Airport Master Plan

Duluth International Airport

Prepared for Duluth Airport Authority

4 Airside Facility Recommendations and Alternatives Analysis

This section identifies airfield (airside) facilities needed to satisfy the 20-year forecast of aviation demand at the Duluth International Airport (DLH). Airport facilities are developed in accordance with FAA airport design standards and airspace criteria.

This study intends to develop realistic recommendations for the planning period. The planning period of this study covers through 2040. Whether the recommendations for the future development will be implemented depends on the actual demand, ability of the Airport to accommodate the development, environmental impacts and available financial and other resources of the local, state and federal decision-makers to meet that demand.

Frequent and rapid changes can occur in the aviation industry as well as increased frequency of regulatory changes within the FAA. It is equally important that an ongoing process of evaluation of changing conditions, needs and near-term trends be implemented to assure the validity of the contents and recommendations of this Master Plan.

The recommendations for this chapter are summarized below. Additional details of the recommendations can be found in the body of this chapter.

- Runway 9/27 Facility Recommendations
  - Runway 9/27 should be designed to RDC D-V standards with a critical aircraft of RDC C-III with approach minimums of less than ¾ of a mile. (See Section 4.3.1)
  - Routine maintenance, such as joint repair and crack sealing should be performed on a scheduled basis to extend the life of the pavement. No other surface improvements to Runway 9/27 are recommended over the planning period. (See Section 4.3.2.5)
  - Shoulder pavement should be reconstructed around 2030 as it is expected to reach the end of its useful life within the 10-year planning term. (See Section 4.3.2.5)
  - The sign system should be updated to LED lighting as signs are replaced. The non-LED signage should be replaced as part of the Taxiway A reconstruction project. (See Section 4.3.2.6)
  - HIRL lighting system should be rehabilitated or replaced when it reaches the end of its useful life or timed to coincide with the shoulder pavement replacement project. This is expected to occur after year 2031 (See Section 4.3.2.6)
  - It is recommended that the Runway 27 PAPI be replaced in the near term. The Runway 27 PAPI also does not provide a coincident glide path with the ILS glide slope. The new location and slope of the PAPI should provide for a coincident glide path. (See Section 4.3.2.7)
  - It is recommended that FAA TechOps evaluate alternative locations that provide a standard localizer siting location and commence with moving the relocation to ensure that the localizer and ILS are reliable and usable by users of the airport. (See Section 4.3.2.8)

  - The glideslope critical area for Runway 9 be paved to ensure AIP funded vehicles can safely operate in the area and avoid vehicle damage (See Section 4.3.2.9)
  - Taxiway and runway alternatives will be designed to correct the non-standard TCH for Runway 27, with a TCH of 60-feet as well as provide a coincident glide path between the PAPI and Localizer. (See Section 4.3.2.10)
  - The 80:1 Clearway should be removed from the Airport Layout Plan and the declared distances for Runway 9/27 be updated to reflect the removal of the Clearway. (see Section 4.3.2.11)

- Runway 3/21 Facility Recommendations
  - Runway 3/21 should be designed to RDC C-III, not lower than 1-mile standards to meet the critical aircraft needs as defined in Chapter 3 (See Section 4.4.1)
  - It is recommended that a Runway 3/21 extension to 8,000 feet be planned for to accommodate both the needs of the civilian aircraft and the 148th Air National Guard. (See Section 4.4.2)
  - Runway 3/21's pavement strength meets the needs of the Critical Aircraft; no additional strengthening is recommended. At the time of full reconstruction, the use of the runway as a taxi route for large aircraft accessing the 148th Fighter Wing via Taxiway F should be considered when determining the required pavement strength of Runway 3/21 during design (See Section 4.4.5)
  - A major rehabilitation project for Runway 3/21 should be completed by 2027
  - Runway reconstruction should be completed around 2040
  - It is recommended that the sign system be updated to LED lighting as signs are replaced (See Section 4.4.6)
  - The Airport should coordinate with FAA Tech Ops to determine if the Runway 3 REILs should be replaced as part of the Runway 3/21 lighting replacement project. (See Section 4.4.7)
  - No improvements are needed to the Runway 3 or 21 PAPIs; however, the airport should continue to coordinate with FAA Tech Ops to plan for future replacement when they reach the end of their useful life. (See Section 4.4.7)
  - The Runway 3/21 Technical Advisory Committee (TAC) recommended planning for approach lighting on one runway end. This recommendation should be considered by the Airport when the Runway is extended to 8,000'. (See Section 4.4.7)

- Navigational Aid Recommendations
  - The airport should continue to maintain the beacon and monitor the need for replacement. Beacon replacement may be needed between 2030 and 2040. The airport should continue to replace wind cones as needed.

- Airspace and Obstruction Recommendations
  - The airport should continue to monitor all runway ends for obstructions and proactively clear vegetation as it grows. (See Section 4.6)
  - The airport should clear the Part 77 approach surface and TERPs departure surface obstructions when Runway 3/21 is rehabilitated in the near term. As part of that design process, the airport should re-survey the obstructions to determine accurate clearing limits to clear vegetation that is expected to be an obstruction within 5-years following the clearing project. (See Section 4.6.3.5)

- Taxiway Network Recommendations
  - It is recommended that Taxiway A be reconstructed in the near-term and that Taxiway A be designed to ADG V and TDG 5 standards. Taxiway A should also be constructed with 25' shoulders (See Section 4.7.2.2)
  - It is also recommended that some areas of Taxiway A and its connectors be realigned during reconstruction to meet design standards and improve sight lines for both aircraft and the air traffic control tower (See Section 4.7.2.2)
  - It is recommended that the above options continue to be explored, starting with the more cost-effective solutions, to mitigate pilot deviations. It is further recommended that the pilot deviations and options listed above continue to be presented and discussed at the annual RSAT meeting (See Section 4.7.2.2.2)
  - It is recommended that a holding bay be added at the departure end of Runway 9. The holding bay should be designed to also accommodate military needs for an arm/dearm pad (See Section 4.7.2.2.3)
  - It is recommended that Taxiway C be reconstructed and that it be relocated to the standard 400' runway centerline to taxiway centerline separation when reconstructed. (See Section 4.7.2.3)
  - The taxiway connector naming convention should be revised to all be alphanumeric when the taxiway is reconstructed (See Section 4.7.2.3)
  - Taxiway D, south of Taxiway A be relocated to the standard 400' from runway centerline when it is reconstructed. (See Section 4.7.2.4)
  - Taxiway lighting be replaced with LED lighting throughout all taxiway networks as the corresponding taxiway pavement is reconstructed (See Section 4.7.3)
  - The Airport should continue to monitor Advisory Circulars for the implementation schedule and guidance on the Approach/Departure holding positions signs. Additionally, the airport should coordinate with stakeholders and the Air Traffic Control Tower prior to the installation of the Approach/Departure sign (See Section 4.7.4)
- Aprons, Aircraft Parking and Hangar Recommendations
  - The Monaco Ramp should be rehabilitated in the near-term. If rehabilitation is not possible due to funding constraints in the near-term, it should be reconstructed between years 5 and 10 (See Section 4.8.1.1)
  - The Monaco Ramp should have a taxilane be designated to accommodate the ADG III aircraft without the need to relocate parked ADG I and II aircraft. (See Section 4.8.1.1)
  - The Midfield Ramp should be reconstructed in the near-term. (See Section 4.8.1.2)
  - A taxilane connector that meets ADG III design standards, be constructed in the near term between the Monaco and Midfield Ramps (See Section 4.8.1.3)
  - Portion of the Tower Ramp that were not reconstructed in the summer of 2021 should be reconstructed in the near-term. (See Section 4.8.1.4)
  - When the adjacent Taxiway A or the Tower ramp is reconstructed, the aircraft parking located on the Tower Ramp should be relocated. The alternatives analysis later in this chapter will evaluate ultimate Tower Ramp layouts (See Section 4.8.1.4)
  - It is recommended that the aircraft parking layouts be able to accommodate the tie-down demand as indicated in the forecast and in Section 4.8.1.5. It is anticipated that a total of 44 tie-downs will be needed through the planning period. (See Section 4.8.1.5)
  - It is recommended that additional hangar spaces (box, ranch or T-hangar) be constructed to accommodate additional aircraft by 2038. Room for approximately 19 additional aircraft should be

