Chapter 3

FACILITY REQUIREMENTS

Proper airport planning requires the translation of forecast aviation demand into the specific types and quantities of facilities that can adequately serve the identified demand. This chapter will analyze the existing capacities of Merrill Municipal Airport (RRL) facilities. The existing capacities will then be compared to the forecast activity levels prepared in Chapter Two to determine the adequacy of existing facilities, as well as to identify whether deficiencies currently exist or may be expected to materialize in the future. This chapter will present the following elements:

- Planning Horizon Activity Levels
- Airfield Capacity
- Airport Physical Planning Criteria
- Airside and Landside Facility Requirements

This exercise is intended to identify the adequacy of existing airport facilities, outline what new facilities may be needed, and determine when these may be needed to accommodate forecast demands. Once the facility needs have been identified, various alternatives for providing these facilities will be detailed for both the airside and the landside. Each alternative will be evaluated to determine the most feasible, cost-effective, and efficient means for implementation.

The facility requirements for Merrill Municipal Airport were evaluated using guidance contained in several Federal Aviation Administration (FAA) publications, including the following:

- Advisory Circular (AC) 150/5300-13B, *Airport Design*
- AC 150/5060-5, *Airport Capacity and Delay*
- AC 150/5325-4B, *Runway Length Requirements for Airport Design*
- Federal Aviation Regulation (FAR) Part 77, *Objects Affecting Navigable Airspace*
- FAA Order 5090.5, *Formulation of the National Plan of Integrated Airport Systems* (*NPIAS) and the Airports Capital Improvement Plan (ACIP)*

DEMAND-BASED PLANNING HORIZONS

An updated set of aviation demand forecasts for Merrill Municipal Airport has been established and was detailed in Chapter Two. These activity forecasts include annual aircraft operations, based aircraft, aircraft fleet mix, and peaking characteristics. With this information, specific components of the airfield and landside system can be evaluated to determine their capacity to accommodate future demand.

Cost-effective, efficient, and orderly development of an airport should be based more on actual demand at an airport than on a time-based forecast figure. In order to develop a master plan that is demand-based rather than time-based, a series of planning horizon milestones has been established which takes into consideration the reasonable range of aviation demand projections. The planning horizons are the short term (years 1-5), the intermediate term (years 6-10), and the long term (years 11-20).

It is important to consider that the 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 by allowing airport management the flexibility to make decisions and develop facilities based on need generated by actual demand levels, rather than dates in time. 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. **Table 3A** presents the short-, intermediate-, and long-term planning horizon milestones for each aircraft activity level forecasted in Chapter Two.

TABLE 3A | Aviation Demand Planning Horizons

	Base Year (2023)	Short Term (1-5 Years)	Intermediate Term (6-10 Years)	Long Term (11-20 Years)
BASED AIRCRAFT				
Single-Engine	44	46	47	48
Multi-Engine	1	1	1	0
Turboprop	0	1	2	3
Jet	0	0	0	2
Helicopter	0	0	0	1
Other	0	0	0	2
TOTAL BASED AIRCRAFT	**45**	**48**	**50**	**56**
ANNUAL OPERATIONS				
Itinerant				
Air Carrier	0	0	0	0
Air Taxi	4	100	100	100
General Aviation	7,875	8,820	9,380	10,520
Total Itinerant	7,879	8,920	9,480	10,620
Local				
General Aviation	7,875	8,780	9,320	10,470
Total Local	7,875	8,780	9,320	10,470
TOTAL OPERATIONS*	**15,754**	**17,700**	**18,800**	**21,100**

*Total operations have been rounded

Source: Coffman Associates analysis

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 aircraft operations near or surpass the ASV, delay factors increase.

RRL's ASV was examined using FAA Advisory Circular (AC) 150/5060-5, *Airport Capacity and Delay*. Several factors were evaluated to calculate the airport's ASV, including:

- Runway configuration
- Runway use
- Exit taxiways
- Weather conditions
- Aircraft mix
- Percent arrivals
- Touch-and-go activity
- Peak period operations

Each factor represents an airfield or operational element that can contribute to delay. When examined together, the ASV at Merrill Municipal Airport is approximately 230,000 annual operations. This does not indicate a point of absolute gridlock, but it does represent a point at which delay for each operation increases exponentially and capacity becomes constrained.

Current operational estimates for RRL represent approximately six percent of the airfield's ASV. By the end of the long-term planning period, total annual operations are expected to represent approximately eight percent of the airfield's ASV. FAA guidance recommends that improvements for airfield capacity purposes should begin to be considered once operations reach 60 to 75 percent of the ASV. At the 80 percent level, planned improvements should be made. As existing and forecast operations remain well below these levels, no significant capacity improvements are planned; however, other options to improve airfield efficiency, such as taxiway geometry improvements, will still be considered.

AIRSIDE FACILITY REQUIREMENTS

Airside facilities include those facilities related to the arrival, departure, and ground movement of aircraft. Airside facility requirements are based primarily upon the runway design code (RDC) for each runway. Analysis in Chapter Two identified the existing RDC for Runway 7-25 as B-I-5000 and the ultimate RDC as B-II-4000. For Runway 16-34, the existing RDC is B-I-VIS, while an RDC of B-I-5000 is considered in the ultimate condition in the event that an instrument approach procedure with visibility minimums not below one-mile were to be implemented. (This will be discussed in a later section.)

RUNWAYS

Runway conditions, such as orientation, length, width, and pavement strength, were analyzed at Merrill Municipal Airport. From this information, requirements for runway improvements were determined for the airport.

Runway Orientation

Key considerations in the runway configuration of an airport involve the orientation for wind coverage and the operational capacity of the runway system. FAA AC 150/5300-13B, *Airport Design*, recommends that a crosswind runway should be made available when the primary runway orientation provides less than 95 percent crosswind component coverage for an aircraft design group. **Table 3B** details the allowable crosswind component for each RDC.

TABLE 3B | Allowable Crosswind Component by RDC

RDC	Allowable Crosswind Component
A-I and B-I (includes small aircraft)	10.5 knots
A-II and B-II	13 knots
A-III and B-III	16 knots
C-I through D-III	
A-IV and B-IV	20 knots
C-IV through C-VI	
D-IV through D-VI	
E-I through E-VI	

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

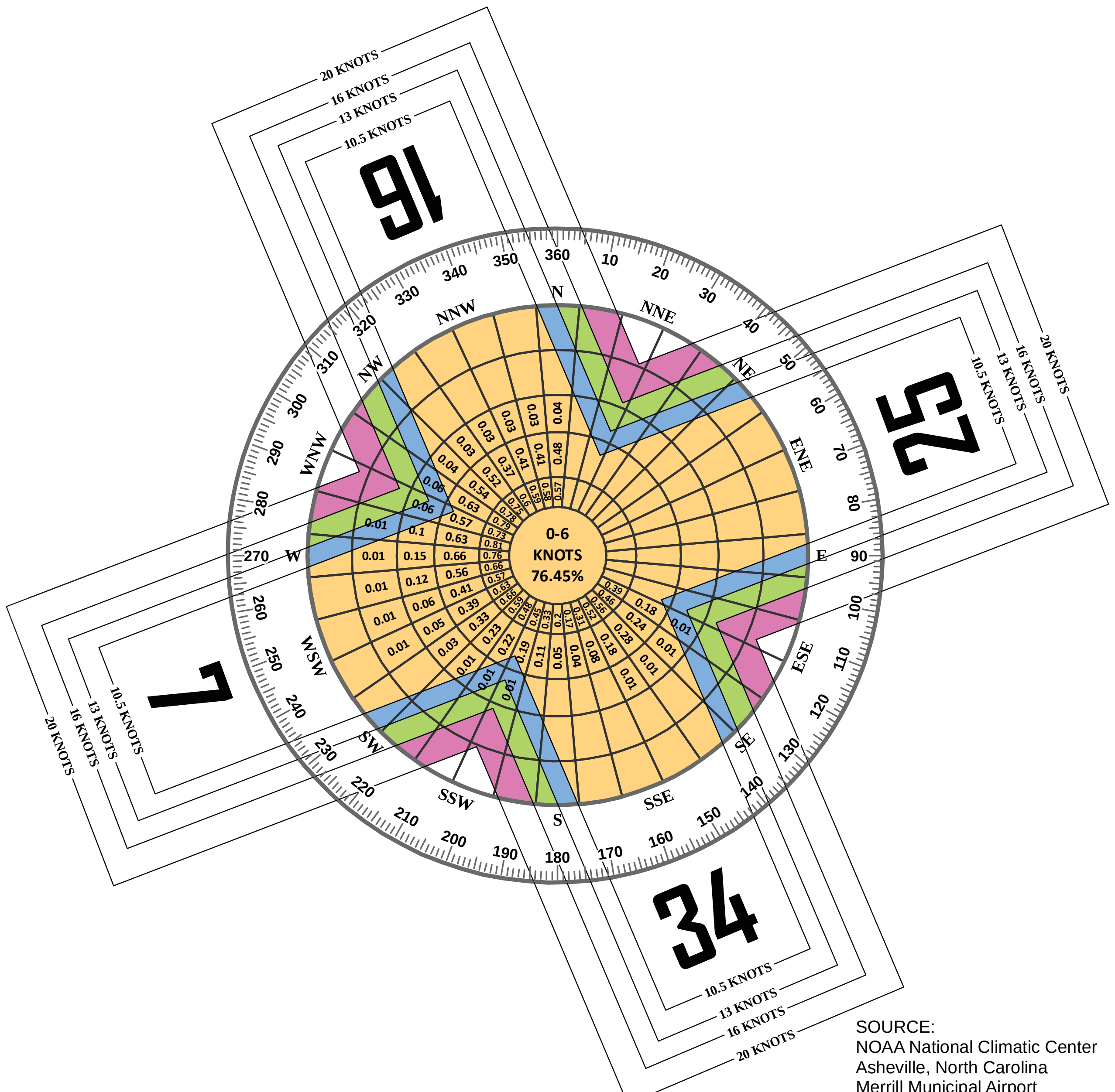
Exhibit 3A presents the generalized, FAA-accepted all-weather and instrument flight rules (IFR) wind roses for the airport. The previous 10 years of wind data[1] were obtained from the on-airport automated weather observation station (AWOS) and have been analyzed to identify wind coverage provided by the existing runway orientations. At Merrill Municipal Airport, the orientation of Runway 7-25 provides 95.80 percent coverage for the 10.5-knot component and greater than 98 percent coverage for 13-, 16-, and 20-knot components in all weather conditions. Runway 16-34 provides greater than 95 percent coverage in each crosswind component category. Combined, the runways provide 99.61 percent coverage in all-weather conditions. In IFR conditions, the individual and combined runways provide greater than 97.00 percent coverage for each crosswind component. *It should be noted that the calculations described above exclude gusting conditions, which the FAA does not consider when determining runway orientation. Gusting conditions, specifically wind gust velocities, affect what runway a pilot chooses to use; however, the FAA does not support using gusts as a means to determine crosswind runway eligibility or justification.*

Wind data for Merrill Municipal Airport have been further analyzed at the monthly and hourly levels, with nighttime data (between 10:00 p.m. and 6:00 a.m.) excluded, as the majority of operations at RRL typically occur during daytime hours. The results of this analysis are included on the back side of **Exhibit 3A**. This analysis goes beyond what is required by the FAA and demonstrates that wind patterns for a specific area can change relatively significantly throughout the year. Moreover, in many midwestern locales, winds vary during daytime and nighttime hours, with daytime hours more important as the vast majority of operations occur during those hours, and wind velocities are typically higher and gustier during daytime hours due to heat from the sun.

[1] 251,945 observations were collected for the period January 1, 2013, through December 31, 2022.

