Chapter Four
FACILITY REQUIREMENTS

To properly plan for the future of the Hillsboro Airport, it is necessary to identify specific types and quantities of facilities required or desired to adequately serve the Airport over the next 20 years. Facilities are broadly classified as airside (i.e., runways, taxiways, navigational aids, marking and lighting) and landside (i.e., hangars, aircraft parking apron, and automobile parking). There are four primary sources to identify the facility requirements:

- Aviation Demand Forecasts: The forecasts of aviation demand developed in the previous chapter serve as data inputs to various models, which have been constructed following Federal Aviation Administration (FAA) guidance, to generate facility needs.
- Design Standards Review: Various design standards that apply to the Airport are reviewed as they can change based on modifications to FAA guidance or activity changes at the Airport. Design standards primarily relate to the numerous safety related surfaces and separation distances.
- Facility Maintenance: Airports are required to maintain their pavement surfaces for the useful life of those pavements. The pavements require routine maintenance and occasionally must be rehabilitated or reconstructed. This category includes maintenance of airport structures and landside facilities.
- Support Facilities: This category includes all airport related facilities that do not naturally fall into the airside and landside categories and includes elements such as fuel facilities, access and circulation, and general on-airport land use.

The objective of this effort is to identify the adequacy of existing airport facilities and outline what new facilities may be needed, and when these may be needed, to accommodate forecast demands. Having established these facility requirements, alternatives for providing these facilities will be evaluated in the next chapter.

The facility requirements at Hillsboro Airport were evaluated using guidance contained in several FAA publications, including the following:

- Advisory Circular (AC) 150/5300-13A, *Airport Design*
- AC 150/5060-5, *Airport Capacity and Delay*
- AC 150/5325-4B (and Draft 4C), *Runway Length Requirements for Airport Design*
- Federal Aviation Regulation (FAR) Part 77, *Objects Affecting Navigable Airspace*
- FAA Order 5090.3C, *Field Formulation of the National Plan of Integrated Airport Systems (NPIAS)*

PLANNING HORIZONS

An updated set of aviation demand forecasts for the Airport has been established, with a summary of the primary forecasting elements presented previously on Exhibit 3G. These activity forecasts include annual operations, based aircraft, based aircraft fleet mix, and peak activity periods. With this information, specific components of the airfield and landside systems can be evaluated to determine their capacity to accommodate future demand.

Cost-effective, efficient, and orderly development of an airport should rely more upon actual demand at an airport than on a time-based forecast figure. To develop a master plan that is demand-based rather than time-based, a series of planning horizon milestones have been established that take into consideration the reasonable range of aviation demand projections. The planning horizons presented in **Table 4A** are segmented as the Short Term (approximately years 1-5), the Intermediate Term (approximately years 6-10), and the Long Term (years 11-20 and possibly beyond).

TABLE 4A
Planning Horizon Activity Levels
Hillsboro Airport

		PLANNING HORIZON		
	Base Year 2016	Short Term	Intermediate Term	Long Term
ANNUAL OPERATIONS				
Itinerant				
General Aviation	77,778	81,500	85,600	94,800
Air Taxi	4,364	4,400	4,600	5,000
Military	268	300	300	300
Local				
General Aviation	115,332	121,800	130,000	147,500
Military	21	100	100	100
Total Annual Operations	197,763	208,100	220,600	247,700
BASED AIRCRAFT	354	375	395	445

Source: Coffman Associates analysis

It is important to consider that actual activity at the Airport may be higher or lower than what the annualized forecast portrays. By planning according to activity milestones, the resultant plan can accommodate unexpected shifts or changes in the area's aviation demand. It is important for the plan to accommodate these changes so that Airport officials can respond to unexpected changes in a timely fashion.

The most important reason for utilizing milestones is to allow airport management the flexibility to make decisions and develop facilities according to needs generated by actual demand levels. The demand-based schedule provides flexibility in development, as development schedules can be slowed or expedited according to demand at any given time over the planning period. The resultant plan provides airport officials with a financially responsible and needs-based program.

AIRFIELD CAPACITY

An airfield's capacity is expressed in terms of its annual service volume (ASV). ASV is a reasonable estimate of the maximum level of aircraft operations that can be accommodated in a year without incurring significant delay factors. As operations near, or surpass, the ASV, delay factors increase exponentially. The Airport's ASV was examined utilizing the FAA's Advisory Circular (AC) 150/5060-5, *Airport Capacity and Delay*.

For this capacity analysis, only those operations utilizing the runway system were considered. At Hillsboro Airport, this includes all fixed-wing aircraft (both local and itinerant) and itinerant helicopters. Local helicopter operations have been excluded from the runway capacity analysis because most of these will operate from a taxiway, and apron area or a designated helipad to the designated helicopter training pattern areas.

This analysis includes an estimate of nighttime activity that occurs when the tower is closed (10:00 p.m. – 6:00 a.m.). The nighttime activity is estimated at three percent of air taxi and general aviation operations. **Table 4B** presents the operations data utilized in the capacity model.

TABLE 4B
Annual Operations for Capacity Calculations
Hillsboro Airport

	2016	Short Term	Intermediate Term	Long Term
General Aviation				
Itinerant	77,778	81,500	85,600	94,800
Local	65,754	69,709	74,774	85,477
Nighttime	4,306	4,536	4,811	5,408
Military				
Itinerant	268	300	300	300
Local	21	100	100	100
Air Taxi				
Itinerant	4,364	4,400	4,600	5,000
Nighttime	131	132	138	150
Total Operations for Capacity Analysis	**152,622**	**160,677**	**170,323**	**191,235**

Note: Local helicopter operations are excluded.

FACTORS AFFECTING ANNUAL SERVICE VOLUME

This analysis takes into account specific factors about the airfield in order to calculate the Airport's ASV. These various factors are depicted in **Exhibit 4A**. The following describes the input factors as they relate to the Airport and include airfield layout, weather conditions, aircraft mix, and operations.

- **Runway Configuration** – The Airport has a three-runway configuration with primary Runway 13R-31L, crosswind Runway 2-20, and parallel Runway 13L-31R. The primary and crosswind runways intersect approximately 1,300 feet from the Runway 31L end and 1,950 feet from the Runway 20 end. The parallel runway does not intersect either of the other two runways. Runway 13R has a precision instrument landing system (ILS) approach providing for visibility minimums as low as ½-mile. Runway 31L has non-precision approaches with the lowest visibility minimum being 1-mile. All other runway ends allow for visual approaches only.

- **Runway Use** – Runway usage is affected by several factors. Safe operations are the highest priority, so the runway's ability to accommodate a variety of aircraft is first and foremost. For example, at 3,821 feet in length, Runway 2-20 will not be as capable of accommodating the full variety of aircraft that operate at the Airport as will primary Runway 13R-31L at 6,600 feet in length. Wind direction is another operational factor for runway selection. The location of the runway in proximity to services and hangars is also a factor to runway use. During active periods when delay may be a factor, air traffic control will operate runway combinations that can safely provide adequate capacity to minimize delays.

  Runway 13R-31L is the primary runway, with Runway 31L the calm wind runway. The calm wind runway is the designated runway to use when wind is not a factor in runway selection.

- **Exit Taxiways**– Based upon the aircraft mix using the Airport, taxiways located between 2,000 and 4,000 feet from the landing threshold and separated by at least 750 feet are factored in the exit rating for the airfield. The greater the number of taxiway exits that are appropriately spaced, the lower the runway occupancy time for an aircraft, which contributes to a higher overall capacity for the airfield. Runway 13R-31L has the maximum number of qualifying taxiways, which is two. The taxiway exits for crosswind Runway 2-20 and parallel Runway 13L-31R are not considered in the capacity model.

- **Weather Conditions** – Visual meteorological conditions are defined as conditions when cloud ceilings are 1,000 feet or above and/or visibility is at least three statute miles (also referred to as visual flight rules [VFR]). Instrument meteorological conditions occur when cloud ceilings are between 500 and 1,000 feet and visibility is between one and three statute miles (referred to as instrument flight rules [IFR]). Poor visibility conditions (PVC) apply for minimums below 500 feet and one mile.

AIRFIELD LAYOUT

Runway Configuration

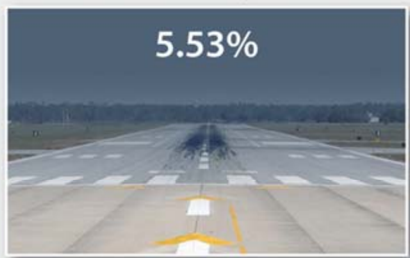
Runway Use

Number of Exits

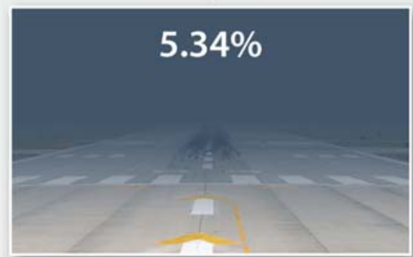
WEATHER CONDITIONS

VMC (VFR)
Visual Meteorological Conditions

IMC (IFR)
Instrument Meteorological Conditions



PVC
Poor Visibility Conditions



AIRCRAFT MIX

Category A & B Aircraft

Category C Aircraft

Category D Aircraft

OPERATIONS

Arrivals

Departures

Touch-and-Go Operations

Total Annual Operations

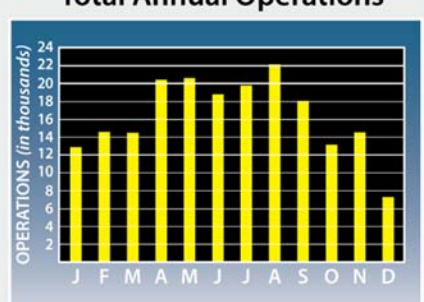


Exhibit 4A
AIRFIELD CAPACITY FACTORS

As shown in **Table 4C**, weather data indicates that the Airport is in VFR approximately 89.13 percent of the year, IFR approximately 5.53 percent of the year, and PVC 5.34 percent of the year.

TABLE 4C
Annual Weather Conditions
Hillsboro Airport

Condition	Cloud Ceiling	Visibility	Observations	Time (min.)	Percent
Visual (VFR)	≥ 1,000' and	≥ 3 mi.	89,019	4,686,992	89.13%
Instrument (IFR)	< 1,000' to ≥ 500' and/or	< 3 mi. and Vis ≥ 1 mi.	11,705	290,830	5.53%
Poor Visibility (PVC)	< 500' or	< 1 mi.	11,607	280,998	5.34%
		TOTAL	**112,331**	**5,258,820**	**100.00%**

Source: National Oceanic and Atmospheric Administration (NOAA). Ten years of data from the on-airport ASOS from January 1, 2006-December 31, 2015.

- **Aircraft Mix** - Descriptions of the classifications and the percentage mix are presented in **Table 4D**. This classification system is based on aircraft weight and not the aircraft approach speed as used in the critical aircraft determination. The vast majority of operations are forecast to be performed by aircraft weighing less than 12,500 pounds. This includes most small business jets. The C category includes medium and large business jets and large turboprops. The D category of aircraft is not expected to impact capacity at the Airport.

TABLE 4D
Aircraft Operational Mix for Capacity
Hillsboro Airport

	A & B	C
2016	90.4%	9.6%
Short Term	90.3%	9.7%
Intermediate Term	90.1%	9.9%
Long Term	89.8%	10.2%

A & B - 12,500 pounds or less
C - 12,500 to 300,000 pounds
D - Over 300,000 pounds

Source: FAA AC 150/5060, Airport Capacity and Delay

- **Percent Arrivals** - The percentage of arrivals as they relate to total operations at the Airport is important in determining airfield capacity. Under most circumstances, the lower the percentage of arrivals, the higher the hourly capacity. The aircraft arrival-departure percentage split is typically 50/50, which is the case at the Airport.

- **Touch-and-Go Activity** – A touch-and-go operation involves an aircraft making a landing and then an immediate takeoff without coming to a full stop or exiting the runway. A high percentage of touch-and-go traffic normally results in a higher operational capacity because one landing and one takeoff occurs within a shorter time period than individual operations. Touch-and-go operations at the Airport have historically averaged approximately 40.0 percent of total annual operations. This is forecast to progressively increase to 41.4 percent by the long-term planning period.

- **Operational Levels** – For the airfield capacity analysis, average daily operations and average design hour (peak hour within the design day as described in the Forecast chapter) operations during the peak month are utilized. Typical operations activity is important in the calculation of an airport's ASV as "peak demand" levels occur sporadically. The peak periods used in the capacity analysis are representative of normal operational activity and can be exceeded at various times throughout the year. At Hillsboro Airport, the peak periods typically occur during the summer months.

ANNUAL SERVICE VOLUME

The following formula is used to determine the annual service volume:

Annual Service Volume (ASV) = C x D x H
C = weighted hourly capacity
D = ratio of annual demand to the average daily demand during the peak month
H = ratio of average daily demand to the design hour demand during the peak month

Following this formula, the current ASV for Hillsboro Airport has been calculated at approximately 384,000 operations. By the long-term planning period, the ASV would decrease slightly to 381,000 annual operations as shown in **Table 4E**. By the long-term planning horizon, total operations are forecast to represent 50.3 percent of the ASV. The ASV is the point at which delay grows exponentially, thereby constraining capacity.

TABLE 4E
Airfield Demand/Capacity Summary
Hillsboro Airport

	PLANNING HORIZON			
	2016	Short Term	Intermediate Term	Long Term
Operational Demand				
Annual*	152,622	160,677	170,323	191,235
Design Hour	61	64	68	76
Capacity				
Annual Service Volume	384,000	381,000	381,000	381,000
Percent Capacity	39.8%	42.2%	44.7%	50.3%
Weighted Hourly Capacity	152	151	151	151
Delay				
Per Operation (Seconds)	24	27	30	36
Total Annual (Hours)	1,017	1,025	1,419	1,912

*Includes 3% nighttime increase for general aviation and air taxi operations. Excludes local helicopter operations.
Source: FAA AC 150/5060-5, Airport Capacity and Delay

AIRCRAFT DELAY

As the number of annual aircraft operations approach the airfield's capacity, increasing delays to aircraft operations begin to occur. Delays occur to arriving and departing aircraft in all weather conditions. Arriving aircraft delays may result in aircraft holding outside of the airport traffic area. Departing aircraft delays result in aircraft holding at the runway end until released by air traffic control.

Annual delay at the Airport now and into the forecast planning horizons is negligible. Over the course of a year, it is estimated that a total of 1,017 hours of delay are experienced. This equates to approximately 24 seconds per operation. In the future, approximately 36 seconds of delay per operations may be anticipated. Some individual operations may experience a significant delay, but overall delay, as a result of airfield capacity constraint, is a minor factor at the Airport.

CAPACITY ANALYSIS CONCLUSION

"Projects specifically designed to improve overall capacity, such as additional taxiway exits and additional runways beyond current planned projects, are not necessary."

According to FAA Order 5090.3C, *Field Formulation of the National Plan of Integrated Airport Systems* (NPIAS), consideration should be given to projects specifically designed to increase overall airfield capacity when operations reach 60-75 percent of the ASV. Since this range is not anticipated to be reached at the Airport within the planning period, capacity improvement projects, such as additional taxiway exits and additional runways beyond current planned projects, are not necessary over the course of the planning horizons.

During the development of the previous master plan, capacity constraint was identified as a significant issue at the Airport. At that time (2003 base year), annual operations represented 107 percent of the ASV. This was the impetus for construction of the parallel runway. Clearly, the availability of the parallel runway has significantly lowered capacity constraint at the Airport to the point where capacity is not anticipated to be an issue through the 20-year planning period of this master plan.

AIRFIELD REQUIREMENTS

As indicated earlier, airport facilities include both airside and landside components. Airside facilities are those related to the arrival, departure, and ground movement of aircraft. The FAA has established various dimensional design standards related to the airfield to ensure the safe operations of aircraft.

The FAA design standards impact the design of each of the airfield components to be analyzed. The following airfield components are analyzed for compliance to FAA design standards in detail:

- Runway Configuration
- Runway Design Standards
- Runways
- Taxiways
- Navigational and Weather Aids
- Instrument Approaches

RUNWAY CONFIGURATION

The Airport's airfield system has three runways. Primary Runway 13R-31L is oriented in a northwest/southeast manner. Crosswind Runway 2-20 is oriented in a southwest/northeast manner. Runway 13L-31R is parallel to the primary runway. The primary and crosswind runways intersect approximately 1,300 feet from the Runway 31L end and 1,950 feet from the Runway 20 end. The parallel runway does not intersect either of the other two runways.

A crosswind runway configuration is very common in locations with variable wind patterns and is recommended to meet local wind conditions as detailed below. For the operational safety and efficiency of an airport, it is desirable for the primary runway to be oriented as close as possible to the direction of the prevailing winds. This reduces the impact of wind components perpendicular to the direction of travel of an aircraft that is landing or taking off.

FAA AC 150/5300-13A, *Airport Design,* recommends that a crosswind runway be made available when the primary runway orientation provides for less than 95 percent wind coverage for specific crosswind components. The 95 percent wind coverage is computed on the basis of not exceeding a 10.5-knot (12 mph) component for runway design code (RDC) A-I and B-I, 13-knot (15 mph) component for RDC A-II and B-II, 16-knot (18 mph) component for RDC A-III, B-III, C-I through C-III, and D-I through D-III, and 20 knots for larger wingspans.

Exhibit 4B presents both an all-weather and IFR wind rose. A wind rose is a graphic tool that gives a succinct view of how wind speed and direction are historically distributed at a particular location. The table at the top of the wind rose indicates the percent of wind coverage for each runway at specific wind intensity. The wind rose is constructed based on data collected from the on-airport Automated Surface Observing System (ASOS). Per FAA guidance, the most recent 10 years of data has been collected and analyzed. This data was previously presented on **Table 4C**.