provided in the near term (18 ADG I and 1 helicopter) and room for an additional 20 should be provided by the end of the 20-year planning term (See Section 4.8.3)

4.1 Minnesota SASP Requirements and Recommendations

As previously discussed in **Section 2.2.2**, Phase I of the 2020 Update to the *Minnesota State Aviation System Plan* (SASP) classifies DLH as a Key Commercial Service Airport. **Table 4-1** includes the minimum objectives (measures) for a Key Commercial Service Airport and recommended improvements for DLH. Recommendations from the SASP will be discussed further in the sections that follow.

Table 4-1 – MnDOT SASP Key Commercial Service Airport Objectives

		DLH Facilities	SASP Airport measures	DLH Performance/ Recommendation
Facilities	Primary Runway Width	150’	Required - 100’ Recommended - 150’	Meets
	Primary Runway Lighting	HIRL	HIRL	Meets
	Primary Runway Approaches	Precision Visibility ½ Mile	Precision Visibility ½ Mile	Meets
	Parallel Taxiway	Full	Full	Meets
	Taxiway Width	75’	Required - 35’ Recommended - 50’	Meets
	Navigation Systems	Approach, REILs, VGSI, Beacon, Wind cone	Approach, REILs, VGSI, Beacon, Wind cone	Meets
	Weather Reporting	ASOS	AWOS	Meets
	Aircraft Parking	**Minimal tie downs at FBO**	**Tie downs for 3 more aircraft than regularly utilize the airport**	**Expand parking to accommodate public parking need**
	Terminal/GA/Admin Building	FBO Building and Commercial Terminal	Terminal building with phone and restroom	Meets
	Automobile Parking	Adequate Parking	Adequate Parking	Meets
	Fencing	Perimeter Fencing	Perimeter Fencing	Meets
	Airport Surfaces	Existing surfaces clear of obstructions	Clear of obstructions	Runway 21 Part 77 Approach Surface obstructions
Services	Fuel	100LL, Jet A	100LL, JetA[1]	Meets
	Courtesy or Rental Car	Rental Car	Courtesy or Rental Car	Meets
	Transient Aircraft Storage	FBO Heated Storage, Apron	Heated Storage[1]	Meets
Administrative	Airport Layout Plan/ Master Plan	Updated or revisit every 10 years	Updated or revisit every 10 years	Meets
	Airport Zoning	Adequate zoning	Adequate Zoning	Meets
	Clear Zone Ownership	Controlled in fee	Controlled in fee	Meets
	Minimum Standards	Minimum Standards	Minimum Standards[1]	Meets

Notes: [1]Recommended

Source: Phase I Minnesota State Aviation System Plan, 2020

4.2 Runway System Recommendations

Airports, in general, are designed by selecting a Runway Design Code (RDC) and then applying those criteria to the rest of the airport. Runways are designed to provide a location for aircraft to safely land or depart from an airport. AC 150/5300-13A, *Airport Design*, provides general runway design principles, which include:

- The runway should be long enough to accommodate landing and departures of the design aircraft.
- Runway ends should be clear of any obstructions to prevent operational restrictions.
- Safety, efficiency, economics and environmental impacts should be considered with runway design.
- Runways should be designed to accommodate 95% wind coverage based on the RDC of the critical aircraft.
  - If the primary runway is not able to accommodate 95%, a crosswind runway should be evaluated.
- Limit the impacts of existing and future environmental factors such as land use, noise, water quality, air, wildlife and historical and architectural features.
- Navigational Aids (NAVAIDs), such as approach lighting systems, should be considered when designing a runway threshold location.
- Protected surfaces should be evaluated for incompatible uses located inside these surfaces.
- Runway locations should not impact future or ultimate locations of other airfield facilities or how they interface with landside facilities such as a terminal building or a Fixed Based Operator (FBO).
- Existing and proposed air traffic control towers need to have an unobstructed view from the tower cab to all runway ends and approach paths.

4.3 Runway 9/27 Facility Recommendations

4.3.1 Runway Design Code (RCD)

As discussed in **Chapter 3**, the civilian critical aircraft for DLH identified for the planning period is the Airbus 319 (A319). The A319 is an Aircraft Approach Category (AAC) C, with an approach speed of 121 knots or more but less than 141 knots. The Airplane Design Group (ADG) is a group III, with a tail height of 30-45 feet and a wingspan of 79-118 feet.

The military critical aircraft for DLH is the Falcon F-16 Fighter Jet. The F-16 is an AAC D, with an approach speed of 141 knots or more but less than 166 knots. The ADG is a Group I, with a tail height of up to but not including 20 feet and a wingspan up to but not including 49 feet.

The runway surface gradients (longitudinal and transverse) that are applicable for Runway 9/27 profile and cross section design are as shown in Figures 3-22 and 3-23 in FAA Advisory Circular 150/5300-13A (2/26/2014). As part of the Runway 9/27 reconstruction project completed in 2016 through 2019, the FAA allowed a portion of Runway 9/27 to continue to have a superelevation due to constraints of the surrounding infrastructure at the time of reconstruction. This includes the runway shoulders and edge lighting, intersection with Runway 3/21, and the related taxiway connections.

The Critical Aircraft for DLH has been identified in the aviation activity forecast as, an Airbus A319 for the current 20-year forecast, which is an RDC C-III aircraft. As part of this master plan process stakeholder feedback indicated that Runway 9/27 should continue to be able to the accommodate larger ADG IV and V civilian and military aircraft that utilize the airport on a less frequent basis. ***As such, it is recommended that Runway 9/27 be designed to RDC D-V standards with a critical aircraft of RDC C-III with approach minimums of less than ¾ of a mile.***

Table 4-2 compares the C-III and D-V design standards for Runway 9/27 with visibility minimums lower than 3/4 mile (see Table A7-9 and A7-11 in AC 150/5300-13A). Standards that differ from C-III to D-V are shown in bold. All C-III and D-V design standards are met.

