14, 2020), McFarland Johnson analysis, 2020.

Airbus A320 (Forecast Scenario) – In light of the Covid-19 pandemic, JetBlue may retire its E190 aircraft sooner than originally planned. It is prudent that the Airport plans for A320 service, so that it does not lose its ability to offer airline service by an existing operator. Aircraft performance for an A320 varies depending on weight variant used. At full passenger load (150 passengers), approximately 6,115 feet of runway would be required for takeoff. For the existing flight to JFK at maximum payload, runway length information is shown in **Table 5-12**. It is anticipated that longer stage lengths may occur within the planning period. Runway length requirements for those are shown in **Table 5-13**. It should be noted

QUALITATIVE PERSPECTIVE

Year-Round Residents: Live Where You Work; Work Where You Live

Year-round service would allow people to fly in and out of the Airport instead of driving to Boston or Providence. A longer runway would support year-round service. This could result in:

- Reducing car congestion/traffic
- Potential for alternate modes of transportation – consideration for a multi-modal center

PLANNING CONSIDERATION

Both GA and commercial runway length analyses support a runway extension.

that most airlines using the A320 will not consider flying into an airport that does not have a 6,000-foot-long runway.

Additionally, the following aircraft were reviewed for certain scenarios to account for potential changes at the Airport. The CRJ-700 and E175 were reviewed for a stage length of approximately 350 NM, for example to Washington D.C, and 825 NM, for example to Atlanta, common origin/destination airports from the northeast region. This is shown in **Table 5-13**.

Per H.R.302 -FAA Reauthorization Act of 2018, Section 47106 of title 49 of the United States Code, "When evaluating the master plan of an airport […], the Secretary shall take into account (1) the role and airport plays with respect to medical emergencies and evacuations; and (2) the role the airport plays in emergency or disaster preparedness in the community served by the airport."[3]

For the entire Cape, HYA is the only public airport with runways that exceed 5,000 feet. In the case of an emergency that requires evacuations of large portions of the population, the Airport will play a key role in evacuations. For these purposes, aircraft similar to Boeing 737/A320-type aircraft should be considered. Generally, these have takeoff distances around 6,400 feet.

Recommendation for Runway Length: Based on the analysis of existing general aviation fleet mix as well as each of the individual aircraft greater than 60,000 pounds that regularly use the Airport, planning for a runway with a length of between 6,000 and 6,400 feet would be considered reasonable based on the guidance outlined in FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*. In addition to this recommendation being the requirement for existing and future users, it is also consistent with the forecast scenarios identified in the forecast chapter; the requirements for the forecast scenarios do not change this recommendation.

PLANNING CONSIDERATION

Previous studies have presented an option to extend Runway 15-33 to between 6,325 and 7,119 feet. Multiple discussions on the need for a longer runway have occurred over the past 20 years. The 2008 Airport Layout Plan depicted a 926-foot extension to Runway 15-33.

This Master Plan revalidates the need for a runway extension based on existing GA and commercial aircraft operating at HYA and anticipated changing aircraft fleet mix.

While the AC suggests that this requirement be applicable to both runways, being cognizant of the physical requirements that will be further detailed in the alternatives chapter, the secondary

[3] https://www.congress.gov/115/plaws/publ254/PLAW-115publ254.pdf

runway length requirement for the runway not extended is 5,500 feet based on accommodating the full general aviation fleet in wet conditions. This runway should also meet RDC-C-III standards.

PLANNING CONSIDERATION

A Runway 15-33 extension could alleviate and help offset capacity challenges at Nantucket Memorial and Martha's Vineyard Airports.

5.2.3. Runway Width

Runways 6-24 and 15-33 are both 150 feet wide. C-III runways have standard width of 100 to 150 feet, depending on the MTOW. For airplanes with MTOW of 150,000 pounds or less, the standard runway width is 100 feet. For airplanes with MTOW of greater than 150,000 pounds, the standard runway width is 150 feet. The current critical aircraft (E190) is being phased out of the North American market by most operators. Two airlines have already retired their Embraer fleet, the largest Embraer operator (JetBlue) is in the process of retiring its fleet and replacing it with the A220, which has a MTOW greater than 150,000 pounds. Both runways meet and should continue to meet FAA standards for C-III runways for greater than 150,000 pounds.

Recommendation for Runway Width: No changes are recommended for Runways 6-24 and 15-33.

PLANNING CONSIDERATION

Should Runway 15-33 not be extended, Runway 6-24 may need to be strengthened to accommodate the design aircraft.

5.2.4. Runway Strength and Condition

Runway Pavement Strength

Pavement strength requirements are related to three primary factors: 1) the weight of aircraft anticipated to use an airport, 2) the landing gear type and geometry of the gear, and 3) the volume of aircraft operations. Airport pavement design, however, is not predicated on a particular weight that is not to be exceeded.

QUALITATIVE PERSPECTIVE

Maintaining two runways at C-III standards allows jet aircraft to use either runway based on wind speed and direction, which keeps a balanced field. The balanced field means no neighborhood is disproportionately impacted.

The Pavement Classification Number (PCN) expresses the load-carrying capacity of a pavement for unrestricted operations[4]. This number is compared to the Aircraft Classification Number (ACN), which is unique to each aircraft, its weight, number of tires, tire pressure, and other factors. The ACN should remain below the PCN to prevent excessive wear and prolong the pavement's useable life. **Table 5-14** shows an ACN and PCN comparison for the Airport.

[4] For information on different components of the PCN, visit: https://www.skybrary.aero/index.php/Pavement_Classification_Number_(PCN).

Table 5-14: Pavement Strength Review

	ACN	Runway 6-24 PCN	Runway 15-33 PCN	Runway Strength Needed
E190	17-27	32/F/A/X/T	43/F/A/X/T	None
A320	19-42	32/F/A/X/T	43/F/A/X/T	Potential Runway 6-24
A220	15.5-31.8	32/F/A/X/T	43/F/A/X/T	None
Gulfstream GV/G500	12-28	32/F/A/X/T	43/F/A/X/T	None

Note: F – Flexible, A – High Strength, X – High Pressure, T – Technical Evaluation; For more details see MassDOT Aeronautics PCI map: https://idea.appliedpavement.com/hosting/massachusetts/airport-details/airport-details.html.

Sources: Embraer 190 Airport Planning Manual, 2013; https://www.grad.unizg.hr/_download/repository/2_acn-tablica.pdf, accessed May 14, 2020; Airbus A220 Airport Planning Manual, 2020; McFarland Johnson analysis, 2020.

Recommendation for Runway Pavement Strength: Runway 6-24 is anticipated to be reconstructed within the planning period (by 2040). Additional recommendations may be made as the result of the 2020 state pavement management study.

Runway Pavement Condition

Massachusetts Department of Transportation (MassDOT) Aeronautics started a new pavement condition index (PCI) update project for 2020. The PCI scale indicates that pavement with a PCI of:

- 71-100 should receive preventative maintenance,
- 41-70 should receive major rehabilitation, and
- 0-40 should be reconstructed.

The most current published 2016[5] showed Runway 15-33 at a PCI between 47 and 64. Runway 15-33 was reconstructed in 2017. Runway 6-24 at a PCI between 30 and 70. Runway 6-24 is due to be rehabilitated in the short-term.

Recommendation for Runway Pavement Condition: The Airport should continue its pavement management plan. Any pavement condition with a PCI rating of 40 or less should be rehabilitated/reconstructed in the short-term. Pavement assessed as 41-70 should be rehabilitated within the planning period.

5.2.5. Runway Orientation

A significant factor in evaluating a runway's orientation is the direction and velocity of the prevailing winds. Ideally, all aircraft take off and land in the direction of the wind. A runway

[5] MassDOT Aeronautics PCI map, accessed April 9, 2021 <https://idea.appliedpavement.com/hosting/massachusetts/airport-details/airport-details.html>.

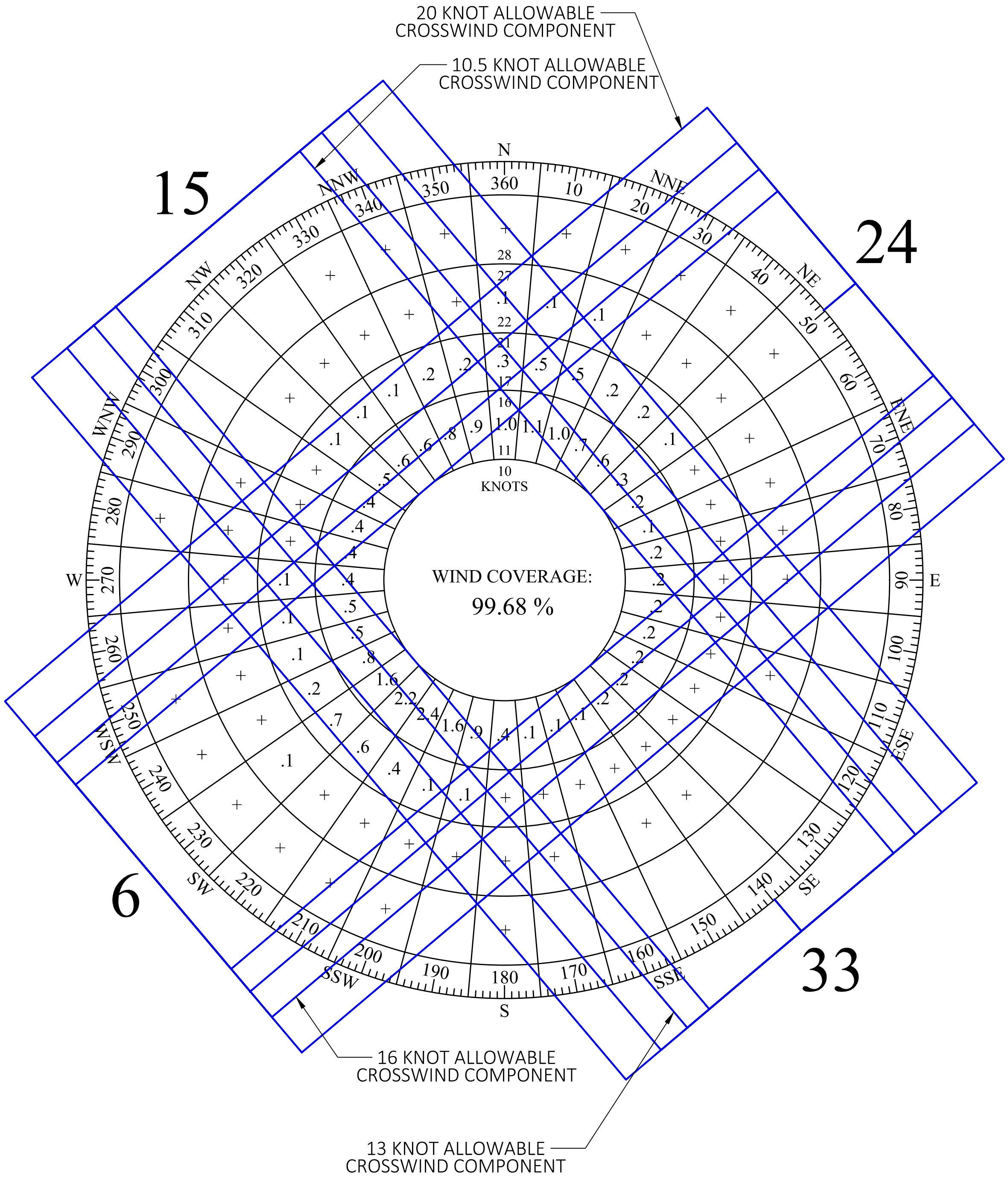
alignment that does not allow an aircraft to go directly into the wind creates what is known as a crosswind component (i.e. winds at an angle to the runway in use), which makes it more difficult for a pilot to guide the airplane down the intended path. The commonly used measure of degree to which a runway is aligned with the prevailing wind conditions is the wind coverage percentage, which is the percent of time crosswind components are below an acceptable velocity. Essentially, this measure indicates the percentage of time aircraft within a particular design group will be able to safely use the runway. Current FAA standards recommend that airfields provide 95 percent wind coverage.

Runway wind coverage varies month to month at the Airport. Wind data for the Airport was obtained from NOAA. The wind data was collected for a 10-year period from 2010 through 2019 at the Airport, and was compiled into all weather, IFR, and VFR wind roses presented in **Figure 5-5**, **Figure 5-6**, and **Figure 5-7** respectively. The RDC of C-III coverage is shown by the 16-knot coverage percentages.

The wind roses show the percentage of time winds at the Airport originated from different directions at various velocities. These percentages were then analyzed based on a monthly basis and for individual runway orientations. All weather, IFR, and VFR percentages are shown in **Table 5-15**, **Table 5-16**, and **Table 5-17**, respectively. Ideally, the primary instrument runway at an airport should be the runway that has the highest percentage of wind coverage under IFR conditions, during which an approach procedure is needed.

According to the monthly wind analysis, Runway 6-24 does not meet the FAA required minimum 95 percent wind coverage for 10.5 or 13 knots in any weather conditions. Therefore, a crosswind runway is necessary. Runway 15 has the best IFR approach at the Airport. During the summer months, when the Airport is at its peak of operations, Runway 15 is the favored runway end during IFR conditions. Throughout the months with the highest percentage of IFR wind conditions, Runway 15 is the single most used runway end due to prevailing winds. From 2010 to 2019, IFR operations accounted for approximately 18.9 percent of the total number of annual operations. Runway 15, the primary instrument runway, accounted for an average of 8,082 operations per year. This equates to approximately 47.1 percent of all IFR operations and 8.9 percent of total annual operations.