ALL WEATHER WIND COVERAGE

Runways	10.5 Knots	13 Knots	16 Knots	20 Knots
Runway 7/25	95.80%	98.00%	99.71%	99.97%
Runway 16/34	95.63%	97.72%	99.43%	99.89%
All Runways	99.61%	99.95%	99.99%	100.00%

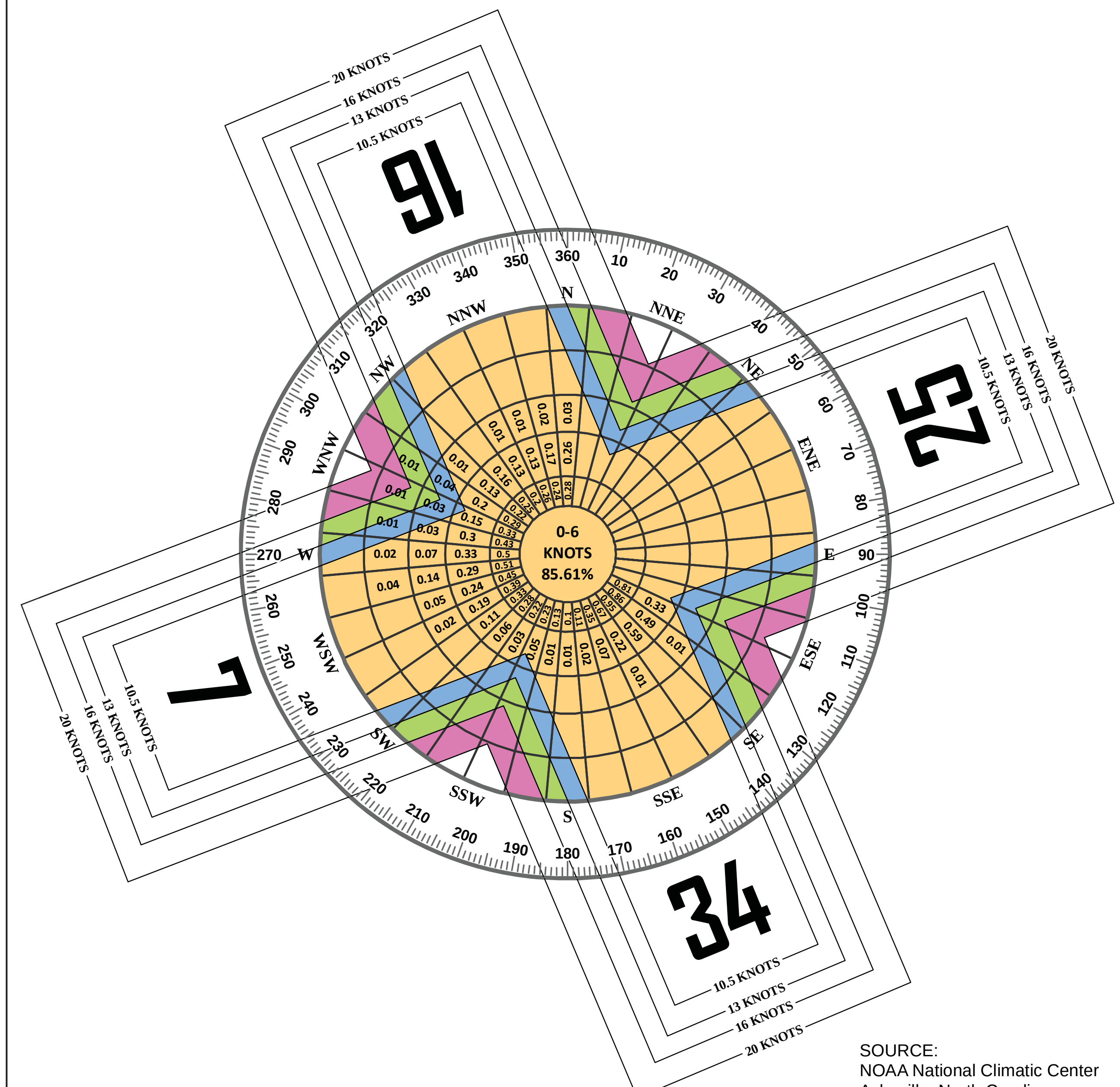


SOURCE:
NOAA National Climatic Center
Asheville, North Carolina
Merrill Municipal Airport
Merrill, Wisconsin

OBSERVATIONS:
251,945 All Weather Observations
Jan. 1, 2013 - Dec, 31 2022

IFR WIND COVERAGE

Runways	10.5 Knots	13 Knots	16 Knots	20 Knots
Runway 7/25	97.57%	98.83%	99.84%	99.98%
Runway 16/34	97.25%	98.52%	99.60%	99.89%
All Runways	99.78%	99.95%	99.99%	99.99%



SOURCE:
NOAA National Climatic Center
Asheville, North Carolina
Merrill Municipal Airport
Merrill, Wisconsin

OBSERVATIONS:
34,072 IFR Observations
Jan. 1, 2013 - Dec, 31 2022

TOTAL MONTHLY WIND ROSE									
		ALL WEATHER WIND COVERAGE				IFR WIND COVERAGE			
Month	Runways	10.5 Knots	13 Knots	16 Knots	20 Knots	10.5 Knots	13 Knots	16 Knots	20 Knots
	Runway 7-25	93.32%	96.88%	99.66%	99.97%	95.20%	97.59%	99.66%	99.96%
JANUARY	Runway 16-34	94.73%	97.44%	99.61%	99.96%	95.94%	97.95%	99.77%	99.99%
	All Runways	99.54%	99.95%	100.00%	100.00%	99.60%	99.96%	100.00%	100.00%
	Runway 7-25	92.56%	96.17%	99.34%	99.90%	94.65%	97.15%	99.25%	99.85%
FEBRUARY	Runway 16-34	92.14%	95.63%	98.79%	99.71%	90.49%	93.67%	96.61%	98.67%
	All Runways	99.35%	99.86%	99.96%	99.99%	98.83%	99.57%	99.91%	100.00%
	Runway 7-25	91.21%	95.63%	99.30%	99.91%	96.84%	98.60%	99.71%	99.92%
MARCH	Runway 16-34	93.25%	96.48%	98.85%	99.63%	94.32%	97.39%	99.49%	99.92%
	All Runways	99.91%	99.81%	99.97%	100.00%	99.60%	99.93%	99.98%	100.00%
	Runway 7-25	90.60%	95.52%	99.29%	99.85%	94.80%	97.48%	99.32%	99.77%
APRIL	Runway 16-34	90.38%	94.78%	98.51%	99.67%	90.63%	94.75%	98.70%	99.78%
	All Runways	98.95%	99.82%	99.98%	99.99%	99.11%	99.75%	99.94%	100.00%
	Runway 7-25	93.29%	96.76%	99.53%	99.94%	96.58%	98.66%	99.96%	100.00%
MAY	Runway 16-34	92.95%	96.30%	99.12%	99.83%	97.09%	98.53%	99.89%	100.00%
	All Runways	99.52%	99.96%	100.00%	100.00%	99.90%	100.00%	100.00%	100.00%
	Runway 7-25	95.35%	97.89%	99.73%	99.97%	97.98%	98.99%	99.94%	100.00%
JUNE	Runway 16-34	94.55%	97.08%	99.19%	99.86%	98.70%	99.21%	99.88%	100.00%
	All Runways	99.52%	99.93%	99.98%	100.00%	99.95%	100.00%	100.00%	100.00%
	Runway 7-25	97.53%	98.99%	99.93%	99.99%	98.88%	99.26%	99.73%	99.96%
JULY	Runway 16-34	95.57%	97.76%	99.64%	99.94%	98.86%	99.29%	99.82%	99.94%
	All Runways	99.77%	99.98%	100.00%	100.00%	99.83%	99.83%	99.92%	100.00%
	Runway 7-25	97.44%	98.86%	99.90%	99.99%	99.19%	99.54%	99.84%	99.96%
AUGUST	Runway 16-34	96.24%	98.06%	99.70%	99.95%	98.89%	99.45%	99.91%	99.93%
	All Runways	99.82%	99.99%	100.00%	100.00%	99.91%	99.97%	100.00%	100.00%
	Runway 7-25	96.33%	98.31%	99.75%	99.98%	97.56%	98.94%	99.91%	100.00%
SEPTEMBER	Runway 16-34	95.87%	98.04%	99.72%	99.97%	98.65%	99.59%	99.98%	100.00%
	All Runways	99.61%	99.94%	99.99%	100.00%	99.84%	100.00%	100.00%	100.00%
	Runway 7-25	93.72%	96.93%	99.54%	99.95%	97.04%	98.44%	99.84%	99.98%
OCTOBER	Runway 16-34	93.14%	96.57%	99.39%	99.91%	96.86%	98.29%	99.71%	99.96%
	All Runways	99.48%	99.94%	100.00%	100.00%	99.93%	100.00%	100.00%	100.00%
	Runway 7-25	92.18%	96.09%	99.32%	99.92%	93.03%	96.66%	99.88%	100.00%
NOVEMBER	Runway 16-34	93.48%	96.76%	99.24%	99.81%	96.58%	98.33%	99.78%	99.97%
	All Runways	99.25%	99.99%	100.00%	100.00%	99.82%	99.99%	100.00%	100.00%
	Runway 7-25	95.84%	98.31%	99.83%	99.98%	97.00%	98.59%	99.88%	99.98%
DECEMBER	Runway 16-34	92.52%	95.78%	98.41%	99.51%	95.69%	97.55%	99.21%	99.72%
	All Runways	99.50%	99.94%	99.99%	100.00%	99.88%	100.00%	100.00%	100.00%

DAYTIME MONTHLY WIND ROSE									
		ALL WEATHER WIND COVERAGE				IFR WIND COVERAGE			
Month	Runways	10.5 Knots	13 Knots	16 Knots	20 Knots	10.5 Knots	13 Knots	16 Knots	20 Knots
	Runway 7-25	93.13%	96.77%	99.65%	99.96%	96.32%	98.12%	99.72%	99.97%
JANUARY	Runway 16-34	94.17%	97.18%	99.58%	99.94%	96.33%	98.06%	99.63%	99.93%
	All Runways	99.49%	99.94%	100.00%	100.00%	99.69%	99.94%	99.99%	100.00%
	Runway 7-25	91.92%	95.79%	99.23%	99.88%	95.97%	97.92%	99.56%	99.92%
FEBRUARY	Runway 16-34	90.98%	94.88%	98.51%	99.63%	94.86%	96.83%	98.71%	99.53%
	All Runways	99.26%	99.83%	99.95%	99.99%	99.33%	99.73%	99.92%	99.99%
	Runway 7-25	90.37%	95.21%	99.22%	99.90%	96.75%	98.39%	99.73%	99.94%
MARCH	Runway 16-34	92.11%	95.91%	98.77%	99.68%	96.28%	98.09%	99.65%	99.93%
	All Runways	99.01%	99.80%	99.97%	100.00%	99.75%	99.96%	99.99%	100.00%
	Runway 7-25	88.61%	94.59%	99.13%	99.84%	96.41%	98.28%	99.70%	99.94%
APRIL	Runway 16-34	88.97%	94.03%	98.21%	99.61%	95.40%	97.53%	99.42%	99.87%
	All Runways	98.69%	99.78%	99.99%	100.00%	99.63%	99.93%	99.99%	100.00%
	Runway 7-25	91.87%	96.05%	99.41%	99.92%	96.80%	98.49%	99.81%	99.96%
MAY	Runway 16-34	91.59%	95.58%	98.92%	99.80%	96.74%	98.23%	99.66%	99.93%
	All Runways	99.44%	99.95%	100.00%	100.00%	99.80%	99.96%	99.99%	100.00%
	Runway 7-25	94.37%	97.45%	99.69%	99.96%	97.00%	98.49%	99.79%	99.96%
JUNE	Runway 16-34	93.28%	96.40%	99.00%	99.82%	96.86%	98.27%	99.65%	99.92%
	All Runways	99.42%	99.91%	99.98%	100.00%	99.80%	99.95%	99.99%	100.00%
	Runway 7-25	97.09%	98.81%	99.93%	100.00%	97.00%	98.48%	99.75%	99.95%
JULY	Runway 16-34	94.67%	97.30%	99.55%	99.93%	96.83%	98.25%	99.62%	99.91%
	All Runways	99.75%	99.98%	100.00%	100.00%	99.77%	99.92%	99.98%	100.00%
	Runway 7-25	97.01%	98.66%	99.87%	99.99%	97.24%	98.61%	99.76%	99.95%
AUGUST	Runway 16-34	95.67%	97.74%	99.64%	99.94%	96.99%	98.35%	99.66%	99.91%
	All Runways	99.80%	99.99%	100.00%	100.00%	99.81%	99.96%	99.99%	100.00%
	Runway 7-25	95.55%	97.97%	99.69%	99.97%	96.88%	98.50%	99.79%	99.96%
SEPTEMBER	Runway 16-34	95.05%	97.68%	99.68%	99.97%	96.87%	98.37%	99.67%	99.93%
	All Runways	99.50%	99.93%	99.99%	100.00%	99.77%	99.95%	99.99%	100.00%
	Runway 7-25	93.08%	96.70%	99.51%	99.94%	96.80%	98.38%	99.77%	99.96%
OCTOBER	Runway 16-34	91.81%	95.85%	99.23%	99.88%	96.35%	97.97%	99.58%	99.92%
	All Runways	99.37%	99.92%	99.99%	100.00%	99.81%	99.96%	99.99%	100.00%
	Runway 7-25	91.38%	95.65%	99.22%	99.89%	96.06%	98.11%	99.80%	99.97%
NOVEMBER	Runway 16-34	93.09%	96.59%	99.18%	99.78%	96.57%	98.20%	99.63%	99.92%
	All Runways	99.25%	99.90%	100.00%	100.00%	99.77%	99.95%	99.99%	100.00%
	Runway 7-25	95.67%	98.28%	99.84%	99.99%	96.78%	98.44%	99.84%	99.97%
DECEMBER	Runway 16-34	92.44%	95.75%	98.48%	99.57%	96.43%	98.00%	99.53%	99.85%
	All Runways	99.49%	99.94%	100.00%	100.00%	99.82%	99.96%	99.99%	100.00%

Note: Months in red indicate less than 95% coverage on the primary runway in 10.5-knot crosswind components.