Table 4-2 – Runway 9/27 Runway Design Standards

AC 150/5300-13A, Table A7-9 and Table A7-11, Runway Design Standards Matrix				
Visibility Minimums: Lower than ¾ Mile				
Airfield Component	**FAA ARC (Civilian) C-III Standards**	**FAA ARC (Civilian) D-V Standards**	**Actual Condition**	**C-III Design Standard Met (✓)**
Runway Width	150’	150’	150’	✓
Runway Shoulder Width	**25’**	**35’**	**35’**	**✓**
Runway Blast Pad Width	**200’**	**220’**	**220’**	**✓**
Runway Blast Pad Length	200’	400’	400’	✓
RSA Width	500’	500’	500’	✓
RSA Length Prior to Threshold	600’	600’	1,000’	✓
RSA Length Beyond Rwy End	1,000’	1,000’	1,000	✓
OFA Width	800’	800’	800’	✓
OFA Length Beyond Rwy End	1,000’	1,000’	1,000’	✓
OFA Length Prior to Threshold	600’	600’	600’	✓
OFZ Width	400’	400’	400’	✓
OFZ Width Beyond Rwy End	200’	200’	200’	✓
OFZ Length Beyond Approach Light	200’	200’	200’	✓
POFZ Width	800’	800’	800’	✓
POFZ Length Beyond Rwy End	200’	200’	200’	✓
Rwy to Twy CL Separation[1]	**400’**	**500’**	**500’-850’**	**✓**
Rwy CL to Holdline Separation[2]	**265’**	**295’**	**300’**	**✓**
Rwy CL to Aircraft Parking	500’	500’	700’	✓
Abbreviations: Rwy – Runway Twy – Taxiway CL – Centerline RSA – Runway Safety Area OFA – Object Free Area OFZ – Obstacle Free Zone				

Source: AC 150/5300-13A

4.3.2 Runway Length Recommendations

The purpose of the runway length analysis is to determine if the length of the existing runways are adequate for existing and projected aircraft fleet operations at DLH. Runway length is dependent on many factors including airport elevation, temperature, wind velocity and direction, ambient air temperature, aircraft weight, flap settings, length of haul, runway surface (wet or dry), runway gradient, presence of obstructions, and any imposed noise abatement procedures or other prohibitions. While the FAA does not have standards for

[1] The runway to taxiway centerline separation standard does not need to be adjusted as taxiing and holding aircraft are able to remain clear of the inner-transitional OFZ.
2 Runway centerline to holdline centerline standard has been adjusted for the airport elevation.

runway lengths, FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*, provides guidance to determine the recommended runway length for an airport based on the above factors.

The process to determine recommended runway length begins by determining the landing weight of the Critical Aircraft and the aircraft anticipated to regularly use the Airport within the planning period. For aircraft weighing 60,000 pounds or less, the runway length is determined by family groupings of aircraft having similar performance characteristics (i.e. small and large airplanes). Small airplanes are defined by the FAA as airplanes weighing 12,500 pounds or less at Maximum Takeoff Weight (MTOW), while large airplanes in this context exceed 12,500 but weigh less than 60,000 pounds. For aircraft weighing more than 60,000 pounds, the required runway length is determined by aircraft specific length requirements.

Table 4-3 summarizes the FAA recommended runway lengths for DLH computed using the guidance provided in FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design.* The runway lengths in AC 150/5325-4B are calculated based on the anticipated types of aircraft using the facility, the Airport elevation, and site meteorological conditions, such as the mean maximum temperature during the hottest month of the year. According to the National Weather Service, the mean maximum temperature of the hottest month in the City of Duluth, Minnesota is 76.3°F and occurs in July. The Airport has an elevation of 1,427.8 feet above mean sea level. The existing and anticipated Critical Aircraft for DLH has an RDC of C-III, weighing more than 60,000 pounds but less than 300,000 pounds.

Table 4-3 – FAA Recommended Runway Lengths

Aircraft Type	Runway Length
Small Airplanes with Approach Speeds <30 knots	343’
Small Airplanes with Approach Speeds ≤50 knots	915’
Small Airplanes with Approach Speeds >50 knots	
Small Airplanes with <10 Passenger Seats	
95% of these Small Airplanes	3,400’
100% of these Small Airplanes	4,100’
Small Airplanes with ≥10 Passenger Seats	4,200’
Large Airplanes ≤60,000 lbs.	
75% of these Airplanes at 60% Useful Load	5,500’[1]
75% of these Airplanes at 90% Useful Load	7,200’[1]
100% of these Airplanes at 60% Useful Load	6,100’[1]
100% of these Airplanes at 90% Useful Load	7,900’[1]

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

[1]Figures 3-1 and 3-2. Adjusted for Non-Zero Runway Gradient and Wet and Slippery conditions. For “60% useful load” up to a length of 5,500 feet and for “90% useful load” up to a length of 7,800 feet.

Runway 9/27 is currently 10,591 feet long by 150 feet wide. Runway 9/27 has a critical aircraft of C-III and is designed to D-V.

FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*, provides guidance to determine the recommended runway length for an airport based on the above factors. The AC states that the “design objective

for a primary runway is to provide a runway length for all airplanes that will regularly use it without causing operational weight restrictions[3]".

AC 150/5325-4B utilizes a five-step process to determine recommended runway length. The five steps include:

1. **Step #1.** Identify the list of critical design airplanes that will make regular use (at least 500 or more annual itinerant operations at the airport for an individual airplane or a family grouping of airplanes) of the proposed runway for an established planning period of at least five years.
2. **Step #2.** Identify the airplanes that will require the longest runway lengths at maximum certificated takeoff weight (MTOW). This will be used to determine the method for establishing the recommended runway length. These methods include:
    a. Aircraft with MTOW of 60,000 pounds or less: the recommended runway length is determined according to a family grouping of airplanes having similar performance characteristics and operating weights.
    b. Aircraft weighting over 60,000 pounds and regional jets: The recommended runway length is determined according to individual airplanes. This runway length is a function of the most critical aircraft's takeoff and landing operating weights, flap settings, airport elevation, temperature, runway surface conditions (wet or dry) and effective runway gradient.
3. **Step #3**. Use Table 1-1 in AC 150/5325-4B and the airplanes identified in Step 2 to determine the method that will be used for establishing the recommended runway length. Table 1-1 identifies the appropriate method for different groupings of aircraft (based on weight, passenger capacity, and approach speed).
4. **Step #4.** Select the recommended runway length from the various lengths generated in Step 3 using the process identified in Chapters 2, 3 or 4 (as applicable) of the AC.
5. **Step #5.** Apply any necessary adjustments to the obtained runway length, when instructed by the applicable chapter of this AC, to the runway length generated by Step 3 to obtain the final recommended runway length. For example, adjustments may be made for runways with non-zero effective runway gradient.