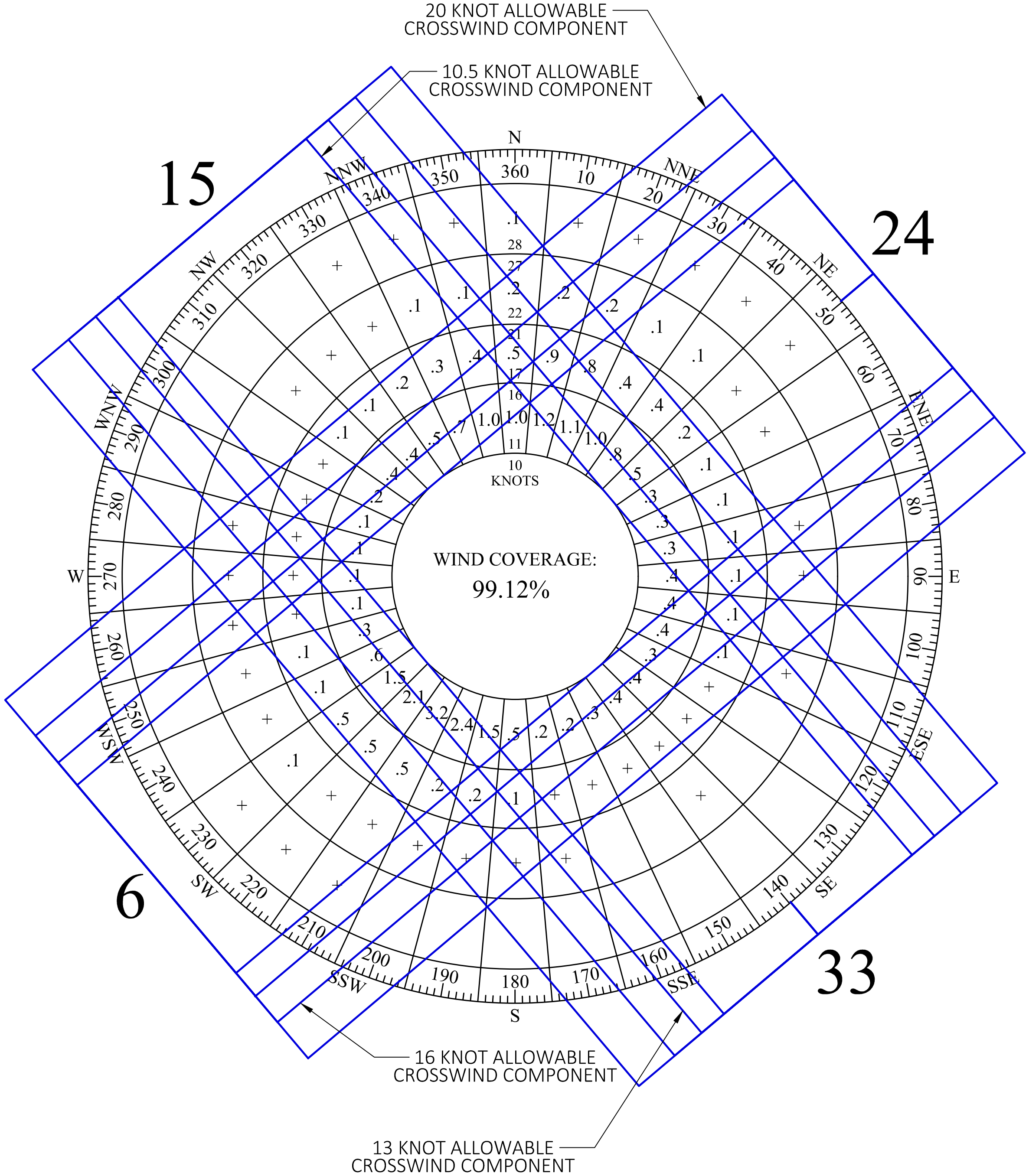
Figure 5-5: HYA All Weather Wind Rose



ALL WEATHER				
	10.5kt	13kt	16kt	20kt
RUNWAY 6-24	89.54%	94.24%	97.95%	99.38%
RUNWAY 15-33	78.85%	86.12%	93.33%	97.35%
COMBINED	97.19%	98.95%	99.68%	99.95%

Source: https://www7.ncdc.noaa.gov/CDO/cdoselect.cmd

Figure 5-6: HYA IFR Wind Rose



IFR				
	10.5kt	13kt	16kt	20kt
RUNWAY 6-24	86.43%	91.94%	96.43%	98.65%
RUNWAY 15-33	72.35%	81.64%	90.88%	96.39%
COMBINED	94.55%	97.54%	99.12%	99.83%

Source: https://www7.ncdc.noaa.gov/CDO/cdoselect.cmd

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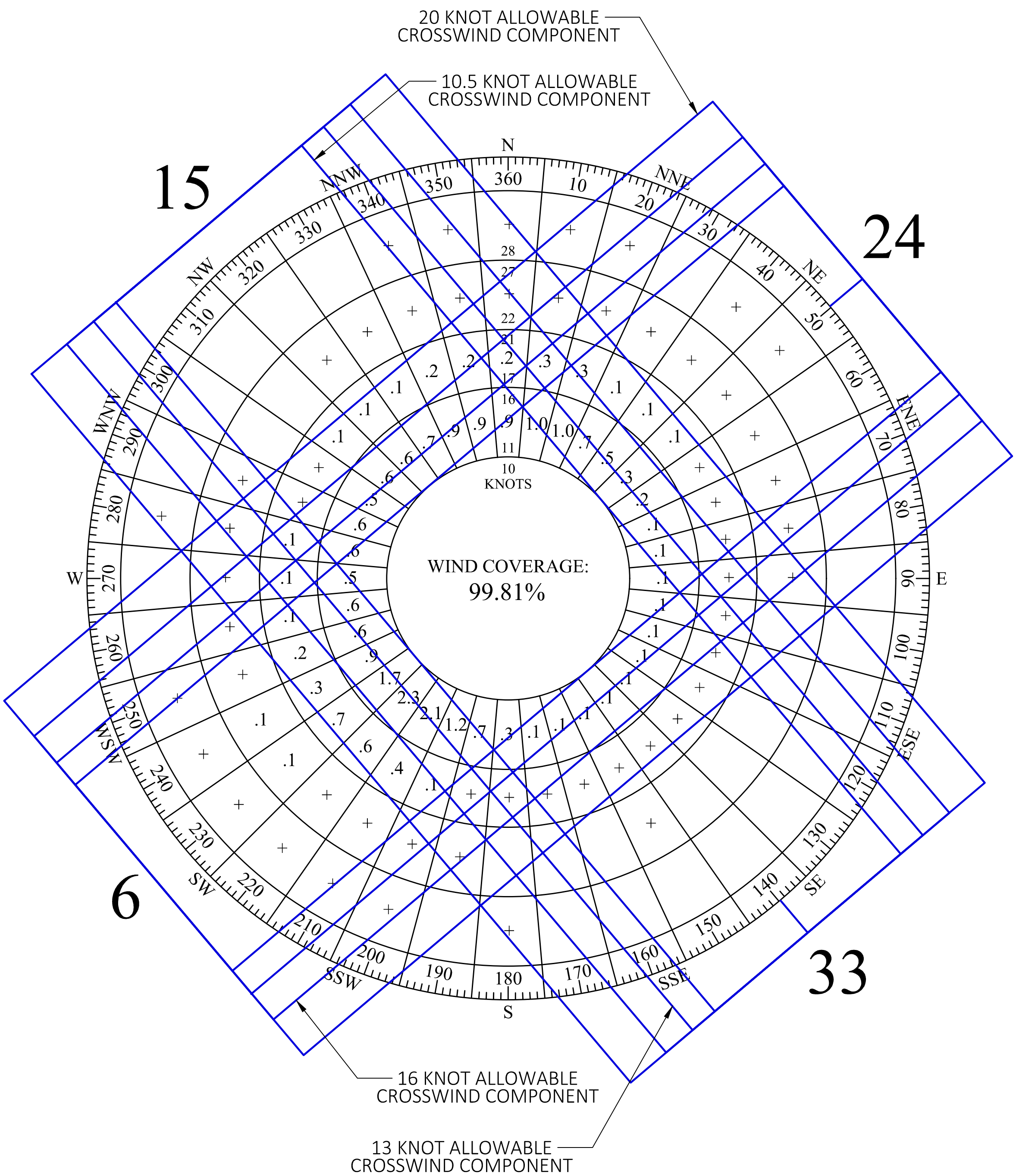
Figure 5-7: HYA VFR Wind Rose



VFR				
	10.5kt	13kt	16kt	20kt
RUNWAY 6-24	90.26%	94.78%	98.30%	99.56%
RUNWAY 15-33	80.36%	87.28%	93.90%	97.57%
COMBINED	97.81%	99.27%	99.81%	99.98%

Source: https://www7.ncdc.noaa.gov/CDO/cdoselect.cmd

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Table 5-15: All Weather[1] Runway Wind Coverage Analysis

RWY	10.5 knots			13 knots			16 knots		
	15-33	6-24	Both	15-33	6-24	Both	15-33	6-24	Both
Jan.	79.71%	83.31%	94.64%	85.95%	90.20%	97.64%	92.09%	96.61%	99.32%
Feb.	81.53%	82.69%	95.48%	88.02%	89.36%	98.09%	93.73%	95.23%	99.44%
Mar.	80.33%	80.32%	92.55%	88.55%	88.55%	96.80%	95.66%	95.65%	99.11%
Apr.	75.37%	87.33%	96.06%	84.17%	93.45%	98.79%	92.27%	97.81%	99.80%
May	78.34%	93.56%	97.75%	85.90%	97.11%	99.44%	93.62%	99.41%	99.89%
Jun.	79.44%	94.26%	98.58%	87.34%	97.50%	99.77%	94.84%	99.57%	99.97%
Jul.	77.59%	97.17%	99.24%	86.14%	98.99%	99.83%	94.74%	99.80%	99.94%
Aug.	80.17%	97.20%	99.26%	87.46%	98.92%	99.84%	95.09%	99.78%	99.94%
Sep.	78.90%	95.09%	98.22%	86.97%	97.83%	99.40%	94.98%	99.43%	99.85%
Oct.	77.06%	91.01%	97.13%	84.18%	94.96%	98.90%	91.30%	98.08%	99.68%
Nov.	78.22%	85.87%	95.19%	85.41%	91.74%	98.01%	92.33%	96.85%	99.44%
Dec.	84.88%	86.53%	96.70%	90.42%	92.25%	98.85%	95.04%	97.09%	99.77%

[1] All Weather Conditions: all cloud ceiling and visibility conditions

Less than FAA required 95%; Equal to or greater than FAA required 95%

Sources: NOAA, 2010-2019; McFarland Johnson analysis, 2020.

Table 5-16: IFR[1] Runway Wind Coverage Analysis

RWY	10.5 knots			13 knots			16 knots		
	15-33	6-24	Both	15-33	6-24	Both	15-33	6-24	Both
Jan.	67.52%	74.17%	87.23%	76.45%	82.44%	93.16%	85.40%	90.59%	97.22%
Feb.	71.55%	77.76%	91.29%	80.64%	84.70%	95.24%	89.85%	91.14%	98.04%
Mar.	62.26%	69.33%	85.20%	71.73%	81.83%	95.24%	81.84%	92.91%	97.36%
Apr.	67.47%	84.16%	95.86%	78.73%	90.84%	99.00%	89.34%	96.18%	99.95%
May	80.44%	93.26%	97.58%	87.57%	96.97%	99.11%	94.68%	99.33%	99.76%
Jun.	77.48%	93.04%	98.45%	86.75%	97.01%	99.62%	95.30%	99.48%	99.91%
Jul.	73.33%	96.42%	98.72%	84.55%	98.43%	99.55%	95.18%	99.48%	99.85%
Aug.	76.57%	96.29%	99.07%	85.28%	98.35%	99.84%	94.41%	99.77%	100.00%
Sep.	73.48%	93.32%	96.31%	83.22%	96.73%	98.57%	93.75%	98.89%	99.64%
Oct.	68.93%	90.40%	96.33%	79.46%	94.56%	98.66%	89.63%	97.51%	99.42%
Nov.	67.63%	80.64%	89.62%	76.64%	87.84%	94.52%	86.76%	94.14%	97.80%
Dec.	74.51%	83.48%	95.57%	82.85%	89.83%	98.51%	90.24%	95.49%	99.68%

[1] IFR Weather Conditions: cloud ceiling less than 1,000 feet and/or visibility below three statue miles

Less than FAA required 95%; Equal to or greater than FAA required 95%

Sources: NOAA, 2010-2019; McFarland Johnson analysis, 2020.

Table 5-17: VFR[1] Runway Wind Coverage Analysis

RWY	10.5 knots			13 knots			16 knots		
	15-33	6-24	Both	15-33	6-24	Both	15-33	6-24	Both
Jan.	82.45%	85.36%	97.28%	88.09%	91.94%	99.07%	93.60%	97.96%	99.79%
Feb.	84.07%	83.95%	97.39%	89.90%	90.55%	99.18%	94.72%	96.27%	99.80%
Mar.	77.72%	82.72%	95.40%	85.02%	90.02%	98.23%	91.81%	96.25%	99.50%
Apr.	77.39%	88.14%	96.76%	85.56%	94.12%	98.93%	93.02%	98.23%	99.76%
May	77.50%	93.68%	98.24%	85.27%	97.16%	99.57%	93.19%	99.44%	99.95%
Jun.	80.05%	94.64%	98.88%	87.53%	97.65%	99.82%	94.69%	99.60%	99.99%
Jul.	78.56%	97.34%	99.36%	86.50%	99.12%	99.89%	94.63%	99.88%	99.97%
Aug.	80.80%	97.36%	99.29%	87.84%	99.02%	99.84%	95.21%	99.78%	99.93%
Sep.	80.11%	95.49%	98.64%	87.80%	98.07%	99.58%	95.25%	99.55%	99.90%
Oct.	78.61%	91.14%	97.95%	85.08%	95.05%	99.20%	91.63%	98.19%	99.73%
Nov.	79.67%	86.59%	96.97%	86.61%	92.27%	98.91%	93.09%	97.22%	99.67%
Dec.	87.12%	87.19%	97.63%	92.06%	92.77%	99.17%	96.07%	97.44%	99.79%

[1] VFR Weather Conditions: cloud ceilings equal to or greater than 1,000 feet and visibility equal to or greater than three statute miles

Less than FAA required 95%; Equal to or greater than FAA required 95%

Sources: NOAA, 2010-2019; McFarland Johnson analysis, 2020.

Further review of the data shows that one single runway is not the favored runway. **Appendix G** shows the breakdown of wind coverage by runway end. This analysis shows that Runways 24 and 33 are typically the two favored runway ends during all weather and VFR conditions. However, the favored runway ends during IFR conditions vary between Runway 6, 15, and 24 depending on wind speed. At higher wind speeds during peak season, Runway 15 is the favored runway. Runway 15 was favored from April through September. Peak month operations at the Airport account for approximately 11.5 percent of the total operations at the Airport. During the summer season, JetBlue operates its C-III aircraft out of the Airport. Due to prevailing winds, Runway 15 is the favored runway end during IFR conditions for larger aircraft in the summer season, when JetBlue is operating; it would be appropriate to extend Runway 15-33 during the planning period. Annual wind coverage percentage is shown in **Table 5-18.**

Table 5-18: Annual Wind Coverage

All-Weather				
	10.5	13	16	20
Runway 6-24	89.54%	94.24%	97.95%	99.38%
Runway 15-33	78.85%	86.21%	93.33%	97.35%
Combined	97.19%	98.95%	99.68%	99.95%

IFR				
	10.5	13	16	20
Runway 6-24	86.43%	91.94%	96.43%	98.65%
Runway 15-33	72.35%	81.64%	90.88%	96.39%
Combined	94.55%	97.54%	99.12%	99.83%

VFR				
	10.5	13	16	20
Runway 6-24	90.26%	94.78%	98.30%	99.56%
Runway 15-33	80.36%	87.28%	93.90%	97.57%
Combined	97.81%	99.27%	99.81%	99.98%

Sources: NOAA, 2010-2019; McFarland Johnson analysis, 2020.

Summary and Recommendation for Runway Orientation:

- Wind coverage for Runway 6-24 does not meet 95 percent wind coverage for all weather, IFR, or VFR conditions at 10.5 knots or 13 knots.
- A crosswind runway is justified for 10.5 and 13 knots for any weather conditions.
- Based on **Section 5.2.1**, Runway 15-33 is justified as a C -III Secondary Runway.
- Runway 15-33 accounts for approximately 53 percent of all IFR operations and is considered the primary IFR runway.
- Maintain both Runways 6-24 and 15-33 in their current orientation and as C-III runways.

5.2.6. Runway Safety Areas

Runway safety areas (RSAs) are defined by the FAA as surfaces surrounding a runway that are prepared or suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or excursion from the runway. RSAs consist of a relatively flat graded area free of man-made and natural obstructions that could damage aircraft. According to FAA guidance, the RSA should be capable, under dry conditions, of supporting aircraft rescue and firefighting (ARFF) equipment, and the occasional passage of aircraft without causing structural damage to the aircraft. The FAA design standards for RSAs surrounding runways serving C-III aircraft (both runways) is a width of 500 feet, a length that extends 600 feet prior to the landing threshold, and a length that extends 1,000 feet beyond the runway end. These are shown visually in **Figure 5-8**.

There is an existing RSA determination in place for both Runways 6-24 and 15-33 that was approved on September 13, 2000. This RSA determination noted that upgrading the RSA to the Runway 33 end was deemed not feasible. In order to create a standard RSA, the Airport would need to purchase property, relocate public roads, relocate utilities and parking lots, purchase and demolish existing structures, grade terrain, and replace some objects with frangible objects (including wind cones and potentially glide slopes). Since this determination, an engineered materials arresting system (EMAS) was constructed at the Runway 6 end, resolving the RSA standards for that runway end. An EMAS is a bed of engineered materials built at the end of a runway to reduce the severity of the consequences of a runway overrun. This is similar to a truck overrun area off a highway. Mitigation efforts to address the Airport perimeter road have also been performed by providing signage to inform vehicles that the road is entering into the RSAs. The RSA determination and Modifications of Design Standards (MOS) at the Airport are summarized in **Table 5-19**. All MOS can be found in **Appendix I**.