When first considering total monthly wind data (daytime and nighttime) for all weather conditions (VFR and IFR combined), the data indicate that primary Runway 7-25 offers less than 95 percent wind coverage for 10.5-knot crosswind components seven months out of the year. When the analysis is further narrowed to include only daytime operations, Runway 7-25 has less than 95 percent wind coverage for eight months out of the year for the 10.5-knot component. It should be noted that, for the 13-knot crosswind component which includes aircraft categorized as B-II, Runway 7-25 meets the 95 percent minimum for all 12 months under the monthly analysis and for 11 months under the daytime-only analysis.

Evaluations of wind data were also conducted by the airport's engineer in 2022. This evaluation considered 11 years of wind data sourced from RRL's AWOS and was based on a methodology that included operational weighting and the FAA's IFP, Operations, Airspace Analytics (IOAA) tool. Using this data, the busiest times of airport usage were determined. Wind measurements recorded during the busiest hours were then given more consideration than those that occurred during times of little use. The result shows wind coverage at 94.8 percent on primary Runway 7-25 for a 10.5-knot max crosswind component. This analysis was submitted to the FAA for consideration in November 2022. The FAA ultimately determined that the weighted-hourly operations analysis was correctly calculated and indicated that primary Runway 7-25 provides less than 95 percent wind coverage for A-I/B-I aircraft; therefore, crosswind Runway 16-34 is an eligible crosswind runway. **Appendix B** includes the FAA memorandum outlining Runway 16-34's crosswind eligibility.

Summary

Runway 7-25 is currently classified as a B-I runway with a forecasted potential to become a B-II runway when operations dictate (i.e., when at least 500 annual operations by aircraft within the B-II family are documented). As detailed in **Table 3B**, the allowable crosswind component for a B-I runway is 10.5 knots. The monthly analysis described above suggests that Runway 7-25 is not a viable option for most pilots operating at RRL for seven months out of the year, and for eight months out of the year when the daytime-only analysis is considered. Other analysis included weighting operations based on when they occurred, which resulted in wind coverage of 94.8 percent on the primary runway. The FAA concurred with this analysis and conclusion in a December 2023 memorandum (**Appendix B**). As such, it is prudent to continue to maintain the current crosswind runway orientation designed to meet A/B-I aircraft operations at Merrill Municipal Airport.

Runway Designations

A runway's designation is based on its magnetic headings, which are determined by the magnetic declination for the area. The magnetic declination near Merrill Municipal Airport is 2° 56′ W ± 0° 2′ W per year. The runway has a true heading of 076°/256°. Adjusting for the magnetic declination, the current magnetic heading of Runway 7-25 is 072°/252° and the heading of Runway 16-34 is 160°/340°. As such, no change to either runway designation is necessary.

Runway Length | AC 150/5325-4B, *Runway Length Requirements for Airport Design*, provides guidance for determining runway length needs. The determination of runway length requirements for the airport 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)

The mean maximum daily temperature of the hottest month for Merrill Municipal Airport is 80.2 degrees Fahrenheit (F), which occurs in July. The airport elevation is 1,318.2 feet mean sea level (MSL). Runway 7-25 has a longitudinal gradient of 0.24 percent, while Runway 16-34 has a gradient of 0.48 percent. Both of these conform to FAA design standards for gradient.

Airplanes operate on a wide variety of available runway lengths. Many factors govern the sustainability of runway lengths for aircraft, such as elevation, temperature, wind, aircraft weight, wing flap settings, runway condition (wet or dry), runway gradient, vicinity airspace obstructions, and any special operating procedures. Airport operators can pursue policies that maximize the sustainability of the runway length. Policies such as area zoning and height and hazard restricting can protect an airport's runway length. Airport ownership (fee simple easement) of land leading to the runway ends reduces the possibility of natural growth or human-made obstructions. Planning for runways should include an evaluation of aircraft types expected to use the airport now and in the future. Future planning should be realistic, supported by the FAA-approved forecasts, and based on the critical aircraft (or family of aircraft).

General Aviation Aircraft

Most operations occurring at Merrill Municipal Airport are conducted using smaller GA aircraft weighing less than 12,500 pounds. Following guidance from AC 150/ 5325-4B, to accommodate 95 percent of these small aircraft with fewer than 10 passenger seats, a runway length of 3,400 feet is recommended. For 100 percent of these small aircraft, a runway length of 4,000 feet is recommended. For small aircraft with 10 or more passenger seats, 4,300 feet of runway length is recommended.

The airport is also utilized by aircraft weighing more than 12,500 pounds, including small- to medium-sized business jet aircraft. Runway length requirements for business jets weighing less than 60,000 pounds have also been calculated. These calculations take into consideration the runway gradient and landing length requirements for contaminated (wet) runways. Business jets tend to need greater runway length when landing on wet surfaces because of their increased approach speeds. AC 150/5325-4B stipulates that runway length determination for business jets considers a grouping of airplanes with similar operating characteristics. The AC provides two separate family groupings of airplanes, each of which is based on its representative percentage of aircraft in the national fleet. The first grouping is those business jets that make up 75 percent of the national fleet, and the second group is those making up 100 percent of the national fleet. **Table 3C** presents a partial list of common aircraft in each aircraft grouping. A third group considers business jets weighing more than 60,000 pounds. Runway length determination for these aircraft must be based on the performance characteristics of the individual aircraft.

TABLE 3C | Business Jet Categories for Runway Length Determination

Aircraft	MTOW (lbs.)
75 Percent of the National Fleet	
Lear 35	20,350
Lear 45	20,500
Cessna 550	14,100
Cessna 560XL	20,000
Cessna 650 (VII)	22,000
IAI Westwind	23,500
Beechjet 400	15,800
Falcon 50	18,500
75-100 Percent of the National Fleet	
Lear 55	21,500
Lear 60	23,500
Hawker 800XP	28,000
Hawker 1000	31,000
Cessna 650 (III/IV)	22,000
Cessna 750 (X)	36,100
Challenger 604	47,600
IAI Astra	23,500
Greater than 60,000 Pounds	
Gulfstream II	65,500
Gulfstream IV	73,200
Gulfstream V	90,500
Global Express	98,000
Gulfstream 650	99,600

MTOW = maximum takeoff weight

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

Table 3D presents the results of the runway length analysis for business jets that was developed following the guidance provided in AC 150/5325-4B. To accommodate 75 percent of the business jet fleet at 60 percent useful load, a runway length of 5,500 feet is recommended. This length is derived from a raw length of 4,766 feet which is adjusted, as recommended, for runway gradient and consideration of landing length needs on a contaminated (wet and slippery) runway. To accommodate 100 percent of the business jet fleet at 60 percent useful load, 5,500 feet is also the recommended runway length.

TABLE 3D | Runway Length Requirements

Fleet Mix Category	TAKEOFF LENGTHS		LANDING LENGTHS	Final Runway Length
	Raw Runway Length from FAA AC	Runway Length with Gradient Adjustment (+360')	Wet Surface Landing Length for Jets (+15%)*	
75% of Fleet at 60% Useful Load	4,766	4,768	5,480	5,500
100% of Fleet at 60% Useful Load	5,451	5,453	5,500	5,500
75% of Fleet at 90% Useful Load	6,083	6,085	6,995	7,000
100% of Fleet at 90% Useful Load	7,995	7,997	7,000	8,000

*Max. 5,500' for 60% useful load and max. 7,000' for 90% useful load in wet condition

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

Utilization of the 90 percent category for runway length determination is generally not considered by the FAA unless there is a demonstrated need at an airport, such as documented activity by a business jet operator that flies out frequently with heavy loads. To accommodate 75 percent of the business jet fleet at 90 percent useful load, a runway length of 7,000 feet is recommended. To accommodate 100 percent of business jets at 90 percent useful load, a runway length of 8,000 feet is recommended.

Another method to determine runway length requirements for aircraft at Merrill Municipal Airport is to examine aircraft flight planning manuals under conditions specific to the airport. Several aircraft were analyzed for takeoff length requirements at a design temperature of 80.2 degrees F and a field elevation of 1,318.2 feet MSL with a 0.24 percent runway grade. **Table 3E** provides a detailed runway length analysis for some of the most common turbine aircraft in the national fleet. This data was obtained from Ultranav software, which computes operational parameters for specific aircraft based on flight manual data. The analysis includes the maximum takeoff weight (MTOW) allowable and the percent useful load from 60 percent to 100 percent.

TABLE 3E | Business Aircraft Takeoff Length Requirements – Runway 7-25

		TAKEOFF LENGTH REQUIREMENTS (feet)				
		Useful Load				
Aircraft Name	MTOW	60%	70%	80%	90%	100%
Pilatus PC-12	9,921	2,085	2,254	2,431	2,617	2,811
King Air C90B	10,100	2,573	2,765	2,966	3,176	3,396
King Air C90GTi	10,100	2,638	2,828	3,034	3,239	3,445
Citation Mustang	8,645	2,766	2,976	3,226	3,563	3,929
King Air 350	15,000	3,360	3,499	3,641	3,883	4,204
Citation II (550)	13,300	2,913	3,205	3,517	3,851	4,207
Citation CJ3	13,870	3,561	3,780	4,006	4,270	4,588
Citation 560 XLS	20,200	3,694	3,989	4,279	4,639	5,053
Beechjet 400A	16,300	3,907	4,202	4,512	4,835	5,184
Lear 40	21,000	4,070	4,382	4,712	5,104	5,604
Hawker 4000	39,500	4,159	4,511	4,888	5,281	5,736
Falcon 50 EX	41,000	4,201	4,638	5,102	5,595	6,052
Challenger 300	38,850	4,330	4,738	5,162	5,598	6,057
Hawker 800/850 XP	28,000	4,238	4,677	5,086	5,582	6,083
Gulfstream 280	39,600	4,171	4,590	5,062	5,590	6,154
Citation III	21,500	4,405	4,807	5,245	5,718	6,226
Citation X	35,700	4,370	4,874	5,341	5,821	6,308
Gulfstream 450	74,600	4,370	4,800	5,273	5,786	6,355
Global 5000	92,500	4,394	4,884	8,397	5,935	6,495
Falcon 900EX	49,200	4,150	4,670	5,260	5,910	6,500
Falcon 7X	70,000	4,335	4,823	5,347	5,904	6,552
Falcon 2000	35,800	4,661	5,083	5,593	6,083	6,814
Challenger 604/605	48,200	4,788	5,284	5,840	6,433	7,036
Gulfstream 650	99,600	4,785	5,281	5,807	6,433	7,119
Lear 60	23,500	4,922	5,405	5,986	6,530	7,125
Global Express	98,000	4,797	5,371	5,975	6,609	7,271
Westwind II	23,500	4,881	5,386	5,912	6,455	Climb Limited

Note: Green cell values are less than or equal to the length of the primary runway at Merrill Municipal Airport; orange cell values are greater than the length of the primary runway at Merrill Municipal Airport.
MTOW = maximum takeoff weight
Climb Limited = input data is outside the operating limits of the aircraft planning manual

Source: Ultranav software

All of the aircraft analyzed are capable of departing at MTOW on the existing runway length during hot weather with useful loads up to 60 percent, and the majority can operate with loads up to 70 percent. Beyond that, the fleet mix analyzed becomes more weight-restricted or, in some cases, unable to take off at loads exceeding 80 percent.

Table 3F presents the runway length required for landing under three operational categories: Title 14 Code of Federal Regulations (CFR) Part 25, CFR Part 135, and CFR Part 91k. CFR Part 25 operations are those conducted by individuals or companies that own their aircraft. CFR Part 135 applies to all for-hire charter operations, including most fractional ownership operations. CFR Part 91k includes operations in fractional ownership that utilize their own aircraft under direction of pilots specifically assigned to said aircraft. Part 91k and Part 135 rules regarding landing operations require operators to land at the destination airport within 60 percent of the effective runway length. An additional rule allows for operators to land within 80 percent of the effective runway length if the operator has an approved destination airport analysis in the airport's program operating manual. The landing length analysis accounts for both scenarios.