Table 4-4 summarizes the runway length determined as part of Steps 1 through 5 within Chapter 1 of AC 150/5325-4B for the runway length needs at DLH. **Table 4-4** documents the most demanding aircraft that operate at DLH on a regular basis, their RDC classification and the recommended runway lengths per performance characteristics of specific aircraft and AC 150/5325-4B (see table notes for the associated chapter and table used for each aircraft). The existing and forecasted operations counts are based the forecast data as presented **Chapter 2**. The recommended runway length for aircraft weighing less than 12,500 pounds was not considered since that length would not be the critical length in the case of DLH.

[3] FAA Advisory Circular 150/5325-4B, Paragraph 103

Table 4-4 – DLH Runway Length Analysis for Existing and Forecasted Aircraft

Aircraft	RDC	MTOW (lbs.)	Rec. Length per AC150/5325-4B[1]	
Aircraft > 12,500 lbs. MTOW and ≤ 60,000 lbs. MTOW (AC 150/5325-4B, Chapter 3) – 75% of Fleet				
Bombardier Challenger 300	B-II	38,850	7,200'	
Citation II/Bravo	B-II	14,800	7,200'	
Citation Latitude	B-II	30,800	7,200'	
Cessna Citation CJ2	B-II	12,500	7,200'	
Cessna Citation V/Ultra/Encore	B-II	16,630	7,200'	
Cessna Citation Sovereign	B-II	30,300	7,200'	
Bombardier Learjet 35/36	D-I	18,000	7,200'	
Raytheon Premier 1/390 Premier 1	B-I	12,500	7,200'	
Aircraft > 12,500 lbs. MTOW and ≤ 60,000 lbs. MTOW (AC 150/5325-4B, Chapter 3) – 100% of Fleet at 90% Useful Load				
Bombardier Challenger 600/601/604	C-II	43,100	7,900'	
Cessna Citation X	B-II	36,100	7,900'	
Dassault Falcon 900	B-II	49,000	7,900'	
Dassault Falcon 2000	B-II	36,500	7,900'	
IAI 1126 Galaxy/Gulfstream G200	D-II	35,650	7,900'	
BAe HS 125/700-800/Hawker 800	B-II	27,400	7,900'	
Aircraft Over 60,000 MTOW and Regional Jets (AC 150/5325-4B, Chapter 4) - Operator Requirements				
Airbus A319[2]	C-III	166,000	7,500'	
Airbus A320[2]	C-III	172,000	7,800'	
Bombardier CRJ-200 (Delta Connection)[3]	C-II	-	6,600'	
Bombardier CRJ-700 (Delta Connection)[3]	C-II	-	5,900'	
Bombardier CRJ-900 (Delta Connection)[3]	C-III	-	7,000'	
Bombardier CRJ-200 (SkyWest Airlines)[4]	C-II	-	6,800'	
Bombardier CRJ-700 (SkyWest Airlines)[4]	C-II	-	6,500'	
Embraer E-145 (Envoy)	C-II	-	6,750'	
Embraer E-175 (Delta Connection)	C-III	-	6,300'	
Embraer E-175 (SkyWest Airlines)	C-III	-	6,500'	
Boeing 737-900 (Delta Airlines)	C-III	-	7,800'	
Military Aircraft				
F-16	D-I	-	7,000'[5]	8,000'[6]

[1]Recommended runway lengths per Advisory Circular (AC) 150/5325-4B, *Runway Length Recommendation for Airport Design at 90% useful load*.

[2]Aircraft Airport Planning Manuals (APM) recommended performance. Temperature 76.3°F, 1,427.8' MSL. Adjusted for Wet and Slippery conditions. It should be noted, operators of this aircraft may have different take off minimum

[3]Aircraft performance provided by Delta Airlines for aircraft flying under Delta Connection (DLH-MSP), April 2020. Temperature 76.3°F, Airport Elevation, wet runway and max landing weight.

[4]Aircreaft performance provided by SkyWest Airlines (DLH-DEN), April 2020. Temperature 76°F, Airport Elevation, dry runway and max landing weight.

[5]Length required for emergency operations of the 148th Air National Guard

[6]Length required normal operations of the 148th Air National Guard

When evaluating the runway length required by operators and aircraft that frequent DLH, the GA aircraft making up 100% of the fleet at 90% useful load will drive the recommended runway length (7,900 feet). The

length required for the narrow body jet (7,800 feet) is close to the runway length required for aircraft in 100% of fleet at 90% useful load as outlined in AC 150/5325-4.

The following summarizes input provided by regional jet and narrow body aircraft operators at DLH.

4.3.2.1.2 Delta Narrow Body Aircraft (A319/A320, B717 and MD88/90)

Delta (main line) was asked to provide information for the runway length needs for each of the jets they operate at DLH. Delta indicated that it would like to utilize the 737-900 length needs as those they will require for all narrow body jets they operate in Duluth. This length would allow the needed flexibility to schedule any of the likely narrow body aircraft into DLH as needed for revenue booking needs. Delta indicated it wants the flexibility to fly varied narrow body aircraft into DLH so as to leverage seat capacity and booking on a per flight basis. As such, the 737-900 runway length requirements are presented for Delta's narrow body jet fleet serving Duluth (A319/320, B737 family, Boeing 717, and MD88/90).

Delta provided information on the runway length needs for the Boeing 737-900 as it is the most demanding mainline aircraft likely to have scheduled service at DLH, including within the next five years and beyond, and allows them the flexibility they require. According to Delta, the 737-900 requires the following runway lengths at DLH:

Aircraft: 737-900

Temperature: 76 Degrees Fahrenheit

QNH: 29.92 in hg

DLH-MSP

Takeoff Weight: Maximum takeoff weight

Takeoff (wet): 7,800 feet

Takeoff (icy): 9,400 feet

Landing Weight: Maximum Landing Weight

Landing (wet): 6,300 feet

Landing (medium breaking action): 8,600 feet

While the wet takeoff length has been chosen as the required runway length for narrow body Delta aircraft, it should be noted that the ice takeoff and medium breaking action lengths (9,400 feet and 8,600 feet respectively) are longer than the wet takeoff length. Because of the winter weather conditions experienced in Duluth, it is likely that aircraft will operate in these conditions and it is beneficial that Runway 9/27, with published ILS approaches, accommodates these lengths.

4.3.2.1.3 F-16 Fighting Falcon (Minnesota Air National Guard)

No adjustments to the F-16 runway length requirements have been included since the MnANG has indicated that 8,000 is the required length. A temporary length of as low as 7,000 feet is possible in temporary conditions, such as short-term runway maintenance. A length of 7,000 feet can also be used in emergency situations.

4.3.2.1.4 Runway Length Recommendation

Based on the existing and future forecasted family of aircraft expected to regularly use DLH, it is recommended that Runway 9/27 be, at a minimum, 7,900' to accommodate the family of general aviation aircraft that makeup the 100% of fleet at 90% useful load. This length also will support the most demanding commercial service aircraft, the grouping of narrow body aircraft as represented by the data provided by Delta Air Lines.