As part of any planning study, a review of incremental improvements to RSAs needs to be made. **Table 5-20** shows what areas of a full dimension RSA would be non-standard.

Table 5-19: RSA Determination and Modifications of Design Standards

MOS No.	Summary	Approved	Active
N/A	Runways 15-33 and 6-24 RSA Determination	09/13/00	Yes
28	Maximum Runway Edge Light Spacing	01/10/78	No
34	Radio Control of Runway Edge Lights with ALSF-1 Lighted During Hours of Control Tower Closure	02/16/78	Yes
88	Runway 15 Runway-Runway Intersection Sign Installed 325' From Runway 6-24	09/18/89	Yes
90	Taxiway Holding Locations	07/11/84	No
93	Clearing of Transitional Surface (Runway 15-33)	03/15/91	Yes
101	Penetrations of Primary Surface for Runway 6-24	07/16/93	Yes
106	Reduced Runway/Taxiway Separation Distance between Runway 15-33 and Taxiway A	08/17/98	No

N/A – Not applicable
Source: Cape Cod Gateway Airport, 2019.

Declared distances, which are defined by FAA AC 150/5300-13A as "maximum distances available and suitable for meeting takeoff, rejected takeoff, and landing distances performance requirements for turbine powered aircraft", may be used to obtain additional RSA and/or runway object free area (ROFA), to mitigate incompatible land uses in the runway protection zone (RPZ), to meet runway approach and/or departure surface clearance requirements, or to mitigate environmental impacts. When an EMAS is installed, all runways of an airport will have published declared distances. Both runways have published declared distances, as shown in **Table 5-21**.

Table 5-20: Full Dimension RSA Non-Standard Conditions

Location	Penetration
South Corner of Runway 33	Two Buildings not owned by the Airport
Runway 15-33	Terrain
Northeast Side of Runway 24	Yarmouth Road, Airport Perimeter Fence, Railroad Tracks, Buildings
Runway 6-24	Terrain

Source: McFarland Johnson Analysis, 2020.

Table 5-21: Declared Distances

Runway	6/24 (feet)	15/33 (feet)
Takeoff Run Available (TORA)	5,425 / 5,425	5,253 / 5,253
Takeoff Distance Available (TODA)	5,425 / 5,425	5,253 / 5,253
Accelerate-stop Distance Available (ASDA)	5,425 / 5,425	5,253 / 5,253
Landing Distance Available (LDA)	5,019 / 5,425	5,253 / 5,103

Source: FAA Form 5010-1, effective 2/27/2020 (viewed 3/23/2020).

Recommendation for Runway Safety Areas: The Airport should control full dimension RSAs through ownership whenever possible or review for incremental improvements with RSAs with equivalent levels of safety.

5.2.7. Runway Object Free Areas

In addition to the RSA, a Runway Object Free Area (ROFA) is also centered around runways to enhance the safety of aircraft operations. The FAA defines ROFAs as an area cleared of all objects except those that are related to navigational aids and aircraft ground maneuvering. However, unlike the RSA, there is no requirement to support an aircraft or emergency response vehicles.

FAA design standards for ROFAs surrounding runways serving AAC-ADG C-III aircraft are a width of 800 feet, a length that extends 600 feet prior to the landing threshold, and a length that extends 1,000 feet beyond the runway end as shown in **Figure 5-8**. ROFAs and objects within it should be at or below the nearest RSA elevation.

There are multiple penetrations to both ROFAs. ROFA penetrations are listed in **Table 5-22** and can be seen in **Figure 5-8**. According to Order 5300.1G, *Modifications to Agency Airport Design, Construction, and Equipment Standards*, MOS need to be updated every five years. The existing MOS's can be seen in **Table 5-19** and found in **Appendix I**.

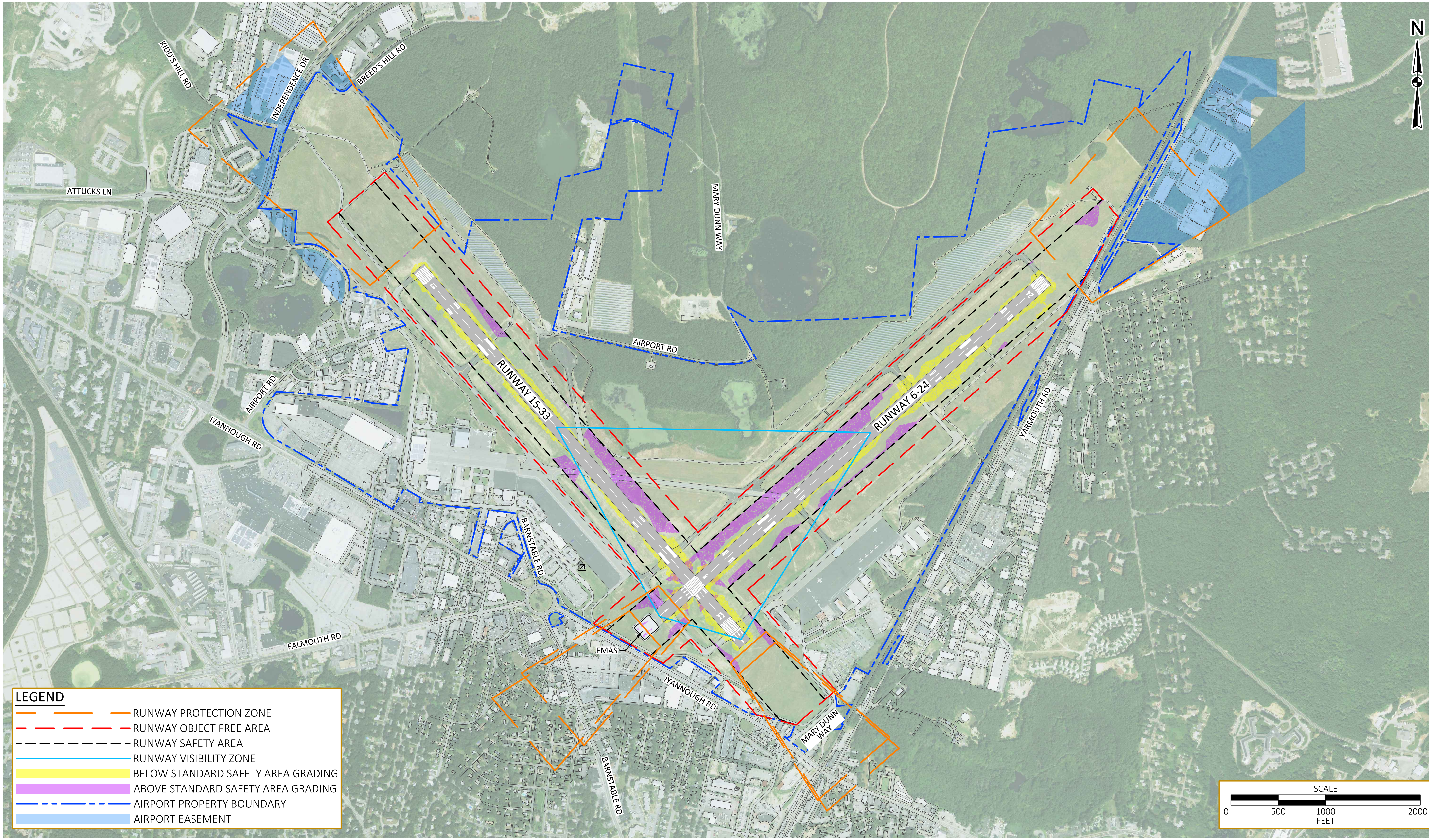
Table 5-22: ROFA Penetrations

Location	Penetration
Runway 33 End	Iyannough Road, Mary Dunn Way, four off-Airport buildings, Airport perimeter fence, ARFF/Maintenance/SRE Ramp;
Runway 24 End	Yarmouth Road, railroad tracks, Airport perimeter fence
Runway 15	Glideslope, runway visual range (RVR), wind cone
Runway 15-33 along the side of the runway	Distance measuring equipment (DME), precision approach path indicator (PAPI) power and control units
Runway 6-24 along the side of the runway	Localizer, DME, PAPI power and control units, glideslope, ASOS

Source: McFarland Johnson, 2020.

Recommendation for Runway Object Free Areas: ROFAs penetrations should be mitigated where possible. MOS should be updated every five years.

Figure 5-8: Airport Design Surfaces



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5.2.8. Runway Protection Zones

RPZs are large trapezoidal areas on the ground off each runway end that are within aircraft approach and departure paths as shown in **Figure 5-8**.

The RPZ is intended to enhance the protection of people and property on the ground. Many land uses (i.e. residential, places of public assembly, fuel storage) are prohibited by FAA standards within these areas. However, these limitations are only enforceable if the RPZ is owned or controlled by the Airport sponsor. Airport control of these areas is strongly recommended and is primarily achieved through Airport property acquisition, but can also occur through easements or zoning to control development and land use activities.

PLANNING CONSIDERATION

For both existing RPZs as well as potential changes, the Airport should continuously monitor opportunities for incremental improvements through enhanced land controls with in the RPZs through easement or fee simple acquisition as they arise.

The dimensions of the RPZ for each runway end are a function of the type of aircraft and the approach visibility minimums associated with operations on that runway. The RPZ begins 200 feet beyond the end of the area useable[6] for takeoff and landing for all runways. The existing approach visibility minimums are shown in **Table 5-23**.

The Airport currently owns land in fee or easement off Runway 15 and 24 ends to control portions of the Airport's RPZs as well as to prevent the construction of obstructions or to maintain vegetative heights to avoid impact to the 14 CFR Part 77 approach surfaces. Areas within RPZs that are not currently under Airport control in avigation easement or fee simple include all portions of the Runway 6 RPZs west of Iyannough Road, the north and southwest corners of the Runway 15 RPZ, the southern corner of the Runway 24 RPZ, the eastern portion of the Runway 33 RPZ.

Table 5-23: RPZ Dimensions Per Runway End

Runway	Minimums	Length (feet)	Inner Width (feet)	Outer Width (feet)	Acreage
Runway 6	1 mile	1,700	500	1,010	29.465
Runway 24	4,000 feet	1,700	1,000	1,510	48.978
Runway 15	2,400 feet	2,500	1,000	1,750	78.914
Runway 33	1 mile	1,700	500	1,010	29.465

Sources: FAA AC 150/5300-13A; FAA HYA Terminal Procedures, effective date: April 23 – May 20, 2020.

There are several public roads, residences, commercial/industrial buildings, rail facilities, and parking lots located within the RPZs. These roads include, but are not limited to, Iyannough Road, Yarmouth Road, Mary Dunn Way, and Barnstable Road. According to recently published guidance

[6] Useable runway length is based on declared distances, which protects for safety areas prior to the landing threshold and beyond the end of the runway.

by the FAA, public roads are not considered compatible land uses within RPZs and are not recommended. The current FAA guidance does not require relocation of existing roadways within RPZs unless one of the following triggers occurs:

1. An airfield project (i.e. runway extension, runway shift)
2. A change in the critical design aircraft that increases the RPZ dimensions
3. A new or revised instrument approach procedure that increases the RPZ dimensions
4. A local development proposal in the RPZ (either new or reconfigured)

Recommendation for Runway Protection Zones: Acquire control of all land uses within existing RPZs (through fee simple acquisition or avigation easements) for those properties not currently under Airport control.

PLANNING CONSIDERATION

A runway extension could result in shifting RPZs, especially the Runway 15 approach RPZ. A review of land use and activity in the new extents of the RPZ will be coordinated with and approved by the FAA.

5.2.9. Runway Visibility Zone

Standards have been developed for pilot visibility along runways, and between intersecting runways, which are known as the runway visibility zone (RVZ). The RVZ is an area formed by imaginary lines connecting the two runway's visibility points, which are located half of the length between each runway end and the runway intersection. The current standard for intersecting runways recommends a clear line of sight between the ends of intersecting runways. According to FAA AC 150/5300-13A, terrain needs to be graded and permanent objects need to be designed or sited so that there will be an unobstructed line of sight from any point five feet above one runway centerline to any point five feet above an intersecting centerline, within the RVZ. These standards are currently met at the Airport through the 2015/2016 tree clearing project and regular vegetative maintenance.

Recommendation for Runway Visibility Zone: No improvements to the existing RVZ are recommended above and beyond regular vegetative maintenance the Airport is already conducting.

5.2.10. Runway Pavement Markings

All runway ends have precision instrument approach runway markings. Consequently, the runway markings at the Airport are appropriate for their current and future approach requirements respectively. It is not anticipated that either runway needs to be renumbered within the planning period based on local magnetic declination.

Recommendation for Runway Pavement Markings: No improvements to the existing runway pavement markings are required.

5.2.11. Taxiways

There are currently seven taxiways at the Airport. Both Runways 6-24 and 15-33 are served by full-length parallel taxiways. Planning standards for taxiways include taxiway width, taxiway safety areas, taxiway object free areas, taxiway shoulders, taxiway gradient, and for parallel taxiways, the distance between the runway and taxiway centerlines. The dimensions of each standard vary based on the identified ADG and taxiway design group (TDG) for each taxiway. The ADG is based on the wingspan and tail height of an aircraft, while the TDG is based on the distance between an aircraft's cockpit to main gear, as well as the width of the main gear. There are six ADG groups, and seven TDG groups. Details regarding the various dimensions follow in **Table 5-24** and **Table 5-25**.

As taxiways are constructed or rehabilitated, design should carefully consider the updated guidance for taxiway design as published in FAA AC 150/5300-13A, Change 1. The requirements include the design of taxiways for cockpit over centerline taxiing as opposed to judgmental oversteering. This change particularly impacts curves and intersections, which will require changes to accommodate the cockpit over centerline taxiing. The dimensions of intersection fillets (where the edge of pavement should be based on FAA design standards) and taxiway curves are based on the associated TDG for each taxiway.

The future design aircraft (A220) for both runways is a TDG 3 aircraft.

Table 5-24: Taxiway Requirements – Airplane Design Group

Design Standard	ADG I	ADG II	ADG III	ADG IV	ADG V	ADG VI
Taxiway Safety Area (feet)	49	79	118	171	214	262
Taxiway Object Free Area (feet)	89	131	186	259	320	386
Runway/Taxiway Separation (feet)	225 – 400*	240 – 400*	400	400	400	500*

Source: FAA AC 150/5300-13A.

* Runway/taxiway separation vary based on approach visibility minimums

Table 5-25: Taxiway Requirements – Taxiway Design Group

Design Standard	TDG 1	TDG 2	TDG 3	TDG 4	TDG 5	TDG 6	TDG 7
Taxiway Width (feet)	25	35	50	50	75	75	82
Taxiway Shoulder Width (feet)	10	15	20	20	30	30	40

Source: FAA AC 150/5300-13A.

Taxiway descriptions are shown in **Table 5-26**.