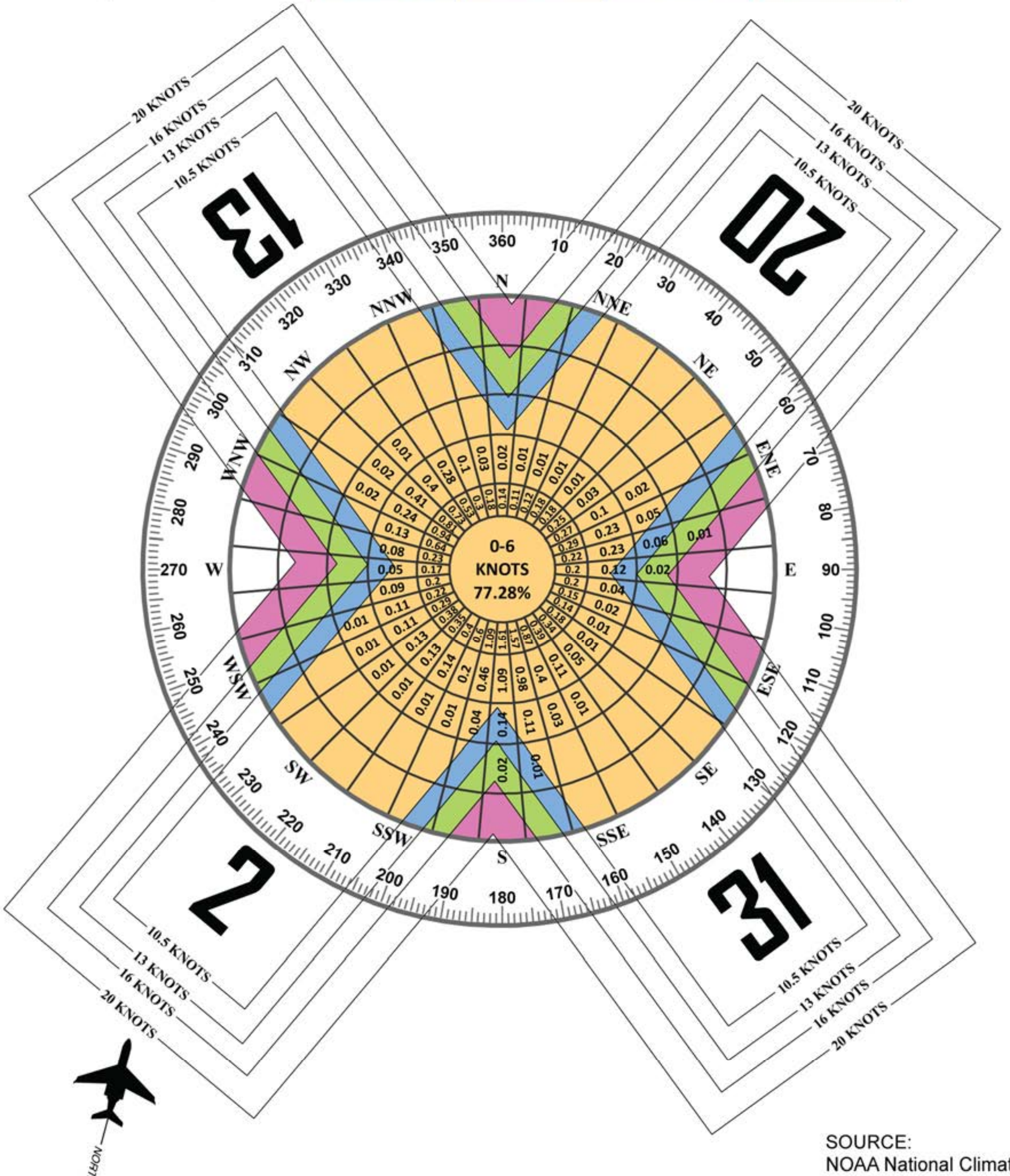
As can be seen on the exhibit, all runways provide greater than 95 percent wind coverage for both all-weather and IFR conditions. If prevailing winds were the only consideration, then there would not be current justification for FAA financial participation in Runway 2-20 as a crosswind runway; however, many busy airports will maintain a secondary runway for capacity and efficiency reasons. Parallel Runway 13L-31R is considered a secondary runway by the FAA, because the airport was operating at above 60 percent of capacity when it was planned and constructed and is therefore eligible for continued FAA financial participation.

According to FAA Order 5100.38D, *Airport Improvement Handbook*, only one runway at any NPIAS airport is eligible for on-going maintenance and rehabilitation funding unless the FAA Airport District Office has made a specific determination that a crosswind or secondary runway is justified. A runway that is not a primary runway, secondary runway, or crosswind runway is considered to be an *additional* runway, which is not eligible for FAA funding. It is not unusual for a two-runway airport to have a primary runway and an additional runway, and no secondary or crosswind runway. **Table 4F** presents the eligibility requirements for runway types.

When Runway 2-20 was reconstructed in 2010, it was considered a crosswind runway based on seasonal wind analysis. Analysis of the most recent 10 years of wind data indicates that Runway 2-20 would no longer be eligible as a crosswind runway. Therefore, it is either a secondary runway (eligible if justified) or an additional runway (ineligible). The only justification as a secondary runway available is if the FAA were to make a specific determination that the runway is required.

As a busy reliever general aviation airport with a significant level of flight training, the airport sponsor could make an appeal to the FAA that the runway is necessary. That effort should take place prior to the need for a significant investment in the runway. If Runway 2-20 is considered an additional runway by the FAA, then the cost to maintain the runway would fall to the airport sponsor.

ALL WEATHER WIND COVERAGE				
Runways	10.5 Knots	13 Knots	16 Knots	20 Knots
Runway 13-31	97.90%	98.98%	99.77%	99.96%
Runway 2-20	96.70%	98.52%	99.78%	99.97%
All Runways	99.59%	99.92%	99.99%	100.00%



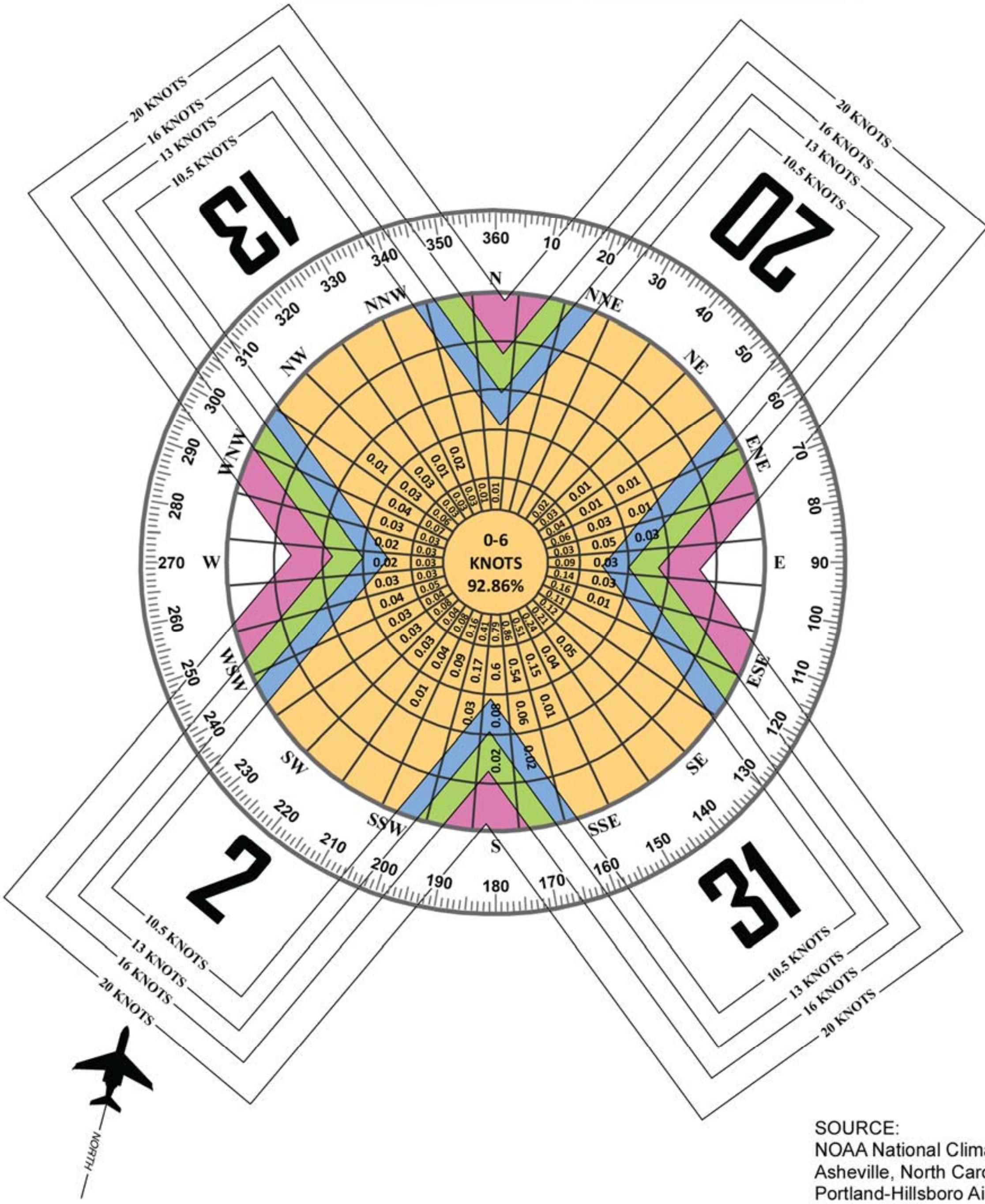
Magnetic Declination
00° 15' 26" East (April 2017)
Annual Rate of Change
00° 08' 00" West (April 2017)

SOURCE:
NOAA National Climatic Center
Asheville, North Carolina
Portland-Hillsboro Airport
Portland, OR

OBSERVATIONS:
112,331 All Weather Observations
Jan. 1, 2006 - Dec, 31 2015

Exhibit 4B
ALL WEATHER WINDROSE

IFR WIND COVERAGE				
Runways	10.5 Knots	13 Knots	16 Knots	20 Knots
Runway 13-31	99.36%	99.71%	99.93%	99.99%
Runway 2-20	99.00%	99.63%	99.92%	99.99%
All Runways	99.83%	100.00%	100.00%	100.00%



Magnetic Declination
00° 15′ 26″ East (April 2017)
Annual Rate of Change
00° 08′ 00″ West (April 2017)

SOURCE:
NOAA National Climatic Center
Asheville, North Carolina
Portland-Hillsboro Airport
Portland, OR

OBSERVATIONS:
23,312 IFR Observations
Jan. 1, 2006 - Dec, 31 2015

Exhibit 4B
IFR WINDROSE

TABLE 4F
Runway Eligibility

For the following runway type…	Must meet all of the following criteria…	And is…
Primary Runway	1. A single runway at an airport is eligible for development consistent with FAA design and engineering standards.	Eligible
Crosswind Runway	1. The wind coverage on the primary runway is less than 95%.	Eligible if justified
Secondary Runway	1. There is more than one runway at the airport.	Eligible if justified
	2. The non-primary runway is not a crosswind runway.	
	3. Either of the following: a) The primary runway is operating at 60% or more of its annual capacity. b) FAA has made a specific determination that the runway is required.	
Additional Runway	1. There is more than one runway at the airport.	Ineligible
	2. The non-primary runway is not a crosswind runway.	
	3. The non-primary runway is not a secondary runway.	

Source: FAA Order 5100.38D, AIP Handbook

Seasonal Wind Analysis

In January 2012, the Airport completed a wind coverage analysis that reviewed wind data covering 1973-2009 recorded over a 24-hour period at Hillsboro. The January 2012 study built upon a wind analysis study conducted on wind data from 2000-2009 (completed in October 2011). The purpose of examining the more extended time period was to determine if the historical trend (1973-2009) would possibly screen for anomalies in the 2000-2009 time-period. The analysis showed that the longer time period of data indicated that for up to six months of the year, Runway 13-31 did not meet the 95 percent wind coverage threshold at 10.5 knots. It concluded, "This data supports Runway 2-20, to allow A-I and B-I aircraft to operate at HIO safely throughout the year."

The FAA recommends wind coverage analysis of the most recent 10 years of wind data in "all-weather" conditions over a 24-hour period. Under certain circumstances, it may be desirable to analyze the wind data on less than a 24-hour observation period because activity tends to decline after dark or when a control tower closes. In some instances, it may be desirable to analyze wind data for seasonal variations, instrument weather conditions, daytime versus nighttime, and regularly occurring gusts. The approach taken in the 2012 study examined four scenarios covering the time period from 1973 to 2009. Each of those scenarios is replicated below utilizing the most recent 10 years of data covering 2006-2015. The input parameters and definitions below are the same as the 2012 study.

Input Parameters

- Runway 13-31 is considered independently. Runway 2-20 operating independently and Runways 2-20 and 13-31 operating as a system are not included in this analysis.
- The true bearing of Runway 13-31 is 143.57° (*Source: FAA AVN Data Systems*). True bearing verified with the FCC bearing and distance calculator.
- Tailwind component: 60 knots (default for a bi-directional runway)
- Data source: NOAA Station 72698 Portland/Hillsboro.
- Total Observations: 112,331 from January 1, 2006 through December 31, 2015.

Definitions

- All Weather Conditions: all cloud ceilings, all visibilities.
- VFR Conditions: Cloud ceiling ≥ 1,000 feet and visibility ≥ 3 miles.
- 24 Hour Observations: All observations recorded are considered.
- ATCT Open: Observations recorded between 0600 and 2200 Pacific Time are considered.

Previous Study and Baseline Comparison

Table 4G shows a comparison of the average annual wind coverage for the all-weather/24-hour and VFR/24-hour conditions for the three time periods (1973-2009; 2000-2009; 2006-2015). As can be seen in **Table 4G**, wind coverage exceeds the 95 percent threshold under these three initial scenarios. The following four scenarios, established in the 2012 study, examine those months when wind coverage for Runway 13-31 falls below 95 percent utilizing the 2006-2015 data.

Table 4G
Runway 13-31 Wind Data Study Comparison

	VFR			All Weather		
Wind Coverage	1973 to 2009[1]	2000 to 2009[1]	2006 to 2015[2]	1973 to 2009[1]	2000 to 2009[1]	2006 to 2015[2]
10.5 knots	96.01%	97.65%	97.52%	96.30%	97.45%	97.90%
13 knots	97.90%	98.73%	98.78%	98.05%	98.83%	98.98%
16 knots	99.42%	99.74%	99.73%	99.45%	99.76%	99.77%
20 knots	99.86%	99.96%	99.95%	99.86%	99.96%	99.96%

[1]HIO Runway 13-31 Wind Coverage Analysis by Mead & Hunt, January 11, 2012.
[2]On-Airport wind observations January 1, 2006-December 31, 2015; Original data from NOAA

Scenario 1: All Weather Conditions, 24-Hour Observations, 2006-2015

In Scenario 1, Runway 13-31 provides 95 percent wind coverage at 10.5 knots for each month of the year. In the 2012 wind analysis study, there were four months (December – March) when the wind coverage fell below the 95 percent threshold. When the analysis is run using the most recent 10 years of data, all 12 months exceed the 95 percent threshold, indicating that a crosswind runway is not justified for FAA funding. The results are included in **Table 4H**.

Table 4H
Wind Analysis Scenario 1
Runway 13-31 All Weather, 24-Hour Observations

	2012 Analysis of Wind from 1973-2009[1]		2018 Analysis of Wind from 2006-2015[2]	
Month	10.5 knots	13 knots	10.5 knots	13 knots
January	**94.19%**	96.77%	98.00%	99.15%
February	**92.81%**	95.84%	95.80%	97.72%
March	**94.95%**	97.49%	97.02%	98.70%
December	**94.79%**	97.17%	97.16%	98.51%
Annual	96.30%	98.05%	97.90%	98.98%

[1]HIO Runway 13-31 Wind Coverage Analysis by Mead & Hunt, January 11, 2012.
[2]On-Airport wind observations January 1, 2006-December 31, 2015; Original data from NOAA
***BOLD text** - Months when crosswind coverage was below 95%*

Scenario 2: VFR Conditions, 24-Hour Observations, 2006-2015

In Scenario 2, Runway 13-31 does not meet 95 percent wind coverage at 10.5 knots for the month of February. The 2012 wind analysis study showed that four months (December – March) fell below the 95 percent threshold. The results are included in **Table 4J**.

Table 4J
Wind Analysis Scenario 2
Runway 13-31 VFR Weather Condition, 24-Hour Observations

	2012 Analysis of Wind from 1973-2009[1]		2018 Analysis of Wind from 2006-2015[2]	
Month	**10.5 knots**	**13 knots**	**10.5 knots**	**13 knots**
January	**92.62%**	95.85%	96.66%	98.59%
February	**92.05%**	95.39%	**94.90%**	997.26%
March	**94.70%**	97.36%	96.74%	98.58%
December	**93.28%**	96.35%	95.78%	97.74%
Annual	96.01%	97.90%	97.52%	98.78%

[1]*HIO Runway 13-31 Wind Coverage Analysis by Mead & Hunt, January 11, 2012.*
[2]*On-Airport wind observations January 1, 2006-December 31, 2015; Original data from NOAA*
***BOLD text** - Months when crosswind coverage was below 95%*

Scenario 3: All Weather Conditions, ATCT Open, 2006-2015

In Scenario 3, Runway 13-31 does not meet 95 percent wind coverage at 10.5 knots for the month of February. The 2012 wind analysis study showed that four months (December – March) fell below the 95 percent threshold. The results are included in **Table 4K**.

Table 4K
Wind Analysis Scenario 3
Runway 13-31 All Weather Condition, ATCT Open (6:00am-10:00pm)

	2012 Analysis of Wind from 1973-2009[1]		2018 Analysis of Wind from 2006-2015[2]	
Month	**10.5 knots**	**13 knots**	**10.5 knots**	**13 knots**
January	**93.46%**	96.32%	97.65%	99.00%
February	**91.70%**	95.20%	**94.71%**	97.15%
March	**93.61%**	96.78%	95.87%	98.15%
April	**94.49%**	97.23%	95.96%	98.09%
December	**94.35%**	96.90%	96.70%	98.30%
Annual	95.46%	97.60%	97.26%	98.65%

[1]*HIO Runway 13-31 Wind Coverage Analysis by Mead & Hunt, January 11, 2012.*
[2]*On-Airport wind observations January 1, 2006-December 31, 2015; Original data from NOAA*
***BOLD text** - Months when crosswind coverage was below 95%*

Scenario 4: VFR Conditions, ATCT Open, 2006-2015

In Scenario 4, Runway 13-31 does not meet 95 percent wind coverage at 10.5 knots for the month of February. The 2012 wind analysis study showed that six months (November – April) fell below the 95 percent threshold. The results are included in **Table 4L**.