Additionally, the MnANG currently operate their F-16's on Runway 9/27. For regular use, the MnANG requires 8,000' and therefore, Runway 9/27 should remain at least ,8,000 feet long.

Runway 9/27 was reconstructed in multiple phases in 2016 through 2019. At the time of reconstruction, it was determined that maintaining the existing runway length was more cost effective and had less environmental impacts than reconstructing to the shorter eligible and justified (7,900 feet) or needed (8,000 feet). ***It is recommended that Runway 9/27 remain at its current length.*** The pavement is in excellent condition and the useful life (30+ years) will extend beyond this Master Plan. At the time of the next reconstruction, the runway length requirements should be reevaluated.

4.3.2.2 Runway Width Recommendations

Runway 9/27 is 150 feet wide, which meets the RDC C-III with visibility minimums lower than 1/2-mile standard of 150 feet. ***Runway 9/27's width meets FAA standards; therefore, no change in runway width is recommended.***

4.3.2.3 Runway Designation

Aircraft compasses and runway identifiers utilize magnetic north for directional guidance. For this reason, it is important to evaluate an airport's runway number designations every few years to ensure that the published runway numbers represent the magnetic heading of the runway. Magnetic forces are constantly shifting, and therefore a declination must be applied to a compass to arrive at a true north heading. The current declination is used to determine the runway designation calculations. According to the National Geophysical Data Center, as of March 23, 2020, the current declination for Duluth, MN is 1°1' West with an uncertainty of 0°26' and is changing by 0°2' west per year.

The current true bearing for Runway 9/27 is North 92°15'20.8760" West. Applying the declination of 1°1' west to the true bearing results in a magnetic heading of 91°14'20.87" for Runway 9 and 271°14'20.87" for Runway 27. ***No change in runway designation is recommended for Runway 9/27.***

4.3.2.4 Runway Pavement Strength

The civilian critical aircraft for DLH is the Airbus A319, which has a Max Takeoff Weight (MTOW) of 166,000 pounds. The military critical aircraft is the F-16, which has a MTOW of 37,500 pounds.

Runway 9/27, the primary runway, has a weight-bearing capacity of 94,000 pounds for Single Wheel Gear aircraft, 180,000 pounds for Dual wheel and 650,000 pounds for 2 dual wheels in tandem. The current pavement strength is sufficient for the critical aircraft.

The PCN for Runway 9/27 is 75 / R / C / W / U. The R is for rigid (concrete) pavement, the C is coded for subgrade strength, the W indicates no tire pressure limit and the U indicates that the PCN was calculated using the "Using Aircraft' approach versus the technical approach.

Runway 9/27's pavement strength exceeds the needs of the Critical Aircraft. Additionally, the pavement strength can support the large aircraft that visit DLH. No additional strengthening is recommended.

4.3.2.5 Runway Pavement Condition

Runway 9/27 was last reconstructed in phases between 2016 and 2019 (see **Section 2.9**). The runway was constructed of Portland Cement Concrete and is rated in "excellent" condition according to the pavement condition index study completed by the Minnesota Department of Transportation. ***Routine maintenance, such as joint repair and crack sealing should be performed on a scheduled basis to extend the life of the pavement. No other surface improvements to Runway 9/27 are recommended over the planning period.***

The paved shoulders on Runway 9/27 are constructed of bituminous pavement and were last reconstructed in three (3) phases in 2006, 2007 and 2008. ***The pavement is expected to reach the end of its useful life within the 10-year planning term and should be reconstructed around year 2030.***

Consideration should be given to completing the Runway 9/27 pavement maintenance (joint repair and crack sealing) referenced above concurrent with the phased shoulder reconstruction projects.

4.3.2.6 Runway Marking, Signage and Lighting Recommendations

Runways 9 and 27 are marked with Precision Runway Markings, which include runway centerline, threshold, aiming point, runway designators, touchdown zone and runway edge markings. ***It is recommended that the Airport Authority ensure that any fading, chipping and loss of reflectivity of markings is corrected as soon as practical. No additional recommendations are needed.***

DLH is equipped with a standard airfield signage system which is approached by the FAA through the Airport's Part 139 Certification Inspector. Standard airfield signage provides essential guidance information that is used to identify items and locations on an airport, as defined in AC 150/5340-1M, *Standards for Airport Sign Systems*. A mix of LED and incandescent lights are used in the existing sign system. ***It is recommended that the sign system be updated to LED lighting as signs are replaced. The non-LED signage should be replaced as part of the Taxiway A reconstruction project.***

Runway 9/27 is equipped with a High-Intensity Runway Edge Lighting System (HIRL). The current system was installed in three (3) phases as part of the Runway 9/27 shoulder reconstruction projects – Phases 1, 2 and 3 which were completed in 2006, 2007 and 2008, respectively. The HIRL lighting is in excellent condition. ***The HIRL lighting is in excellent condition. The HIRL lighting system should be rehabilitated or replaced when it reaches the end of its useful life or timed to coincide with the shoulder pavement replacement project. This is expected to occur after year 2031.***

Runway 9/27 is equipped with a standard FAA Centerline Lighting System (CTL). The current LED system was replaced through the multi-phased runway reconstruction project in 2017-2019. ***There are no recommended improvements to the Runway 9/27 centerline lighting system in the planning term.***

The Runway 9 end of the runway (west end) is equipped with a standard LED FAA Touchdown Zone (TDZ) lighting system. The current system was installed in 2017 as part of Phase 2 of the runway reconstruction project. There are no recommended improvements to the Touchdown Zone Lighting system in the planning term.

4.3.2.7 Approach Lighting Systems and Visual Glide Slope Indicators

Runway 9 has an FAA owned and maintained ALSF-2 / SSALR System that was constructed in 2000-2001. Runway 27 has an FAA owned and maintained MALSR System that was installed in 2000. The Runway 27 in-pavement MALSR threshold light bar was replaced in 2019 as part of the Runway reconstruction project. ***There are no recommended improvements to the Runway 9/27 approach lighting systems.***

Both runways have FAA-owned PAPIs installed for visual approaches. During the inventory phase, it was noted that replacement parts for the Runway 27 PAPI are difficult to obtain and nearing the end of its useful life. ***It is recommended that the Runway 27 PAPI be replaced in the near term. The Runway 27 PAPI also does not provide a coincident glide path with the ILS glide slope. The alternatives analysis should evaluate the ultimate location and slope of the PAPI and its ability to provide a coincident glide path.*** A more detailed discussion on the glide slope antenna is included in **Section 4.3.2.10**.