Table 5-26: Taxiway Descriptions

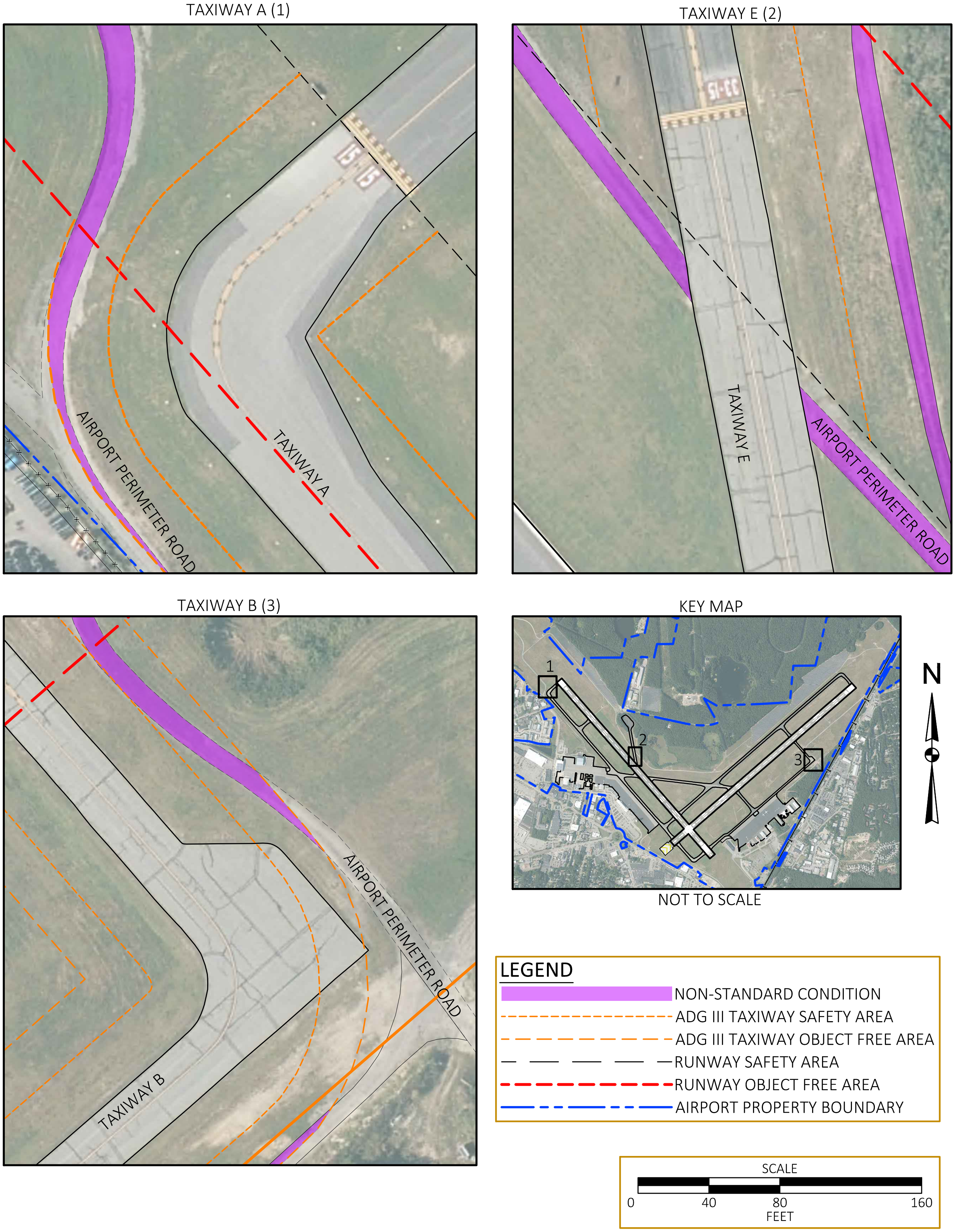
Taxiway	Width	Type of Taxiway	Runway-separation	Non-Standard Conditions	PCI (2016)	Notes
A	50'	Full-length parallel to Runway 15-33	400'	Perimeter Road in TOFA near Runway 15	80-97	Near Terminal Ramp was shifted in 2013

Taxiway	Width	Type of Taxiway	Runway-separation	Non-Standard Conditions	PCI (2016)	Notes
						Remainder was rehabilitated in and straightened in 2015
A1	65’	Stub	N/A	None	76	None
B	40’	Partial parallel to Runway 6-24	675’	Perimeter Road leading to wingspan restrictions	63-100	Aircraft are restricted to wingspans of 118’ or less (ADG III standards), except between Taxiway D and Runway 6-24, where aircraft are restricted to wingspans of 78’ or less.
C	50’	Full-length parallel to Runway 6-24	400’	None	54-100	From Taxiway D to Runway 24 was rehabilitated in 2016 Remainder was reconstructed and straightened in 2017
C1	55’	Stub	N/A	None	100	None
D	50-75’	Crossover	N/A	None	74-100	None
E	50’	Other	N/A	Perimeter Road and trees in TOFA	63	Connects Runway 15-33 to a run-up pit, measuring approximately 42,300 SF, located north of Runway 15-33

Sources: MassDOT Aeronautics Pavement Management System, 2016; AGIS Survey Data, 2019; and McFarland Johnson, 2021.

Non-standard taxiways can be seen in **Figure 5-9**.

Figure 5-9: Non-Standard TOFA and TSA Conditions



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Recommendations for Taxiways: The following non-standard design conditions were found and should be reviewed during the alternatives:

- Taxiway A TOFA: Airport perimeter road near the Runway 15 end penetrates the Taxiway A TOFA.
- Taxiway B TOFA: Airport perimeter road on the north side of Taxiway B penetrates the TOFA.
- Taxiway E TOFA: Airport perimeter road on the east side of Taxiway E and trees on the west side of Taxiway E penetrate the TOFA.

Additionally, the Airport should continue its pavement management plan. Any pavement condition with a PCI rating of failed, serious, very poor, and poor condition should be rehabilitated in the short-term. Pavement assessed as fair should be rehabilitated within the planning period.

If any changes to the taxiways occur, Engineering Brief No. 89, *Taxiway Nomenclature Convention*, dated March 29, 2012 should be reviewed to ensure clear taxiway nomenclature.

5.2.12. Passenger Terminal Ramp

The Terminal Ramp is approximately 160,000 SF, and extends approximately 830 feet along Taxiway A. The width of the Terminal Ramp is approximately 185-215 feet to the Airport perimeter road. This area of the Terminal Ramp will be utilized to determine the number of aircraft parking positions for this Master Plan.

The capacity of a Terminal Ramp is determined by the type of aircraft utilizing the terminal, guidance for wingtip separation and nose-to-building or wing-to-building clearances and considers the type of passenger loading bridges in use (not applicable at the Airport). Published guidance utilized to determine Terminal Ramp capacity are FAA AC 150/5360-13, *Planning and Design Guidelines for Airport Terminal Facilities*, and Air Transport Association of America, *Safety Guidelines SG 908, Revision 2010.1.* The Terminal Ramp is divided into two separately painted areas both of which accommodate ground-loaded parking positions for scheduled passenger and charter service. The Terminal Ramp, including all three areas described below, were rated in 2016 to have PCIs of 89-93.

Security Identification Display Area (SIDA)

The southern area of the Terminal Ramp is a security identification display area (SIDA), which means passengers must comply with Transportation Security Administration (TSA) requirements and come from the secure area of the terminal. This area of the Terminal Ramp has two marked parking positions: a large gate stand for the existing JetBlue service and a smaller marking that can accommodate up to an ADG II aircraft. The gate stand can accommodate the existing E190 service. The A220 is recommended to have 21.5 feet of wingtip clearance, 19 feet are provided between the aircraft wingspan and the existing light pole. It is recommended that pilots take caution and/or a wing-walker be used. The A320 meets wingtip clearance requirements.

Some rutting has occurred since the E-190 began utilizing the SIDA portion of the Terminal Ramp. Pavement strength should be reviewed at the next rehabilitation/reconstruction to account for existing and future design aircraft use.

Unsecure Ramp

This ramp area has seven parking areas and can accommodate up to three parking position for aircraft in ADG I (Cessna 402 or similar) and four positions for ADG II aircraft (Cessna Citation X or similar). This portion of the ramp is utilized by Cape Air flights traveling to and from Nantucket and Martha's Vineyard.

Deicing Area

Located south of the Terminal Ramp is the deicing ramp. The deicing ramp is also utilized as a self-service wash rack for aircraft.

Recommendation for Passenger Terminal Ramp: Pavement strength should be reviewed at the next rehabilitation/reconstruction to account for existing and future design aircraft use. If scheduled passenger service increases significantly, or changes to the type of aircraft utilizing the terminal occur, reconfiguration or expansion of the Terminal Ramp and review of deicing ramp may be required.

5.2.13. Potential Hot Spots and Geometry Requirements

PLANNING CONSIDERATION

The FAA continues to update its standards and recommendations as new information becomes available and new safety studies are conducted.

In 2012, the FAA released the updated AC 150/5300-13A. This release came after numerous studies identified airfield geometry as a key factor in runway incursions. A runway incursion is any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and takeoff of aircraft.[7] The FAA continues to review runway and taxiway geometry to identify and address problematic geometry and is continuously updating safety and design standards. FAA AC 150/5300-13B is expected to come out in 2021.

A hot spot is defined as "a location on an airport movement area with a history of potential risk of collision or runway incursion, and where heightened attention by pilots and drivers is necessary."[8] There are no published hot spots at the Airport.

Between 1990 and 2020 there were 15 accidents at the Airport, none of which are attributed to airport geometry. The Airport had four runway incursions since 2001.[9] At one of these incursions in 2004, an aircraft entered Runway 6-24 at Taxiway D (non-standard intersection angle) without

[7] FAA Runway Incursions, accessed April 8, 2021 <https://www.faa.gov/airports/runway_safety/resources/runway_incursions/>.
[8] Runway Safety – Hot Spot List, accessed Sep. 20, 2016 <http://www.faa.gov/airports/runway_safety/hotspots/hotspots_list/>.
[9] FAA Runway Incursion Database, accessed March 24, 2020 <http://www.asias.faa.gov>.

ATCT clearance. Two incursion reports do not have descriptions and therefore it is unknown if airport geometry was a factor.

Geometry Requirements

FAA AC 150/5300-13A has multiple criteria in the design of taxiways. These geometry criteria are as follows:

- **Three Node Concept**: The three node concept means that any taxiway intersection has no more than three choices – ideally left, straight, and right. Any more decision points make it potentially confusing to a pilot and does not allow for the proper placement of airfield markings, signage, and lighting. The three-node concept helps pilots maintain situational awareness. There are no intersections that exceed the three node concept at the Airport.

- **Taxiway Intersection Angles**: Taxiway intersections are preferred to be 90-degrees whenever possible. Standard angles including 30, 45, 60, 90, 120, 135, and 150 degrees are preferred over other, non-standard, angles. Although the AC provides standard angles and recommends using them, it is not considered a non-standard condition to have taxiways that do not match those angles. Those fillets will be designed based on aircraft movement modeling.

- **Wide Expanse of Pavement**: Wide pavements require placement of signs far from the pilot's eye which can be missed during low visibility conditions and should be avoided. This is especially critical at runway entrance points.

- **Runway Crossings**: Limiting runway crossings reduces the opportunity for human error and reduces air traffic controller workload.

- **Avoid "High Energy" Intersections**: These intersections are located in the middle third of runways. This portion is where the pilot can least maneuver to avoid a collision.

PLANNING CONSIDERATION

The FAA's airfield geometry goal is to standardize taxiway networks across all airports to reduce risks for runway incursions by minimizing confusing or uncommon/non-standard turning movements while taxiing.

- **Runway Intersection Angles/Increase Visibility**: Right (perpendicular) angle intersections, both between taxiways and runways provide the best visibility to the left and right for a pilot. A right angle at the end of a parallel taxiway is a clear indication of approaching a runway. Acute angle runway exits (ex. high-speed taxiways) provide for greater efficiency in runway usage, but should not be used as a runway entrance or crossover point. Parallel taxiways crossing other runways are considered standards.

- **Avoid "Dual Purpose" Pavement**: Runways used as taxiways and taxiways used as runways can lead to confusion. A runway should always be clearly identified as a runway and only a runway. There is no dual purpose pavement at the Airport.

- **Indirect Access**: Taxiways leading directly from an apron to a runway without requiring a turn can lead to confusion when a pilot typically expects to encounter a parallel taxiway but instead accidentally enters a runway.

- **Multiple Taxiway Crossings Near Runway**: A taxiway crossing a high-speed taxiway or multiple taxiways crossing each other between the hold line and the runway could cause confusion, additional time on the runway, and wrong turns/loss of pilot situational awareness.

- **Taxiway Intersecting Multiple Runways**: Taxiways must never coincide with the intersection of two runways. This creates a large expanse of pavement making it difficult to provide proper signage, marking, and lighting. These could lead to pilot disorientation and potential wrong runway use. There are no taxiways intersecting multiple runways at the Airport.

- **Aligned/Inline Taxiway**: An aligned taxiway is one whose centerline coincides with a runway centerline. This places taxiing aircraft in direct line with aircraft landing or taking off therefore closing the runway for other traffic and potentially causing loss of situational awareness. Existing aligned taxiways should be removed as soon as practicable. There are no inline taxiways at the Airport.

- **"Y" Shaped Taxiway Crossing a Runway**: Any runway crossing or runway exit that requires a pilot to make a decision prior to exiting the runway may cause a delay in the aircraft existing the runway and loss of situational awareness.

- **Multiple Runway Thresholds in Close Proximity to One Another**: If possible, safety areas of runway ends should not overlap, since work in the overlapping area would affect both runways. Configurations where runway thresholds are closer together should be avoided, as they can be confusing to pilots, resulting in wrong-runway takeoffs. The angle between extended runway centerlines should not be less than 30 degrees to minimize confusion. There are no multiple runway thresholds in close proximity to one another at the Airport.

- **Short Taxi Distance**: A short distance between the terminal and the runway requires flight crews to complete the same number of checklist items in a shorter timeframe and requires more heads-down time during taxi. Many of the event reports mentioned that the flight crew members were rushing to complete their checklists or to expedite their departures.

- **Taxiway Stubs**: Short taxiway stubs including overlapping holdlines or holdlines too close together to accommodate the length of an aircraft can create confusion and may cause runway incursions or accidents. Holdlines are property located and spaced at the Airport.

- **Unexpected Holdlines**: Holdlines located on a parallel taxiway or other unexpected location are more likely to be overlooked and cause a runway incursion or accident and should be avoided.

- **Intersection Departures**: Airports with a single runway layout were not immune to airplanes taking off on the wrong runway, especially when intersection departures were made. In these events, the flight crew taxied onto the runway and turned in the wrong direction, taking off 180 degrees from the intended direction.

The following elements or contributing factors are historically associated with wrong runway uses and should have the highest priority in resolving: [10,11]

- Multiple runway thresholds located in close proximity to one another
- A short distance between the airport terminal and the runway
- A complex airport design
- The use of a runway as a taxiway
- A single runway that uses intersection departures
- A single taxiway leading to multiple runways
- More than two taxiways intersecting in one area
- A short runway (less than 5,000 feet)
- Joint use of a runway as a taxiway

Table 5-27 shows non-standard geometry at the Airport.

Table 5-27: Non-Standard Geometry at HYA

Geometry Requirement	Taxiway/Taxiway Intersection	Runway/Taxiway Intersection
Three Node Concept	None	None
Taxiway Intersection Angle	Taxiways A & D - 138° (fillets meet standards)	See Increase Visibility
Wide Expanse of Pavement	N/A	None
Runway Crossings	N/A	RWY 6-24 – 2 RWY 15-33 – 2
High Energy Intersections	N/A	RWY 15-33 at TWYs D & E RWY 6-24 at TWY D (RWY 24 & RWY 6 departures) RWY 6-24 at TWYs B & C1
Increase Visibility	See Taxiway Intersection Angle	RWY 6-24 at TWY D RWY 15-33 at TWY D RWY 15-33 at TWY E
Dual Purpose Pavement[1]	N/A	RWY 6 threshold RWY 33 threshold RWY 24 from TWY B
Direct Access	N/A	RWY 15-33 at TWY D
Multiple Taxiways Crossing	N/A	TWYs D, E, and RWY 15-33

[10] Wrong Runway Departures, Aviation Safety Information Analysis and Sharing, July 2007.