Table 4L
Wind Analysis Scenario 4
Runway 13-31 VFR Weather Condition, ATCT Open (6:00am-10:00pm)

	2012 Analysis of Wind from 1973-2009[1]		2018 Analysis of Wind from 2006-2015[2]	
Month	**10.5 knots**	**13 knots**	**10.5 knots**	**13 knots**
January	**91.78%**	95.31%	96.44%	98.50%
February	**90.80%**	**94.66%**	**93.39%**	96.79%
March	**93.27%**	96.61%	95.63%	98.04%
April	**94.37%**	97.17%	95.66%	97.66%
November	**94.71%**	97.51%	96.20%	98.21%
December	**92.89%**	96.11%	95.33%	97.63%
Annual	95.11%	97.41%	96.89%	98.47%

[1]*HIO Runway 13-31 Wind Coverage Analysis by Mead & Hunt, January 11, 2012.*
[2]*On-Airport wind observations January 1, 2006-December 31, 2015; Original data from NOAA*
***BOLD text** - Months when crosswind coverage was below 95%*

The updated wind analysis indicates that Runway 13-31 falls below the FAA recommended 95 percent wind coverage threshold for a 10.5 knot crosswind, for aircraft design groups A/B-I during February, depending on the scenario. If it can be shown that during this month, when the crosswind coverage does not exceed the 95 percent threshold, there are more than 500 operations by aircraft using Runway 2-20, a case may be made that Runway 2-20 continues to be needed and justified.

In the forecast chapter of this master plan, Table 3AA documented the number of operations to Runway 2-20 as captured by the Airport Noise Monitoring and Management System (AMONS). This system identified a total of 1,700 operations in 2016. However, the ANOMS system only captured 12.5 percent of total operations in 2016. By extrapolating the number of operations captured, an estimate of 13,600 annual operations utilizing Runway 2-20 can be made. The total number of operations in the month of February 2016 represented 7.34 percent of total annual operations (14,512/197,763). Therefore, it is estimated that there were 998 operations to Runway 2-20 in February 2016 (7.34% * 13,600). In the worst-case scenario, Runway 13-31 provided adequate wind coverage 93.39 percent of the time and did not 6.61 percent of the time. Therefore, 6.61 percent of 998equals 66 operations when Runway 2-20 was needed due to strong crosswinds.

Based on the monthly wind analysis for the most recent 10 years of data (2006-2015), it is unlikely that Runway 2-20 is used more than 500 times annually in 10.5 knot wind conditions by operators of small aircraft in ARC A/B-I that would need the runway. Therefore, Runway 2-20 is not eligible as a crosswind runway. It may still be eligible as a secondary runway as determined by FAA. It can also be maintained locally as an additional runway.

Runway 2-20 provides options to tower controllers and pilots that improves the efficiency of movement around the airfield. While the wind analysis does not indicate a need for a crosswind runway, the Port of Portland should consider maintaining a three-runway system. For this master plan, all three runways are planned to be maintained.

RUNWAY DESIGN STANDARDS

The FAA has established several design standards to protect aircraft operational areas and keep them free from obstructions that could affect their safe operation. These include the runway safety area (RSA), runway object free area (ROFA), runway obstacle free zone (OFZ), and runway protection zone (RPZ).

The entire RSA, ROFA, and ROFZ should be under the direct ownership of the airport sponsor to ensure these areas remain free of obstacles and can be readily accessed by maintenance and emergency personnel. The RPZ for each runway end should also be under airport ownership where feasible. An alternative to outright ownership of the RPZ is the purchase of avigation easements (acquiring control of designated airspace within the RPZ) or having sufficient land use control measures in place which ensure the RPZ remains free of incompatible development. Dimensional standards for the various safety areas associated with the runways are a function of the type of aircraft expected to use the runways, as well as the instrument approach capability. **Exhibit 4C** presents the dimensional design standards for the runways at the Airport.

As discussed in the previous chapter, the applicable design standards are primarily based upon the critical design aircraft and the instrument approach visibility minimums. The critical design aircraft is that aircraft or group of aircraft with similar characteristics, accounting for 500 or more annual operations. Runway 13R-31L is designed to D-III standards. Runway 2-20 has been designed to B-II standards. And parallel Runway 13L-31R is designed to B-I (small aircraft) standards. These applicable design standards represent no change from what is on the current Airport Layout Plan (ALP).

It should be noted that Runway 2-20 has historically been planned and designed to B-II design standards and it meets the B-II design standards for RSA, ROFA, OFZ and RPZs. As documented in the previous chapter, the type of aircraft that operates on the runway more than 500 times per year, thus establishing the critical aircraft for the runway, fall in design category A-I. It is the intention of the Port of Portland to maintain Runway 2-20 to B-II design standards because:

- Runway 2-20 experiences approximately 13,600 annual operations (See Table 3AA);
- Runway 2-20 experiences activity by B-II aircraft;
- Runway 2-20 provides efficiencies for controllers and pilots.

All references to the applicable design standards for Runway 2-20 will consider it to have a current and future ARC of B-II. The Port of Portland understands that when it comes time to request FAA funds for maintenance and/or rehabilitation of Runway 2-20, only that portion necessary to meet A-I standards will be eligible unless a new determination is made at that time.

CURRENT AIRPORT DATA	Runway 13R-31L	Runway 2-20*	Runway 13L-31R
Design Aircraft	**D-III-2**	**B-II-1A**	**B-I-1A (small)**
Runway Design Code	**D-III-2400**	**B-II-VIS**	**B-I-VIS**
Visibility Minimums	**½-mile**	**VIS**	**VIS**
RUNWAY DESIGN			
Runway Width	100 (**150**)	75	60
Runway Shoulder Width	20	10	10
Blast Pad Length/Width	200/140	150/95	60/80
RUNWAY PROTECTION			
Runway Safety Area (RSA)			
Width	500	150	120
Length Beyond Departure End	1,000	300	240
Length Prior to Threshold	600	300	240
Runway Object Free Area (ROFA)			
Width	800	500	250
Length Beyond Departure End	1,000	300	240
Length Prior to Threshold	600	300	240
Runway Obstacle Free Zone (ROFZ)			
Width	400	400	250
Length Beyond End	200	200	200
Approach Runway Protection Zone (RPZ)			
Length	2,500	1,000	1,000
Inner Width	1,000	500	250
Outer Width	1,750	700	450
Departure Runway Protection Zone (RPZ)			
Length	1,700	1,000	1,000
Inner Width	500	500	250
Outer Width	1,010	700	450
RUNWAY SEPARATION			
Runway Centerline to:			
Parallel Runway (Visual)	700	700	NA
Holding Position	250	200	125
Parallel Taxiway	400	240	150
Aircraft Parking Area	500	250	125

*Current (2017) critical aircraft is ARC A-I (small)
Bold figures are existing conditions
Note: All dimensions in feet
Source: FAA AC 150/5300-13A, *Airport Design*

Exhibit 4C
FAA DESIGN STANDARDS

Runway Safety Area (RSA)

The RSA is defined in FAA Advisory Circular (AC) 150/5300-13A, *Airport Design,* as a "surface surrounding the runway prepared or suitable for reducing the risk of damage to airplanes in the event of undershoot, overshoot, or excursion from the runway." The RSA is centered on the runway and dimensioned in accordance to the approach speed of the critical design aircraft using the runway. The FAA requires the RSA to be cleared and graded, drained by grading or storm sewers, capable of accommodating the design aircraft and fire and rescue vehicles, and free of obstacles not fixed by navigational purpose, such as runway edge lights or approach lights.

The standard width for the RSA surrounding Runway 13R-31L is 500 feet and it extends 1,000 feet beyond the takeoff end of the runway and 600 feet prior to the landing runway end. The RSA for Runway 2-20 is 150 feet wide and it extends 300 feet beyond the runway ends. The RSA for parallel Runway 13L-31R is 120 feet wide and it extends 240 feet beyond the runway ends.

The north end of the RSA for Runway 13R-31L is bisected by a slow-moving ditch/urban tributary and associated wetland that impounds water year-round. The RSA extends a distance of approximately 385 feet before it reaches the narrow ditch. The RSA, other than the ditch, meets grading standards. The alternatives chapter will include an analysis of mitigation options for the Runway 13R RSA. All other RSA areas meet the applicable design standard.

Runway Object Free Area (ROFA)

The ROFA is "a two-dimensional ground area surrounding runways, taxiways, and taxilanes, which is clear of objects except for objects whose location is fixed by function (i.e., airfield lighting)." The ROFA does not have to be graded and level like the RSA; instead, the primary requirement for the ROFA is that no object in the ROFA penetrates the lateral elevation of the RSA. The ROFA is centered on the runway, extending out in accordance to the critical design aircraft utilizing the runway.

The ROFA for primary Runway 13R-31L is 800 feet wide and it extends 1,000 feet beyond the departure runway end. It extends 600 feet prior to the threshold for landing operations. The ROFA on the northwest end of the runway crosses through the perimeter fence and over a small portion of 25th Avenue. The ROFA on the southwest end of the runway is penetrated by the airport perimeter fence and crosses over a small portion of Cornell Rd. **Exhibit 4D** shows the ROFA penetrations in detail. Additional analysis will be undertaken in the alternatives analysis chapter to identify mitigating options.

The ROFA for crosswind Runway 2-20 is 500 feet wide and it extends 300 feet beyond the runway ends. The ROFA for parallel Runway 13L-31R is 250 feet wide and it extends 240 feet beyond the runway ends. The ROFA for both these runways meets standard and should be maintained.

"The ROFA beyond both ends of Runway 13R-31L have object penetrations."

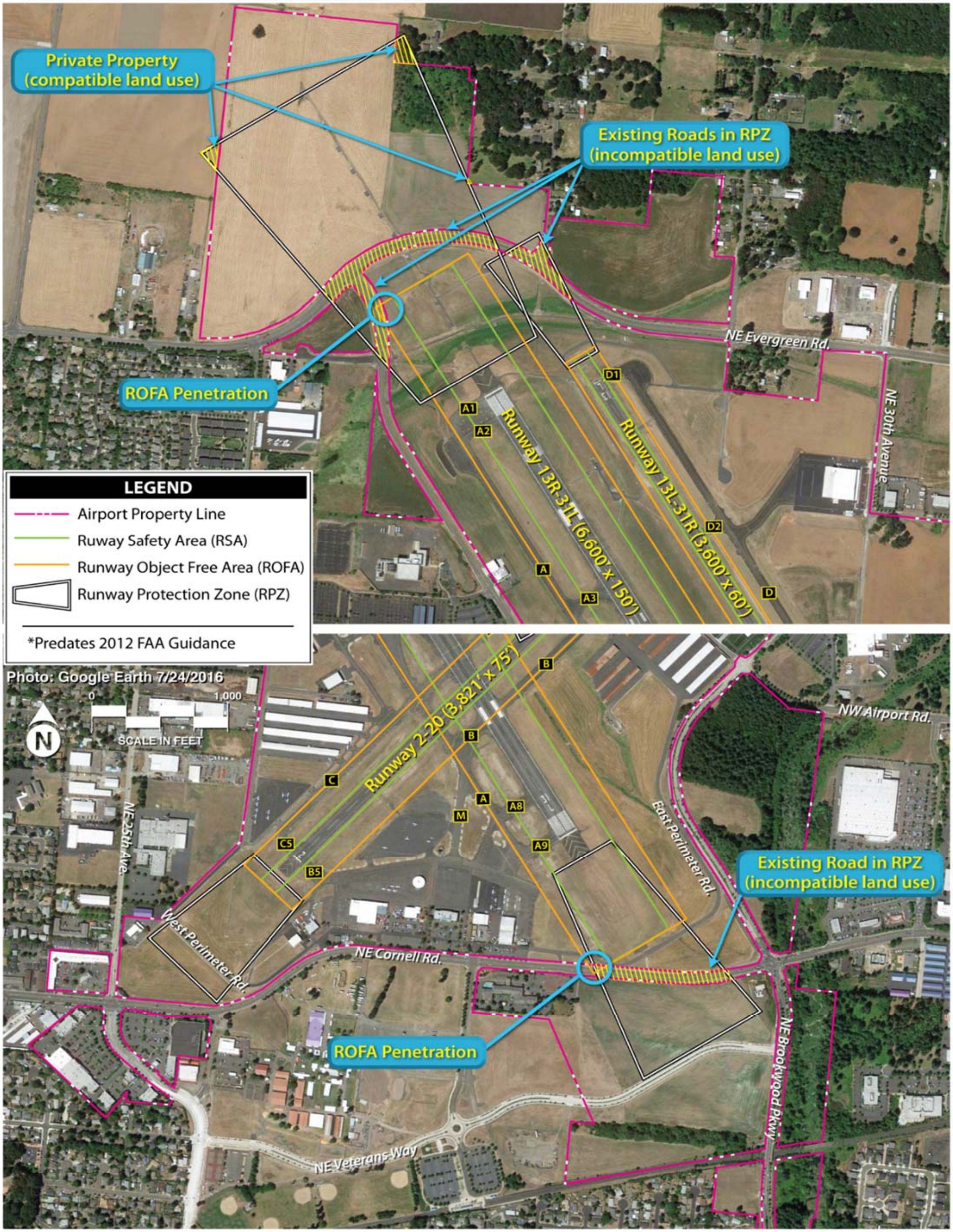


Exhibit 4D
EXISTING RPZ AND ROFA DETAIL

Runway Obstacle Free Zone (OFZ)

The OFZ is an imaginary volume of airspace which precludes object penetrations, including taxiing and parked aircraft. The only allowance for ROFZ obstructions is navigational aids mounted on frangible bases which are fixed in their location by function, such as airfield signs. The OFZ is established to ensure the safety of aircraft operations. If the OFZ is obstructed, the airport's approaches could be removed or approach minimums could be increased.

The OFZ for primary Runway 13R-31L and crosswind Runway 2-20 is 400 feet wide, extending 200 feet beyond the runway ends. The OFZ for parallel Runway 13L-31R is 250 feet wide extending 200 feet beyond the runway end. The OFZ for all runways meet current design standards and should be maintained.

Runway Protection Zones (RPZ)

The RPZ is a trapezoidal area centered on the runway, typically beginning 200 feet beyond the runway end. The RPZ has been established by the FAA to provide an area clear of obstructions and incompatible land uses in order to enhance the protection of people and property on the ground. The RPZ is comprised of the central portion of the RPZ and the controlled activity area. The central portion of the RPZ extends from the beginning to the end of the RPZ, is centered on the runway, and is the width of the ROFA. The controlled activity area is any remaining portions of the RPZ. The dimensions of the RPZ vary according to the visibility minimums serving the runway and the type of aircraft (design aircraft) operating on the runway.

While the RPZ is intended to be clear of incompatible objects or land uses, some uses are permitted with conditions and other land uses are prohibited. According to FAA AC 150/5300-13A, *Airport Design*, the following land uses are permissible within the RPZ:

- Farming that meets the minimum buffer requirements;
- Irrigation channels, as long as they do not attract birds;
- Airport service roads, as long as they are not public roads and are directly controlled by the airport operator;
- Underground facilities, as long as they meet other design criteria, such as RSA requirements, as applicable; and
- Unstaffed navigational aids (NAVAIDs) and facilities, such as required for airport facilities that are fixed by function in regard to the RPZ.

Any other land uses considered within RPZ land owned by the airport sponsor must be evaluated and approved by the FAA Office of Airports. The FAA has published *Interim Guidance on Land Uses within a Runway Protection Zone* (9.27.2012), which identifies several potential land uses that must be evaluated and approved prior to implementation (to be referred to as *Interim Guidance*). The specific land uses requiring FAA evaluation and approval include:

- Buildings and structures (examples include, but are not limited to: residences, schools, churches, hospitals or other medical care facilities, commercial/industrial buildings, etc.)
- Recreational land use (examples include, but are not limited to: golf courses, sports fields, amusement parks, other places of public assembly, etc.)
- Transportation facilities. Examples include, but are not limited to:
  - Rail facilities - light or heavy, passenger or freight
  - Public roads/highways
  - Vehicular parking facilities
- Fuel storage facilities (above and below ground)
- Hazardous material storage (above and below ground)
- Wastewater treatment facilities
- Above-ground utility infrastructure (i.e., electrical substations), including any type of solar panel installations

The *Interim Guidance* states, "RPZ land use compatibility also is often complicated by ownership considerations. Airport owner control over the RPZ land is emphasized to achieve the desired protection of people and property on the ground. Although the FAA recognizes that in certain situations the airport sponsor may not fully control land within the RPZ, the FAA expects airport sponsors to take all possible measures to protect against and remove or mitigate incompatible land uses."

Currently, the RPZ review standards are applicable to any new or modified RPZ. The following actions or events could alter the size of an RPZ, potentially introducing an incompatibility:

- An airfield project (e.g., runway extension, runway shift),
- A change in the critical design aircraft that increases the RPZ dimensions,
- A new or revised instrument approach procedure that increases the size of the RPZ, and/or
- A local development proposal in the RPZ (either new or reconfigured).

Since the *Interim Guidance* only addresses new or modified RPZs, existing incompatibilities are generally (but not always) grandfathered. While it is still necessary for the airport sponsor to take all reasonable actions to meet the RPZ design standard, FAA funding priority for certain actions, such as relocating roads or acquiring land and structures, are typically determined on a case-by-case basis.

"The introduction of new or additional RPZ land use incompatibilities may require FAA headquarters' review."

Table 4M presents detail about the existing RPZs at the Airport. Because the approach RPZs to each runway end encompasses the departure RPZs as well, the following discussion addresses only the approach RPZs.

Approximately 72.6 acres of the RPZ on approach to Runway 13R is owned by the Airport. This represents 92.2 percent of the RPZ. Approximately 0.9 acres of the RPZ is not owned by the Airport and is currently agricultural land, which is a compatible land use. The remaining 5.4 acres is Evergreen Road and 25th Avenue. Public roads are considered an incompatible land use, however, the RPZs existed prior to the 2012 FAA *Interim Guidance*.