TABLE 3F | Business Aircraft Landing Length Requirements – Runway 7-25

		LANDING LENGTH REQUIREMENTS (feet)					
		Dry Runway Condition			Wet Runway Condition		
Aircraft Name	MLW	Part 25	80% Rule	60% Rule	Part 25	80% Rule	60% Rule
Westwind II	19,000	2,470	3,088	4,117	2,840	3,550	4,733
Global 5000	78,600	2,733	3,416	4,555	3,143	3,929	5,238
Global Express	78,600	2,733	3,416	4,555	3,143	3,929	5,238
King Air 350	15,000	2,873	3,591	4,788	3,304	4,130	5,507
Falcon 7X	62,400	3,005	3,756	5,008	3,455	4,319	5,758
Falcon 50 EX	35,715	3,007	3,759	5,012	3,458	4,323	5,763
Gulfstream 280	32,700	3,015	3,769	5,025	3,467	4,334	5,778
Citation Mustang	8,000	2,557	3,196	4,262	3,585	4,481	5,975
Lear 40	19,200	2,876	3,595	4,793	3,643	4,554	6,072
Falcon 2000	33,000	3,210	4,013	5,350	3,691	4,614	6,152
Hawker 4000	33,500	3,271	4,089	5,452	3,762	4,703	6,270
Hawker 800/850 XP	23,350	2,730	3,413	4,550	4,093	5,116	6,822
Citation CJ3	12,750	3,084	3,855	5,140	4,200	5,250	7,000
Falcon 900EX	44,500	3,769	4,711	6,282	4,335	5,419	7,225
Challenger 604/605	38,000	2,877	3,596	4,795	4,396	5,495	7,327
Lear 60	19,500	3,660	4,575	6,100	4,887	6,109	8,145
Challenger 300	33,750	2,669	3,336	4,448	5,116	6,395	8,527
Gulfstream 650	83,500	3,895	4,869	6,492	5,118	6,398	8,530
Citation 560 XLS	18,700	3,492	4,365	5,820	5,499	6,874	9,165
Citation X	31,800	3,889	4,861	6,482	5,549	6,936	9,248
Beechjet 400A	15,700	3,762	4,703	6,270	5,592	6,990	9,320
Gulfstream 450	66,000	3,349	4,186	5,582	5,716	7,145	9,527
Citation II (550)	12,700	2,475	3,094	4,125	5,982	7,478	9,970
Citation III	19,000	4,173	5,216	6,955	6,050	7,563	10,083
King Air C90GTi	9,600	1,405	1,756	2,342	N/A	N/A	N/A
King Air C90B	9,600	1,370	1,713	2,283	N/A	N/A	N/A
Pilatus PC-12	9,921	2,336	2,920	3,893	N/A	N/A	N/A

Note: Green cell values are less than or equal to the length of the primary runway at Merrill Municipal Airport; orange cell values are greater than the length of the primary runway at Merrill Municipal Airport.
MLW = maximum landing weight
N/A = not applicable; some turboprop aircraft landing lengths are not adjusted for wet runway conditions
Source: Ultranav software

The landing length analysis shows that all Part 25 and most Part 91k operations (with the Citation III as the exception) can land on the available runway length at Merrill Municipal Airport during dry runway conditions, as well as about half of the aircraft analyzed if operating under Part 135. During wet (or contaminated) runway conditions, a majority of the aircraft analyzed and operating under Part 25 can land, but fewer aircraft are able to operate under Part 91k. Only one of the aircraft evaluated – the Westwind II – meets the landing length requirements under Part 135.

Runway Length Summary

Many factors are considered when determining appropriate runway length for safe and efficient operations of aircraft at Merrill Municipal Airport. The airport should strive to accommodate smaller business jets and turboprop aircraft to the greatest extent possible, as demand dictates. Primary Runway 7-25 is currently 5,100 feet long and, as detailed in the tables above, can accommodate many of the more common business jets operating at Merrill Municipal Airport under moderate loading conditions.

Justification for any runway extension to meet the needs of turbine aircraft would require regular use (500 annual itinerant operations) by these aircraft, which is the minimum threshold required to obtain FAA grant funding assistance. While the primary runway at RRL currently exceeds the recommended length for all small aircraft, the runway length recommendation per FAA AC 150/5325-4B is 5,500 feet to accommodate at least 75 percent of the business jet fleet at 60 percent useful load. Moreover, roughly half of the turbine aircraft currently using and anticipated to use the runway at Merrill Municipal Airport are unable to operate when taking on useful loads of 80 percent and greater, according to Ultranav calculations. As such, runway extension options should be considered.

Consideration should also be given to the potential for extending Runway 16-34, which is currently 2,997 feet long. As detailed previously, guidance from AC 150/ 5325-4B recommends a length of 3,400 feet to accommodate 95 percent of small aircraft with fewer than 10 passenger seats. A runway length justification report previously completed for the crosswind runway also determined that a length of 3,400 feet would be justified. This report, which is included as **Appendix C**, was prepared in 2018 by the airport's engineer and a representative from the Wisconsin Department of Transportation (WisDOT) Bureau of Aeronautics (BOA). As such, the alternatives in the next chapter will examine potential extensions up to 5,500 feet for Runway 7-25, and up to 3,400 feet for Runway 16-34 while considering appropriate safety design standards (these standards will be detailed later in this chapter).

Runway Width | Runway width design standards are primarily based on the critical aircraft but can also be influenced by the visibility minimums of published instrument approach procedures. For primary Runway 7-25, existing RDC B-I-5000 design criteria stipulate a runway width of 60 feet, while ultimate RDC B-II-4000 standards call for a width of 75 feet. Runway 7-25 is currently 75 feet wide, which should be maintained throughout the planning period.

For crosswind Runway 16-34, the RDC is B-I-VIS in the existing condition with the potential to convert to B-I-5000 if an instrument approach procedure with minimums not lower than one mile were to be implemented. The runway width standard for both scenarios is 60 feet. Crosswind Runway 16-34 is currently 75 feet wide. While the additional width provides added safety enhancements for aircraft that operate at the airport, it is likely that the FAA will only participate in maintaining the recommended width of 60 feet for Runway 16-34, should this runway continue to be eligible for grant funding assistance. If so, it should be noted that future maintenance/rehabilitation projects should account for the potential that the airport sponsor may be responsible for maintaining the additional width beyond the standard on the runway in the event it wants to maintain 75 feet.

Pavement Strength | An important feature of airfield pavement is its ability to withstand repeated use by aircraft of varying weights. The FAA reports the pavement strength for primary Runway 7-25 as 45,000 pounds for single wheel aircraft (S), 65,000 pounds for dual wheel aircraft (D), and 100,000 pounds for dual tandem wheel aircraft (2D). Crosswind Runway 16-34 is reported to have a weight-bearing capacity of 26,000 S.

The strength rating of a runway does not preclude aircraft weighing more than the published strength rating from using the runway. All federally obligated airports must remain open to the public, and it is typically up to the pilot of the aircraft to determine if a runway can safely support their aircraft. An airport sponsor cannot restrict an aircraft from using the runway simply because its weight exceeds the published strength rating. On the other hand, the airport sponsor has an obligation to properly maintain and protect the useful life of the runway, typically for 20 years.

The strength rating of a runway can change over time. Regular usage by heavier aircraft can decrease the strength rating, while periodic runway resurfacing can increase the strength rating. The current runway strength rating on each runway is adequate to accommodate the aircraft that currently and are anticipated to operate at the airport. The ultimate critical aircraft, represented by the King Air 350, can weigh 15,000 pounds on dual-wheel main landing gear; therefore, the existing pavement strength rating for each runway is sufficient throughout the planning period.

Runway Line-of-Sight and Gradient | The FAA has instituted various line-of-sight requirements to facilitate coordination among aircraft and between aircraft and vehicles that are operating on active runways. This allows departing and arriving aircraft to verify the location and actions of other aircraft and vehicles on the ground that could create a conflict.

Line-of-sight standards for an individual runway are based on whether there is a parallel taxiway available. When a partial-parallel taxiway is available, then any point five feet above the runway centerline must be mutually visible with any other point five feet above the runway centerline. Both runways meet the line-of-sight standard.

The surface gradient of a runway affects aircraft performance and pilot perception. The surface gradient is the maximum allowable slope for a runway. For runways designated for approach categories A and B, the maximum longitudinal grade is 2.0 percent. Runway 7-25 has a longitudinal grade of 0.24 percent, while Runway 16-34 has a longitudinal grade of 0.48 percent. Both runways meets the gradient standard.

SAFETY AREA DESIGN STANDARDS

The FAA has established several imaginary surfaces to protect aircraft operational areas and keep them free from obstructions. These include the runway safety area (RSA), runway object free area (ROFA), runway obstacle free zone (ROFZ), and runway protection zone (RPZ).

The entire RSA, ROFA, and ROFZ must 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. RPZs should also be under airport ownership. 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. The various airport safety areas and their dimensions, as sourced from FAA AC 150/5300-13B, *Airport Design*, are presented graphically on **Exhibit 3B**.

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

The FAA places high significance on maintaining adequate RSA at all airports. Under Order 5200.8, effective October 1, 1999, the FAA established the *Runway Safety Area Program.* The Order states, "The objective of the Runway Safety Area Program is that all RSAs at federally obligated airports…shall conform to the standards contained in AC 150/5300-13, *Airport Design*, to the extent practicable." Each Regional Airports Division of the FAA is obligated to collect and maintain data on the RSA for all runways and perform airport inspections.

As shown on **Exhibit 3B**, for existing RDC B-I-5000 design standards on primary Runway 7-25, the FAA calls for the RSA to be 120 feet wide and extend 240 feet beyond the runway ends. In the ultimate RDC B-II-4000 environment, the dimensions of the Runway 7-25 RSA increase to 150 feet wide and extending 300 feet beyond the end of the runway. For crosswind Runway 16-34 in both the existing and ultimate runway environment, the RSA dimensions are 120 wide and extending 240 feet beyond the runway ends. For both runways, at the dimensions detailed above, the RSA is fully contained within airport property and free of obstructions.

Runway Object Free Area | The ROFA is "a clear area limited to equipment necessary for air and ground navigation and provides wingtip protection in the event of an aircraft excursion from the runway." It is a two-dimensional ground area surrounding runways, taxiways, and taxilanes which is clear of objects, except for objects with locations 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 with the critical aircraft utilizing the runway.

	EXISTING RUNWAY DATA	
	7 - 25	16 - 34
Runway Design Code (RDC)	B-I-5000	B-I-VIS
Runway Safety Area (RSA)	120' wide x 240' beyond runway end	120' wide x 240' beyond runway end
Runway Object Free Area (ROFA)	400' wide x 240' beyond runway end	400' wide x 240' beyond runway end
Runway Obstable Free Zone (ROFZ)	400' wide x 200' beyond runway end	250' wide x 200' beyond runway end
Runway Protection Zones		
Approach (inner width x outer width x length)	1,000' x 500' x 700'	1,000' x 500' x 700'
Departure (inner width x outer width x length)	1,000' x 500' x 700'	1,000' x 500' x 700

	ULTIMATE RUNWAY DATA	
	7 - 25	16 - 34
Runway Design Code (RDC)	B-II-4000	B-I-5000
Runway Safety Area (RSA)	150' wide x 300' beyond runway end	Same as Existing
Runway Object Free Area (ROFA)	500' wide x 300' beyond runway end	Same as Existing
Runway Obstable Free Zone (ROFZ)	Same as Existing	Same as Existing
Runway Protection Zones		
Approach (inner width x outer width x length)	1,700'x 1,000' x 1,510'	Same as Existing
Departure (inner width x outer width x length)	Same as Existing	Same as Existing