[11] Wrong Runway Departures, FAA Runway Safety, September 2009, accessed Feb. 3, 2016 <https://www.faa.gov/airports/runway_safety/publications/media/wrong%20runway%20FINAL%20draft%20sept09.pdf>.

Geometry Requirement	Taxiway/Taxiway Intersection	Runway/Taxiway Intersection
Taxiway Intersecting Multiple Runways	N/A	None
Aligned Taxiway	N/A	None
Y-Shaped Runway Crossing	N/A	None
Multiple Runway Thresholds in Close Proximity	N/A	None
Short Taxi Distance	N/A	None
Taxiway Stubs	N/A	None
Unexpected Holdline	N/A	None
Intersection Departure	N/A	TWY B for RWY 24 TWY C1 for RWY 24 (if TWY C is blocked)

N/A – not applicable; RWY – runway; TWY – taxiway
[1] These identify where taxiways should line up with runways thresholds. There is no location on the Airport that is considered full dual purpose pavement.
Source: McFarland Johnson Analysis, 2020.

Recommendation for Hot Spots and Geometry Requirements: Non-standard geometry should be resolved as much as practicable. Priority should be set to resolve the geometry requirements outlined in the above **Table 5-27**: high energy intersections, direct access, and multiple taxiways crossing a runway.

5.2.14. Airfield Lighting and Signage

Approach Lighting

The existing precision instrument approach to Runway 24 is equipped with 1,400-foot medium intensity approach lighting system with sequence flashers (MALSF). The precision approach to Runway 15 is equipped with 2,400-foot medium intensity approach lighting system with runway alignment indicator lights (MALSR). Presently, no approach lighting systems are available for Runways 6 or 33. The Airport has a MOS for the MALSF, which was approved on February 16, 1978 for being radio controlled during hours when the ATCT is not operating. This MOS can be found in **Appendix I**.

The current approach lighting systems on Runways 15 and 24 meet the standards for ILS category (CAT) I approach. During IFR conditions, wind conditions favor Runways 15 during high wind speeds and during peak seasons while winds favor Runway 24 during lower wind speeds.

Recommendation for Approach Lighting: There are no recommendations for changes to approach lighting.

Runway and Taxiway Lighting

Both Runways 15-33 and 6-24 are equipped with high intensity runway edge lights (HIRLs). These help pilots see the runways at night and during low visibility conditions.

Taxiway edge lights are provided on most taxiways. Taxiways A, A1, portions of B, C, C1, and D are equipped with high intensity taxiway lights (HITLs). The portion of Taxiway B from Taxiway D to Runway 24 has medium intensity taxiway lights (MITLs). The Airport also has reflective markers to mark the pavement edge of the run-up area near Runway 24 on Taxiway B and to mark the no-taxi island on the East Ramp beyond the intersection of Taxiways B and D. Taxiway E is unlit.

Runway threshold lights at the Runway 15 end are approximately 1.5 feet from the runway end, whereas the minimum standard is two feet.

Airfield lighting is controlled by an on-site Airport electric vault located on the East Ramp. The Airport also has a new backup generator and regulators.

Recommendation for Runway and Taxiway Lighting: Taxiway lights or reflective markers should be considered for Taxiway E in its current location. The Runway 15 threshold should be reviewed for separation between the runway end point and the runway threshold lights.

Airfield Signage

Airfield signage helps pilots identify where on the Airport they are located. There have been no complaints about missing or confusing airfield signage. There is currently one MOS for Airport signage. The runway-runway intersection sign on Runway 15 is 325 feet from Runway 6-24. Standard distance would be 500 feet from Runway 6-24 when hold short operations are conducted. Placing the sign 500 feet from the runway would result in the sign being located on Taxiway C. This MOS was approved on September 18, 1989. Should the Federal Aviation Regulations (FAR) Part 139 inspections identify any additional non-standard conditions, these should be addressed.

Recommendation for Airfield Signage: There are no recommendations for airfield signage.

5.2.15. Visual Approach Aids

Visual approach aids help pilots visually confirm they are on the right glide path to the runway. Runways 6, 24, and 33 are equipped with a 4-box precision approach path indicator (PAPI) system on the left side of each end with a standard 3-degree glide path. Runway 6 is also equipped with runway end identifier lights (REILs) at the end of the runway.

Recommendation for Visual Approach Aids: It is recommended a PAPI be installed for Runway 15 during the planning period.

5.2.16. Airfield Facility Requirements Summary

Several requirements for airside facilities have been discussed throughout this section. A summary of the key requirements identified can be found in **Table 5-28**. Geometry issues are identified in **Table 5-27**.

Table 5-28: Summary of Airside Facility Requirements

Item/Facility	Existing Facility or Capacity	Ultimate Requirement	Additional Need
Runway Length (Section 5.2.2)	Runway 15-33 – 5,253' Runway 6-24 – 5,425'	One or both runways 6,000'-6,400'	575'-1,147'
Runway Width (Section 5.2.3)	Runway 15-33 – 150' Runway 6-24 – 150'	Runway 15-33 – 150' Runway 6-24 – 150'	None
Runway Strength and Condition (Section 5.2.4)	Runway 15-33 – 43 F/A/X/T Runway 6-24 – 32 F/A/X/T	Runway 15-33 – 43 F/A/X/T Runway 6-24 – 32 F/A/X/T	Potential Runway 6-24 strengthening
Runway Orientation (Section 5.2.5)	Runway 15-33 – C-III Runway 6-24 – C-III	Maintain current orientation and Runway 15-33 – C-III Runway 6-24 – C-III	None
Runway Safety Areas (Section 5.2.6)	Portions of Runways RSAs off Airport property	Provide standard RSA on all runways	Enhanced control of all RSA through ownership
Runway Object Free Areas (Section 5.2.7)	Portions of Runways ROFAs off Airport property	Provide standard on all runways	Enhanced control of all ROFA through ownership or avigation easements
Runway Protection Zones (Section 5.2.8)	Partially under airport control through ownership and avigation easements	Under airport control through ownership or avigation easements	Enhanced control of all RPZs through ownership or avigation easements
Runway Visibility Zone (Section 5.2.9)	Half of the length between each runway end and the runway intersection	Half of the length between each runway end and the runway intersection	None
Runway Pavement Markings (Section 5.2.10)	Runway 15-33 – Precision Runway 6-24 – Precision	Runway 15-33 – Precision Runway 6-24 – Precision	None
Taxiways (Section 5.2.11)	Runway 15-33 – Full Parallel Runway 6-24 – Full Parallel Non-standard TSA/TOFAs	Runway 15-33 – Full Parallel Runway 6-24 – Full Parallel Standard TSA/TOFAs	Meet FAA standards
Taxiway Width (Section 5.2.11)	40' – 65'	50' – 75'	Meet TDG 3 guidelines

Item/Facility	Existing Facility or Capacity	Ultimate Requirement	Additional Need
Passenger Terminal Ramp (Section 5.2.12)	160,000 SF	Meet Demands of Future Design Aircraft	Potentially reconfigure Terminal Ramp to accommodate future design aircraft
Potential Hot Spots and Geometry Requirements (Section 5.2.13)	See **Table 5-27**	Meet FAA geometry standards	Address airfield geometry concerns
Runway Lighting and Signage (Section 5.2.14)	Runway 15-33 – HIRLs Non-standard Runway 15 threshold lights Runway 6-24 – HIRLs	Runway 15-33 – HIRLs Standard Runway 15 threshold lights Runway 6-24 – HIRLs	Address Runway 15 threshold lights
Approach Lighting/ Instrument Approaches (Section 5.2.14)	Runway 15 – ILS/DME, GPS Runway 33 – GPS Runway 6 – GPS, VOR Runway 24 – ILS/DME, GPS	Runway15 – ILS/DME, GPS Runway 33 – GPS Runway 6 – GPS, VOR Runway 24 – ILS/DME, GPS	None
Taxiway Lighting (Section 5.2.14)	Taxiways A, Portion of B, C, D – HITLs Portion of Taxiway B - MITLs Taxiway E - Unlit	All taxiways lit or marked with reflective markers	Add MITLs or reflective markers to Taxiway E
Runway Visual Aids (Section 5.2.15)	Runway 15 – None Runway 33 – PAPI Runway 6 – PAPI Runway 24 – PAPI	Runway 15 – PAPI Runway 33 – PAPI Runway 6 – PAPI Runway 24 – PAPI	Add PAPI to Runway 15

Sources: FAA Form 5010-1; McFarland Johnson analysis, 2020.

5.3. PASSENGER TERMINAL FACILITY REQUIREMENTS

This section addresses the methodology, assumptions, and general planning-level factors used to analyze facility requirements for key functional areas of the Airport passenger terminal. Requirements were analyzed based on a multitude of factors and compared to growth triggers identified in Chapter 4, *Forecasts*. The primary tool used to model various terminal space requirements was ACRP Report 25, *Airport Passenger Terminal Planning and Design, Volume 2: Spreadsheet Models and User's Guide (the Model)*. Additionally, guidelines published in the following publications were included:

- International Air Transport Association's (IATA) *Airport Development Reference Manual* (ADRM, 10th Edition);

- FAA AC 150/5360-13A, *Airport Terminal Planning*; and
- FAA AC 150/5300-13A (Change 1), *Airport Design*.

This review was conducted based on standard terminal design. New guidance may come out because of COVID-19 social distancing requirements, which may result in additional need above and beyond what is identified in this section.

5.3.1. Existing Passenger Terminal

The Airport terminal building was constructed in 2011 and consists of two floors. The first floor encompasses approximately 26,600 SF and provides secure and non-secure areas for passengers. Secure areas and sterile areas are areas that authorized Airport personnel and passengers may enter after having been processed through the security screening checkpoint overseen by the TSA.

The second floor is comprised entirely of sterile space, including Airport and TSA offices, as well as support space and storage.

5.3.2. Methodology

Utilizing the Model and FAA and industry standards guidance listed above, the following passenger processing functions were examined:

- Terminal Curb Length
- Passenger Check-In and Ticketing
- Outbound Baggage Screening and Make-Up
- Passenger Security Screening Checkpoint
- Passenger Holdrooms
- Concessions
- Inbound Baggage Handling and Baggage Claim
- Other Terminal Support Functions

To best inform potential future needs, the terminal building analysis was performed under three scenarios:

- Existing provision
- 150 peak hour passengers
- 200 peak hour passengers

Application of the Model under these scenarios is presented in the following sections.

Application of the ACRP Model

The Model is designed to determine terminal requirements by functional area based on historical and forecasted annual enplanements, departures, and gates. The Model uses these inputs (along with a variety of assumptions) to identify peak hour activity. From this point, the Model relies on peak hour activity levels to produce space requirements that can accommodate demand as it grows. In this way, the Model serves as “top down” analysis, starting with annual demand to estimate peak activity demand. Facility requirements at the Airport were determined using the three planning activity levels of existing provision, 150, and 200 peak hour passengers. All outputs of this analysis reflect the standard spaces required and standard operating procedures regardless of the existing conditions/configuration so that an accurate assessment of future needs can be identified.

5.3.3. Assumptions

This section summarizes the assumptions utilized for the assessment of the existing Airport terminal building.

Percentage of Originated Passengers

For purposes of analyzing passenger terminal space requirements, it is assumed that 100 percent of enplaned (departing) passengers are originating at the Airport. The originating passenger percentage is used to determine the number of passengers to be processed through check-in/ticketing and security screening, along with associated demands on outbound baggage functions, holdroom usage, and gate/boarding area egress.

Vehicle Demand at Terminal Curb

Vehicle demand is measured based on the range of vehicle types used by passengers as ground transport to an airport for departing flights. These include everything from private automobiles typically carrying one to three passengers to tour buses carrying large groups of passengers. While some hotel shuttles and buses may drop off and pick up passengers, they are infrequent in nature and also not overly common at other similar sized airports, therefore the focus is placed on the use and operation of personal vehicles and/or those that share the size and characteristics of such.

The estimated passenger breakdown by landside mode is as follows:

- Parking lots: 40 percent
- Pick-up/drop-off: 25 percent
- Taxis and transportation network companies (TNCs): 25 percent
- Rental cars: 10 percent

In addition to this breakdown, the analysis also assumes an average party size of 1.25 people for parked vehicles and those involved in personal pick-ups and drop offs. Rental cars, taxis and TNCs (Uber, Lyft, etc.) all assume one passenger per transaction. With the introduction of more leisure-oriented service, the average party size may increase; however, the lower party size is a more conservative estimate in facility planning (meaning the requirement will be greater) and facility needs should be reevaluated with a focus on party size should the service offering at the airport change to more of a leisure mix.

The terminal curb is approximately 375 feet in length. Of the total length, approximately 245 linear feet (LF) are associated with passenger drop-off/ticketing and 120 LF are located outside the doors leading to baggage claim for passenger pick-up.

Table 5-29 illustrates the assumed breakdown of existing peak vehicle demand at the curb, dwell time assumptions, and passenger per vehicle assumptions, all of which are integral to the calculation of terminal curb requirements. It is assumed that 50 percent of the peak hour demand will occur during the peak 20-minutes, representative of the peak conditions that occur before or after a flight. Curb front and landside elements should be planned for the peak 20-minute period.

Table 5-29: Peak Hour Vehicle Assumptions

	Existing Conditions		150 Peak Hour Passengers		200 Peak Hour Passengers	
	Cars	Curb (LF)	Cars	Curb (LF)	Cars	Curb (LF)
Parking Lot						
Parking Lot	16	N/A	24	N/A	32	N/A
Parking Lot Peak 20 min.	8	N/A	12	N/A	16	N/A
Curb Length						
Pick-up/ Drop-off Peak Hour	32	128	48	192	64	256
Pick-up/ Drop-off Peak 20 min.	16	64	24	96	32	128
Taxi/TNC's Peak Hour	20	80	30	120	40	160
Taxi/TNC's Peak 20 min.	10	40	15	60	20	80
Total Curb Peak Hour	52	208	78	312	104	416
Total Curb Peak 20 min.	**26**	**104**	**39**	**156**	**52**	**208**
Exit Traffic	**Vehicles Only, includes Parking and Rental Cars**					
Total Exit Peak Hour	88		132		176	
Total Exit Peak 20 min.	44		66		88	

Source: McFarland Johnson analysis, 2020.

Not all landside passengers will utilize the curb, such as parked vehicles and rental cars, however the total peak 20-minute numbers can also be used when planning traffic and roadway improvements associated with the terminal operation. As seen in **Table 5-29,** the long-term peak 20-minute need for the length of a vehicle curb at the Airport is up to 208 LF compared to the existing available useful curb length of 375 LF.

Recommendation for Terminal Curb Length: The existing and available useful curb length at the passenger terminal should be sufficient for each of the forecast scenarios under consideration in the 20-year plan.

Passenger Check-in /Ticketing

Passenger check-in/ticketing includes the functions of full-service staffed airline counter positions, self-serve kiosks, active check-in area, passenger queue area, airline ticket office areas, circulation area, and public restrooms accessible from the ticketing lobby. Assumptions for these areas include the following:

- 60 percent of peak hour passengers could be experienced in the peak 30-minute period.
- 75 percent of passengers use check-in and ticketing facilities.
- 50 percent will use self-service check-in and 50 percent will use staffed positions
- Average passenger processing time at the counter or kiosk is three minutes.

Industry trends favor an increase in self-service check-in practices. While there is presently no self-tagging/checked baggage drop at the Airport, this is a provision that should be planned for in the future. Staffed check-in positions in the traditional form are likely to be minimal by the end of the planning period and replaced with more kiosks or mobile supporting technology that occurs away from the traditional ticket counters.

Summary of Passenger Check-in/Ticketing: The current passenger check-in/ticketing space spans approximately 3,670 SF. Approximately 1,446 SF are needed to accommodate 150 peak-hour passengers and 1,897 SF to accommodate 200 peak-hour passengers.