TABLE 4M
Runway Protection Zone Detail
Hillsboro Airport

Runway	RPZ Dimensions (ft.)		RPZ Size (ac.)	Owned in Fee acres/%	Compatibility Status
13R	Inner Width:	1,000	78.9	72.6/ 92.2%	0.9 acres of private land (compatible)
	Outer Width:	1,750			Evergreen Road/25th Avenue (incompatible)
	Length:	2,500			[redacted]
31L	Inner Width:	500	29.5	27.4/ 92.9%	Cornell Road (incompatible)
	Outer Width:	1,010			[redacted]
	Length:	1,700			
2	Inner Width:	500	13.8	13.8/100%	Fully compatible
	Outer Width:	700			[redacted]
	Length:	1,000			
20	Inner Width:	500	13.8	13.8/100%	Fully compatible
	Outer Width:	700			[redacted]
	Length:	1,000			
13L	Inner Width:	250	8.0	6.6/ 82.5%	Evergreen Road/NW 273rd Ave. (incompatible)
	Outer Width:	450			[redacted]
	Length:	1,000			
31R	Inner Width:	250	8.0	8.0/100%	Fully compatible
	Outer Width:	450			[redacted]
	Length:	1,000			

Approximately 27.4 acres of the 29.5-acre RPZ on approach to Runway 31L is owned by the Airport. This is approximately 92.9 percent of the RPZ. Cornell Road passes through the RPZ and is considered an incompatible land use. This condition also existed prior to the FAA *Interim Guidance*.

Approximately 6.6 acres of the RPZ on approach to Runway 31L is owned by the Airport. This is approximately 82.5 percent of the RPZ. The remaining 1.4 acres are portions of Evergreen Road and NW 273rd Ave. The design of this runway and the associated RPZ predates the FAA *Interim Guidance*.

The RPZs for Runway 2-20 and Runway 31R are owned by the Airport and are fully compatible with airport operations.

The existing RPZ incompatibilities (shown on **Exhibit 4D**) are public roads that existed prior to the 2012 FAA *Interim Guidance*. Since the *Interim Guidance* only addresses new or changed RPZs, the Airport is typically not required to remove those incompatible land uses. Instead, when feasible, the Airport should pursue opportunities to address compatible land uses within the RPZs. For example, if local transportation planning considers relocation of the roads in the RPZs, the Airport should be supportive of those efforts. In addition, the airport should acquire any RPZ property not already owned.

Any changes to the RPZs initiated by the Airport that would encompass additional or different road segments within the RPZs would require implementation of the *Interim Guidance* process for alternatives analysis and ultimately FAA headquarters approval. The Airport should also be aware of any plans by other agencies that could affect the land uses within the RPZ. Specific alternatives to mitigate the existing RPZ land use incompatibilities are not required currently.

RUNWAY SEPARATION STANDARDS

There are several standards related to separation distances from runways. Each of these is designed to enhance the safety of the airfield. **Table 4N** presents the applicable design standard and the current condition on the airfield.

TABLE 4N
Runway Separation Design Standards
Hillsboro Airport

Runway	Primary 13R-31L	Crosswind 2-20	Parallel 13L-31R
RDC	D-III-2400	B-II-VIS	B-I-VIS (small)
Runway to Runway Separation Standard*	700'	700'	700'
Current Condition	700'	NA	700'
Parallel Taxiway Separation Standard	400'	240'	150'
Current Condition	400'	250'	240'
Hold Line Separation Standard	252'	200'	125'
Current Condition	252'	200'	125'
Aircraft Parking Separation Standard	500'	250'	125'
Current Condition	500'	250'	125'

* Simultaneous visual takeoffs and landings
Source: FAA AC 150/5300-13A, Airport Design

Runway/Runway Separation

The FAA provides standard separation recommendations for parallel runways. Parallel runways that are less than 700 feet, centerline to centerline, are to be considered a single runway and operated as such by tower personnel. To attain simultaneous (independent) landings and takeoffs on parallel runways in visual conditions, the minimum separation is 700 feet. To attain simultaneous takeoffs and landings in instrument conditions, the minimum separation required is 3,000 feet.

At Hillsboro Airport, the parallel runways are separated by 700 feet, thus permitting simultaneous use of the runways in visual conditions. Since the shorter parallel runway is intended to accommodate training operations, which occur primarily during visual conditions, the existing runway separation is appropriate and should be maintained.

Runway/Taxiway Separation

The design standard for the separation between runways and parallel taxiways is a function of the runway design code (RDC). Taxiway A is 400 feet from primary Runway 13R-31L, which meets the separation standard for RDC D-III-2400 and should be maintained. Taxiway B is 250 feet from crosswind Runway 2-20. The standard runway/taxiway separation for this B-II-VIS runway is 240 feet. Taxiway B should be maintained at its current separation distance. Taxiway C is 240 feet from crosswind Runway 2-20 which meets standard and should be maintained. Taxiway D is 240 feet from parallel Runway 13L-31R. The design standard for this B-I-VIS (small aircraft) runway is 150 feet. With a runway/taxiway separation distance of 240 feet, parallel Runway 13L-31R can accommodate a more restrictive RDC should that be necessary in the future. Taxiway D should be maintained at its current separation distance from the runway.

Hold Line Separation

The location of aircraft hold lines leading to runways are a function of the RDC for each runway. On taxiways leading to primary Runway 13R-31L, the hold lines should be set 252 feet from the runway centerline. On taxiways leading to crosswind Runway 2-20, the hold lines should be set at 200 feet. On taxiways leading to parallel Runway 13L-31R, the hold lines should be set at 125 feet. All hold lines are in the proper location at the Airport.

Aircraft Parking Area Separation

The proximity of aircraft parking areas such as an aircraft tie-down apron is a function of the RDC for the runway. Where a parallel taxiway is present, the aircraft parking area may need to be set back an additional distance that is clear of the taxiway object free area. Parking areas should be no closer than 500 feet from primary Runway 13R-31L, 250 feet from crosswind Runway 2-20, and 125 feet from parallel Runway 13L-31R. All aircraft parking areas meet this standard.

Runway Visibility Zone (RVZ)

The RVZ is an area formed by imaginary lines connecting the line-of-sight points of intersecting runways. The purpose of the RVZ is to facilitate coordination among aircraft and between aircraft and vehicles that may be operating on active runways. Having a clear line-of-sight allows departing aircraft and arriving aircraft to verify the location and actions of other aircraft and vehicles on the ground that could create a conflict. Within the RVZ, any point five feet above the runway centerline must be mutually visible with any other point five feet above the centerline of the crossing runway.

Prior to 2010, the RVZ was not clear as the T-hangars near the tower blocked the view from Runway 13R to Runway 2. Runway 2-20 was reconstructed and shifted slightly in order to provide a clear RVZ. The existing clear RVZ should be maintained.

Building Restriction Line (BRL)

The BRL identifies suitable building area locations on an airport. The BRL encompasses the RPZs, the ROFA, navigational aid critical areas, areas required for terminal instrument procedures, and other areas necessary for meeting airport line-of-sight criteria, such as the RVZ.

Two primary factors contribute to the determination of the BRL: type of runway (utility or other-than-utility) and the capability of the instrument approaches. Parallel Runway 13L-31R is considered a "utility" runway because it has a pavement strength of 12,500 pounds. The primary and crosswind runways are considered an "other-than-utility" runway because they have a pavement strength above 12,500 pounds. Runway 13R has a precision instrument approach, and Runway 31L has a non-precision instrument approaches. All other runway ends are visual.

The BRL is the product of the Code of Federal Regulations (CFR) Part 77 transitional surface clearance requirements. These requirements stipulate that no object be located in the primary surface. From the primary surface, the transitional surface extends upward and outward at a slope of one vertical foot for every seven horizontal feet. Therefore, the BRL is a sloping surface with variable height restrictions based upon the distance from the edge of the primary surface.

"The BRL line represents an elevation that structures should remain below."

The primary surface, centered on the runway, for primary Runway 13R-31L is 1,000 feet wide. For crosswind Runway 2-20, the primary surface is 500 feet wide. For parallel Runway 13L-31R, the primary surface is 250 feet wide.

Common practice is to depict a BRL as a single line; however, this is frequently misinterpreted to mean that no structures can be located in front (closer to the runway) of the BRL. Instead, the BRL line represents an elevation that structures should remain below. The 20-foot BRL for Runway 13R-31L is 640 feet from the runway centerline. For Runway 2-20, the 20-foot BRL is set at 390 feet from the runway centerline. For parallel Runway 13L-31R, the 20-foot BRL is set at 265 feet from the runway centerline. All structures at the Airport are clear of the BRL.

RUNWAYS

The adequacy of the existing runway system at Hillsboro Airport has been analyzed from a number of perspectives, including runway orientation and adherence to safety area standards. From this information, requirements for runway improvements will be determined for the Airport. Runway elements, such as length, width, and strength, are now presented.

Runway Length

FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*, provides guidance for determining runway length needs. The AC provides formulas for determining runway length needs for general aviation aircraft weighing up to 60,000 pounds. Individual aircraft flight planning manuals are to be utilized for aircraft weighing more than 60,000 pounds.

A draft revision of this AC is currently available (150/5325-4C) and the FAA is utilizing the draft revision in most cases when evaluating runway length needs for airports. The primary difference between the two ACs is that the formulas apply to aircraft weighing 12,500 pounds or less and flight planning manuals are to be used for all aircraft weighing more than 12,500 pounds. Runway length analysis using both versions is presented below.

There is not a direct relationship between the classification of the design aircraft (e.g., D-III) and runway length as airplanes operate on a wide variety of available runway lengths. The suitability of the runway length is governed by many factors, including elevation, temperature, wind, aircraft weight, wing flap settings, runway condition (wet or dry), runway gradient, vicinity airspace obstructions, useful load, and any special operating procedures.

Airport sponsors can pursue policies that can maximize the suitability of the runway length. Policies, such as area zoning and height and hazard restrictions, can protect an airport's runway length. Airport ownership (fee simple or easement) of land leading to the runway ends can reduce the possibility of natural growth or man-made obstructions. Planning of runways should include an evaluation of aircraft types expected to use the airport, or a particular runway, now and in the future. Future plans should be realistic and supported by the FAA-approved forecasts and should be based on the critical design aircraft (or family of aircraft).

The determination of runway length requirements is based on five primary factors:

- Mean maximum temperature of the hottest month
- Airport elevation
- Runway gradient
- Critical aircraft type expected to use the runway
- Stage length of the longest nonstop destination (specific to larger aircraft)

Aircraft performance declines as elevation, temperature, and runway gradient factors increase. For the Airport, the mean maximum daily temperature of the hottest month is 81.4 degrees Fahrenheit (F), which occurs in August. The Airport elevation is 208 feet above mean sea level (MSL). The gradient of primary Runway 13R-31L is 0.4 percent. The RDC for Runway 13R-31L is D-III, for Runway 2-20 the RDC is B-II, and for parallel Runway 13L-31R the RDC is B-I (small aircraft). Aircraft stage lengths can vary, but for planning purposes it is common to utilize increments of 500 miles.

Parallel Runway 13L-31R Length Recommendation

Table 4P presents the minimum runway length requirements for small aircraft. Parallel Runway 13L-31R is currently 3,600 feet long. It was constructed to accommodate 100 percent of the small aircraft fleet that would typically use the runway in a training function. There are some small aircraft with 10 or more passenger seats that could use this runway; however, these are rarely used in a training function. FAA guidance suggests a runway length of 3,600 feet to accommodate 100 percent of small aircraft. The current length of the parallel runway meets this need and should be maintained.

TABLE 4P
Small Aircraft Runway Length Requirements
Hillsboro Airport

Small Aircraft Fleet Mix Category	Runway Length
95% of small aircraft	3,100'
100% of small aircraft	3,600’
10+ Passenger Seats	4,100'

Source: FAA AC 150/5325-4B, Runway Length Requirements for Airport Design

Crosswind Runway 2-20 Length Recommendation

The crosswind runway is 3,821 feet long. As noted previously, this runway is needed to accommodate smaller aircraft that are more susceptible to crosswinds. This runway also serves an important function as a back-up runway for times when the primary runway is unavailable (typically due to maintenance). Because of its weight bearing capacity, Runway 2-20 can accommodate some aircraft that may not be able to use the parallel runway. The recommended length for crosswind Runway 2-20 is between 3,600 feet and 4,100 feet. The current length of Runway 2-20 is adequate to meet the needs of the Airport and should be maintained.

Primary Runway 13R-31L Length Recommendation

Table 4Q presents the runway length recommendations for general aviation jet aircraft weighing between 12,500 pounds and 60,000 pounds, which includes most small- and medium-sized business jets. Two categories of general aviation jet aircraft are identified: those making up 75 percent of the national fleet and those making up 100 percent of the national fleet. The 75 percent category includes Cessna Citation jets (models 500, 510, 525, 550, 560, 650), Learjets (models 31, 35, 45), Beechjet 400, and Falcon jets (models 10, 20, 50). The 100 percent category includes the remaining medium and most larger business jets (those under 60,000 pounds). Examples include Cessna Citation jets (models 650, 680, X), Learjets (models 55, 60), Hawker jets (models 800XP, 1000, 4000), and Challenger 600s.

To accommodate 75 percent of the general aviation jet fleet at 60 percent useful load, a runway length of 5,300 feet is recommended. To accommodate 100 percent at 60 percent useful load, a runway length of 5,500 feet is recommended. To accommodate 75 percent of the general aviation jet fleet at 90 percent useful load, a runway length of 7,000 feet is recommended, and for 100 percent at 90 percent useful load, a length of 7,600 feet is recommended. The FAA typically would only consider the 90 percent useful load categories if there was an identified specific need, such as air cargo activity or specific operators flying heavy loads long distances.

TABLE 4Q
Runway Length Requirements
Hillsboro Airport

Airport Elevation	208' feet above mean sea level			
Average High Monthly Temp.	81.4 degrees (August)			
Runway Gradient	0.4% Runway 13R-31L/0.18% Runway 2-20/0.0% Runway 13L-31R			
Fleet Mix Category	**Raw Runway Length from FAA AC**	**Runway Length with Gradient Adjustment**	**Wet Surface Landing Length for Jets (+15%)***	**Final Runway Length**
75% of fleet at 60% useful load	4,619'	4,639'	5,311'	5,300'
100% of fleet at 60% useful load	5,116'	5,136'	5,500'	5,500'
75% of fleet at 90% useful load	6,142'	6,162'	7,000'	7,000'
100% of fleet at 90% useful load	7,621'	7,641'	7,000'	7,700'

*Max 5,500' for 60% useful load and max 7,000' for 90% useful load in wet conditions
Source: FAA AC 150/5325-4B, Runway Length Requirements for Airport Design.

Hillsboro Airport experiences a high level of business jet operations and has 49 jets based at the Airport. Of this total, 22 are in the 75 percent category and 13 are in the 100 percent category. The remaining 14 aircraft are large business jets that are above the 100 percent category, thus requiring flight planning manual analysis under both ACs. Since these business jets are known to be utilized for cross-country and international flights, the 90 percent category should be considered. As a result, the recommended runway length is 7,700 feet.

In addition to using the general runway length categories listed in **Table 4Q**, an analysis of the flight planning manuals for common business jets has been prepared. This method for determining runway length requirements follows FAA Draft AC 150/5325-4C, *Runway Length Requirements for Airport Design.* **Table 4R** shows the calculated runway length requirements for the most common business jets operating at the Airport for takeoff and landing. Per FAA guidance, takeoff lengths are calculated at maximum certified takeoff weight. The takeoff and landing lengths highlighted in red indicate a runway length requirement that exceeds 6,600 feet, which is the length of the longest runway at the Airport.

Under dry conditions, most of the business jets can takeoff unrestricted. A few of the business jets, including the Global Express, Gulfstream 550, Hawker 800, and Lear 35A, may be slightly weight restricted. When an aircraft is weight restricted, this means they cannot operate at maximum certified takeoff weight. Most aircraft do not operate at 100 percent of capacity. The second column in the table shows the available useful load. Only one of these business jets, the Hawker 800, would fall below 90 percent useful load.

Under wet conditions, which are characterized as a runway with ⅛-inch or less of water covering 25 percent or more of the pavement surface, additional runway length may be required. Several additional jets would have some weight restriction, including the Gulfstream 650, Falcon 2000, Gulfstream IV, and the Citation X. These necessary weight restrictions in wet conditions are modest, with most jets still able to achieve at least 90 percent useful load.

TABLE 4R
Runway Length Requirements for Business Jets
Hillsboro Airport

Airfield Parameters	Elevation: 208' MSL Temp: 81.4°F 0.4% Runway 13R-31L

Runway Parameters	**Take-off Length Required at MTOW**		**% Useful Load for Takeoff on 6,600' Runway**		**Landing Length Requirements**					
					CFR Part 25 (Unfactored)		**CFR Part 135 (60% factored)**		**CFR Part 91k (80% factored)**	
Runway Condition	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**
Beechjet 400A	4,816	5,996	100%	100%	3,621	5,285	6,035	8,808	4,526	6,606
Citation V (560)	3,566	6,282	100%	100%	2,971	4,358	4,952	7,263	3,714	5,448
Citation 560 XL	4,081	4,177	100%	100%	3,303	5,231	5,505	8,718	4,129	6,539
Citation X	5,926	6,708	100%	98%	3,578	5,016	5,963	8,360	4,473	6,270
Citation Bravo	4,638	4,700	100%	100%	3,370	5,276	5,617	8,793	4,213	6,595
Citation Encore	3,914	5,122	100%	100%	2,878	4,340	4,797	7,233	3,598	5,425
Citation Sovereign	3,927	4,651	100%	100%	2,738	3,410	4,563	5,683	3,423	4,263
Citation VII	5,627	6,361	100%	100%	3,037	4,076	5,062	6,793	3,796	5,095
Citation CJ3	3,485	3,921	100%	100%	2,880	3,920	4,800	6,533	3,600	4,900
Challenger 601	6,800	N/A	99%	N/A	3,335	4,002	5,558	6,670	4,169	5,003
Falcon 2000	6,484	6,763	100%	97%	3,137	3,608	5,228	6,013	3,921	4,510
Gulfstream 550	6,720	6,958	98%	96%	2,784	4,695	4,640	7,825	3,480	5,869
Gulfstream III	5,673	6,466	100%	100%	3,185	6,106	5,308	10,177	3,981	7,633
Gulfstream IV	6,334*	7,222	95%*	85%	3,643	6,984	6,072	11,640	4,554	8,730
Gulfstream 650	6,509	7,439	100%	83%	3,679	4,611	6,132	5,764	4,599	5,764
Global Express	6,913	7,036	95%	93%	2,681	3,084	4,468	5,140	3,351	3,855
Hawker 800	7,476	N/A	86%	N/A	2,880	3,710	4,800	6,183	3,600	4,638
Lear 31A	4,431	N/A	100%	N/A	2,957	4,140	4,928	6,900	3,696	5,175
Lear 35A	6,904*	N/A	91%*	N/A	3,188	4,464	5,313	7,440	3,985	5,580
Lear 45	5,583	5,482	100%	100%	2,755	3,482	4,592	5,803	3,444	4,353

KEY: MSL - Mean Sea Level; MTOW - Maximum takeoff weight; CFR - Code of Federal Regulations; No Data - No Ultranav calculation available; Off Chart - Calculator result out of limits for aircraft.
CFR Part 25: Standard unfactored landing lengths.
CFR Part 135: 60% factored landing length as required by commuter/on-demand operators.
CFR Part 91k: 80% factored as required by fractional operators.
Red Numbers: Indicate the length exceeds 6,600 feet.
*Weight limited due to climb performance

Source: Aircraft operating manuals.