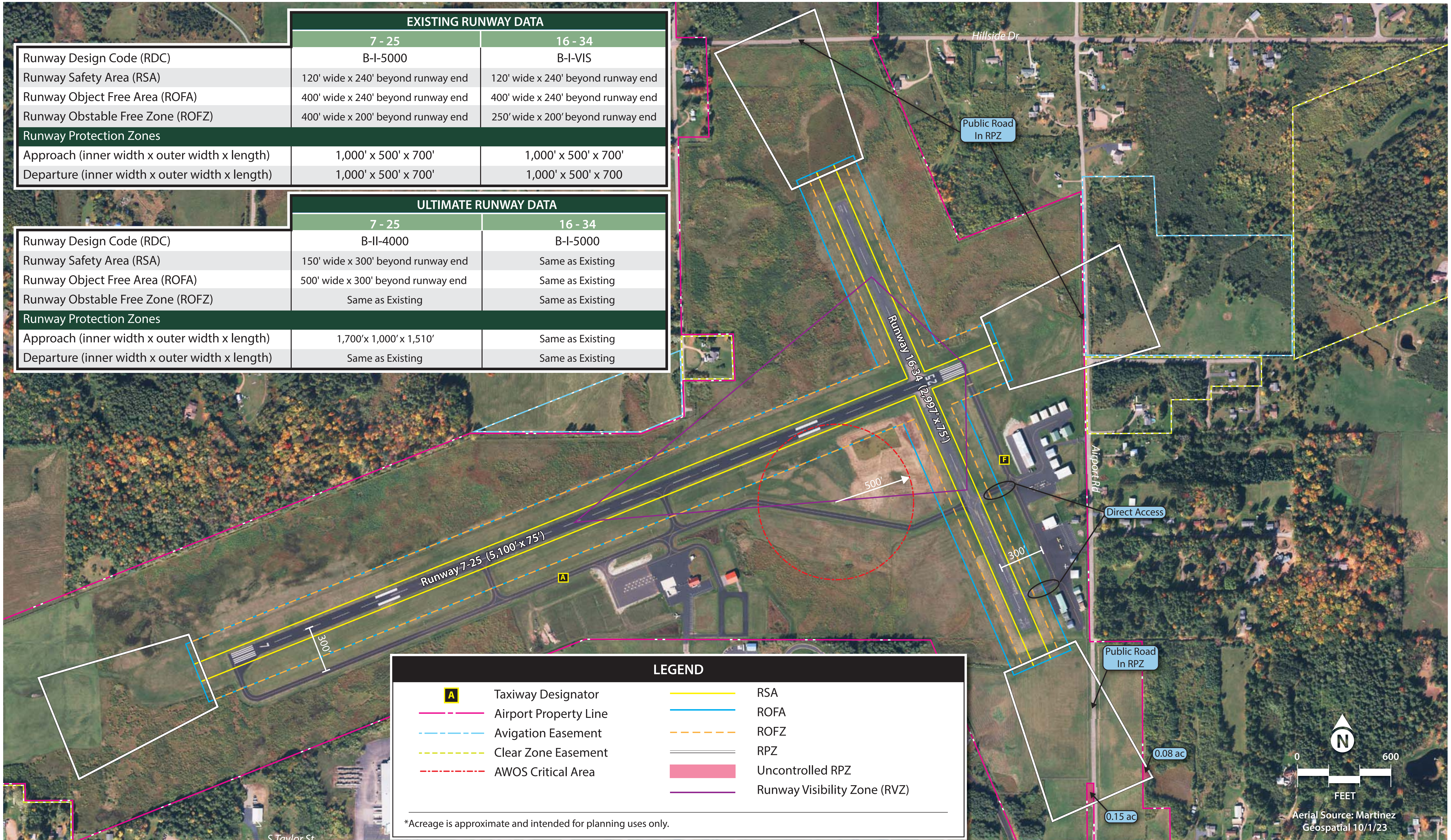


Exhibit 3B
RUNWAY SAFETY AREAS

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The ROFA design standards associated with primary Runway 7-25 for existing RDC B-I-5000 are set at 400 feet wide and extending 240 feet beyond the runway end. These dimensions increase to 500 feet wide and extending 300 feet beyond the end of the runway in the ultimate B-II-4000 environment. For crosswind Runway 16-34, the ROFA dimensions are 400 feet wide and extending 240 feet beyond the end of the runway for both the existing and ultimate conditions. The ROFAs associated with each runway in both the existing and ultimate scenarios are fully contained on airport property. In the existing condition, the ROFAs are free of obstructions; however, in the ultimate condition, the supplemental wind cone near Runway 7 would become an obstruction. The alternatives will consider relocation of the supplemental wind cone outside of this safety area.

Obstacle Free Zone | The ROFZ is an imaginary surface that 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 locations by function, such as airfield signs. The ROFZ is established to ensure the safety of aircraft operations. If the ROFZ is obstructed, the airport's approaches could be removed or approach minimums could be increased.

For all runways serving aircraft over 12,500 pounds, the ROFZ is 400 feet wide, centered on the runway, and extends 200 feet beyond the runway ends. This standard applies to primary Runway 7-25 at Merrill Municipal Airport. For runways serving small aircraft under 12,500 pounds but with approach speeds greater than or equal to 50 knots, the ROFZ is 250 feet wide, centered on the runway, and extends 200 feet beyond the runway ends. This standard applies to crosswind Runway 16-34. Under the current evaluation with available data, there are no ROFZ obstructions at the airport.

Runway Protection Zone | An RPZ is a trapezoidal area centered on the extended runway centerline beginning 200 feet from the end of the runway. This safety area is established to protect the end of the runway from airspace penetrations and incompatible land uses. The RPZ dimensions are based on the established RDC and the approach visibility minimums serving 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 AC 150/5300-13B, 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;
- Unstaffed navigational aids (NAVAIDs) and facilities, such as those required for airport facilities that are fixed by function in regard to the RPZ; and
- Aboveground fuel tanks associated with backup generators for unstaffed NAVAIDS.

In September 2022, the FAA published AC 150/5190-4B, *Airport Land Use Compatibility Planning*, which states that airport owner control over RPZs is preferred. Airport owner control over RPZs may be achieved through:

- Ownership of the RPZ property in fee simple;
- Possessing sufficient interest in the RPZ property through easements, deed restrictions, etc.;
- Possessing sufficient land use control authority to regulate land use in the jurisdiction containing the RPZ;
- Possessing and exercising the power of eminent domain over the property; or
- Possessing and exercising permitting authority over proponents of development within the RPZ (e.g., where the sponsor is a state).

AC 150/5190-4B further states that "control is preferably exercised through acquisition of sufficient property interest and includes clearing RPZ areas (and keeping them clear) of objects and activities that would impact the safety of people and property on the ground." The FAA recognizes that land ownership, environmental, geographical, and other considerations can complicate land use compatibility within RPZs; regardless, airport sponsors must comply with FAA grant assurances, including but not limited to Grant Assurance 21, *Compatible Land Use*. Sponsors are expected to take appropriate measures to "protect against, remove, or mitigate land uses that introduce incompatible development within RPZs." For proposed projects that would shift an RPZ into an area with existing incompatible land uses, such as a runway extension or construction of a new runway, the sponsor is expected to have or secure sufficient control of the RPZ, ideally through fee simple ownership. Where existing incompatible land uses are present, the FAA expects sponsors to "seek all possible opportunities to eliminate, reduce, or mitigate existing incompatible land uses" through acquisition, land exchanges, right-of-first-refusal to purchase, agreement with property owners on land uses, easements, or other such measures. These efforts should be revisited during master plan or ALP updates, and periodically thereafter, and documented to demonstrate compliance with FAA grant assurances. If new or proposed incompatible land uses impact an RPZ, the FAA expects the airport to take the above actions to control the property within the RPZ, along with adopting a strong public stance opposing the incompatible land uses.

For new incompatible land uses that result from a sponsor-proposed action (i.e., an airfield project such as a runway extension, a change in the critical aircraft that increases the RPZ dimension, or lower minimums that increase the RPZ dimension), the airport sponsor is expected to conduct an Alternatives Evaluation. The intent of the Alternatives Evaluation is to "proactively identify a full range of alternatives and prepare a sufficient evaluation to be able to draw a conclusion about what is 'appropriate and reasonable.'" For incompatible development off-airport, the sponsor should coordinate with the Airports District Office (ADO) as soon as the sponsor is aware of the development, with the alternatives evaluation conducted within 30 days of the sponsor's first awareness of the development within the RPZ. The following items are typically necessary in an alternatives evaluation:

- Sponsor's statement of the purpose and need of the proposed action (airport project, land use change, or development)
- Identification of any other interested parties and proponents
- Identification of any federal, state, and local transportation agencies involved
- Analysis of sponsor control of the land within the RPZ
- Summary of all alternatives considered, including:
    - Alternatives that preclude introducing the incompatible land use within the RPZ (e.g., zoning action, purchase, and design alternatives, such as implementation of declared distances, displaced thresholds, runway shift or shortening, raising minimums)

- Alternatives that minimize the impact of the land use in the RPZ (e.g., rerouting a new roadway through less of the RPZ, etc.)
- Alternatives that mitigate risk to people and property on the ground (e.g., tunnelling, depressing and/or protecting a roadway through the RPZ, implementing operational measures to mitigate any risks, etc.)

- Narrative discussion and exhibits or figures depicting the alternative
- Rough order of magnitude cost estimates associated with each alternative, regardless of potential funding sources
- Practicability assessment based on the feasibility of the alternative in terms of cost, constructability, operational impacts, and other factors

Once the alternatives evaluation has been submitted to the ADO, the FAA will determine whether the sponsor has made an adequate effort to pursue and give full consideration to appropriate and reasonable alternatives. **The FAA will not approve or disapprove the airport sponsor's preferred alternative; rather, the FAA will only evaluate whether an acceptable level of alternatives analysis has been completed before the sponsor makes the decision to allow or not allow the proposed land use within the RPZ.**

In summary, the RPZ guidance published in September 2022 shifts the responsibility of protecting the RPZ to the airport sponsor. The airport sponsor is expected to take action to control the RPZ or to demonstrate that appropriate actions have been taken. The decision to permit or disallow existing or new incompatible land uses within an RPZ is ultimately up to the airport sponsor, with the understanding that the sponsor still has grant assurance obligations, and the FAA retains the authority to review and approve or disapprove portions of the ALP that would adversely impact the safety of people and property within the RPZ.

RPZs have been further designated as approach and departure RPZs. The approach RPZ is a function of the aircraft approach category (AAC) and approach visibility minimums associated with the approach runway end. The departure RPZ is a function of the AAC and departure procedures associated with the runway. For a particular runway end, the more stringent RPZ requirements (usually associated with the approach RPZ) will govern the property interests and clearing requirements the airport sponsor should pursue.

As shown on **Exhibit 3B**, the existing RPZs associated with each runway end are almost entirely controlled by the airport through outright ownership or through protections associated with clear zone and avigation easements. The only uncontrolled areas are located within the Runway 34 RPZ, with two small areas outside the airport's boundary. One of these areas encompasses 0.15-acres and abuts Airport Road. The second uncontrolled area is a 0.08-acre area on the southeast corner of the RPZ. There are public roadways that pass through the RPZs associated with Runways 25, 16, and 34. As mentioned previously, public roadways are generally considered incompatible uses within an RPZ; however, the FAA considers existing roads to be grandfathered so that no corrective action is necessary. It should be noted that a change to the runway environment that alters the size of the RPZ may negate the grandfathered condition. If, in the future, the runways were equipped with lower instrument visibility minimums, then the area contained within the applicable RPZs would increase; thus, the level of potentially incompatible land uses within the larger RPZ would also increase. To lower the visibility minimums, the airport will have to develop a plan of action to mitigate the newly introduced incompatible land uses and work in consultation with the FAA to determine if the additional incompatible land is acceptable. The alternatives discussion in the next chapter will discuss options to mitigate potential incompatibilities (i.e., roads).

SEPARATION STANDARDS

There are several other standards related to separation distances from runways and taxiways. Each is designed to enhance the safety of the airfield.

Runway/Taxiway Separation

The design standard for the separation between runways and parallel taxiways is a function of the critical aircraft and the instrument approach visibility minimum. The separation standard for primary Runway 7-25 in the existing RDC B-I-5000 condition is 225 feet from the runway centerline to the parallel taxiway centerline. In the ultimate B-II-4000 environment, the separation standard increases to 240 feet. Parallel Taxiway A is currently separated from the runway by 300 feet and should be maintained in its current location. For crosswind Runway 16-34, the runway-to-taxiway separation standard in both the existing and ultimate conditions is 225 feet. Taxiway F is located 300 feet from Runway 16-34 and should be maintained in its current location.

Exhibit 3C – Hold Line Separation

Hold Line Position Separation

Hold line position markings are placed on taxiways leading to runways. When instructed, pilots are to stop short of the holding position marking line. The existing and ultimate design standards for both runways call for holding positions to be separated from the runway centerline by 200 feet.

At Merrill Municipal Airport, each hold line position marking on taxiways leading to primary Runway 7-25 is situated 200 feet from the runway centerline, with the exception of the hold line on Taxiway F where it connects to Runway 25, as shown on **Exhibit 3C**. This holding position is located 125 feet from the runway centerline. The holding positions on taxiways connecting to crosswind Runway 16-34 on the east side are situated 125 feet from the runway centerline, while the hold line on the west side of the runway is located 200 feet from the centerline. The alternatives in the next chapter will consider relocating the hold lines that do not meet the 200-foot separation standard.