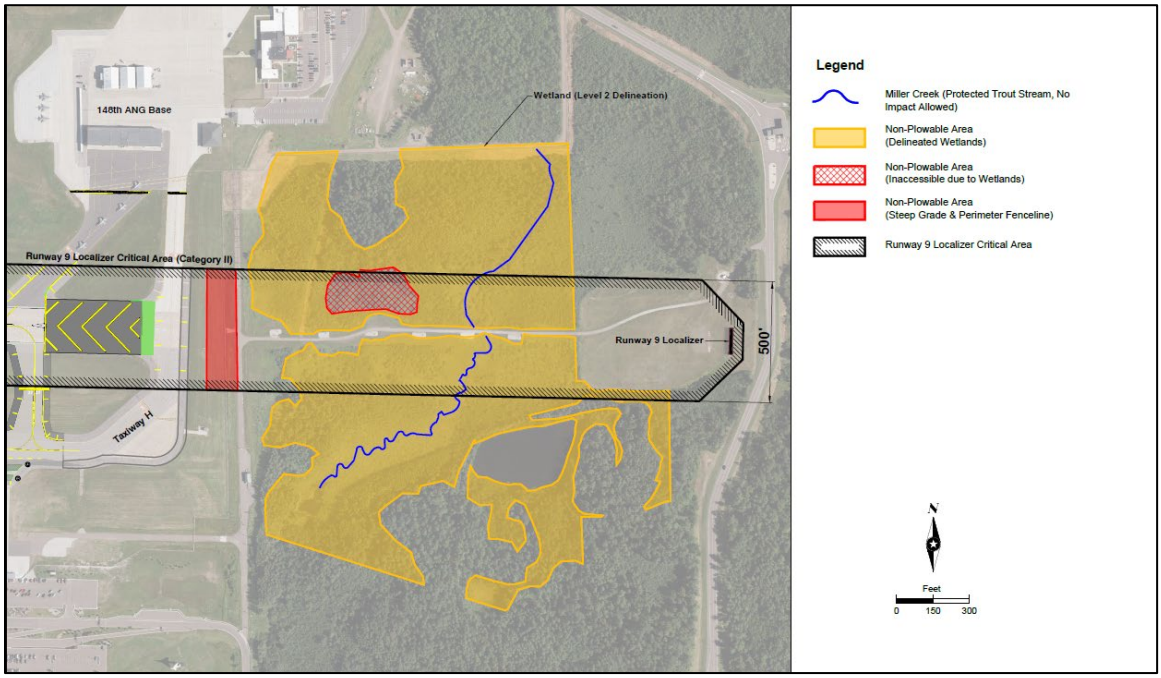
The SASP recommends a minimum of an instrument approach, REILs and VGSI[4] be installed on primary runways for key commercial service airports. The approach lighting installed for Runway 9 and 27 exceeds the minimum within the SASP.

4.3.2.8 Runway 9 Localizer

The Runway 9 localizer, owned and maintained by the FAA, is currently located in a location that affects the localizer's reliability. The localizer platform was rebuilt in 2016 to improve the reliability of the signal. Since that time, reliability issues continue. The signal can degrade due to snow accumulation in the critical area.

Although removal of snow in this area could mitigate the signal issues, this area is largely wetland and impassable by snow removal equipment and the ground in this area does not freeze sufficiently to support snow removal equipment. The unplowable areas are, as depicted below in **Exhibit 4-1** can cause the ILS to become unusable and frequent outages continue to be experienced.

Exhibit 4-1 – Restricted Plowing Zones



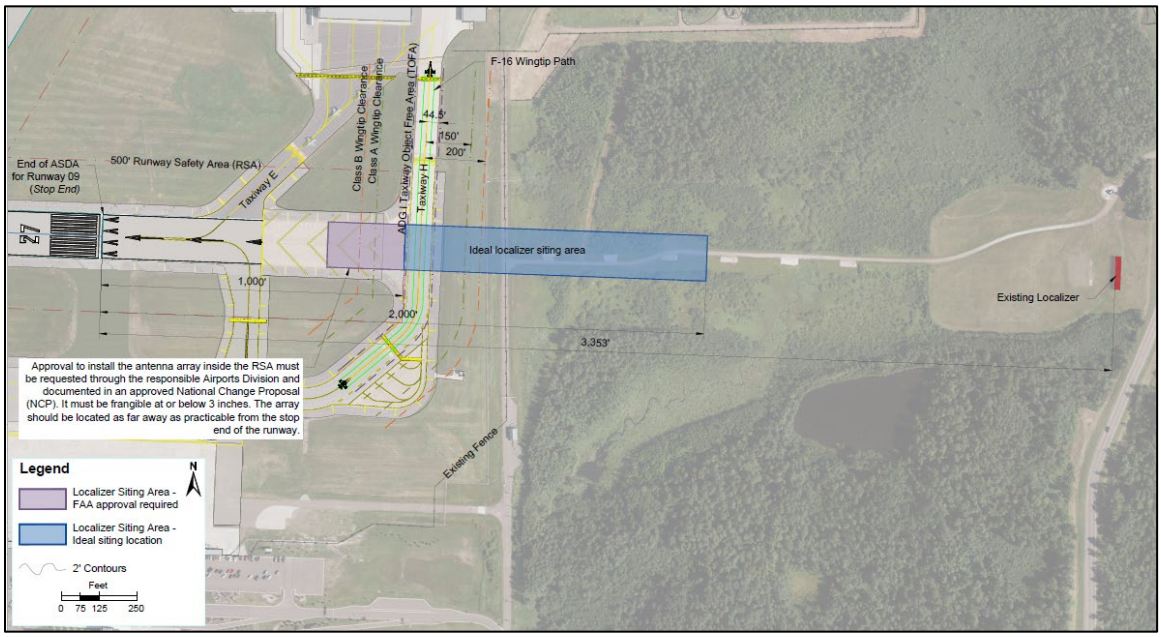
Taxiway H crosses the extended runway centerline off the departure end of Runway 9 and passes through the localizer critical area. Feedback from the 148th Air National Guard indicated that Taxiway H must have a 200' taxiway centerline to fixed or moveable object clearance area where pavement is exclusively used by military aircraft (UFC 3-260-0-1 requirements).

According to FAA Job Order 6750.16E, the localizer must be located at least 1,000 feet beyond the runway stop end if a graded area is obtainable. If a significant signal advantage can be obtained, a maximum distance of up to 2,000 feet from the runway stop end is allowable (note the existing localizer is 3,350 feet

[4] PAPIs provide color-coded descent guidance to a runway.

from the runway stop end). The Localizer should remain clear of the RSA and all applicable TERPs surfaces. **Exhibit 4-2** below depicts the existing localizer location along with the described ideal siting location.

Exhibit 4-2 – Localizer Siting Criteria



Two alternatives were evaluated for a future localizer antenna for Runway 9 based on the criteria described above. These two alternatives are shown in **Figure 4-1** and described below.