Business jets may operate under different regulations depending on the type of flight being conducted. These regulations may impact the calculated runway length available for landing. An analysis of CFR Part 91k and Part 135 landing length restrictions was conducted. CFR Part 91k refers to operations conducted via fractional ownership, and Part 135 refers to commuter/on-demand (charter) operations. Both operation types are required to meet specific landing length standards for safety purposes. Fractional operations must be capable of landing within 80 percent of the landing distance available (LDA), and commuter/on-demand operations must be capable of landing within 60 percent of the LDA. Operations conducted under CFR Part 25 are general aviation operations conducted by private owners, including companies.

The landing length requirements for the select business jets, under both dry and wet conditions, are also presented in **Table 4R**. All the business jets listed are capable of landing at the Airport in dry conditions regardless of the CFR type restrictions. In wet conditions, we begin to see limitations on landing length, but it should be understood that aircraft typically weigh less when landing, as aircraft burn fuel during flight, thereby reducing their weight. When factoring the Part 135 and Part 91 flight restrictions in wet conditions, more of the business jet fleet would be weight-restricted for landing.

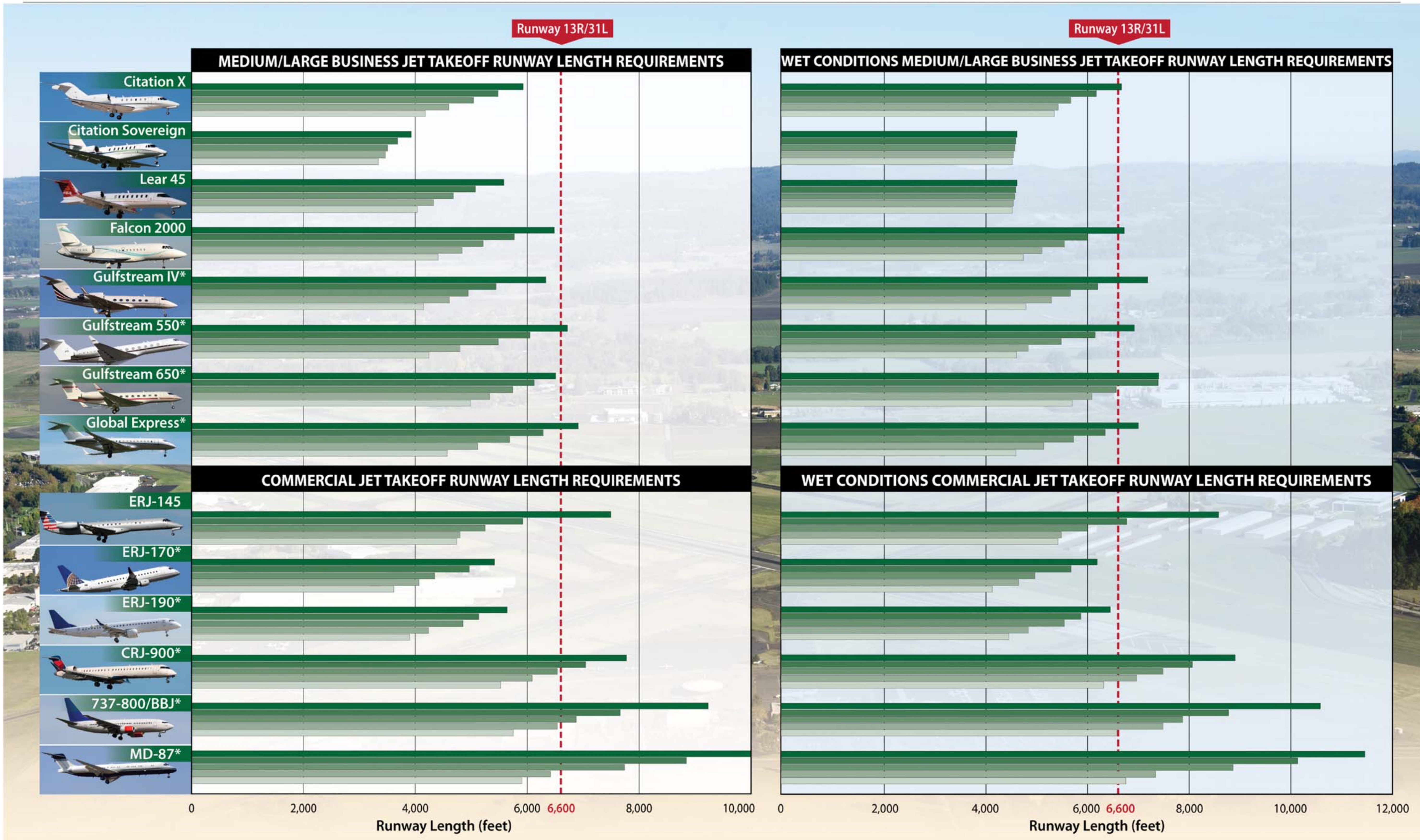
All the business jets considered are capable of landing within the 6,600-foot length of primary Runway 13R-31L in dry conditions. When operating under CFR Part 91k and CFR 135, more runway length is necessary.

Exhibit 4E presents additional runway takeoff length analysis in graphic form. The top half of the exhibit presents the takeoff length requirements for a sampling of the most common business jets utilizing the Airport. The required runway length for each aircraft is shown in both wet and dry conditions and under varying loading measures. All business jets can operate with at least 90 percent useful load in dry conditions. In wet conditions, all can operate at 80 percent useful load.

The bottom half of the exhibit shows the takeoff length requirements for passenger aircraft. These are presented as a point of reference and are not used to determine the recommended runway length, which is determined by the critical design aircraft (Gulfstream 650). However, some of these aircraft do operate at the Airport.

The ERJ-145 (50 seats) is the aircraft used by one of the corporate shuttle operators at the Airport. It can operate without restriction up to approximately 95 percent useful load. Both the ERJ-170 (76 seats) and the ERJ-190 (90 seats) can operate unrestricted; however, both exceed the weight bearing capacity of the runway. The Boeing Business Jet (a variant of the 737-800) can take off at approximately 70 percent useful load. The MD-87 is also shown because they operate at the Airport currently. A business at the Airport is converting these older aircraft into aerial tankers to fight forest fires. The aircraft operate with no passengers and light fuel simply for the purposes of arriving and departing.

As noted previously, the haul length of an aircraft may also be a factor in determining runway length. This is especially true for commercial passenger aircraft. **Table 4S** presents the runway length requirements for these aircraft with haul lengths of 500 and 1,000 miles. The most relevant of these is the ERJ-145, which shuttles approximately 1,000 nautical miles to Arizona multiple time a day. As can be seen from the table, no additional runway length is needed by this aircraft to complete its current routes.



* May exceed the weight bearing capacity of the existing runway.

Exhibit 4E
RUNWAY LENGTH RECOMMENDATIONS

TABLE 4S
Commercial Jet Runway Requirements
Hillsboro Airport

Aircraft	MTOW		500 miles		1,000 miles	
	Dry	Wet	Dry	Wet	Dry	Wet
ERJ-145	7,495	8,619	4,299	4,944	5,296	6,090
ERJ-170	5,416	6,228	3,537	4,068	3,733	4,293
ERJ-190	5,641	6,487	4,057	4,666	4,415	5,077
CRJ-900	7,775	8,941	4,856	5,584	5,296	6,090
737-700	11,259	12,948	4,123	4,741	4,319	4,967
737-800/BBJ	9,236	10,621	4,417	5,080	4,612	5,304
737-900	11,034	12,689	5,100	5,865	5,687	6,540
MD-88	9,998	11,498	4,468	5,138	4,579	5,266
757-200	8,649	9,946	3,869	4,449	3,968	4,563

MTOW: Maximum takeoff weight
Note: All aircraft except the ERJ-145 exceed the weight bearing capacity of the existing runway.

Runway Length Conclusion

The current available runway length of 6,600 feet does an excellent job of meeting the needs of the existing business jet users at the Airport. Under more extreme conditions (e.g., wet runways, extremely hot days), these operators may experience additional weight restrictions. Some operators of larger corporate jets have expressed a desire for additional runway length; however, the above calculations show most operators can operate in almost all (most) conditions with minimal restrictions.

The methodology used to determine the recommended runway length is outlined in FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design.* The AC indicates that flight planning manuals should be consulted for a critical aircraft weighing more than 60,000 pounds. The critical aircraft at Hillsboro Airport is the Gulfstream 650, which has a recommended takeoff length of 7,439 feet at maximum takeoff weight under wet conditions. FAA guidance indicates that values above 30 should be rounded up to the nearest 100; therefore, the recommended primary runway length for Hillsboro Airport would be approximately 7,500 feet. This length would fully accommodate all corporate jet operators at maximum takeoff weight under wet and dry conditions.

There are significant constraints to attaining this runway length at the Airport. Cornell Road to the south and Evergreen Road to the north are obvious limitations. At a minimum, the existing length of 6,600 feet should be preserved and maintained. In the alternatives chapter, the impacts to extending the runway will be examined.

Runway Width

Runway 13R-31L is 150 feet wide. The design standard for an RDC D-III (less than 150,000-pound aircraft) runway is 100 feet. Typically, major elements such as runway width are maintained for their useful life and reexamined when a major reconstruction is needed. Runway 13R-31L is planned for reconstruction beginning in 2019. Analysis conducted related to the project has determined that 100 feet is justified for FAA financial participation. The Port of Portland has elected to maintain the runway at 150 feet in width, paying to maintain the additional 50 feet. The Port has elected to do this following extensive interviews with tenants, who indicated that the additional width provides a valuable safety margin. Therefore, no change is anticipated to the width of the primary runway.

Runway 2-20 is currently 75 feet wide which meets the design standard for this B-II runway. In 2014, the runway was reconstructed and shifted. At that time, it was narrowed from 100 feet in width to the current 75 feet. The current width of the runway should be maintained. Parallel Runway 13L-31R is 60 feet wide which meets the design standard for a B-I (small aircraft) runway. The width should be maintained through the planning period.

Runway Strength

An important feature of airfield pavement is its ability to withstand repeated use by aircraft. Historically, pavement strength has been measured in terms of the weight of an aircraft and the landing gear configuration. Today, the more detailed pavement classification number (PCN) is used to establish pavement strength (see Chapter 1 – Inventory for a detailed description). The Aircraft Classification Number (ACN) relates specific aircraft models to the PCN. The ACN for a specific aircraft should be below the PCN of the runway to fully accommodate unlimited operations for the useful life of the pavement surface.

Since the parallel runway and the crosswind runway have been recently reconstructed, the PCN values are known. PCN values for the primary runway will be established during the upcoming reconstruction project.

The PCN for crosswind Runway 2-20 is expressed as 20/F/C/X/T. This means that the underlying pavement value has a load-carrying capacity of 20 (unitless), is flexible (asphalt), is low subgrade strength, has high tire pressure capability, and was calculated through a technical evaluation. The PCN for parallel Runway 13R-31L is 10/F/D/Y/T, which means the underlying pavement has a load-carrying capacity of 10 (unitless), is flexible (asphalt), is ultra-low subgrade strength, has medium tire pressure capability, and was calculated through a technical evaluation.

Small aircraft weighing 12,500 pounds or less generally have an PCN of 10 or below. With a PCN of 10, parallel Runway 13L-31R is capable of accommodating repeated operations by the intended aircraft type (small aircraft). With a PCN of 20, the crosswind Runway 2-20 is capable of accommodating repeated operations by somewhat heavier aircraft (turboprops and small business jets). The PCN values for these runways are adequate for the type of aircraft planned to use these runways and should be maintained.

The G650 business jet (design aircraft) has an ACN of between 26 and 33. Therefore, the PCN of the primary runway, once it is reconstructed, should fall within this range to fully accommodate the critical design aircraft.

No changes to the pavement strength of any of the runways is planned at this time.

Runway Grade

The FAA provides guidance regarding the maximum allowable grade change for a runway. FAA AC 150/5300-13A, Change 1, *Airport Design*, Paragraph 313.b.2 states, "the maximum allowable grade change is ±1.50 percent; however, no grade changes are allowed in the first and last quarter, or first and last 2,500 feet, whichever is less, of the runway length." For Runway 13R-31L, no vertical grade changes are allowable in the first or last 1,650 feet of the runway. The existing grade within the northern quarter of the runway exceeds the maximum allowable vertical grade change. Essentially, the northern quarter of the runway does not have a uniform grade.

The airport is currently in design for reconstruction of Runway 13R-31L. The design includes correction of the non-standard vertical grade of the runway.

TAXIWAYS

The design standards associated with taxiways are determined by the ADG of the critical design aircraft and the taxiway design group (TDG). Not all aircraft types that operate at the Airport will use all taxiway surfaces; therefore, taxiways can and should be designed to the most appropriate design standard.

Table 4T presents the taxiway design standards. All taxiways that could potentially see movement by the D-III critical aircraft should be planned to these standards. This includes Taxiway A, related connectors, and Taxiway B.

TABLE 4T
Taxiway Dimensions and Standards
Hillsboro Airport

STANDARDS BASED ON WINGSPAN	ADG III	ADG II	ADG I
Taxiway Protection			
Taxiway Safety Area (TSA) width	118'	79'	49'
Taxiway Object Free Area (TOFA) width	186'	131'	89'
Taxilane Object Free Area width	162'	115'	79'
Taxiway Separation			
Taxiway Centerline to:			
Fixed or Movable Object	93'	65.5'	44.5'
Parallel Taxiway/Taxilane	152'	105'	70'
Taxilane Centerline to:			
Fixed or Movable Object	81'	57.5'	39.5'
Parallel Taxilane	140'	97'	64'
Wingtip Clearance			
Taxiway Wingtip Clearance	34'	26'	20'
Taxilane Wingtip Clearance	27'	18'	15'
STANDARDS BASED ON TDG	**TDG 3**	**TDG 2**	**TDG 1A**
Taxiway Width Standard	50'	35'	25'
Taxiway Edge Safety Margin	10'	7.5'	5'
Taxiway Shoulder Width	20'	15'	10'

ADG: Airplane Design Group
TDG: Taxiway Design Group
Source: FAA AC 150/5300-13A, Airport Design

Taxiway C rarely has movements by the critical aircraft; therefore, it should be planned to the appropriate design standards related to Runway 2-20. Currently, the airport maintains Runway 2-20 to B-II standards and, therefore, Taxiway C should be planned to TDG 2 (captures B-II turboprops that use the runway) and ADG II. It should be noted that operational activity on Runway 2-20 suggests that it is currently eligible for FAA funding to A-I standards; therefore, at the time of the next request for funding of improvements to Taxiway C, a determination will need to be made if the current 35-foot width (TDG 2) is eligible or if the 25-foot width for A-I is eligible.

Taxiway D and related connecting taxiways should be designed to TDG 1A and ADG I design standards. Only small aircraft use these taxiways.

Taxiways F, G, M and AA all support movement by the critical aircraft and should be planned to TDG 2 and ADG III. **Table 4U** presents the suggested and planned future TDG and ADG for each existing taxiway.

TABLE 4U
Applicable Design Standards for Taxiways
Hillsboro Airport

Taxiway Designation	Suggested Current TDG	Suggested Future TDG	Suggested Current ADG	Suggested Future ADG
Taxiway A, A1, A2, A3, A4, A5, A6, A7, A8, A9	2	3	III	III
Taxiway B	2	3	III	III
Taxiway B1, B2, B5	2	2	II	II
Taxiway C, C1, C2, C5	2	2	II	II
Taxiway D, D1, D2, D3, D4	1A	1A	I	I
Taxiway F	2	3	III	III
Taxiway G	2	3	III	III
Taxiway M	2	3	III	III
Taxiway AA	2	3	III	III

Taxiway Design Considerations

FAA AC 150/5300-13A, *Airport Design*, provides guidance on recommended taxiway and taxilane layouts to enhance safety by avoiding runway incursions. A runway incursion is defined as "any occurrence at an airport 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."

The taxiway system at the Airport generally provides for the efficient movement of aircraft; however, recently published FAA AC 150/5300-13A, *Airport Design*, provides recommendations for taxiway design. The following is a list of the taxiway design guidelines and the basic rationale behind each recommendation:

1. **Taxi Method**: Taxiways are designed for "cockpit over centerline" taxiing with pavement being sufficiently wide to allow a certain amount of wander. On turns, sufficient pavement should be

provided to maintain the edge safety margin from the landing gear. When constructing new taxiways, upgrading existing intersections should be undertaken to eliminate "judgmental over-steering," which is where the pilot must intentionally steer the cockpit outside the marked centerline in order to assure the aircraft remains on the taxiway pavement.