Aircraft Parking Area Separation

According to FAA AC 150/5300-13B, aircraft parking positions should be located to ensure that aircraft components (wings, tail, and fuselage) do not:

1. Conflict with the object free area for adjacent runway or taxiways:
   a. Runway object free area (ROFA)
   b. Taxiway object free area (TOFA)
   c. Taxilane object free area (TLOFA)
2. Violate any of the following aeronautical surfaces and areas:
   a. Runway approach or departure surface
   b. Runway visibility zone (RVZ)
   c. Runway obstacle free zone (ROFZ)
   d. Navigational aid equipment critical areas

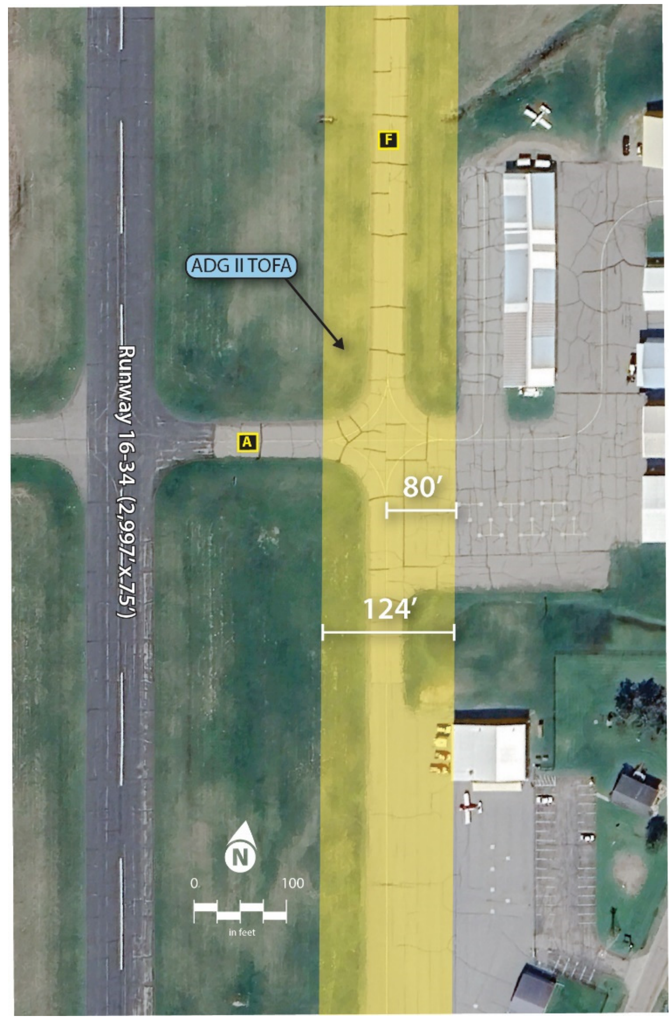

Exhibit 3D – Aircraft Parking Area Separation

Existing aircraft parking positions at Merrill Municipal Airport are located on each of the three aircraft parking aprons. In their existing locations, each marked aircraft parking position at RRL is clear of the safety areas, as well as the aeronautical surfaces and areas detailed above. When considering each area detailed above, the nearest marked tiedown is located on the FBO apron and is separated from the taxiway centerline by approximately 80 feet. As illustrated in **Exhibit 3D**, this parking position is clear of the TOFA[2] associated with Taxiway F.

TAXIWAYS

The design standards associated with taxiways are determined by the taxiway design group (TDG) or the ADG of the critical aircraft. As determined previously, the applicable ADG for both runways in the existing condition is ADG I, with primary Runway 7-25 identified as ADG II in the ultimate condition. **Table 3G** presents the various taxiway design standards related to both ADG I and II. The table also shows those taxiway design standards related to TDG. The TDG standards are based on the main gear width (MGW) and cockpit to main gear (CMG) distance of the critical aircraft expected to use those taxiways. Different taxiway and taxilane pavements can and should be planned to the most appropriate TDG design standards based on usage.

[2] The TOFA illustrated in Exhibit 3D is representative of an Airplane Design Group (ADG) II TOFA, which measures 124 feet wide, centered on the taxiway centerline.

The current design for all taxiways at RRL is TDG 2A, which dictates a width of 35 feet. Taxiway A and its associated connectors are currently 35 feet wide, while Taxiway F and its connectors are 40 feet wide. While the 40-foot width provides an added safety margin for aircraft operating at the airport, the BOA may elect not to fund regular pavement maintenance for the portions of taxiway pavement that exceed the standard. If the airport chooses to maintain the taxiways at their current widths, the costs may need to come from a local funding source, rather than federal or state grant monies. Certain portions of the landside area that are utilized exclusively by small aircraft, such as the T-hangar areas, should adhere to TDG 1A/1B standards.

Table 3G | Taxiway Dimensions and Standards

STANDARDS BASED ON WINGSPAN	ADG I	ADG II
Taxiway and Taxilane Protection		
Taxiway Safety Area Width (TSA)	49'	79'
Taxiway Object Free Area Width (TOFA)	89'	124'
Taxilane Object Free Area Width (TLOFA)	79'	110'
Taxiway and Taxilane Separation		
Taxiway Centerline to Parallel Taxiway Centerline	70'	101.5'
Taxiway Centerline to Fixed or Moveable Object	44.5'	62'
Taxilane Centerline to Parallel Taxilane Centerline	64'	94.5'
Taxilane Centerline to Fixed or Moveable Object	39.5'	55'
Wingtip Clearance		
Taxiway Wingtip Clearance (feet)	20'	22.5'
Taxilane Wingtip Clearance (feet)	15'	15.5'
STANDARDS BASED ON TDG	**TDG 1A/B**	**TDG 2A/B**
Taxiway Width Standard	25'	35'
Taxiway Edge Safety Margin	5'	7.5'
Taxiway Shoulder Width	10'	15'

ADG = airplane design group
TDG = taxiway design group
Note: All dimensions are in feet.

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

Exhibit 3E depicts the TOFA and TLOFA, which are based upon ADG I standards in the existing condition. The TOFA for taxiways serving either runway is 89 feet wide, while the TLOFA for taxilanes serving hangar areas is 79 feet wide. Like the ROFA, these areas should be cleared of objects and parked aircraft, except for objects needed for air navigation or aircraft ground maneuvering purposes. The TOFAs associated with the airfield taxiways and TLOFAs associated with hangar areas are clear of obstructions, except for potential penetrations of the TLOFAs between the hangars on the southeast side of the airport and adjacent the T-hangar on the north side. Currently, there is approximately 78 feet of separation between the hangars on the southeast side, which is just shy of a standard ADG I TLOFA. On the north side, the western edge of the T-hangar is situated approximately 26 feet from the taxilane centerline. When applying the 79-foot standard TLOFA to this taxilane, a penetration to the TLOFA results; however, taxilanes can be designed based on the types of aircraft using that pavement, meaning that a smaller TLOFA standard could apply depending on the type of aircraft using those taxilanes.

In the ultimate B-II-4000 condition, ADG II standards would apply to taxiways serving primary Runway 7-25. The width of the TOFA in this environment increases to 124 feet wide, centered on the taxiway. When this standard is applied, the TOFA on taxiways serving crosswind Runway 7-25 remains clear of obstructions.

Exhibit 3E
TAXIWAY AND TAXILANE OBJECT FREE AREAS

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Taxiway and Taxilane Design Considerations

FAA AC 150/5300-13B, *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 following is a list of the taxiway design guidelines and the basic rationale behind each recommendation included in the current AC, as well as previous FAA safety and design recommendations.

1. **Taxiing Method**: Taxiways are designed for cockpit-over-centerline taxiing with pavement that is wide enough 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, existing intersections should be upgraded to eliminate judgmental oversteering, which is when a pilot must intentionally steer the cockpit outside the marked centerline in order to assure the aircraft remains on the taxiway pavement.
2. **Curve Design**: Taxiways should be designed such that the nose gear steering angle is no more than 50 degrees, which is the generally accepted value to prevent excessive tire scrubbing.
3. **Three-Path Concept**: To maintain pilot situational awareness, taxiway intersections should provide a pilot with a maximum of three choices of travel. Ideally, these are right, left, and a continuation straight ahead.
4. **Channelized Taxiing**: To support visibility of airfield signage, taxiway intersections should be designed to meet standard taxiway width and fillet geometry.
5. **Designated Hot Spots and Runway Incursion Mitigation (RIM) Locations**: A hot spot is a location on the airfield with elevated risk of a collision or runway incursion. Mitigation measures should be prioritized for areas the FAA designates as hot spots or RIM locations.
6. **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.
7. **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 by using the three-path 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 a simple reduction in the number of occurrences and 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.
   - *Increase Visibility*: Right-angle intersections, between both taxiways and runways, provide the best visibility. Acute-angle runway exits provide 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.
- *Direct 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.

8. **Runway/Taxiway Intersections**
   - *Right Angle*: Right-angle intersections are the standard for all runway/taxiway intersections, except where there is a need for an acute-angled 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. The construction of high-speed exits is typically only justified for runways with regular use by jet aircraft in approach categories C and above.
   - *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.
9. **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 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.
   - *Wide Throat Taxiways*: Wide throat taxiway entrances should be avoided. Such large expanses of pavement may cause pilot confusion and make lighting and marking more difficult.
   - *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 or a no-taxi island that forces pilots to make a conscious decision to turn.
   - *Apron to Parallel Taxiway End*: Avoid direct connection from an apron to a parallel taxiway at the end of a runway.

The taxiway system at Merrill Municipal Airport generally provides for the efficient movement of aircraft, and there are no FAA-designated hot spots at the airport; however, there is direct access from both aprons on the east side of the airport, as shown on **Exhibit 3F**. Additionally, the lack of taxiway access to Runway 16 requires pilots to back-taxi, which could be considered a dual purpose use of Runway 16-34 (i.e., the runway being used as a taxiway). Potential solutions to correct this issue will be examined in the alternatives chapter. Analysis in the next chapter will also consider improvements that could be implemented on the airfield to minimize runway incursion potential, improve efficiency, and conform to FAA standards for taxiway design.

Taxilane Design Considerations

Taxilanes are distinguished from taxiways in that they do not provide access to or from the runway system directly. Taxilanes typically provide access to hangar areas and can be planned to varying design standards, depending on the type of aircraft utilizing the taxilane, as described previously.

Exhibit 3F – Direct Access

NAVIGATIONAL AND APPROACH AIDS

Navigational aids are devices that provide pilots with guidance and position information when utilizing the runway system. Electronic and visual guidance to arriving aircraft enhance the safety and capacity of the airfield. Such facilities are vital to the success of an airport and provide additional safety to pilots and passengers using the air transportation system. While instrument approach aids are especially helpful during poor weather, they are often used by pilots conducting flight training and operating larger aircraft when visibility is good.

Instrument Approach Aids

Merrill Municipal Airport has two published instrument approaches. A localizer performance with vertical guidance (LPV) via an area navigation (RNAV) GPS instrument approach is available to each end of Runway 7-25. This approach has visibility minimums down to one-mile for Categories A, B, and C aircraft, but is not available to Category D aircraft. These approaches are considered adequate for primary Runway 7-25 at this time. If, however, a reduction in the visibility minimums to lower than one-mile but not below ¾-mile were implemented, it would result in an increase to the RPZ dimensions for the affected runway. **Exhibit 3G** presents a comparison of the RPZs currently serving Runways 7 and 25 versus what they would be if visibility minimums not lower than ¾-mile were to be implemented. As can be seen in the graphic, the RPZs would increase significantly in size, resulting in areas of uncontrolled property containing potentially incompatible land uses, including residential land uses. If Runway 7-25 is extended in the future, additional property would be uncontrolled with potentially incompatible land uses. For planning purposes, the alternatives to follow in the next chapter will depict instrument approaches with not lower than ¾-mile minimums on Runway 7-25, which correlates to the ultimate B-II-4000 environment.