Outbound Baggage Make-Up and Screening

Outbound baggage screening and make-up functions includes operations by TSA to screen checked baggage and airline staff to collect and disperse bags to carts and the appropriate aircraft prior to departure. The ACRP Model assumes that this practice will be done with Explosive Detection System (EDS) baggage screening technology. With the existing seasonality and low level of activity, the Airport currently resorts to the slower, more manual method of Explosive Trace Detection (ETD). At larger airports, when newer, more efficiently technology is introduced, it often creates surplus equipment for airports like HYA so this analysis is based on the application and operation of EDS technology for baggage screening. Assumptions for these areas include the following:

- 65 percent of passengers will check a bag
- Average of one bag per passenger
- TSA surge factor of 50 percent for peak processing
- 20 percent alarm rate for additional screening (level 2 on-screen resolution (OSR)), 95 percent clear rate, 5 percent requiring level 3, explosives trace detection (ETD)
- Level 1 EDS screening rate of 220 bags per hour, with an alarm rate of 20 percent
- Level 2 OSR processing ration was set at 60 bags per hour
- Level 3 ETD screening, the TSA suggests 24 bags per hour per operator

Baggage screening space requirements contained in the Model were utilized here, and are as follows:

- Level 1 Area: 500 SF per EDS unit
- Level 2 Area: 40 SF per OSR station

- Level 3 Area: 100 SF per ETD station

An additional 35 percent of space is added for circulation area and 15 percent to allow for future equipment changes and any required reconfiguration or renovations.

Summary of Outbound Baggage Make-Up and Screening: The current outbound baggage make-up and screening space spans approximately 2,000 SF. Approximately 3,240 SF are needed to accommodate 150 and up to 200 peak-hour passengers.

Passenger Security Screening Checkpoint

This section discusses the assumptions utilized to analyze the future demand for security screening of departing passengers. The assumed processing rate for the analysis is 120 persons per hour for a single lane screening module and 175 persons per hour for a two-lane screening module configuration. The constrained configuration of the Airport means 120 peak hour passengers is an optimistic case.

PLANNING CONSIDERATION

Technology trends for enhanced self-service and biometric passenger identification should be monitored for application/implementation to support passenger processing at the Airport.

Although TSA recommends 2,800 SF of space for a two-lane (two bag screening with a shared walk through) screening module, HYA currently accommodates one lane (one bag screening with one walk through) within roughly 1,300 SF. The single lane has an approximate throughput of 120 peak hour passengers while a two-lane checkpoint can process approximately 175 peak hour passengers. Based on these throughputs a two-lane checkpoint would likely be required if multiple forecast scenarios occur.

The percentage of assumed non-passenger traffic, such as employees and crew, represents ten percent of the throughput, which was added to the design peak hour passenger screening demand and is based on recent experience at other airports.

As with other functional areas, allowances were also included for future equipment changes (ten percent) or reconfigurations and TSA support space (12 percent).

Summary of Passenger Security Screening Checkpoint: The current passenger security screening checkpoint space spans approximately 2,305 SF. Approximately 4,981 SF are needed to accommodate 150 peak-hour passengers and 6,366 SF to accommodate 200 peak-hour passengers.

Passenger Lounges/Holdrooms (Secure)

Holdroom space typically accounts for seating a certain percentage of passengers, with the remaining passengers either not in the holdroom area or standing. The analysis assumed 15 SF per seated passenger and 10 SF per standing passenger. The Model also includes some flexibility to account for amenities (e.g., children’s play area, telephones, work areas, charging stations, etc.), and high utilization and holdroom sharing, when the holdroom is utilized for passengers waiting for more than one flight or is shared between gates. Other assumptions include:

- 80 percent of passengers are seated
- 20 percent of passengers are standing
- No sharing of holdroom space with adjacent gates (there is only one hold room under existing conditions)

Allowances for amenities, circulation, and restrooms are assumed to be 5 percent, 35 percent, and 15 percent, respectively.

Summary of Secure Passenger Lounges/Holdrooms: The current secure passenger lounges/holdroom space spans approximately 2,550 SF. Approximately 6,878 SF are needed to accommodate 150 peak-hour passengers and 9,072 SF to accommodate 200 peak-hour passengers.

Inbound Baggage Handling and Baggage Claim

Inbound baggage handling includes the unloading of baggage from aircraft and transferring them to the baggage claim unit for circulation to the baggage claim hall. The Model calculates baggage claim requirements assuming that a certain percentage of passengers will deplane in a peak 30-minute period. As previously noted, it is also assumed that 65 percent of passengers will check one bag. Much of the assumptions and analysis in the model assumes some sort of baggage claim device other than a chute, which is currently used at the Airport. The resulting baggage claim requirements are reflective of a more standardized claim device, which would become necessary with increased activity. Additionally, the following assumptions are made:

- An additional 10 percent is applied to the number of passengers checking bags to account for meters and greeters
- 1.3 LF of claim is required for each person in the claim lobby
- Baggage claim area is increased by 15 percent to provide for baggage services office
- Baggage claim area is increased by 15 percent to provide for meet and greet area
- Baggage claim area is increased by 20 percent to provide for circulation space
- Baggage claim area is increased by 10 percent to provide for restroom facilities

To account for inbound baggage handling area the following assumptions are made:

- Take off belts require 850 SF of space each
- Baggage train circulation requires 1,275 SF of per take off belt
- 255 SF per take off belt is provided to account for conveyor belts equipment and other miscellaneous equipment

Some of these areas supporting the inbound baggage delivery do not necessarily need to be within the building envelope.

Summary of Inbound Baggage Handling and Baggage Claim: The current inbound baggage handling and baggage claim space spans approximately 1,385 SF. Approximately 4,292 SF are needed to accommodate 150 peak-hour passengers and 8,820 SF to accommodate 200 peak-hour passengers.

Concessions

Terminal concessions include both non-secure and secure area retail establishments to service departing and arriving passengers. This assessment is generalized due to the low activity and limited existing concessions at the Airport. The Model makes the following assumptions to calculate spatial requirements:

- Food and beverage-based concessions require seven SF per peak hour passenger
- Retail based concessions requires 3.5 SF per peak hour passenger
- Service based concessions require 0.5 SF per peak hour passenger
- A multiplier of 20-30 percent is used to account for support space for food, beverage, and retail concessions
- Internal circulation area allowance of 15 percent is also included for terminal building concession areas

While the primary concession at the Airport is currently vending, the output of this analysis should be used to inform the terminal development alternatives so that more traditional concessions can be accommodated as passenger activity increases. It is assumed that even with the robust forecast scenarios that concession offerings at the Airport will be limited, with a focus on enhanced vending and grab-and-go style kiosks. Any full-service restaurant type of facility will likely be non-secure and also have a public-facing component to it.

Other Terminal Support Facilities

The final consideration of passenger terminal functional areas includes allowances for the various support areas.

A provision of five percent of the total departure/arrival areas is provided for the following:

- Airline operations
- Ground handling services
- Airport operations and maintenance
- Facilities support and services

A provision of ten percent of the total departure/arrival areas is provided for the following:

- Building structure
- Vertical circulation
- Mechanical/electrical/utility
- Allowance for other tenants/configurations

Summary of Other Terminal Support Facilities: The current terminal support facilities space spans approximately 13,645 SF. Approximately 15,644 SF are needed to accommodate 150 peak-hour passengers and 17,871 SF to accommodate 200 peak-hour passengers.

Concourse Gates, Passenger Board Bridges, and Terminal Ramp

To determine the required number of concourse gates, and subsequently passenger boarding bridges and terminal ramp requirements, the Model employs a passengers per gate approach and a departure per gate approach. The resulting average of these two approaches is a total of three gates. It is recommended that the three gates have a minimum sizing capability for servicing of an E190, with a standard AAC-ADG C-III sizing to accommodate an A320 or Boeing 737 for operational flexibility in the future.

Summary of Concourse Gates, Passenger Board Bridges, and Terminal Ramp: Future operational flexibility requires a total of three gates with a minimum sizing capability for servicing an E190, with a standard AAC-ADG C-III sizing.

5.3.4. Results of Analysis

The results of the terminal capacity assessment are summarized in **Table 5-30**.

Table 5-30: Terminal Requirements Summary

Terminal Functional Area	Existing Provision (SF)	150 Peak Hour Passenger Requirements (SF)	200 Peak Hour Passenger Requirements (SF)
Check-In /Ticketing (including airline ticket offices)	3,670	1,446	1,897
Outbound Baggage Screening & Makeup	2,000	3,240	3,240
Passenger Security Screening Checkpoint	2,305	4,981	6,366
Secure Holdrooms	2,550	6,878	9,072
Baggage Claim and Inbound Baggage Handling	1,385	4,292	8,820
Non-Secure Areas	5,065	3,329	4,814
Other Functions/Tenants	13,645	15,644	17,871
Total (interior space)	30,620	39,810	51,422
Passenger Terminal Requirement Range		**35,000-40,000**	**50,000-55,000**
Difference between Existing Provision and Requirement (SF)		**4,380-9,380**	**19,380-24,820**

Source: ACRP Model and McFarland Johnson analysis, 2020.

Recommendation for Terminal: It is recommended the Airport pursue a terminal building of at least 35,000 SF to meet existing demand and up to 55,000 SF to meet demand at 200 peak hour passengers. Some of these functional space requirements may be achieved by repurposing space within the existing building (approximately 30,600 SF).

5.4. PARKING AND ROADWAY ACCESS FACILITY REQUIREMENTS

The following facilities were considered:

- Airport Access and Signage
- Passenger Parking Requirements
- Rental Car Parking Requirements

5.4.1. Airport Access and Signage

As noted in Chapter 2, *Inventory*, there is no clear entrance to the Airport. Since there is no dedicated on-airport entrance road, traffic is routed different ways, depending on where it is coming from. The FAA requires that airport revenues can only be spent on airport property, which means off-property access improvements require a different sponsor such as the Town of Barnstable or MassDOT.

The four most common routes to the Airport direct traffic from Route 6 via Exit 68, Route 6 via Exit 72, Centerville, and the waterfront. Traffic coming from the north along Route 6 via Exit 68 is directed to Attucks Lane and Airport Road. Attucks Lane dead-ends into Airport Road, which turns into Barnstable Road. Traffic coming from the west along Routh 6 via Exit 72 is directed to Iyannough Road (via Willow Street and Yarmouth Road) which provides access to the Airport's general aviation facilities on the East Ramp and Airport Road prior to the rotary. Traffic coming from the south and west are directed to access Barnstable Road via Hinckley Road after passing through the rotary.

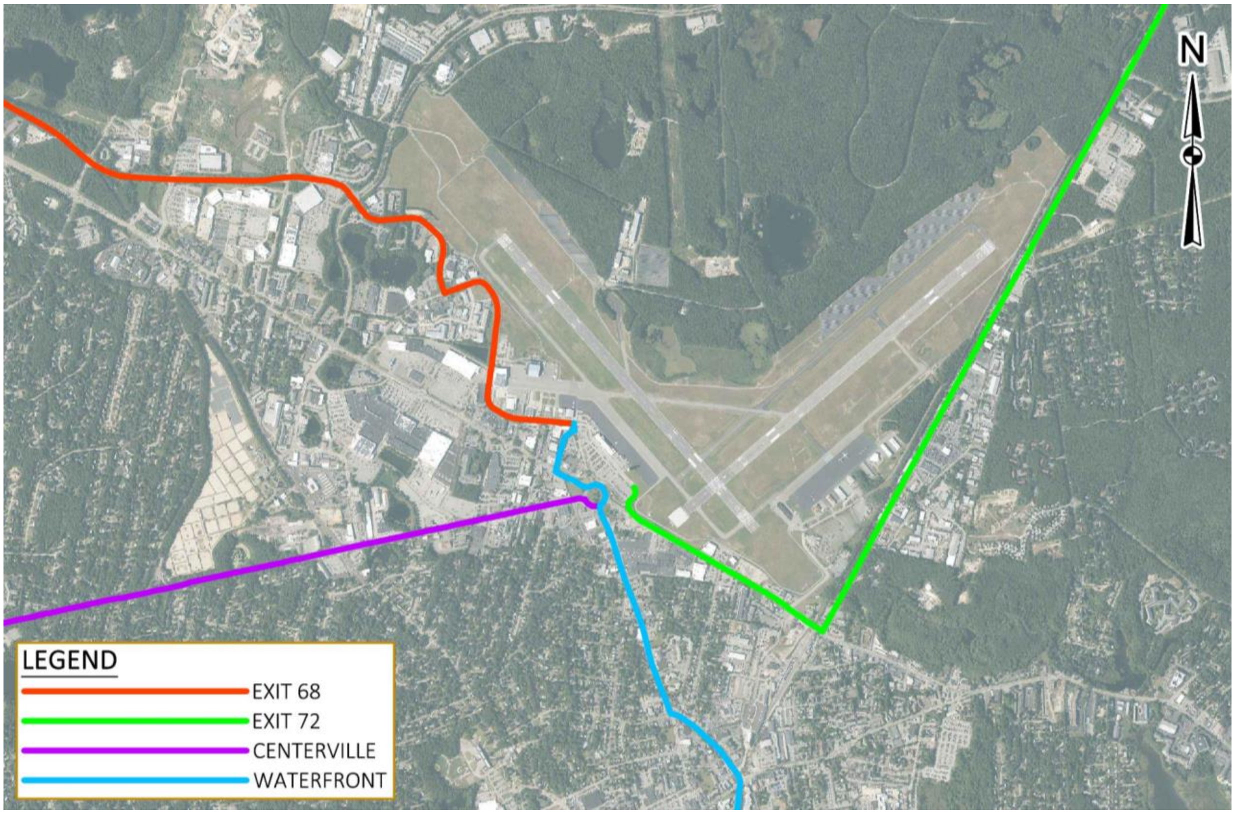
Accessing the Airport can be confusing to its users and, during peak season, traffic through the rotary backs up, making accessing the Airport difficult. There are multiple ways to get to the Airport with numerous decision points along the way. The four most common routes are summarized in **Table 5-31** and shown in **Figure 5-10**.

Table 5-31: Airport Access Routes

Access Routes	Number of Decision Points
Route 6 via Exit 68 to Airport	10
Route 7 via Exit 72 to Airport	4
Centerville to Airport	12
Waterfront to Airport	10

Source: McFarland Johnson Analysis, 2020.

Figure 5-10: Routes to HYA



Source: McFarland Johnson Analysis, 2020.

Airport signage is small and unclear. Sign spacing leads to confusion as there is not enough time to change lanes or more than one sign, with conflicting directions, can be seen at once.

The Airport Road is accessed off of Barnstable Road as well as Iyannough Road. The entrance road offers three ticket locations for access to the terminal parking lot.

Recommendations for Airport Access and Signage: A follow-on Airport signage and access study should be considered due to the congestion of the area surrounding the Airport and lack of a direct access to the terminal. Wayfinding and signage should be improved throughout the Airport entrance circulation. Ways of access and routes to the Airport should be simplified to reduce confusion and reduce traffic through the rotary. Branding and illumination should be incorporated to improve Airport identification and clearly direct users to the correct area of the Airport.

5.4.2. Passenger Parking Requirements

As presented in Chapter 2, *Inventory*, the Airport maintains three terminal area parking lots and one overflow lot. The passenger parking lot contains 585 spaces. The overflow parking lot, which accommodates approximately 400 parking spaces, is available during peak season. The long-term requirement for passenger auto parking will vary greatly with the different forecast scenarios previously presented for consideration. Baseline demand levels consist of primarily day trips or short duration trips to the Nantucket, with some people starting their longer duration trips at the Airport and flying to Boston (and/or JFK in the summer season) to connect onward. This baseline passenger auto parking demand is estimated to be approximately 125 spaces. Under different forecast scenarios the demand for passenger auto parking will increase. If there are daily departures year-round to network airline hubs and also if there are bi-weekly flights to Florida, auto parking demand could rise to as much as to need roughly 465 spaces on average (potentially higher during peak times). The existing lot in front of the passenger terminal has sufficient space to meet the demand under both the baseline and various forecast scenarios.