2. **Steering Angle**: Taxiways should be designed such that the nose gear steering angle is no more than 50 degrees, the generally accepted value to prevent excessive tire scrubbing.
3. **Three-Node Concept**: To maintain pilot situational awareness, taxiway intersections should provide a pilot a maximum of three choices of travel. Ideally, these are right- and left-angle turns and a continuation straight ahead.
4. **Intersection Angles**: Design turns to be 90 degrees wherever possible. For acute-angle intersections, standard angles of 30, 45, 60, 120, 135, and 150 degrees are preferred. Typically, parallel taxiways that intersect crossing runways at a non-standard angle are permissible. .
5. **Runway Incursions**: Design taxiways to reduce the probability of runway incursions.
   - *Increase Pilot Situational Awareness*: A pilot who knows where he/she is on the airport is less likely to enter a runway improperly. Complexity leads to confusion. Keep taxiway systems simple using the "three-node" concept.
   - *Avoid Wide Expanses of Pavement*: Wide pavements require placement of signs far from a pilot's eye. This is especially critical at runway entrance points. Where a wide expanse of pavement is necessary, avoid direct access to a runway.
   - *Limit Runway Crossings*: The taxiway layout can reduce the opportunity for human error. The benefits are twofold – through simple reduction in the number of occurrences, and through a reduction in air traffic controller workload.
   - *Avoid "High-Energy" Intersections*: These are intersections in the middle third of runways. By limiting runway crossings to the first and last thirds of the runway, the portion of the runway where a pilot can least maneuver to avoid a collision is kept clear. Typically, parallel taxiways that cross the "high-energy" portion of another runway are permissible to preserve the parallel taxiway system.
   - *Increase Visibility*: Right-angle intersections, both between taxiways and runways, provide the best visibility. Acute-angle runway exits provide for greater efficiency in runway usage, but should not be used as runway entrance or crossing points. A right-angle turn at the end of a parallel taxiway is a clear indication of approaching a runway.
   - *Avoid "Dual Purpose" Pavements*: 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.
   - *Indirect Access*: Do not design taxiways to lead directly from an apron to a runway. Such configurations can lead to confusion when a pilot typically expects to encounter a parallel taxiway.
   - *Hot Spots*: Confusing intersections near runways are more likely to contribute to runway incursions. These intersections must be redesigned when the associated runway is subject to reconstruction or rehabilitation. Other "hot spots" should be corrected as soon as practicable.

6. **Runway/Taxiway Intersections**:
   - *Right-Angle*: Right-angle intersections are the standard for all runway/taxiway intersections, except where there is a need for a high-speed exit. Right-angle taxiways provide the best visual perspective to a pilot approaching an intersection with the runway to observe aircraft in both the left and right directions. They also provide optimal orientation of the runway holding position signs so they are visible to pilots.
   - *Acute-Angle*: Acute angles should not be larger than 45 degrees from the runway centerline. A 30-degree taxiway layout should be reserved for high-speed exits. The use of multiple intersecting taxiways with acute angles creates pilot confusion and improper positioning of taxiway signage.
   - *Large Expanses of Pavement*: Taxiways must never coincide with the intersection of two runways. Taxiway configurations with multiple taxiway and runway intersections in a single area create large expanses of pavement, making it difficult to provide proper signage, marking, and lighting.
7. **Taxiway/Runway/Apron Incursion Prevention**: Apron locations that allow direct access into a runway should be avoided. Increase pilot situational awareness by designing taxiways in such a manner that forces pilots to consciously make turns. Taxiways originating from aprons and forming a straight line across runways at mid-span should be avoided.
8. **Wide Throat Taxiways**: Wide throat taxiway entrances should be avoided. Such large expanses of pavement may cause pilot confusion and makes lighting and marking more difficult.
9. **Direct Access from Apron to a Runway**: Avoid taxiway connectors that cross over a parallel taxiway and directly onto a runway. Consider a staggered taxiway layout that forces pilots to make a conscious decision to turn.
10. **Apron to Parallel Taxiway End**: Avoid direct connection from an apron to a parallel taxiway at the end of a runway.

FAA AC 150/5300-13A, *Airport Design*, states that, "existing taxiway geometry should be improved whenever feasible." To the extent practicable, the removal of existing pavement may be necessary to correct confusing layouts. **Exhibit 4F** identifies the primary airfield areas of concern that will be addressed in the alternatives chapters. The exhibit includes the RPZ and ROFA items discussed previously. New material presented on the exhibit includes taxiway geometry, airfield hot spots, and Runway Incursion Mitigation (RIM) areas.

Taxiway A5 provides direct access from an apron to Runway 13R-31L. A more typical layout is to force pilots exiting from an apron to make a turn onto a parallel taxiway prior to turning toward the runway.

Taxiway A6 violates several geometry standards and is a designated hot spot by the FAA. The geometry issues are:

- The convergence of two acute-angled taxiways creates a wide expanse of pavement;
- The hold bar is longer than desired (to be avoided);.
- The convergence of two acute-angled taxiways should be avoided;
- Taxiway A6 is two taxiways which can be confusing.

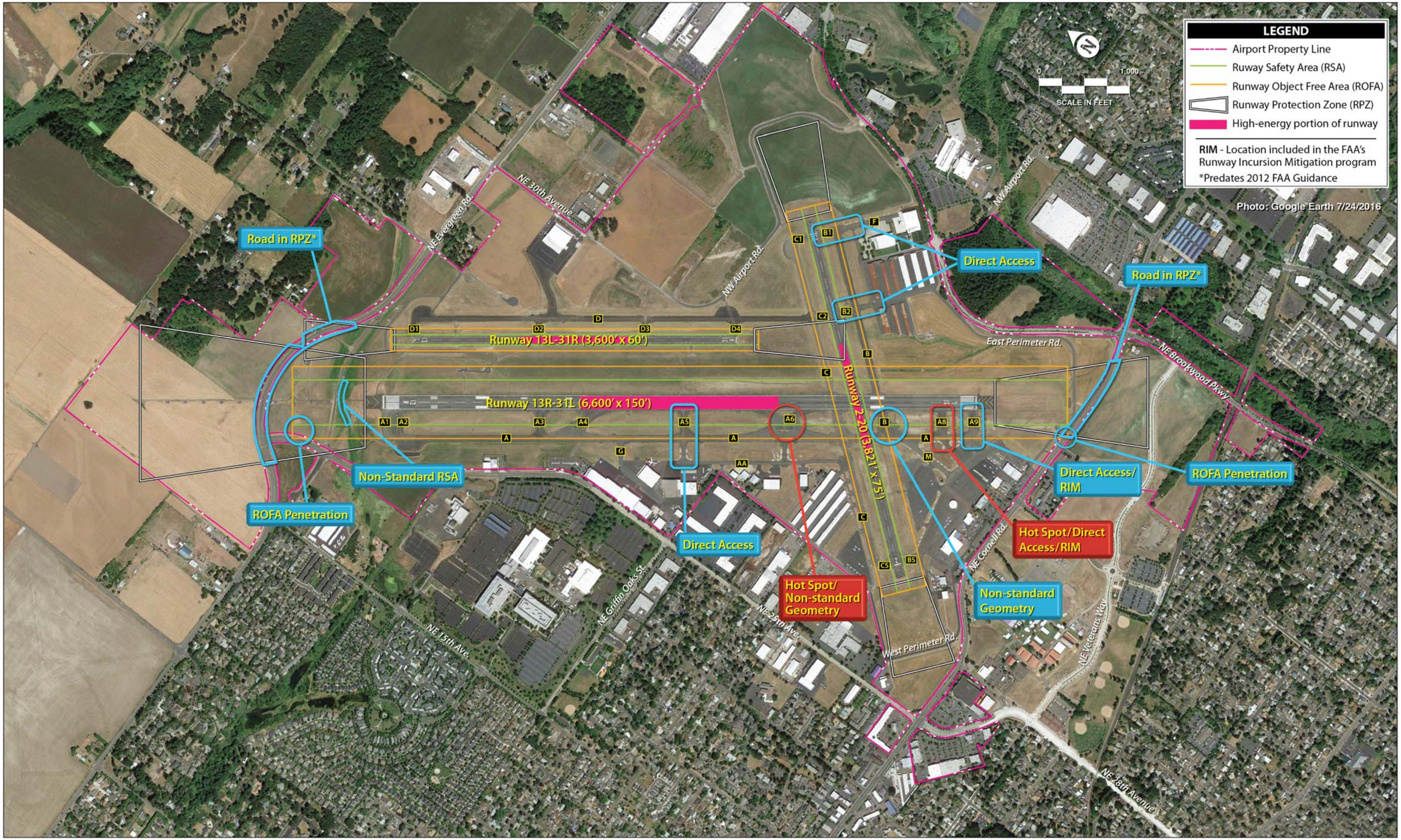


Exhibit 4F
AIRFIELD AREAS OF FOCUS

As a designated hot spot, the FAA has drawn special attention to the Taxiway A6 area. Specifically, the hot spot alerts pilots to the fact that the hold bar on Taxiway A6 is located 95 feet from the Taxiway A centerline, which means holding aircraft are within the taxiway's object free area, thus blocking passage by other aircraft on Taxiway A.

The intersection of Taxiway A and B is a wide expanse of pavement measuring 140 feet wide at the hold bar. There is a need for wider taxiway at this location in order to facilitate taxiing of large business jets from the corporate hangars located adjacent to Runway 20, to the Runway 13L threshold. Large business jets, with their wide wheel base, use the wider pavement in order to avoid their wheels inadvertently running off the taxiway. This layout will be examined in the alternatives chapter.

Taxiway A8 is a designated hot spot. The concern here is that pilots transitioning from the Runway 31L run-up area to the runway will sometimes fail to hold short of Runway 31L. Taxiway A9 allows direct access from the terminal area apron to the runway without forcing pilots to make a turn onto a parallel taxiway.

Taxiways A8 and A9 are included in the FAA's Runway Incursion Mitigation (RIM) program. RIM is an FAA initiative that began in 2015, which identifies airport risk factors that might contribute to a runway incursion and develops strategies to help airport sponsors mitigate those risks. Runway incursions occur when an aircraft, vehicle, or person enters the protected area of an airport designated for aircraft landings and take offs. Risk factors that contribute to runway incursions may include unclear taxiway markings, airport signage, and more complex issues such as the runway or taxiway layout. Through RIM, the FAA will focus on reducing runway incursions by addressing risks at specific locations at the airport that have a history of runway incursions.

Any project developed to resolve an airfield issue listed in the RIM database, is a high priority for the FAA. In some cases, depending on the risk associated with the location, the FAA may initiate an immediate solution or a temporary fix to mitigate the issue. The alternatives chapter of this master plan will provide long term solutions for these RIM locations.

Taxiways B1 and B2 allow direct access from the aircraft storage areas to Runway 2-20. As noted, current design standards promote a geometry that requires pilots to make a turn onto a parallel taxiway prior to turning toward the runway.

HOLDING BAYS

Holding bays are locations on the airfield where aircraft pull to the side of primary taxiways to perform pre-flight checks, run-ups, and to await departure clearance. FAA AC 150/5300-13A, *Airport Design*, suggests that holding bays should be provided when runway operations reach a level of 30 per hour. Analysis in Chapter Three - Forecasts, presented the operational peaking characteristics in which it was determined that the current design hour is 79, increasing to 98 by the long-term planning period.

The most advantageous location for holding bays is adjacent to the taxiway serving the runway end. Hold bays must be designed in such a manner to keep aircraft out of the RSA and OFZ. They should also be designed such that the TOFA is clear and aircraft can safely pass other aircraft positioned in the hold bay.

All runway ends except Runway 2 have existing designated hold bays. The hold bays in proximity to runway ends 13R, 13L, 31R, and 20 are appropriately located and sized and should be maintained. A new hold bay in proximity to Runway 2 may be considered, but it is not necessary because of the relatively low utilization of this runway.

The hold bay located in proximity to Runway 13R is appropriately located and has a surrounding protective earthen berm. The berm was constructed to mitigate aircraft noise emanating from this location. The side of the berm facing the hold bay is layered in rock. It is understood that jet blast from the hold bay can dislodge smaller rocks and project them. This situation is noted, as such, some other type of inner surface for the berm should be considered.

The hold bay in proximity to Runway 31L is of a non-standard design and may be contributing to runway incursions in this area. If feasible, this hold bay should be redesigned to meet design standard, which in turn may help resolve the hot spot and RIM issues. The alternatives chapter will consider these options.

INSTRUMENT APPROACH CAPABILITY

Instrument approaches are classified as either precision or non-precision. Precision instrument approaches provide both vertical and horizontal guidance. Currently, precision approaches require an instrument landing system (ILS); however, advances in GPS technology may soon make precision approaches available without the costly ground-based equipment, such as a localizer and glide slope antenna. Precision approaches typically provide for visibility minimums of ½-mile or lower and cloud ceiling minimums of 200 feet. This is typically the lowest visibility minimums available to general aviation airports and is common at reliever airports.

Non-precision instrument approaches typically provide only horizontal guidance; however, relatively new non-precision GPS localizer performance with vertical guidance (LPV) approaches do provide horizontal guidance. Non-precision instrument approaches typically have visibility minimums of greater than ½-mile and cloud ceiling minimums higher than 200 feet.

Several design requirements are associated with the instrumentation of a runway. Visibility minimums of ½-mile require an approach lighting system (ALS) and they are recommended for ¾-mile. Visibility minimums above ¾-mile do not need an ALS. The size of the RPZs can change based on the visibility minimums. If a planned change to the size or location of the RPZs were to introduce new incompatible land uses, then a special alternatives analysis is required which would be reviewed by FAA headquarters.

At Hillsboro Airport, Runway 13R has a precision ILS approach providing ½-mile visibility minimums. Runway 31L has a non-precision GPS approach with 1-mile visibility minimums. All other runways are visual only and do not have instrument approach capability.

As a reliever airport, it is appropriate for Runway 13R to be outfitted with ½-mile visibility minimums. This capability should be preserved at the Airport.

Runway 31L is highly utilized as the calm wind runway. As such, it should be considered for the lowest visibility minimums feasible. Lower visibility minimums down to ¾-mile or ½-mile would change the size of the RPZ leading to the runway end. The larger RPZ associated with these visibility minimums would introduce new incompatible land uses into the new RPZs. Recent (2012) standards related to RPZs make introducing new incompatible land uses to the RPZ very challenging and ultimately would require FAA headquarters approval. Existing incompatible land uses do not require this extra level of review.

Exhibit 4G shows the existing 1-mile RPZ for Runway 31L and the impact of both a ¾-mile or ½-mile RPZ. The ¾-mile RPZ would add new portions of Cornell Road, Brookwood Parkway and the Dawson Creek Pump Station into the RPZ. The ½-mile RPZ would additionally introduce Brookwood Parkway and Veterans Drive into the RPZ. Each of these is considered a new incompatible land use. Since the existing 1-mile approach to Runway 31L has been sufficient and a precision approach is available to Runway 13R, the existing 1-mile instrument approach is planned to be maintained and lower visibility minimums to Runway 13L are not considered further.

For highly utilized crosswind runways, it is common to have an instrument approach, typically with visibility minimums of not lower than 1-mile. Runway 2-20 is not highly utilized, accounting for an estimated five percent of operations. Runway 2-20 is specifically addressed in the HIO Fly Friendly program. According to the program documentation, "Runway 2-20 is highly noise sensitive. Arrivals to Runway 2 and departures from Runway 20 are discouraged unless conditions necessitate." Because of these factors, new instrument approaches are not considered for Runway 2-20.

The visual capability of parallel Runway 13L-31R is appropriate for this runway. No instrument approaches are considered for this runway.

HELICOPTER TRAINING PAD

Hillsboro Airport has emerged as an important helicopter flight training facility. Approximately 30 percent of all operations are by helicopters. The airport, in conjunction with the control tower and the helicopter flight training schools, has developed various procedures to enhance the safety of these helicopter training operations and to reduce noise impacts to surrounding neighborhoods.

The most common helicopter flight training practice at the Airport is to utilize Delta Pattern and Taxiway D. There are three locations physically identified on Taxiway D where helicopters will approach and depart to and from Delta Pattern. Taxiway D is intended to facilitate the movement of fixed wing aircraft. Therefore, a dedicated helicopter training pad is recommended.

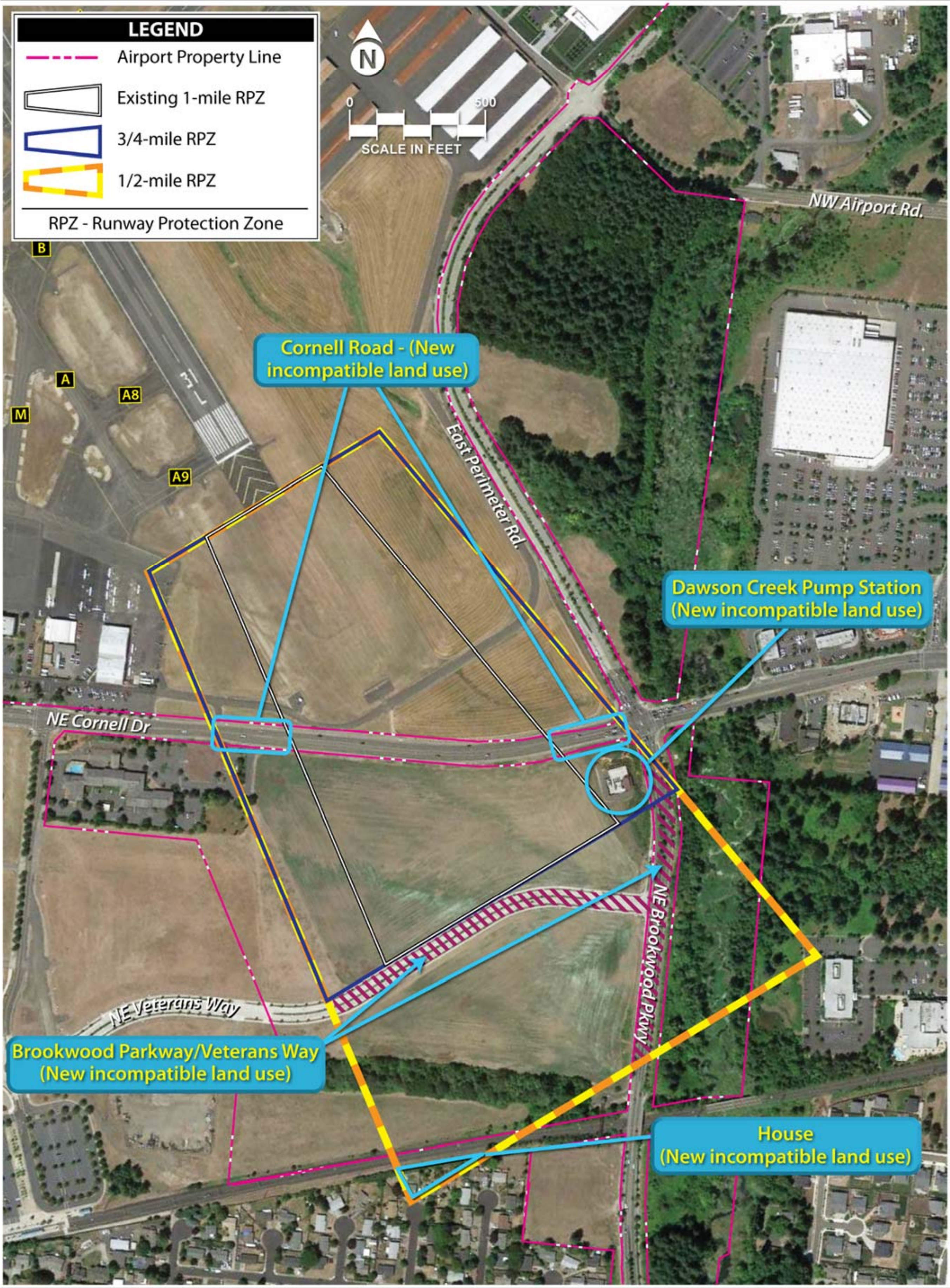


Exhibit 4G
RUNWAY 31L RPZ CONSIDERATIONS

A helicopter training pad is included on the current airport layout plan for the Airport. It is proposed to be located at the north end, approximately 240 feet to the east of Taxiway D. It is 700 feet long and has three landing pads. This is an appropriate location for a helicopter training pad as it is in proximity to Delta Pattern and it is farthest away from higher density neighborhoods. This location may be maintained, or another suitable location may be considered based on the overall plan for the Airport. The alternatives analysis will consider the appropriate location of a helicopter training pad.