- **Alternative 1:** Relocate closer to the Runway 27 end, but locate the localizer outside of the UFC required wing tip clearance area for Taxiway H. This alternative includes relocating the localizer to an upland area in the approximate location of a former vehicle road. This road location is a lower elevation than the runway environment and would still require a tall localizer structure. UFC requirements for wingtip clearances are substantially larger than that of the FAA's Object Free Area (OFA) requirements.
- **Alternative 2:** This alternative considers options that would be available if Taxiway H were removed. a taxiway network alternative is chosen as the preferred alternative which provides a new connector taxiway (with a standard grade) into the Guard ramp. The removal of Taxiway H provides an opportunity for the localizer antenna to be placed in that location, as depicted on **Figure 4-1**. The geometric changes that would be part of this overall alternative would improve safety on the Runway 27 end, reducing pilot deviations that result from the runway geometry that includes Taxiway H.

It is recommended that FAA TechOps evaluate alternative locations that provide a standard localizer siting location and commence with moving the relocation to ensure that the localizer and ILS are reliable and usable by users of the airport. Alternative location 1 should be depicted on the ALP as it provides a near-term opportunity for relocation with Taxiway H remaining in its current location.

4.3.2.9 Runway 9 Glideslope Antenna and Critical Area

Runway 9 has a published ILS CAT-II approach. The glideslope antenna for the ILS approach is located on the left side of the runway approximately 1,000' from the runway threshold. The glideslope antenna has a NAVAID critical area which ensures there is no interference with the radio signals and is important that the critical area be cleaned of snow during the winter months. This ensures the reliability and accuracy of the

glideslope signal. It was noted by airport staff that, during the clearing of snow from the critical area, vehicle damage can occur due to ground conditions.

Therefore, it is recommended that the glideslope critical area for Runway 9 be paved to ensure AIP funded vehicles can safely operate in the area and avoid vehicle damage.

4.3.2.10 Runway 27 Non-Standard Threshold Crossing Height

The Runway 27 ILS approach has a non-standard threshold crossing height (TCH) of 80 feet. In addition, the PAPI and glideslope paths are non-coincidental[5] and the TCH for the PAPI is 91 feet, both factors are non-standard. The TCH varies with the height group of aircraft that primarily use the runway. **Table 4-5** shows the TCHs for each height group of aircraft.

Table 4-5 – Aircraft Threshold Crossing Height

Height Group (HG)	Representative Aircraft Type	Glidepath-to-wheel Hight (approximate)	Recommended TCH[12]	Visual Threshold Crossing Height	Remarks
HG 1	GA aircraft small commuters, Corporate TurboJets, T-38, C-12, C-21, Fighter Jets	10’ or less	40’	40’ (+5, -20)	Normally runways < 6,000’
HG 2	F-28, B-737, DC-9, C-2	15’	45’	45’ (+5, -20)	Regional airport with limited air carrier service
HG 3	B-727/707/720/757, C-135, C-17	20’	50’	50’ (+5, -15)	Runways not normally used
HG 4	B-747/767/777, DC-10, A-300	25’	55’	75’ (+5, -15)	Most primary runways at major airports

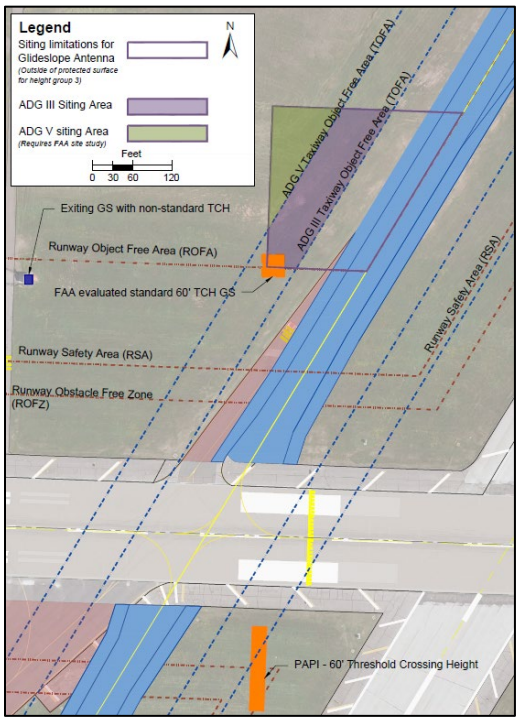
Notes: [1]To determine the minimum allowable TCH, add 20 feet to the glidepath-to-wheel height and to determine the maximum allowable TCH, add 50 feet to the glidepath-to-wheel height (not to exceed 60 feet).

Source: FAA Order 8260.3D, Table 10-1-1; FAA Advisory Circular 150/5340-30J, Table 7-1

The TCH for a runway is ultimately determined by FAA Flight Producers. Due to the length of Runway 9/27 and the large aircraft that frequent DLH, the FAA has indicated that the TCH must meet the requirements of height group 4. These FAA requirements will need to be met. The FAA funded a glideslope siting study in 2017 and had positive findings for a location that provided a 60’ TCH for Runway 27. This location was feasible following the realignment of Taxiway C (ADG III, per current ALP). Additional studies would be required for alternative locations or new taxiway layout. **Exhibit 4-3** shows the location of a future glideslope and the comparison of object free areas for Taxiway C. Therefore, ***it is recommended taxiway and runway alternatives will be designed to correct the non-standard TCH for Runway 27, with a TCH of 60-feet as well as provide a coincident glide paths between the PAPI and Localizer.***

[5] Does not happen or exist at the same time

Exhibit 4-3 – Runway 27 Glideslope Siting Location



4.3.2.11 Runway 9/27 Declared Distances

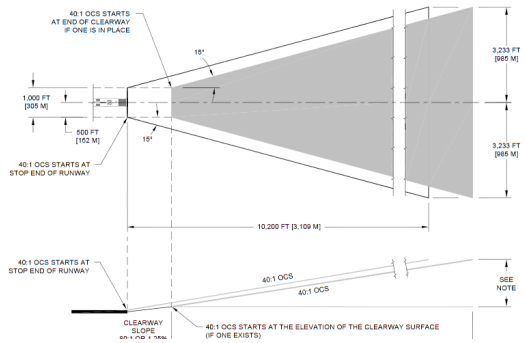
A multi-year, multi-phase Runway 9/27 reconstruction project was completed in the summer of 2019. The project corrected two previous Hot Spots and several non-standard design features on the approach end of Runway 27.

During the planning and design phases of this project, the TERP's 40:1 Departure Surface was 1,000' x 10,200' x 6,466'. To mitigate congestion on Taxiway A in front of the commercial service terminal apron, a clearway was added to Runway 9 to move the departure surface away from the terminal apron to the eastern edge of Taxiway H, allowing aircraft to hold on Taxiway A in front of the terminal and along Taxiway E and H between the Runway and the 148th Fighter Wing. Typically, a clearway is used to add takeoff distance without increasing the total runway length to accommodate heavier aircraft and their performance needs.