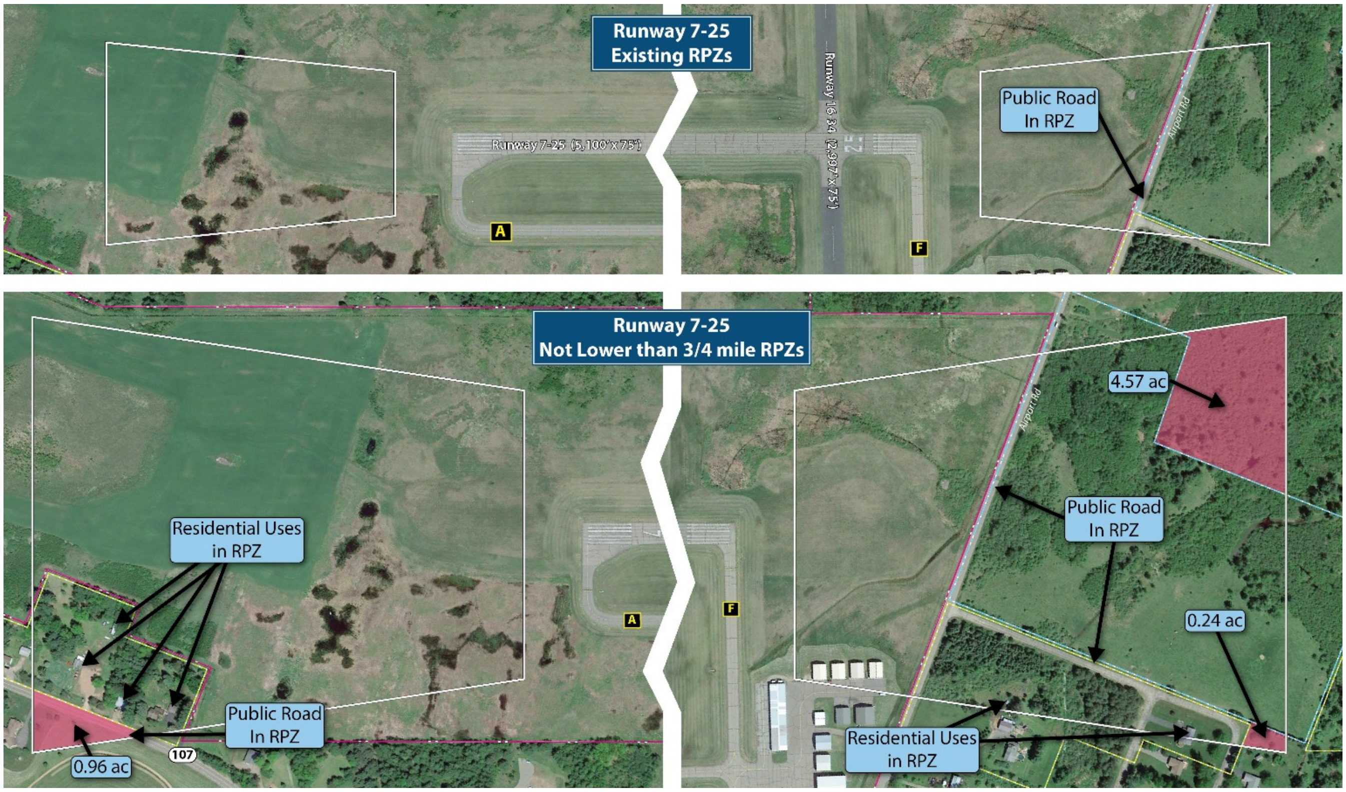

Exhibit 3G – RPZ Dimension Comparison

Crosswind Runway 16-34 is currently a visual runway with no published instrument approach procedures. For future planning purposes, the alternatives will consider the possible implementation of an instrument approach procedure with visibility minimums not lower than one-mile. This would not alter the size of the existing RPZs associated with Runway 16-34.

Visual Approach Aids

In most instances, the landing phase of any flight must be conducted in visual conditions. To provide pilots with visual guidance information during landings to the runway, electronic visual approach aids are commonly provided at airports. Both ends of primary Runway 7-25 are currently equipped with a two-box precision approach path indicator (PAPI-2). As more turbine aircraft begin to operate at the airport, consideration should be given to upgrading the PAPI-2 to a PAPI-4 (four-box system) on each runway end.

Runway end identification lights (REILs) are flashing lights located at the runway threshold end that facilitate rapid identification of the runway end at night and during poor visibility conditions. REILs provide pilots with the ability to identify the runway thresholds and distinguish the runway end lighting from the other lighting on the airport and in the approach areas. The FAA indicates that REILs should be considered for all lighted runway ends not planned for more sophisticated approach lighting systems. Both ends of primary Runway 7-25 are equipped with REILs, which should be maintained.

Crosswind Runway 16-34 is not equipped with any visual approach aids. Consideration should be given to installing PAPI-2 systems and REILs at each runway end, especially if the runway is to be served by a published instrument approach procedure.

Weather Reporting Aids

Merrill Municipal Airport has a lighted wind cone and wind tee, which are centrally located near the intersection of the two runways and adjacent Taxiway A. A supplemental wind cone is located near Runway 7. These provide information to pilots regarding wind speed and direction and should be maintained through the planning period. A segmented circle is often co-located with an airport's primary wind cone. The segmented circle consists of a system of visual indicators designed to provide traffic pattern information to pilots. RRL does not have a segmented circle, and consideration should be given to installing one.

The airport is also equipped with an automated weather observation station (AWOS), which provides weather observations 24 hours per day. The system updates weather observations every minute, continuously reporting significant weather changes as they occur in real time. This information is transmitted via a designated radio frequency at regular intervals. FAA siting criteria indicate that the AWOS should be located between 1,000 and 3,000 feet from the runway threshold and between 500 to 1,000 feet perpendicular to the runway centerline. The AWOS also has a 500-foot radius critical area which must be kept free of obstructions that could interfere with its sensors. The AWOS at Merrill Municipal Airport should be maintained in its current location through the planning period.

AIRFIELD LIGHTING, MARKING, AND SIGNAGE

Several lighting and pavement marking aids serve pilots using the airport. These aids assist pilots in locating the airport and runway at night or in poor visibility conditions. They also serve aircraft navigating the airport environment on the ground when transitioning to/from aircraft parking areas to the runway.

Airport Identification Lighting | Merrill Municipal Airport's rotating beacon is located on the east side of the airport property at the entrance to the public parking area. The beacon is in poor condition. Consideration should be given to removing the existing beacon and installing a new beacon near the terminal building.

Runway and Taxiway Lighting | Both runways are equipped with a medium intensity runway lighting (MIRL) system. This system is adequate and should be maintained. Taxiway A and its associated taxiways are equipped with medium intensity taxiway lighting (MITL). This system is also adequate and should be maintained. Planning should consider expansion of the MITL system to include Taxiway F and associated pavements, as well as expansion of both MIRL and MITL systems if/when new pavements are constructed.

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 on the runway and taxiway systems on the airfield. The signage system includes lighted runway and taxiway designations and routing/directional signage. All of these signs should be maintained throughout the planning period.

It should be noted that many airports are transitioning to light emitting diode (LED) systems. LEDs have many advantages, including lower energy consumption, longer lifespan, increased durability, reduced size, greater reliability, and faster switching. While a larger initial investment is required up front, the energy savings and reduced maintenance costs will outweigh any additional costs in the long run. At Merrill Municipal Airport, the taxiway lighting on parallel Taxiway A is LED, while the runway lighting, PAPIs, and REILs have incandescent bulbs. When these systems need to be repaired/replaced, consideration should be given to upgrading them to LED systems.

Pavement Markings | Runway markings are typically designed to the type of instrument approach available on the runway. FAA AC 150/5340-1K, *Standards for Airport Markings*, provides guidance necessary to design airport markings. Runway 7-25 is equipped with non-precision markings, while Runway 16-34 has basic markings. These runway markings should be maintained throughout the long-term planning horizon, with consideration given to upgrading Runway 16-34 to non-precision markings. Non-precision markings would be necessary if an instrument approach were to be established to Runway 16-34.

A summary of the airside facilities at Merrill Municipal Airport is presented on **Exhibit 3H**.

LANDSIDE FACILITY REQUIREMENTS

Landside facilities are those necessary for the handling of aircraft and passengers while on the ground. These facilities provide the essential interface between the air and ground transportation modes. The capacity of the various components of each element was examined in relation to projected demand to identify future landside facility needs. At Merrill Municipal Airport, this includes components for general aviation needs, such as:

- General Aviation Terminal Facilities and Auto Parking
- Aircraft Storage Hangars
- Aircraft Parking Aprons
- Airport Support Facilities

Projections made for aircraft storage hangars, aircraft parking aprons, and marked parking positions are based on the number of aircraft currently based and forecast to base on the airport property over the 20-year planning horizon. Terminal facilities, auto parking, and other airport support facilities are based on the annual number of operations projected to occur over the planning period.

In addition to landside facility requirements, potential non-aeronautical land uses will also be evaluated in subsequent chapters. These are portions of airport property that are suitable for non-aviation purposes and can generate revenue for the airport, such as agriculture or industrial uses. While airport property is generally subject to Airport Improvement Program (AIP) grant assurances, airports can request a release from aeronautical federal obligations for certain areas of property that are not necessary for aviation uses. These requests are facilitated under the *FAA Reauthorization Act of 2018*, Section 163, which governs the FAA's authority over non-aeronautical development.

	Runway 7-25 Existing	Runway 7-25 Ultimate	Runway 16-34 Existing	Runway 16-34 Ultimate
Runways				
Runway Design Code (RDC)	B-I-5000	B-II-4000	B-I-VIS	B-I-5000
Dimensions	5,100' x 75'	Consider extenstion; maintain width	2,997' x 75'	Consider extenstion; maintain width if feasible
Pavement Strength	45,000 lbs S | 65,000 lbs D | 100,000 lbs 2D	Maintain	26,000 lbs S	Maintain
Safety Areas				
RSA	Standard RSA	Maintain	Standard RSA	Maintain
ROFA	Standard ROFA	Relocate obstruction (wind cone)	Standard ROFA	Maintain
ROFZ	Standard ROFZ	Maintain	Standard ROFZ	Maintain
RPZ	RPZs on airport property or controlled through easement; public road in Runway 25 RPZ	Consider mitigation of potential incompatible uses	Portion of Runway 34 RPZ uncontrolled and public roads in both RPZs	Consider mitigation of potential incompatible uses
Taxiways				
Design Group (TDG)	2A	Maintain	2A	Maintain
Parallel Taxiway	Taxiway A (partial parallel)	Maintain	Taxiway F (partial parallel)	Maintain
Parallel Taxiway Separation from Runway	300'	Maintain	300'	Maintain
Widths	35' (Taxiway A and connectors)	Maintain	40' (Taxiway F and connectors)	Maintain if feasible
Holding Position Separation	125' & 200'	Re-mark at 200'	125' & 200'	Re-mark at 200'
Notable Conditions	None	Maintain	Direct access from east aprons; dual-purpose pavment	Consider corrective measures
Navigational and Weather Aids				
Instrument Approaches	LPV GPS (7, 25)	Maintain	Visual only	Consider GPS approach
Weather Aids	AWOS, wind cones, rotating beacon	Maintain equipment; relocate/install new beacon		
Approach Aids	PAPI-2 & REILS on both runway ends	Consider upgrade to PAPI-4; maintain REILs	None	Consider PAPI-2s and REILs
Lighting and Marking				
Runway Lighting	MIRL	Maintain	MIRL	Maintain
Runway Marking	Non-precisioin	Maintain	Basic	Consider non-precision markings
Taxiway Lighting	MITL (Taxiway A)	Maintain	No lighting on Taxiway F	Install MITL on Taxiway F

KEY
- **AWOS** - Automated Weather Observing System
- **D** - Dual Wheel
- **2D** - Dual Tandem Wheel
- **MIRL** - Medium Intensity Runway Lighting
- **MITL** - Medium Intensity Taxiway Lighting
- **PAPI** - Precision Approach Path Indicator
- **RDC** - Runway Design Code
- **REIL** - Runway End Identification Lights
- **ROFA** - Runway Object Free Area
- **ROFZ** - Runway Obstacle Free Zone
- **RPZ** - Runway Protection Zone
- **RSA** - Runway Safety Area
- **S** - Single Wheel
- **TDG** - Taxiway Design Group

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GENERAL AVIATION TERMINAL SERVICES

The general aviation terminal facilities at an airport often provide corporate officials and visitors with their first impression of the community. General aviation terminal facilities at an airport provide space for passenger waiting, a pilots' lounge, flight planning, concessions, management, storage, and many other various needs. This space is not necessarily limited to a single, separate terminal building, but can include space offered by fixed base operators (FBOs) and other specialty operators for these functions and services. At Merrill Municipal Airport, general aviation terminal services are provided in the terminal building, which includes a lobby, a pilots' lounge, a conference room, a kitchen, and restrooms.

The methodology used in estimating general aviation terminal facility needs was based on the number of airport users expected to utilize general aviation facilities during the design hour. This methodology is a general airport planning practice and is not considered exacting, as each airport terminal serves unique functions. The space requirements for terminal building facilities were based on providing 125 square feet (sf) per design hour itinerant passenger. A multiplier of 2.5 in the short term, increasing to 4.0 in the long term, was also applied to terminal facility needs to better determine the number of passengers associated with each itinerant aircraft operation. This increasing multiplier indicates an expected increase in larger aircraft operations throughout the long term. These operations typically support larger turboprop and jet aircraft, which can accommodate an increasing passenger load factor. Such is the case at Merrill Municipal Airport, where an increasing number of turbine operations are anticipated.