VISUAL NAVIGATION AIDS

The location of the airport at night is universally indicated by a rotating beacon, which is located on top of a steel lattice structure in the terminal parking lot. If planned development of the terminal area impacts the beacon location, another suitable location will be identified.

All runway ends are equipped with precision approach path indicator (PAPI) lights. These visual approach lighting systems should be maintained through the long-term planning period.

Runway end identification lights (REIL) are strobe lights set to either side of the runway. These lights provide rapid identification of the runway threshold. REILs should be installed at runway ends not currently providing an approach lighting system but supporting instrument operations. REILs are currently available at the end of Runway 31L and should be maintained. Runway 13R already has an approach lighting system. REILS are not needed on any other runway ends.

Runway 13R is equipped with a medium intensity approach lighting system with runway alignment indicator lights (MALSR). This system of lights provides a lighted, visual grid for pilots to identify the runway end while on final approach. This system is required as part of the ILS and should be maintained.

A MALSR is a requirement if instrument approaches below ¾-mile are implemented. No other runway ends are considered for visibility minimums below ¾-mile as no other runway is planned with a MALSR system.

AIRFIELD LIGHTING, MARKING, AND SIGNAGE

Airfield lighting, signage, and markings aid pilots when navigating the airport environment.

Runway and Taxiway Lighting

Runway lighting provides the pilot with positive identification of the runway and its alignment. Primary Runway 13R-31L is outfitted with high intensity runway lighting (HIRL). This is the appropriate intensity for this precision instrument runway. Both other runways have medium intensity runway lighting (MIRL), which is appropriate. The intensity of the runway edge lighting should be maintained through the long-term planning period.

Taxiway edge lighting provides for safe and efficient ground movements at night and at times of poor visibility. All taxiways have medium intensity taxiway lighting (MITL). These should be maintained through the long-term planning period.

Pavement Markings

Runway markings are typically designed to the type of instrument approach available on the runway. FAA AC 150/5340-1L, *Standards for Airport Markings*, provides guidance necessary to design airport markings. Runway 13R has precision marking corresponding to the precision approach. Runway 31L has non-precision markings. Runways 2-20 and 13L-31R have basic markings which are appropriate. These are the appropriate runway markings and should be maintained through the long-term planning period. If an instrument approach were added to either of these runways, then non-precision markings would be required.

Airfield Signs

Airfield identification signs assist pilots in identifying their location on the airfield and directing them to their desired location. Lighted signs are installed in proximity to the runways and taxiways on the airfield. The signage system includes runway and taxiway designations, holding positions, routing/directional, and runway exits. All these signs should be maintained throughout the planning period.

Consideration should be given to installing distance remaining signage for the primary runway. These lighted signs alert pilots to how much runway length remains in 1,000-foot increments.

WEATHER AND COMMUNICATION AIDS

Hillsboro Airport has a full complement of seven windsocks located on the airfield which should be maintained.

Hillsboro Airport is equipped with an ASOS. This is an important system that automatically records weather conditions, such as wind speed, wind gust, wind direction, temperature, dew point, altimeter setting, visibility, fog/haze condition, precipitation, and cloud height. This information can be accessed by pilots and individuals via an automated voice recording on a published telephone number. This system should be maintained through the planning period.

AIRSIDE SUMMARY

The Hillsboro Airport is an asset and economic engine for the community and the region. It is also important to the National Airspace System and is designated as a reliever airport.

Primary Runway 13R-31L is 6,600 feet long. Considering today's fleet mix utilizing the runway, the optimal length would be 7,500 feet, in an unconstrained environment. At least one option for extending the runway will be examined in the Alternatives chapter; however, considering the known constraints (i.e., surrounding roads), it may be a challenge to implement. At a minimum, Runway 13R-31L should be maintained at no less than 6,600 feet.

Crosswind Runway 2-20 is 3,821 feet long and is designed to accommodate aircraft in crosswind conditions. This length is adequate and should be maintained. The availability of Runway 2-20 allows the airport to remain operational when the primary runway is closed (typically due to a construction project or an emergency) and it provides a safer landing option when winds dictate.

The FAA places a high priority on airports having control over land uses within RPZs. The RPZs at the Airport have incompatible land uses within them, specifically roads. Incompatible RPZ land uses that existed before 2012 are generally considered "grandfathered"; however, it is still the responsibility of the Airport to have a plan in place to improve RPZ land use compatibility where feasible. It is often a function of funding availability that determines when a mitigating solution can be pursued. If new incompatible land uses are considered for an RPZ, then an extensive review and approval by FAA headquarters is required.

The FAA is also placing a high priority on mitigating or eliminating, through redesign, potentially confusing geometry at airports. Several taxiways do not meet current geometric design standards. The long-term plan for the Airport will consider implementation of taxiway geometry that meets standards.

The Airport has two designated hot spots and two areas on the FAA's runway incursion mitigation list. These are high priority areas for the FAA. The alternatives chapter will present options to mitigate these focus areas.

The Airport has a precision approach to Runway 13R and a non-precision instrument approaches to Runway 31L. These are planned to be maintained. No other instrument approaches are necessary.

A summary of the airside needs at Hillsboro Airport is presented on **Exhibit 4H**.

RUNWAYS

AVAILABLE	POTENTIAL IMPROVEMENT/CHANGE
RUNWAY 13R-31L	
RDC: D-III-2400	Maintain
Runway length/width: 6,600' x 150'	Consider extension to 7,500'
Pavement strength: Planned PCN of 26-33	Maintain
RSA: 500' wide x 1,000' beyond runway ends	Non-standard RSA grade on Rwy 13R end
ROFA: 800' wide x 1,000' beyond runway ends	Non-standard: ROFA extends over roads
OFZ: 400' wide x 200' beyond runway ends	Meets standard - maintain
RPZ ownership: partial ownership	Acquire if feasible
RPZ Incompatibilities: Roads	Remove RPZ incompatibilities if feasible
Precision (13R)/ Nonprecision (31L) markings	Meets standard - maintain
High intensity runway lighting (HIRL)	Meets standard - maintain
Distance-To-Go signs: None	Add Distance-To-Go signs
RUNWAY 2-20	
RDC: B-II-VIS	RDC: B-II-5000
Runway length/width: 3,821' x 75'	Maintain
Pavement strength: PCN = 20	Maintain
Standard RSA, OFA, OFZ	Meets standard - maintain
RPZ ownership: full ownership	Maintain
RPZ Incompatibilities: None	Maintain
Basic marking	Non-precision marking
Medium intensity runway lighting (MIRL)	Meets standard - maintain
RUNWAY 13L-31R	
RDC: B-I(s)-VIS	Maintain
Runway length/width: 3,600' x 60'	Maintain
Pavement strength: PCN = 10	Maintain
Standard RSA, OFA, OFZ	Meets standard - maintain
RPZ ownership: partial ownership	Acquire if feasible
RPZ Incompatibilities: Road	Remove RPZ incompatibilities if feasible
Basic marking	Meets standard - maintain
Medium intensity runway lighting (MIRL)	Meets standard - maintain

TAXIWAYS

AVAILABLE	POTENTIAL IMPROVEMENT/CHANGE
TDG-2	Meets standard - maintain
Centerline markings	Meets standard - maintain
Width standard is 50 feet	Implement uniform 50' taxiway width
Medium intensity taxiway lighting (MITL)	Meets standard - maintain
Taxiway layout/geometry deficiencies	Redesign taxiway layout/geometry deficiencies

INSTRUMENT NAVIGATION AND WEATHER AIDS

AVAILABLE	POTENTIAL IMPROVEMENT/CHANGE
ASOS	Maintain
Beacon	Maintain
5 Windsocks	Maintain
RUNWAY 13R-31L	
½-mile precision ILS (13R)	Maintain
1-mile non-precision GPS (31L)	Maintain
RUNWAY 2-20	
Visual	Maintain
RUNWAY 13R-31L	
Visual	Maintain

VISUAL AIDS

AVAILABLE	POTENTIAL IMPROVEMENT/CHANGE
RUNWAY 13R-31L	
PAPI-4L	Maintain
REILs (31L)	Maintain
RUNWAY 2-20	
PAPI-4L	Maintain
RUNWAY 13R-31L	
PAPI-4L	Maintain

ASOS - Automated Surface Observation System
MIRL/HIRL - Medium/High Intensity Runway Lighting
MITL - Medium Intensity Taxiway Lighting
OFZ - Obstacle Free Zone
PAPI - Precision Approach Path Indicator
PCN - Pavement Classification Number
RDC - Runway Design Code
REIL - Runway End Identification Lights
ROFA - Runway Object Free Area
RPZ - Runway Protection Zone
RSA - Runway Safety Area
TDG - Taxiway Design Group

Exhibit 4H
AIRSIDE FACILITY REQUIREMENTS

LANDSIDE REQUIREMENTS

Landside facilities are those necessary for handling aircraft and passengers while on the ground. These facilities provide the essential interface between the air and ground transportation modes. The capacities of the various components of each area were examined in relation to projected demand to identify future landside facility needs. This analysis is focused on the needs to support general aviation activity, which includes recreational flying, business aviation, charter, military, and some portions of air cargo and air ambulance activity. The landside components include:

- Aircraft Hangars
- Aircraft Parking Apron
- Automobile Parking and Access
- General Aviation Terminal Building Services

AIRCRAFT HANGARS

Owning an aircraft represents a significant financial investment. Most aircraft owners prefer to store their aircraft in an enclosed hangar space as opposed to utilizing outside aircraft tie-down positions. In more mild climates, such as Oregon, some owners will prefer a less-expensive outside tie-down position. Enclosed hangar space provides protection from the elements and an increased level of security. It is estimated that 85 percent of aircraft are stored in hangars at the Airport. This is forecast to remain level through the long-term planning period.

There are three general types of aircraft storage hangars: T-hangars, executive/box hangars, and conventional hangars. T-hangars are "T-shaped" and will typically house a single engine piston-powered aircraft. Some multi-engine aircraft owners may elect to utilize these facilities as well. There are typically many T-hangar units "nested" within a single structure. Box hangars are larger, open-space hangars typically used to store somewhat larger personal/business aircraft and/or to house aviation businesses. Conventional hangars are the familiar large hangars with open floor plans that can store several aircraft.

Calculations of current and future hangar needs by hangar type have been developed. Currently, there is approximately 219,500 square feet of T-hangar aircraft storage space at the Airport providing 182 positions. Future estimates of T-hangar needs are based on providing 1,400 square feet per T-hangar unit. The long-term need is for 182 individual T-hangar positions and 255,000 square feet of space. Essentially, if the airport were to replace any existing T-hangars, it would be recommended that they are slightly larger, thus more square footage would be needed. This conclusion is supported by the fact that T-hangars currently have a 70 percent occupancy rate.

Executive/box hangars are an increasingly popular storage option. Estimates of future needs are based on providing 2,200 square feet per aircraft. There is a current need for approximately 46,100 square feet of executive/box hangar space. In the long-term planning period, there is a total need for an additional 66,100 square feet.

Conventional hangar aircraft parking space is estimated by providing 2,500 square feet per aircraft. The calculations indicate that the current supply of conventional hangars is adequate through the long-term planning period.

Table 4V presents aircraft storage needs based on the demand forecasts. Estimates indicate a long-term need for an additional 73,000 square feet of aircraft storage space to accommodate the forecast growth at the Airport.

Most hangars will have some space dedicated for non-aircraft storage purposes. This may include an office or lounge area. Active airports with a significant general aviation presence, such as Hillsboro Airport, will also have a variety of aviation businesses on the airfield. These operators typically dedicate hangar space for this purpose, rather than storage. Future office/maintenance hangar space needs are calculated at 175 square feet per based aircraft. This shows that there is a need for approximately 25,800 square feet of additional office/maintenance hangar space by the long term. Hangar and office/maintenance space combined indicated a total need for approximately 98,800 square feet.

Hangar requirements are general in nature and are based on standard hangar size estimates and typical user preferences. If a private developer desires to construct or lease a large hangar to house one plane, any extra space in that hangar may not be available for other aircraft. The actual hangar area needs will be dependent on the usage within each hangar.

TABLE 4V
Hangar Needs
Hillsboro Airport

	Currently Available	Short Term	Intermediate Term	Long Term	Total Need Less Current Supply
Based Aircraft	354	375	395	445	
Aircraft to be Hangared	301	319	336	378	77
T-Hangar Positions	182	158	165	182	0
Box Hangar Positions	25	49	51	58	33
Conventional Hangar Positions	170	113	120	138	-32
Hangar Area Requirements					
T-Hangar Area	219,500	221,000	230,000	255,000	35,500
Box Hangar Area	60,900	107,000	113,000	127,000	66,100
Conventional Hangar Area	373,600	282,000	300,000	345,000	-28,600
Total Storage Area (s.f.)	**654,000**	**610,000**	**643,000**	**727,000**	**73,000**
Maintenance Area	52,200	66,000	69,000	78,000	25,800

Source: Coffman Associates analysis.

GENERAL AVIATION AIRCRAFT APRON

Aircraft aprons are paved areas utilized for access, circulation, and aircraft parking needs. Some apron areas may be designated for transient visitors to the Airport and others may be designated for local aircraft tie-down needs.

An important consideration when planning aircraft apron demand is to distinguish between the space needed for small and large aircraft. Small aircraft space is needed for both transient and local aircraft. Large aircraft space is needed for transient operators as based large aircraft, such as business jets and turboprops, are rarely stored outside at a tie-down position. Therefore, two separate calculations are employed to determine local and transient apron needs, and transient apron needs are further classified for small and large aircraft.

Transient Apron Requirements

FAA AC 150/5300-13A, *Airport Design*, suggests a methodology by which transient apron requirements can be determined from knowledge of busy-day operations. At the Airport, the number of transient spaces required is estimated at 15 percent of the busy-day transient general aviation operations. Busy day operations are calculated by multiplying the design day by 1.27 (derived from analysis of tower operations). This results in a current need for 56 transient aircraft positions and a long-term need for 69 positions.

A planning criterion of 800 square yards per small aircraft and 1,600 square yards for large aircraft was applied to determine current and future transient apron area requirements. These area estimates include circulation areas and take into account the higher frequency of ground movements by transient aircraft. Small aircraft are estimated to account for 80 percent of transient operations, and larger business jets and turboprops account for the remaining 20 percent. There is a current need for 21 transient positions for small aircraft. By the long-term planning period, there is a forecast need for a total of 31 positions for small aircraft. There is a current need for four aircraft positions for large aircraft and by the long-term, a need for seven large aircraft transient positions.

"Additional aircraft apron is needed, especially for transient operators."

Transient apron needs have also been calculated in terms of area requirements. Existing transient apron area is estimated at 44,800 square yards. The current need is for 54,200 square yards and the long-term need is for 59,600 square yards. When considering what is currently available, there is a long-term need for an additional 21,100 square yards of transient apron.

Local Apron Requirements

Local tie-down positions are assumed to be utilized by owners of small single engine aircraft and, therefore, a planning criterion of 500 square yards per aircraft is utilized. An additional 10 spaces are planned to accommodate temporary usage by local users. As noted previously, it is estimated that 15 percent of based aircraft owners will utilize outside tie-down positions. Because of the relatively mild climate, there will always be a demand for local tie-down positions to some degree.

The Airport currently has an excess supply of aircraft tie-down positions. The vast majority are located on the central apron in the terminal area. Currently, there is 46,500 square yards of local apron and a long-term need for only 38,400 square yards. This difference presents an opportunity for the Airport when considering future development because some portion of the local apron area can be redeveloped to meet other needs without negatively impacting local tie-down users.

Aircraft Apron Summary

There is currently 91,300 square yards of aircraft apron space available at the Airport and a long-term need for 104,300 square yards. While the forecast distinguishes between local and transient apron, operationally it is common for pilots to utilize an available space. **Table 4W** summarizes the aircraft apron needs at the Airport.

TABLE 4W
Aircraft Apron Requirements
Hillsboro Airport

			FORECAST		
	Currently Available (2016)	Calculated Need (2016)	Short Term	Intermediate Term	Long Term
Local Apron Positions	179	63	66	69	77
Local Apron Area (s.y.)	46,500	31,600	33,100	34,600	38,400
Transient Apron Positions	31	56	59	62	69
Piston Transient Positions	24	45	47	50	55
Turbine Transient Positions	7	11	12	12	14
Transient Apron Area (s.y.)	44,800	54,200	56,800	59,600	65,900
Total Apron Area (s.y)	91,300	85,800	89,900	94,200	104,300

Source: Coffman Associates analysis

VEHICLE PARKING

Parking needs are attributable to locally-based users, transient airport users, and on-airport businesses. As with many general aviation airports, most locally-based aircraft owners will park their vehicles in or adjacent to their hangar when attending to or flying their aircraft. Current planning standards suggest that dedicated vehicle parking lots be made available to hangar owners/occupants, where feasible. This has the positive effect of removing vehicular traffic from aircraft movement areas.

Vehicle parking needs for locally-based aircraft operators are estimated at half of the total number of based aircraft. Thus, 177 parking spaces would be needed for local aircraft owners. The City of Hillsboro Municipal Code, Chapter 12.50.320, suggests that a dedicated vehicle parking space be made available for each aircraft space. Since aircraft owners do not all fly at the same time and because many will park in their hangar, the airport planning estimate of 177 is carried forward as the vehicle parking requirement for locally-based aircraft owners.