Recommendation for Passenger Parking: There is no recommendation for additional passenger parking. Under several of the forecast scenarios, it may become necessary to limit the number of non-aviation contracts that also utilize the parking lot at the Airport.

5.4.3. Rental Car Parking Requirements

Rental car demand has been evolving as there has been consolidation within the parent companies of the various brands. In addition, ride-sharing companies have made it easier for users to not need rental cars if the driving is going to be limited and nearby. Additional industry disrupters such as more widespread vehicle subscription services and car-sharing apps will likely influence future demand as well and should be reviewed before and significant improvements are made. Under the highest forecast scenarios, aviation-related rental car demand would be approximately 60 cars per day which is well below the 100 spaces currently available.

Recommendation for Rental Car Parking: There is no recommendation for additional rental car parking.

5.5. GENERAL AVIATION AND LANDSIDE FACILITY REQUIREMENTS

The existing GA areas are located on the southeast and west sides of the Airport. This section discusses the requirements for each of the GA elements while the Alternatives chapter (Chapter 6) will explore the future location of the required facilities. Requirements for GA facilities at HYA were calculated on the basis of data collected during the inventory, forecasts, consultation with Airport staff, as well as FAA standards. The following facilities were examined:

- General Aviation Aircraft Hangars
- Aircraft Parking Ramps
- General Aviation Automobile Parking
- Airport Administrative/Operations Offices

5.5.1. General Aviation Aircraft Hangars

GA hangars at an airport are planned for both based and itinerant aircraft. Requirements are calculated based on the size and quantity of aircraft based at the Airport. While each aircraft will vary in size, the following planning factors were used to calculate the approximate hangar space requirements for aircraft based at the Airport:

- 1,200 SF for Single Engine and Rotor Aircraft
- 1,600 SF for Multi-Engine Aircraft
- 3,200 SF for Jet Aircraft

When calculating hangar demand, it is assumed that 70 percent of single engine and 35 percent multi-engine aircraft will be stored in individual hangars. It is also assumed that 25 percent of single engine aircraft, 60 percent of multi-engine aircraft, and 100 percent of jet aircraft will be stored in conventional hangars.

The forecast for based aircraft reflects a 0.4 percent decline of total based aircraft based on the historical trends of the Airport. These trends represent a small increase in small jet growth but the consolidation of light GA aircraft because of flying clubs and fractional ownership. More people will use based aircraft, which is why based aircraft numbers may decline, but aircraft operations increase. Existing hangar space is shown in **Table 5-32**. The overall hangar requirements are displayed in **Table 5-33.**

There are currently empty hangar spaces. However, this is at the desire of the hangar owner. There are also currently 17 people on the waitlist for t-hangars. These may or may not come to fruition at a higher price point. To accommodate those on the waitlist as well as any that may be added onto the waitlist during the planning period, an additional six individual hangars and two conventional hangars should be constructed above and beyond the baseline demand summarized in **Table 5-33**.

Additionally, HYA is in the optimal position to serve new businesses on Cape Cod. Therefore, the Airport should have a provision of two to four conventional hangars to provide the necessary space for a new business to utilize HYA.

PLANNING CONSIDERATION

Future hangar development should consider longer wingspans, which are a feature of modern single- and multi-engine aircraft. The typical t-hangar door width is 42 feet and modern ADG I aircraft have wingspans of 44 – 48 feet.

Recommendation for Aircraft Hangars: There is an existing shortage of conventional hangar space, which should be accommodated. Should demand exceed what is forecast, it is recommended to plan for six individual hangars and up to eight new conventional hangars to account for unplanned growth and new businesses.

Table 5-32: Existing Hangar Facilities

Building Number	Owner (Lessee)	Individual Hangar Units	Conventional Hangar Space in SF (% used for Aircraft Storage)
1	Ross Rectrix Aerodrome Center	N/A	35,000 SF (10%, Primarily for itinerant use)
2	HYA Fleet Hangar (Leased by Hyannis Air Service AKA Cape Air and Nantucket Airlines)	N/A	39,500 SF (0%, Primarily used for fleet maintenance)
3	Griffin Avionics	N/A	19,000 SF (0%, Primarily used for aircraft maintenance)
4	HYA Hangar II (Leased Cape Air)	N/A	12,500 SF (0%, Primarily used for office and storage space)
6	Airline Realty Trust (Leased by Allies Aviation)	N/A	5,000 SF (70%, 30% Itinerant use)
7	Hangar 51 LLC (Leased by Allies Aviation)	N/A	10,500 SF (70%, 30% Itinerant use)
13	Air Cape Cod	N/A	6,000 SF (50%, Itinerant use)
16	Airport T-hangar (Individual Leases)	7 (6 available for aircraft storage)	N/A
17	Aero Management Association (AMA), Inc (Individual Leases)	3	N/A
18	Cape Flight Instruction Inc.	N/A	7,500 SF (100%)
19	Hyannis Hangar LLC (Individual Leases)	8	N/A
20	Hexagon Hangars (Privately Owned) (Individual Leases)	6	N/A
21	Kingsbury Aviation (Individual Leases)	4	N/A
22	Kingsbury Aviation (Individual Leases)	6	N/A

Source: Airport Management; McFarland Johnson, 2020.

Table 5-33: Aircraft Hangar Demand

Year	Facility Demand	Current Provision	Additional Need
Baseline			
Individual Hangars	28	33	0
Conventional Hangars	27,860 SF	24,850 SF	3,010 SF
2025			
Individual Hangars	27	33	0
Conventional Hangars	28,220 SF	24,850 SF	3,370 SF
2030			
Individual Hangars	25	33	0
Conventional Hangars	27,620 SF	24,850 SF	2,770 SF
2040			
Individual Hangars	24	33	0
Conventional Hangars	30,220 SF	24,850 SF	5,370 SF

Source: McFarland Johnson, 2020.

5.5.2. Aircraft Parking Ramps

There are four components that typically determine the required ramp area for GA uses. They are:

1. Based aircraft parking,
2. Itinerant aircraft parking (transient aircraft parking),
3. Aircraft fueling ramp, and
4. Staging and maneuvering areas.

The sum of these components determines the total area of apron required to meet the forecasted level of general aviation activity at the Airport.

Based Aircraft Parking

Based aircraft tie-down requirements were developed in the *Aircraft Hangars* section since they are a factor in determining hangar requirements. All designated based aircraft tie-downs are located on the east side of the Airport.

There are approximately 55 tie-downs available on the East Ramp. During the planning period, it is anticipated that three based aircraft will be stored on tie-downs. Since the existing number of total tie-downs exceeds the future demand throughout the planning period, there is no need to add additional tie-downs.

Recommendation for Based Aircraft Parking: There are no recommendations for additional based aircraft tie-downs.

Transient Aircraft Parking

The second major ramp need is parking space for itinerant aircraft. FAA AC 150/5300-13A suggests one methodology for determining ramp space requirements for transient aircraft. This methodology has been adjusted as outlined below to reflect seasonal demand conditions at the Airport and is used to project future transient ramp space requirements.

- Calculate the transient aircraft by assuming all GA itinerant and 50 percent of annual air taxi operations
- Calculate the total peak month design day operations for transient operations using an 11.5 percent peak month factor.
- Calculate itinerant arrivals on the design day assuming that half of the operations are arrivals.
- Assume that approximately 75 percent of these aircraft will require transient parking space during the course of the day. The other 25 percent of the itinerant arrivals are based aircraft that will return to their designated parking areas on the airport (hangar).
- Assume an overnight factor that up to that up to 50 percent will remain one night, 25 percent will remain two nights, and 10 percent will remain three nights.
- Allow an area of 3,600 SF per transient airplane, due to the need for taxiing space and aircraft of different sizes.

Table 5-34 presents the results of these computations. According to the above methodology, approximately 372,000 SF of apron space is currently required for transient parking. By the end of the planning period this need is forecast to increase to approximately 424,000 SF.

Table 5-34: Transient GA Aircraft Apron Area Demand

Year	Peak Month Transient Operations	Daytime Transient Parking Demand (# of Tie-Downs)	Overnight Transient Parking Demand (# of Tie-Downs	Required Transient Ramp Space (SF)	Additional Need (SF)
Baseline	4,616	56	48	371,871	2,371
2025	4,694	57	49	378,185	8,685
2030	4,855	59	50	391,114	21,614
2040	5,260	64	54	423,773	54,273

Source: McFarland-Johnson Analysis, 2020.

Transient aircraft are parked on both the North and East Ramps. Total ramp space for transient aircraft is approximately 369,500 SF.

Recommendation for Transient Aircraft Parking: It is recommended that between 40,000 SF and 67,000 SF of additional apron space be built (location and configuration/operational flow will determine actual size requirements).

Aircraft Fueling Ramp

There are three aviation fuel storage facilities at the Airport. Currently, there are no self-fueling options at the Airport. All access to fuel tanks is done by fuel trucks and fueling ramps do not need to accommodate aircraft. Should this change, a ramp would need to be constructed to accommodate single engine aircraft utilizing 100LL Avgas fuel.

Recommendation for the Aircraft Fueling Ramp: Should 100LL Avgas self-service fueling be constructed at the Airport, a fueling ramp should accommodate the maneuvering of multi-engine aircraft while still maintaining safety clearances.

Staging and Maneuvering Areas

Adequate space for the safe maneuvering of aircraft to and from ramps, hangars, and taxiways must also be included in any forecast of apron requirements. Staging and maneuvering is most closely associated with the provision of space in front of conventional hangars and between rows of box and t-hangars. **Table 5-35** shows the taxiway and taxilane object free area requirements (TOFA and TLOFA, respectively).

Currently, there are several non-standard TLOFAs on the East Ramp of the Airport. These non-standard conditions are show in **Figure 5-11**. These individual hangars are constructed for small, general aviation aircraft and should meet ADG I taxiway and TLOFA requirements.

Table 5-35: Taxiway/Taxilane Design Standards by ADG

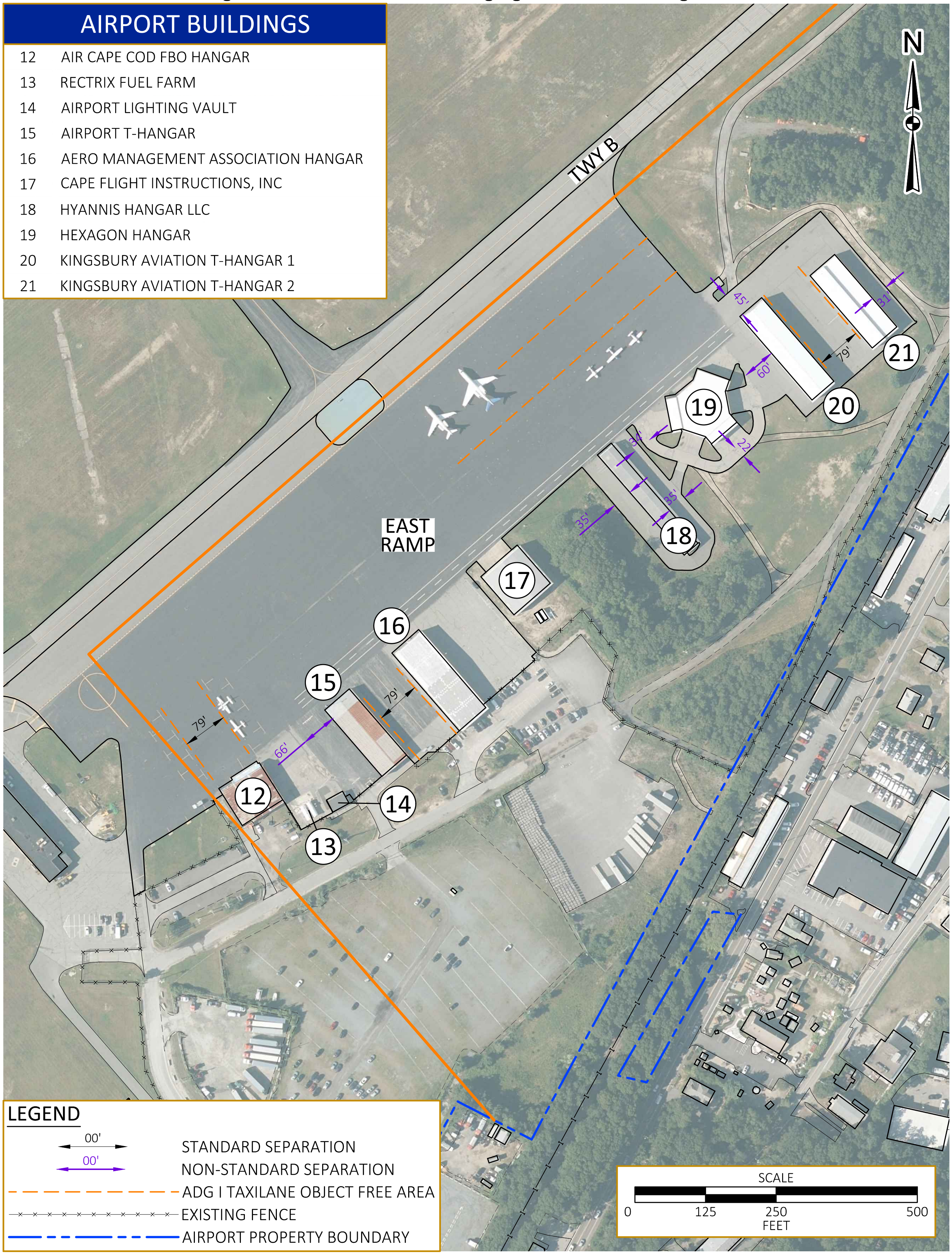
ADG	I	II	III
Taxiway OFA	89’	131’	186’
Taxilane OFA	79’	115’	162’
Taxilane centerline to parallel taxilane centerline	64’	97’	140’
Taxilane centerline to fixed or moveable object	39.5’	57.5’	81’
Taxilane wingtip clearance	15’	18’	22’

Source: FAA AC 150/5300-13A.

The following areas with TLOFA less than 79 feet are present on the East Ramp. These are not necessarily non-standard, but include limitations of wingspans less than ADG I aircraft to meet standard wingtip clearances.

- There is a 66-foot clearance southwest of Building 15. As presently constructed, this taxilane provides standard wingtip clearance for aircraft up to wingspans of 36 feet (this represents approximately 47 percent of all ADG I aircraft). Aircraft with larger wingspans are expected to take caution and visually confirm adequate clearance from objects.
- On either side of Building 18 there is 35 feet of pavement. Pilots should proceed with caution and visually confirm adequate clearance from objects.
- Between Buildings 18 and 20, pilots should proceed with caution and visual confirm adequate clearance from objects and aircraft before taxiing.
- Taxilanes surrounding Building 19 are 22 feet wide, which does not meet TDG 1A and 1B 25-foot width standards.
- There is 45-foot wide pavement northwest of Building 20. As presently constructed, this taxilane provides standard wingtip clearance for aircraft up to wingspans of 35 feet (this represents approximately 35 percent of all ADG I aircraft). Aircraft with larger wingspans are expected to take caution and visually confirm adequate clearance from objects.
- There is 31-foot wide pavement northeast of Building 21. Pilots should proceed with caution and visually confirm adequate clearance from objects.

Figure 5-11: Non-Standard Staging and Maneuvering Areas



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Recommendation for Staging and Maneuvering Areas: Correct non-standard taxilane widths and clearances during the next reconstruction of pavement and/or buildings.

5.5.3. General Aviation Automobile Parking

There are two GA hangar areas on the Airport which provide multiple automobile parking lots adjacent to the buildings for their users.