Table 3H outlines the space requirements for general aviation terminal services at Merrill Municipal Airport through the long-term planning period. The amount of space currently offered in the terminal building is approximately 3,200 sf. As shown in the table, this is adequate through the long-term planning period.

Table 3H | General Aviation Terminal Area Facilities

	Currently Available	Short-Term Need	Intermediate-Term Need	Long-Term Need
Terminal Building (sf)	3,200	1,400	1,900	2,600
General Aviation Design Hour Passengers		11	15	21
Passenger Multiplier		2.5	3.2	4.0
Visitor/Tenant Vehicle Parking	77	52	63	73

Source: Coffman Associates analysis

General aviation vehicle parking demands have also been determined for the airport. Space determinations for passengers were based on an evaluation of existing airport use, as well as standards set forth to help calculate projected terminal facility needs. There are currently 77 marked individual vehicle spaces provided at the airport; 42 spaces are located at the terminal and 35 spaces are on the east side of the field by Park City Aviation. Most based aircraft owners park near their hangars. As can be seen in the table, vehicle parking is another segment that is adequate throughout the planning period. Nevertheless, proposed hangar facility layouts will include dedicated vehicle parking for tenants, as will be illustrated in the next chapter.

AIRCRAFT HANGARS

Utilization of hangar space varies as a function of local climate, security, and owner preference. The trend in general aviation aircraft is toward more sophisticated (and consequently, more expensive) aircraft; therefore, many aircraft owners prefer enclosed hangar space as opposed to outside tiedowns.

The demand for aircraft storage hangars is dependent on the number and type of aircraft expected to be based at the airport in the future. For planning purposes, it is necessary to estimate hangar requirements based on forecast operational activity; however, hangar development should be based on actual demand trends and financial investment conditions.

While most aircraft owners prefer enclosed aircraft storage, some will still use outdoor tiedown spaces, usually due to lack of available hangar space, high hangar rental rates, or operational needs; therefore, enclosed hangar facilities do not necessarily need to be planned for each based aircraft.

Hangar types vary greatly in size and function. T-hangars, box hangars, and shade hangars are popular with aircraft owners who need to store one private aircraft. These hangars often provide individual spaces within a larger structure or in standalone portable buildings. There is approximately 12,600 sf of T-hangar storage space at the airport. For determining future aircraft storage needs, a planning standard of 1,200 sf per aircraft is utilized for this type of hangar.

Executive box hangars are open-space facilities with no interior supporting structure. These hangars can vary in size from 1,500 and 2,500 sf to nearly 10,000 sf. They are typically able to house single-engine, multi-engine, turboprop, and jet aircraft, as well as helicopters. Executive box hangar space at Merrill Municipal Airport is estimated at 47,600 sf. For future planning, a standard of 3,000 sf per turboprop, 5,000 sf per jet, and 1,500 sf per helicopter is utilized for executive box hangars.

Conventional hangars are large, open-space facilities with no supporting interior structure. These hangars provide for bulk aircraft storage and are often utilized by airport businesses, such as FBOs or aircraft maintenance operators. Conventional hangars are generally larger than executive box hangars and can range in size from 10,000 sf to more than 20,000 sf. Often, a portion of a conventional hangar is utilized for non-aircraft storage needs, such as maintenance or office space. There are no conventional hangars at Merrill Municipal Airport. For planning purposes, the same aircraft sizing standards utilized for executive hangars are also utilized for conventional hangars.

Requirements for maintenance/service hangar area have also been calculated. There is one maintenance/service provider on the airport which operates out of an executive hangar approximately 4,700 sf in size. To determine service hangar needs, a planning standard of 250 sf per based aircraft has been calculated.

Future hangar requirements for the airport are summarized in **Table 3J**. While most based aircraft owners prefer enclosed hangar space, it is assumed that some will use tiedowns on the apron. The analysis shows that future hangar requirements indicate a potential need for almost 50,000 sf of new hangar storage capacity through the long-term planning period. This includes a mixture of hangar types, with the largest need projected in the executive/conventional hangar category. Due to the projected increase in based aircraft, the existing demand for hangar space, annual general aviation operations, and hangar storage needs, facility planning will consider additional hangars at the airport. It is expected that the aircraft storage hangar requirements will continue to be met through a combination of hangar types.

Table 3J | Aircraft Hangar Requirements

	Currently Available	Short-Term Need	Intermediate-Term Need	Long-Term Need	Difference
Total Based Aircraft	45	48	50	56	+11
Hangar Area Requirements					
T-Hangar Area (sf)	12,600	22,200	28,200	28,100	+15,500
Executive Box/Conventional Hangar Area (sf)	47,600	53,600	58,100	72,600	+25,000
Service Hangar Area (sf)	4,700	12,000	12,500	14,000	+9,300
Total Hangar Area (sf)	**64,900**	**87,800**	**98,800**	**114,700**	**+49,800**

Source: Coffman Associates analysis

It should be noted that hangar requirements are general in nature and are based on the aviation demand forecasts. The actual need for hangar space will further depend on the usage within the hangars. For example, some hangars may be utilized entirely for non-aircraft storage, such as maintenance; yet they have an aircraft storage capacity from a planning standpoint. Therefore, the needs of an individual user may differ from the calculated space necessary.

AIRCRAFT PARKING APRONS

The aircraft parking apron is an expanse of paved area intended for aircraft parking and circulation. Typically, a main apron is centrally located near the airside entry point, such as the terminal building or FBO facility. Ideally, the main apron is large enough to accommodate transient airport users as well as a portion of locally based aircraft. Smaller aprons are often available adjacent to FBO or specialty aviation service operator (SASO) hangars and at other locations around the airport. The apron layout at Merrill Municipal Airport generally follows this typical pattern, with aprons adjacent to both the terminal and the FBO facility (Park City Aviation). A third apron, located north of Park City Aviation, provides additional dedicated aircraft parking space.

To determine future apron needs, the FAA-recommended planning criterion[3] of 330 square yards (sy) was used for single- and multi-engine itinerant aircraft, while a planning criterion of 791 sy was used to determine the area for transient turboprop and jet aircraft. A parking apron should also provide space for locally based aircraft that require temporary tiedown storage. Locally based tiedowns typically will be utilized by smaller single-engine aircraft; thus, a planning standard of 230 sy per position is utilized.

The total apron parking requirements are presented in **Table 3K**. The existing apron pavement area at Merrill Municipal Airport currently encompasses approximately 18,700 sy of space divided among the three apron areas. Approximately 7,800 sy of this space is used exclusively for aircraft parking. Using the

[3] Refer to Advisory Circular (AC) 150/5300-13B, *Airport Design*, Appendix E

planning standards described above and factoring in assumptions regarding operational and based aircraft growth, additional apron space is projected to be needed, with an additional 2,600 sy of aircraft parking apron pavement estimated to be needed over the next 20 years.

There are currently 18 marked parking positions available for based and itinerant aircraft at the airport. There is no helicopter parking. As shown in the table, additional aircraft parking is projected to be needed beginning in the short term, including dedicated parking for helicopters and small corporate jets.

Table 3K | Aircraft Parking Apron Requirements

	Available	Short Term	Intermediate Term	Long Term
Aircraft Parking Positions				
Based/Local GA Aircraft		2	3	3
Transient GA Aircraft		18	19	21
Corporate Jet Aircraft		1	2	3
Helicopter		1	1	2
Total Parking Positions	**18**	**22**	**25**	**29**
Total Apron Area	**7,800**	**7,500**	**8,700**	**10,400**

Source: Coffman Associates analysis

SUPPORT FACILITIES

Various other landside facilities that play a supporting role in overall airport operations have also been identified. These support facilities include:

- Aviation Fuel Storage
- Perimeter Fencing and Gates

Aviation Fuel Storage

The airport's fuel storage tanks are located on the terminal apron. There is one 12,000-gallon aboveground tank for 100LL Avgas and one 12,000-gallon tank for Jet A fuel. Fuel flowage records for the airport were not available, so it is unclear whether existing capacity meets demand. As the fleet mix transitions to include more frequent operations by turbine aircraft, fuel storage and capacities should be evaluated to ensure an adequate supply of fuel is available. Planning should also consider an additional tank to store unleaded aviation fuel (100UL). The FAA has recently approved the use of 100UL in piston-powered aircraft, although unknowns regarding infrastructure and distribution remain. Nevertheless, the alternatives will include placeholders for these facilities.

Maintenance and Snow Removal Equipment (SRE) Facility

Maintenance equipment is currently stored in a hangar on the airport's east side (identified as Building #14 on Exhibit 1G). This includes a McCormick tractor with blower and mowing attachments, a single-axle dump truck with a snow blade, a Chevy truck with a box plow, a Ford F-150, and various maintenance tools and small equipment. While this facility is adequately sized for accommodating this equipment, it may be better served as an aircraft storage facility due to its location (i.e., accessibility to taxiways and proximity to other aircraft storage hangars). As such, alternatives presented in the next chapter will assess other locations on the airfield that may be better suited as a maintenance and SRE facility.

Perimeter Fencing and Gates

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

- Gives notice of legal boundary of the outermost limits of the facility or security-sensitive areas;
- 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);
- Deters casual intruders from penetrating the aircraft operations areas on the airport;
- Creates a psychological deterrent;
- Demonstrates a corporate concern for facilities; and
- Limits inadvertent access to the aircraft operations area by wildlife.

As detailed in Chapter One, Merrill Municipal Airport operations areas are completely enclosed by 10-foot security fencing and controlled access gates are available for use at the airport. All fencing and gates should be maintained throughout the planning period and should be regularly inspected to ensure they are functioning properly and are undamaged.

A summary of the overall general aviation landside facilities is presented in **Exhibit 3J**.

SUMMARY

This chapter has outlined the safety design standards and facilities required to meet potential aviation demand projected at Merrill Municipal Airport for the next 20 years. In an effort to provide a more flexible master plan, the yearly forecasts from Chapter Two have been converted to planning horizon levels. The short term roughly corresponds to a five-year timeframe, the intermediate term is approximately 10 years, and the long term is 20 years. By utilizing planning horizons, airport management can focus on demand indicators for initiating projects and grant requests rather than on specific dates in the future.

In Chapter Four, potential improvements to the airside and landside systems will be examined through a series of airport development alternatives. Most of the alternatives discussion will focus on those capital improvements that would be eligible for federal and state grant funds. Other projects of local concern will also be presented. Ultimately, an overall airport development plan that presents a vision beyond the 20-year scope of this master plan will be developed for Merrill Municipal Airport.

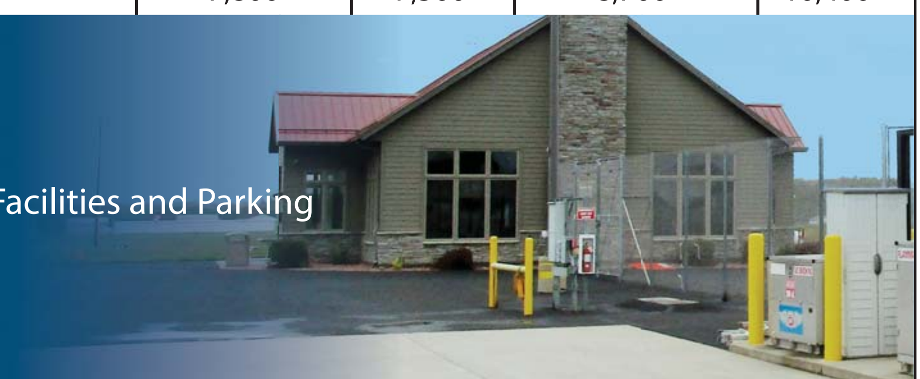
Aircraft Storage Hangar Requirements

	Available	Short Term	Intermediate Term	Long Term
Aircraft to be Hangared	45	46	48	53
T-Hangar Area (sf)	12,600	22,200	28,200	28,100
Executive/Conventional Hangar Area (sf)	47,600	53,600	58,100	72,600
Service/Maintenance Area (sf)	4,700	12,000	12,500	14,000
Total Hangar Storage Area (sf)	64,900	87,800	98,800	114,700

Aircraft Parking Apron

	Available	Short Term	Intermediate Term	Long Term
Aircraft Parking Positions	18	22	25	29
Total Public Apron Area (sy)	7,800	7,500	8,700	10,400

General Aviation Terminal Facilities and Parking



	Available	Short Term	Intermediate Term	Long Term
Building Space (sf)	3,200	1,400	1,900	2,600
Total GA Parking Spaces	77	52	63	73

Exhibit 3J
LANDSIDE FACILITY REQUIREMENTS