Airport businesses, including FBOs have vehicle parking needs for both employees and transient users. A modest 1.0 percent annual growth rate was applied to the existing number of airport business parking spaces to estimate the number of spaces needed for employees. Transient parking needs for airport businesses are a function of the number of potential general aviation passengers during the design hour. The number of design hour itinerant passengers is multiplied by 1.9 (average vehicle occupants), which results in a total number of vehicle parking spaces needed. The combination of airport business employees and their transient users provides an estimated need for 100 additional vehicle parking spaces over the long-term for these local businesses.

A separate analysis of the vehicle parking needs in the terminal area was conducted because of the unique nature of use of these terminal parking lots. Of the 460 spaces available in the terminal area (reference Exhibit 1P), 209 are reserved for the corporate air shuttle service and 139 are reserved for rental cars. This distribution resembles a small commercial service airport. As a result, the terminal area parking needs were calculated utilizing FAA guidance on terminal design, much of which is a function of enplanements (passenger board an aircraft).

The corporate shuttle had approximately 84,000 enplanements in 2016. A modest growth rate of 0.88 annually was applied to provide a 20-year estimate of 100,000 annual enplanements. Design day and design hour enplanement levels were then determined based on the flight schedule for the air shuttle operator and known loading factors. In addition, a modal split was applied that includes private automobile (86%), bus (4%), and rental cars (10%). The bus mode was increased above typical averages because the corporate air shuttle provides bus service for their employees. Nonetheless, the modal split should be considered a conservative estimate based on the analyst judgement and knowledge that the current terminal parking lot is frequently at capacity.

The terminal area analysis shows that there is a short-term need for 82 parking spaces and a long-term need for 285 spaces. **Table 4Y** presents the vehicle parking estimates. Providing for adequate vehicle parking will be an important consideration in the alternatives analysis, especially since parking is currently constrained in the terminal area.

TABLE 4Y
Vehicle Parking Estimate
Hillsboro Airport

	Existing	Short Term	Intermediate Term	Long Term	Change
Terminal Area Parking					
Terminal Area	283	362	436	541	258
Employee	38	40	42	45	7
Rental Car	139	140	146	159	20
Subtotal Terminal Parking	**460**	**542**	**624**	**745**	285
Other Local Parking					
Based Aircraft Owners[1]	177	188	198	223	46
Airport Businesses	396	418	443	496	100
Subtotal Other Local Parking	**573**	**606**	**641**	**719**	146
Total All Parking	**1,033**	**1,148**	**1,265**	**1,464**	431

[1]Estimated need if dedicated parking were made available; however, most based aircraft owners will park in their hangar when flying.

TERMINAL SERVICES

Typically, certain services will be made available to general aviation users. This may include a pilot's lounge, flight planning station, line services, conference room, and restrooms. These facilities may be provided by a dedicated terminal building and/or shared with FBO facilities. At Hillsboro Airport, these services are shared among the FBOs and the Airport terminal building. It is estimated that pilot service functions currently account for approximately 2,000 square feet in the main terminal building with an additional 10,000 square feet of space estimated to be available at the FBOs.

The airport terminal building is approximately 22,600 square feet in size currently. This is a two-story structure with no aviation services on the second floor. Much of the first floor is leased space, including the corporate air shuttle operators space.

A dual approach to determining the overall size needed for the terminal building was undertaken. The first was to calculate the needs for general aviation services, and the second was to calculate the needs for a commercial/charter facility. While commercial service is not anticipated during the 20-year term of this master plan, the corporate air shuttle operates much like a commercial airline, and certain terminal building functions such as a waiting room, restrooms, concessions, lobby, and rental cars are still needed.

General Aviation Terminal Needs

General aviation terminal needs are a function of the design hour itinerant operations. Essentially, space planning results from the number of people that may be in the facility in the design hour. Since itinerant operations are approximately 42 percent of overall operations and the design hour is 83 operations (in the short term), the itinerant design hour is 34 operations. This is multiplied by a factor of 2, which represents the average number of passengers on each aircraft. Approximately 120 square feet is made available for each person in the building in the design hour. Thus, in the short term, approximately 8,300 square feet of space would be needed for a typical general aviation terminal building. In the long-term, this increases to 9,500 square feet.

Charter Terminal Needs

The corporate air shuttle at the Airport operates much like a commercial airline. They have a schedule of flights, passengers (i.e., employees), and a need to use the terminal to accommodate those passengers. Because of these similarities, two primary sources were consulted to determine terminal facilities for a commercial/charter building:

- FAA AC 150/5360-13, *Planning and Design Guidelines for Airport Terminal Facilities;*, and
- Airport Cooperative Research Council (ARCP), Report 25, *Airport Passenger Terminal Planning and Design*.

Most terminal building space needs are a function of enplanements (passengers boarding an aircraft). As noted previously, if the passengers using the corporate air shuttle were considered commercial enplanements, there would be approximately 84,000 in 2016. A modest growth rate of 0.88 annually was applied to provide a 20-year estimate of 100,000 annual enplanements. Design day and design hour enplanement levels were then determined based on the flight schedule for the air shuttle operator and known loading factors. The design day and design hour enplanements levels are used to determine specific terminal building space requirements by function. Typical commercial terminal building functions include ticketing/check-in, airline operations, gate facilities and hold room capacity, baggage claim, concessions, public lobby, security check point, restrooms, administration, circulation, and building systems (i.e., HVAC).

Utilizing the guidance provided, it was determined that a commercial terminal building, providing all of these functions, would need to be approximately 22,700 square feet in size in the short term. By the long term, to accommodate 100,000 annual enplanements, the building would need to be approximately 43,000 square feet in size.

Since the terminal building is not planned to support commercial service, certain traditional functions can be eliminated including ticketing/check-in, airline operations, baggage claim, and security check point. The remaining elements give us an indication of the size needed to support the existing type of corporate air shuttle operations, including modest increases in passengers over time. In the short term, a facility encompassing approximately 12,300 square feet is needed. By the long term, the building should be approximately 21,400 square feet.

Table 4Z presents the results of the terminal building analysis. The top half of the table shows the results of the general aviation terminal building analysis. As can be seen, much of these functions are, and will continue to be, provided by FBOs. A small portion should be included to accommodate certain general aviation functions, such as restrooms and a public lobby. When combining the general aviation need and the charter need, a terminal building of approximately 13,300 square feet would be needed in the short term. By the long term, a building of approximately 22,900 square feet would be needed.

TABLE 4Z
General Aviation Terminal Area Facilities
Hillsboro Airport

	Short Term	Intermediate Term	Long Term
General Aviation Terminal Area Facilities			
Terminal Building Public Space (s.f.)	1,245	1,305	1,425
FBO GA Services Space (s.f.)	7,055	7,395	8,075
Total GA Terminal Building Space (s.f.)	8,300	8,700	9,500
Charter Terminal Building			
Gate Facilities - Hold Room	2,200	3,300	4,400
Rental Car Counters	1,170	1,365	1,560
Concessions	2,384	3,626	4,901
Public Lobby	1,107	1,775	2,520
Restrooms	518	802	1,102
Admin/Office	1,880	1,920	2,000
Circulation	1,852	2,557	3,297
HVAC	926	1,279	1,648
Charter Terminal Building Total	**12,036**	**16,624**	**21,428**
Total Terminal Building Space	**13,281**	**17,929**	**22,853**

Source: Coffman Associates analysis

Terminal Building Condition

The two-story terminal building was dedicated in 1976 and is constructed of tube steel columns and wood posts supporting glulam beams. The first floor encompasses 10,670 square feet of space and the second floor encompasses 11,908 square feet. The total size of the building is 22,578 square feet. The terminal building is not arranged to serve public passenger air service; rather, its layout is similar to that of an office building. A corporate air shuttle operator leases space on the first floor where they have a counter and passenger seating area; however, this space is not available to the general public.

Consideration should be given to replacing the existing terminal building due to age, lack of seismic resiliency, lack of functionality as an aviation facility, and location. The current location of the building limits available vehicle parking space. When considering a new facility, it should be planned to meet the long-term needs of the Airport. As discussed, the long-term need is estimated at 22,900 square feet dedicated to aviation functions. Additional square footage would be necessary to provide such features as a restaurant, community conference rooms, and other commercial uses such as office space.

LANDSIDE SUMMARY

An analysis of the required landside facilities necessary to meet projected demand has been presented. Currently, it is estimated that there is approximately 654,000 square feet of aircraft storage space in existing hangars. By the long-term planning period, a total of 727,000 square feet is forecast to be needed. An additional 25,800 square feet is projected to be needed for hangar office/maintenance space.

General aviation aircraft apron space was calculated for both itinerant and local tie-down needs. Currently, itinerant apron area is deficient and local tie-down apron exceeds the projected need. Therefore, opportunities exist to reduce local aircraft tie-down apron and convert a portion to transient purposes. In total, approximately 13,000 square yards of new apron area is projected to be needed by the long-term planning period. In addition, dedicated spaces for larger transient aircraft should be identified.

The need for vehicle parking space was analyzed for both locally-based users and transient users. Currently, there are approximately 1,033 spaces. In the long term, there is a forecast need for 1,463 spaces. In the terminal area, there are 460 spaces and a long-term need for 745 spaces.

The terminal building serves a variety of functions including leasable office space, corporate air shuttle operations, and rental cars. It is an aging structure that does not meet modern design for an aviation facility. The location of the building also limits the opportunities to provide adequate vehicle parking. If a new terminal building were to be considered, a building encompassing approximately 22,900 square feet should be considered. Additional space may be desired for certain non-aviation functions such as a restaurant, community space, conference rooms, etc.

Exhibit 4J presents a summary of the landside requirements, as well as the support requirements that are discussed in the next section.

HIO MASTER PLAN UPDATE PORT OF PORTLAND

HANGAR POSITIONS

	Available	Short Term	Intermediate Term	Long Term
Based Aircraft	**354**	**375**	**395**	**445**
Hangar Positions				
T-Hangars	182	158	165	182
Executive/Box Hangars	25	49	51	58
Conventional Hangar Positions	170	113	120	138
Hangar Area (s.f.)				
T-Hangars	219,500	221,000	230,000	255,000
Conventional Hangar	373,600	282,000	300,000	345,000
Executive/Box Hangars	60,900	107,000	113,000	127,000
Total Hangar Area	**654,000**	**610,000**	**643,000**	**727,000**
Maintenance Area	52,200	66,000	69,000	78,000

AIRCRAFT PARKING

	Available	Short Term	Intermediate Term	Long Term
Aircraft Parking Positions				
Local Positions	179	66	69	77
Transient Piston Positions	24	47	50	55
Transient Business Jet Positions	7	12	12	14
Aircraft Parking Apron (s.y.)				
Local Apron Area	46,500	33,100	34,600	38,400
Transient Apron Area	44,800	56,800	59,600	65,900
Total Apron	**91,300**	**89,900**	**94,200**	**104,300**

	Available	Short Term	Intermediate Term	Long Term
Auto Parking				
Terminal Area	283	362	436	540
Terminal Employee	38	40	42	45
Terminal Rental Car	139	140	146	159
Local Based Aircraft Owners	177	188	198	223
Airport Businesses	396	418	443	496
Total Parking Spaces	**1,033**	**1,148**	**1,265**	**1,463**
Terminal Building				
GA Area (s.f.)	-	1,245	1,305	1,425
Charter Area (s.f.)	-	12,036	16,624	21,428
Total Building Area (s.f.)	**-**	**13,281**	**17,929**	**22,853**
Fuel Storage (static)				
Jet A Capacity	223,500 gal.	Maintain	Maintain	Maintain
AvGas Capacity	110,000 gal.	Maintain	Maintain	Add 10,000 gal. tank
Perimeter Fencing				
Linear Feet	32,100	Maintain and Replace As Needed	Maintain and Replace As Needed	Maintain and Replace As Needed

RED - Total need exceeds existing availability

Exhibit 4J
LANDSIDE AND SUPPORT REQUIREMENTS

AIRPORT SUPPORT REQUIREMENTS

Various facilities that do not logically fall within classifications of airside or landside facilities have also been identified. These other areas provide certain support functions related to the overall operation of the Airport.

AIRCRAFT RESCUE AND FIREFIGHTING (ARFF) FACILITIES

Since the Airport is not a Part 139 commercial service airport, it is not required to have on-site ARFF. However, it is a busy general aviation reliever airport and does benefit from having Hillsboro Fire Station No. 5 (Jones Farm Fire Station) physically located on the east side of Airport property, on NE 25th Avenue. No additional firefighting facilities are required.

MAINTENANCE BUILDING

The primary airport maintenance building is located in the southwest corner of the Airport at 1040 NE 25th Avenue. The structure is a two-story building with two large bays to accommodate maintenance equipment. The building footprint is approximately 7,000 square feet and the gross building area is 8,600 square feet. The building was privately constructed in 1976 and acquired by the Port in 1994. The building consists of a shop area, offices, and a conference room. A smaller 600 square-foot maintenance building is located on the north edge of the terminal apron.

The location of the maintenance building is appropriate as it is set away from the runway and taxiway system and does not occupy land that could otherwise be used for aircraft. However, access to the building can be challenging at times. Street access to the maintenance building is from 25th Avenue, approximately 500 feet from the intersection with Cornell Road. During busy rush hours, turning movements to/from the maintenance facility can be difficult as cars queue up from the intersection. The City/County are considering upgrades to 25th Avenue which may also impact the maintenance facility. In addition, the building is lacking in size and is becoming more expensive to maintain as it ages.

Future planning for the airport will include consideration of appropriate locations for a replacement maintenance building that has the capacity to allow consolidation of all airport maintenance equipment. A building size of at least 12,000 square feet will be considered. Additional short-term considerations will include the possibility of improving vehicular access for staff.

FUEL STORAGE

At Hillsboro Airport, the FBOs and other tenants are responsible for determining their own fuel storage and delivery needs. There are 16 Jet A static tanks with a total capacity of 223,500 gallons. There are 15 AvGas static tanks with a total capacity of 110,000 gallons.

The Port has invested in a 5,000-gallon static storage tank for MoGas (ethanol-free unleaded gasoline) at the Airport. The static MoGas tank is available for lease by an FBO when use of MoGas as an aviation fuel becomes more common. The FAA is currently conducting an extensive study of the viability of MoGas as an aviation fuel with the aim of ultimately transitioning from leaded to unleaded aviation fuel.

Additional fuel storage capacity should be planned when the Airport is unable to maintain an adequate supply and reserve. A 14-day reserve is common; however, more frequent deliveries can be arranged to make up for times when reserves are low. When additional capacity is needed, it should be planned in 10,000 to 12,000-gallon increments, which can accommodate common fuel tanker trucks that typically have an 8,000-gallon capacity. Fuel storage requirements can vary based upon individual supplier and distributor policies.

Projections of future fuel supply needs are a function of the aircraft fleet mix operations at the Airport. Assumptions of fuel usage are based upon historical averages. It is forecast that the Airport currently has adequate fuel storage capacity through the long-term planning horizon. **Table 4AA** presents the fuel storage requirements.

TABLE 4AA
Fuel Storage Requirements
Hillsboro Airport

			Planning Horizon		
	Current Capacity	Baseline Consumption (2016)[1]	Short Term	Intermediate Term	Long Term
Jet A Requirements	223,500				
Annual Usage (gal.)		3,273,863	3,515,980	3,759,080	4,313,660
Daily Usage (gal.)		8,969	9,633	10,299	11,818
14-Day Storage (gal.)		125,573	134,860	144,184	165,455
Avgas Requirements	110,000				
Annual Usage (gal.)		284,863	348,585	368,910	412,445
Daily Usage (gal.)		780	955	1,011	1,130
14-Day Storage (gal.)		10,926	13,370	14,150	15,820

Assumptions:
Jet A 104.3 gallons per operation by jet/turbo engine.
Avgas 2 gallons per operation by AvGas engine.

Source: [1]Airport fuel report; Coffman Associates analysis

Many airports, large and small, will consolidate fuel storage functions to a single location. This facilitates consolidated fuel tanker truck deliveries, affords financial savings, and encourages proper adherence to various environmental regulations. At Hillsboro Airport, it is also common for on-airport fuel delivery trucks to cross active runways and taxiways to access the opposite side of the airfield. This practice, though necessary, is discouraged. During the alternatives analysis, consideration will be given to locations for a consolidated fuel farm. Further considerations will be given to the possibility of a fuel farm on each side of the primary runway to provide greater convenience and to reduce runway crossings.

PERIMETER FENCING

Perimeter fencing is used at airports primarily to secure the aircraft operational area. The physical barrier of perimeter fencing:

- Gives notice of the legal boundary of the outermost limits of a facility or security-sensitive area;
- Assists in controlling and screening authorized entries into a secured area by deterring entry elsewhere along the boundary;
- Supports surveillance, detection, assessment, and other security functions by providing a zone for installing intrusion-detection equipment and closed-circuit television (CCTV), if necessary;
- Deters casual intruders from penetrating a secured area by presenting a barrier that requires an overt action to enter;
- Demonstrates the intent of an intruder by their overt action of gaining entry;
- Causes a delay to obtain access to a facility, thereby increasing the possibility of detection;
- Creates a psychological deterrent;
- Optimizes the use of security personnel, while enhancing the capabilities for detection and apprehension of unauthorized individuals;
- Demonstrates a corporate concern for facility security;
- Limits inadvertent access to the aircraft operations area by wildlife.

The Airport is served by eight-foot high chain link fencing with three-strand barbed wire on top. The fencing serves to provide both operational security, as well as a deterrent to wildlife accessing the airfield movement areas.

General aviation airports are not required to have full perimeter security fencing. Those airports located in more urban areas will often prioritize security fencing. Full perimeter security/wildlife fencing is installed at Hillsboro Airport and it should be maintained.

SUMMARY

This chapter has outlined the facilities required to meet potential aviation demands projected for the Airport for the next 20 years. The next chapter, Chapter Five - Alternatives, examines potential improvements to the airfield system and the landside area. Most of the discussion focuses on those capital improvements that would be eligible for federal grant funds as administered by the FAA. Other projects of local concern will be considered on a limited basis. Several facility layouts that meet the forecast demands over the next 20 years are presented, and an overall ALP that presents a long-term vision will ultimately be developed.