The methodology used below is based on a previously completed Aircraft Owners and Pilots Association (AOPA) survey that found an average of 2.5 persons aboard the average GA operation and automobile parking requirements for GA operations are displayed in **Table 5-36**.

- Determine the number of peak hour operations from the *Forecasts* chapter.
- Determine the number of peak hour pilots and passengers by multiplying the number of peak hour operations by 2.5.
- Determine the number of parking spaces for individual unit hangars needed by dividing the number of units by 2.
- Determine the number of parking spaces needed for conventional hangars by dividing the total SF of conventional hangar space used by based by 1,000, the total SF of space used for maintenance by 750, and the total SF of space used for offices by 200.
- Assume the number of parking spaces needed for GA terminal use is one space for every 200 SF of GA terminal space recommended by Airport Cooperative Research Program (ACRP) Report 113.

As shown, a need of 331 parking spaces is identified for based and transient GA operations at the Airport through 2040. There are currently ten automobile parking lots for GA operations: five on each the North and East Ramps. Within the North Ramp parking areas, there are 145 marked parking spaces. Within the East Ramp parking areas, there are 56 marked parking spaces along with three unmarked parking areas with space for at least 50 cars. Therefore, the need of 331 parking spaces by the end of the planning period exceeds the current provision of 251 spaces, 201 marked parking spaces plus 50 unmarked parking spaces.

Table 5-36: GA Automobile Parking Space Requirements

Year	Conventional Hangar Parking Demand (# of Parking Spaces)	Individual Unit Hangar Parking Demand (Based) (# of Parking Spaces)	Transient and GA Terminal Parking Demand (# of Parking Spaces)	Total Parking Demand (# of Parking Spaces)	Additional Need (# of Parking Spaces)
Baseline	238	17	55	313	59
2025	239	17	60	319	65
2030	238	17	64	322	68
2040	241	17	73	331	80

Source: McFarland Johnson, 2020.

Recommendations for GA Automobile Parking: The addition of 80 automobile parking spaces by 2040 is recommended to meet both current and future need. Should additional unplanned growth or new businesses come to the Airport, GA automobile parking will need to accommodate the demand and spaces should be added.

5.5.4. Airport Administration/Operations Offices

There are no self-standing Airport administrative offices at the Airport. These offices are in the passenger terminal building. Operations staff also provide ARFF service; therefore, operations and ARFF are staffed in a shared building. Currently, space is shared between ARFF/operations and the public. The Airport's ultimate plan is to separate ARFF/operations from space utilized by the public.

Recommendation for Airport Administration/Operations Offices: Create a separation between ARFF/operations and the public.

5.6. SUPPORT FACILITIES AND UTILITIES

5.6.1. Aviation Fueling

As noted in Chapter 2, *Inventory*, HYA offers both Jet A and 100LL Avgas fuel. **Table 5-37** shows existing fuel storage tanks at the Airport.

Table 5-37: Existing Fuel Capacity

	Jet A	100LL Avgas
HYA Airport	3 x 20,000 gallons	-
Ross Rectrix/Air Cape Cod	10,000 gallons	10,000 gallons
Griffin Avionics	-	2 x 10,000 gallons
Total	**70,000 gallons**	**30,000 gallons**

Sources: Airport management and McFarland Johnson analysis, 2019.

On average, the Airport received approximately 9,900 gallons of Jet A fuel every two to three days during the peak month. In 2019, the average three-day Jet A fuel consumption was 8,300 gallons and 20,800 gallons per three-day period during peak month. The Airport has an average of almost a month supply during average months and over a week supply of Jet A fuel during peak month as shown in **Table 5-38**.

QUALITATIVE PERSPECTIVE

Cape Air has ordered electric aircraft, putting the Airport at the forefront of electric aviation. Portions of apron adjacent to the passenger terminal should be reserved to support the needs of both commercial and general aviation electric aircraft.

During the 2019 peak season, Griffin Avionics sold approximately 11,000 gallons of 100LL Avgas per month while Rectrix sold approximately 4,300 gallons of 100LL Avgas per month. The Airport has approximately a one-month supply during peak season and an even greater supply during the remaining months of the year.

Currently, all aircraft fueling is provided via full-service fuel trucks. There is a desire for the Airport to put in a self-service 100LL Avgas fuel tank. It is anticipated that with increased fuel efficiency, fuel demand will remain similar during the planning period. However, if scheduled passenger service increases significantly, or changes to the type of aircraft occur, additional fuel demand may warrant additional fuel tanks.

Table 5-38: 2019 Fuel Calculations

	Jet A (gallons)	100LL Avgas (gallons)
Existing Storage Supply	70,000	30,000
2019 Peak 7-day Demand	44,607	4,993
2019 Peak 14-day Demand	89,214	9,987
Additional Need	0 - 19,214	0

Sources: HYA, Rectrix, and McFarland Johnson, 2020.

The future of electric aircraft presents potential opportunity for the Airport. Cape Air intends to operate electric aircraft in the next decade.

Recommendations for Aviation Fueling: All underground fuel tanks are recommended to be dug out and made to be above ground tanks. If necessary, consider constructing an additional Jet A fuel tank. As noted in **Section 5.5.2**, it is also recommended that a self-service 100LL Avgas option be provided. The Airport should plan a location and parking for the charging of itinerant ADG II electric aircraft.

5.6.2. Air Traffic Control Tower (ATCT)

The current ATCT is located southeast of the terminal building along the Terminal Ramp. It is operated between 6:00 a.m. and 10:00 p.m. local time. the ATCT at the Airport is a federal contract tower owned by the Airport and operated by Midwest Air Traffic Control Services. While the ATCT is operating, all aircraft within HYA's Class D airspace are provided radar services below 2,600 feet mean sea level. Prior to operating in the Airport's airspace, pilots must establish two-way radio communication with the ATCT to enter the Class D airspace.

As noted in Chapter 2, *Inventory*, of this Master Plan, the Airport underwent big transformations in 2011 and 2012 including the reconstruction of a new ATCT. The ATCT houses its own backup generator should the tower lose power. The building as currently constructed meets FAA requirements.

Recommendation for ATCT: There are no changes to the ATCT recommended.

5.6.3. Aircraft Rescue and Fire Fighting

As discussed in Chapter 2, *Inventory*, of this Master Plan, the ARFF station at the Airport is a multi-use ARFF/maintenance/SRE facility and operates as an Index A under FAR Part 139. However, during JetBlue operations, the Airport operates as an Index B. The ARFF station is located on the East Ramp with access to Taxiway B. The station vehicles are shown in **Table 5-39**. Vehicle 816 was replaced in 2020.

The ARFF space of the facility occupies approximately 3,000 SF of the total 15,000 SF building. Overall, the building was in poor condition and in need of a roof replacement at the assessment. Repairs were completed in 2020. The leaks from the roof have left indoor spaces unusable and damaged from water. The environmental filtering system within the building is also broken and unable to be repaired due to the old age of the system.

Table 5-39: Airport ARFF Equipment

Vehicle Call Sign	Year	Condition	Make/Model	Index	Storage Location
820	1992	Fair	E-One Titan	B	ARFF/SRE
817	2006	Good	E-One Titan	B	ARFF/SRE
816	1999/ 1998	Poor	Ford F-450 / 11102; Fire Combat Skid Plate & Fire Compression System	A	Outside ARFF/SRE

Source: Cape Cod Gateway Airport, 2019.

The building should be large enough to house all ARFF vehicles. Currently, one ARFF vehicle is being stored outside.

Recommendations for ARFF: The ARFF facility needs to be updated and damage needs to be repaired to spaces ruined by the leaking roof; the leaking roof was replaced 2020. The building should be big enough to accommodate all vehicles.

5.6.4. Airfield Maintenance Facility and Snow Removal Equipment (SRE)

The Airport operations staff performs the day-to-day responsibilities of maintaining and inspecting the airfield facilities, including the removal of snow during winter months. The existing number of maintenance and snow removal equipment, along with the number of Airport Improvement Program (AIP) eligible vehicles, is shown in **Table 5-40**.

Table 5-40: Maintenance Equipment and SRE

	Number of Existing Vehicles	Number of Existing Vehicles Older than 10 years	Number of AIP Eligible Vehicles
Maintenance	24	14	0
Snow Removal	15	10	7
Total	39	24	7

Sources: Cape Cod Gateway Airport Management and McFarland Johnson, 2021.

Storage space in the ARFF/maintenance/SRE building is limited and many vehicles are stored outside.

Per FAA AC 150/5220-20A, *Airport Snow and Ice Control Equipment*, the Airport is eligible for the following:

- One rotary plow
- Two displacement plows
- Two sweepers
- Two hopper spreaders

The existing maintenance/SRE storage building spans is comprised of approximately 12,000 SF of the joint ARFF/maintenance/SRE facility. With approximately 1.6 million SF of paved runway, per FAA AC 150/5220-18A, *Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials*, the Airport is classified as a very large airport or one with over 1 million SF of paved runway. As a very large airport, HYA is eligible for an SRE building of approximately 20,000 SF.

While maintenance equipment other then SRE is not eligible to be purchased with FAA AIP funds, the Airport should plan for a facility that can store the entire Airport fleet of equipment. This may require alternate funding sources for portions of the storage and maintenance facility that are not eligible for AIP funds.

Any changes recommended to this building should include an expansion so all ARFF/maintenance/SRE vehicles can be stored indoors to maximize their useful life.

Recommendation for Equipment and Airfield Maintenance and SRE Facility: Airfield maintenance and SRE equipment should be maintained or replaced, as needed, throughout the planning period. The Airport should plan for a building of approximately 20,000 SF to house maintenance equipment/SRE (compared to existing 12,000 SF).

5.6.5. Utilities

There is a separate utility study being conducted. The utility study can be found in **Appendix J**. At this time, there are no issues to be seen. The Airport currently has a backup generator for the terminal building as well as backup generators for the airfield should power ever go down.

Recommendation for Utilities: It is recommended that with any new utility projects, a survey and updated mapping is completed.

5.7. FACILITY REQUIREMENTS SUMMARY

This section summarizes all facility requirements for the Airport as shown in **Table 5-41**.

Table 5-41: Facility Requirements Summary

Item/Facility	Existing Facility or Capacity	Ultimate Requirement	Additional Need
Runway Length (Section 5.2.2)	Runway 15-33 – 5,253’ Runway 6-24 – 5,425’	One or both runway 6,000’-6,400’	575’-1,147’
Runway Width (Section 5.2.3)	Runway 15-33 – 150’ Runway 6-24 – 150’	Runway 15-33 – 150’ Runway 6-24 – 150’	None
Runway Strength and Condition (Section 5.2.4)	Runway 15-33 – 43 F/A/X/T Runway 6-24 – 32 F/A/X/T	Runway 15-33 – 43 F/A/X/T Runway 6-24 – 32 F/A/X/T	Potential Runway 6-24 strengthening
Runway Orientation (Section 5.2.5)	Runway 15-33 – C-III Runway 6-24 – C-III	Runway 15-33 – C-III Runway 6-24 – C-III	None

Item/Facility	Existing Facility or Capacity	Ultimate Requirement	Additional Need
Runway Safety Areas (Section 5.2.6)	Portions of Runways RSAs off Airport property	Provide standard RSA on all runways	Control of all RSA through ownership
Runway Object Free Areas (Section 5.2.7)	Portions of Runways ROFAs off Airport property	Provide standard on all runways	Control of all ROFA through ownership or avigation easements
Runway Protection Zones (Section 5.2.8)	Partially under Airport control through ownership and avigation easements	Under airport control through ownership or avigation easements	Control of all RPZs through ownership or avigation easements
Runway Visibility Zone (Section 5.2.9)	Half of the length between each runway end and the runway intersection	Half of the length between each runway end and the runway intersection	None
Runway Pavement Markings (Section 5.2.10)	Runway 15-33 – Precision Runway 6-24 – Precision	Runway 15-33 – Precision Runway 6-24 – Precision	None
Taxiways (Section 5.2.11)	Runway 15-33 – Full Parallel Runway 6-24 – Full Parallel Non-standard TSA/TOFA	Runway 15-33 – Full Parallel Runway 6-24 – Full Parallel Standard TSA/TOFA	Meet FAA standards
Taxiway Width (Section 5.2.11)	40' – 65'	50' – 75'	Meet TDG 3 guidelines
Passenger Terminal Ramp (Section 5.2.12)	160,000 SF	Meet Demands of Future Design Aircraft	Potentially reconfigure Terminal Ramp to accommodate future design aircraft
Potential Hot Spots and Geometry Requirements (Section 5.2.13)	See **Table 5-27**	Meet FAA geometry standards	Address airfield geometry concerns
Runway Lighting and Signage	Runway 15-33 – HIRLs	Runway 15-33 – HIRLs Standard Runway 15 threshold lights	Address Runway 15 threshold lights

Item/Facility	Existing Facility or Capacity	Ultimate Requirement	Additional Need
(Section 5.2.14)	Non-standard Runway 15 threshold lights Runway 6-24 – HIRLs	Runway 6-24 – HIRLs	
Approach Lighting/ Instrument Approaches (Section 5.2.14)	Runway 15 – ILS/DME, GPS Runway 33 – GPS Runway 6 – GPS, VOR Runway 24 – ILS/DME, GPS	Runway15 – ILS/DME, GPS Runway 33 – GPS Runway 6 – GPS, VOR Runway 24 – ILS/DME, GPS	None
Taxiway Lighting (Section 5.2.14)	Taxiways A, Portion of B, C, D – HITLs Portion of Taxiway B - MITLs Taxiway E - Unlit	All taxiways lit or marked with reflective markers	Add MITLs or reflective markers to Taxiway E
Runway Visual Aids (Section 5.2.15)	Runway 15 – None Runway 33 – PAPI Runway 6 – PAPI Runway 24 – PAPI	Runway 15 – PAPI Runway 33 – PAPI Runway 6 – PAPI Runway 24 – PAPI	Add PAPI to Runway 15
Terminal Facility (Section 5.3)	30,620 SF	150 Peak Passengers: 35,000 – 40,000 SF 200 Peak Passengers: 50,000 – 55,000 SF	5,000 – 25,000 SF
Airport Access and Signage (Section 5.4.1)	4 Ways of Access	Direct Route to Airport	Review Direct Route to Airport Improve Wayfinding
Terminal Area Parking (Sections 5.4.2 and 5.4.3)	1,085 Spaces	1,085 Spaces	None
Hangars (Section 5.5.1)	33 Individual Units 24,850 SF Conventional Space	24 Individual Units 30,220 SF Conventional Space	None 5,370 SF Conventional Space
GA Transient Ramp (Section 5.5.2)	369,500 SF	423,773 SF	40,000 SF – 67,000 SF
GA Auto Parking (Section 5.5.3)	201 Paved Spaces 50+ Unpaved Spaces	331 Spaces	80 Spaces
Aviation Fueling (Section 5.6.1)	30,000 Gallons 100LL Avgas 70,000 Gallons Jet A	30,000 Gallons 100LL Avgas 70,000 Gallons Jet A	Consider Adding a Jet A Fuel Tank

Item/Facility	Existing Facility or Capacity	Ultimate Requirement	Additional Need
			Add 100LL Avgas Self-Fueling Plan a Location for 6 ADG II Electric Aircraft Charging Stations
ATCT (Section 5.6.2)	Operated 6:00 a.m. – 10:00 p.m.	Operated 6:00 a.m. – 10:00 p.m.	None
ARFF (Section 5.6.3)	Operates as Index A except for JetBlue flights when it operates as Index B; 3,000 SF of building space	Operates as Index A except for JetBlue flights when it operates as Index B; 3,000 SF of building space	Repair interior damage caused by leaking roof (replaced in 2020)
Maintenance and SRE (Section 5.6.4)	12,000 SF of building space	20,000 SF of building space	Increase size of building by 8,000 SF

Source: McFarland Johnson Analysis, 2020.