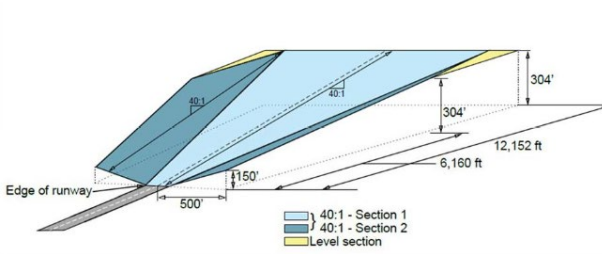
The use of a clearway and the resulting lengthened TODA eliminated confusing holding locations along Taxiway A prior to the Runway 27 end. Additionally, it improved the operational usability of Taxiway A east of Taxiway A5 and Taxiway H as these pavement areas were no longer within the Departure Surface.

On July 24, 2020, Engineering Brief (EB) 99A was issued by the FAA, updating TERPs Approach and Departure surfaces. The previous 40:1 Departure Surface and the updated EB99A Instrument Departure Runway Obstacle Clearance Surface are shown below. The update changed the dimensions and elevations of the Departure Surface, the new Row 7 Departure surface is depicted below. The new Section 1 surface begins at the runway end (or end of clearway if there is one) and is the width of the runway, as opposed to 1,000 feet wide. An additional Section 2 transitional surface extends upward from the edges of Section 1 at a 40:1 slope. The previous clearway and location was based on the previous Departure Surface standards. The new dimensions provide an opportunity for reanalysis as part of this Master Plan effort.

AC 15/5300-13A (Figure 3-4) 40:1 Departure Surface
(No longer standard following the release of EB99A)

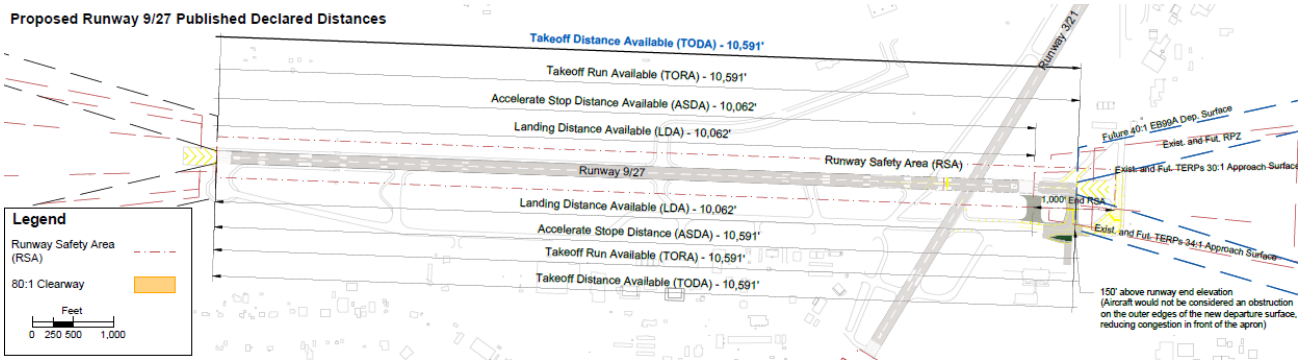


Engineering Brief 99A Row 7- Instrument Departure Runway Obstacle Clearance Surface



Declared distances should only be used where it is impracticable to meet the airport design standards or mitigate the environmental impacts by other means, and the use of declared distances is practical. Due to the revised guidance in EB99A, ***it is recommended that the 80:1 Clearway be removed from the Airport Layout Plan and the declared distances be updated to reflect the removal of the Clearway.*** The removal of the clearway would result in the published Takeoff Distance Available (TODA) be the same as the Takeoff Run Available (TORA). The proposed declared distances for Runway 9/27, with the removal of the clearway, depicted below in **Exhibit 4-4**. The declared distances should be updated through NFDC once the ALP is approved. No airfield or other physical changes are required to initiate the declared distance change.

Exhibit 4-4 – Ultimate Runway 27 Approach End Declared Distances



4.4 Runway 3/21 Facility Recommendations

4.4.1 Runway Design Code (RDC)

Section 2.13 discussed the wind analysis for DLH using the ASOS data from the previous 10 years. According to the wind data, Runway 3/21 is eligible and justified to be considered a crosswind runway for A-I/B-I aircraft, as outlined in FAA Order 5100.38D, Change 1, *Airport Improvement Handbook (*wind coverage for these aircraft is below 95%). However, based on conversations with stakeholders and the Air Traffic Control Tower, Runway 3/21 is utilized for approximately 31% for all arrivals, and 25% of jet operations utilize Runway 3/21. DLH has an Air Traffic Control tower that ultimately decides which runway to designate as '*in use'* based on current wind direction, operations being conducted at the airport and in the local airspace.

Table 4-6 shows the percentage of operations, grouped by RDC, that occur to Runway 3/21 based on input from the ATCT. In this analysis it is assumed that all aircraft larger than a C-III operate 100% of their operations on Runway 9/27 due to runway length and width needs. However, C-III aircraft frequently use Runway 3/21 at DLH when it is in use. Military operations are excluded from operation counts in **Table 4-6**.

Table 4-6 – Runway 3/21 Usage Operation Counts

RDC	% of Total Operations	Runway 3/21 Operations (31% of total operations)			
		2018 (58,426 Total Ops) (18,112 – 3/21 Ops)	2023 (62,549 Total Ops) (19,390 – 3/21 Ops)	2028 (66,182 Total Ops) (20,516 – 3/21 Ops)	2038 (73,117 Total Ops) (22,666 – 3/21 Ops)
A/B-I	37.4%	6,767	7,244	7,665	8,468
A/B-II	12.6%	2,276	2,437	2,579	2,849
A/B-III	3.3%	600	642	679	750
C/D/E-I	1.5%	277	296	313	346
C/D/E-II	34.7%	6,279	6,722	7,113	7,858
C/D/E-III	**10.0%**	**1,815**	**1,943**	**2,056**	**2,272**
C/D/E-IV	0.1%	-	-	-	-
C/D/E-V	0.0%	-	-	-	-

Notes: Due to the length of Runway 3/21 it is assumed larger commuter and air carrier aircraft would use Runway 9/27

Source: L&B Forecast, FAA Traffic Management Flow System Counts (TFMSC) for DLH January 2019 through December 2019

Based on runway usage estimated from the Air Traffic Control Tower and stakeholder input, more than 500 C-III operations occur annually on Runway 3/21, therefore, ***it is recommended that Runway 3/21 be designed to RDC C-III standards to meet the critical aircraft needs as defined in Chapter 3.***

Due to the constraints of the perimeter road, public roadways, the location of the terminal and pending updates to the airport safety zoning ordinance, ***it is recommended Runway 3/21 maintain a not lower than 1-mile approach.*** As part of the Master Plan process, the Technical Advisory Committee (TAC) for Runway 3/21 did not recommend improving the approaches to include minimums of lower than 1 mile (see **Appendix A**). The TAC concluded that because periods of low visibility are often in low-wind conditions, the value did not outweigh the costs of improving the visibility minimums. Additionally, Runway 9/27 provides instrument procedures with minimums as low as ½ mile with 200-foot ceilings. During periods of low visibility in DLH, there is frequently low wind conditions, lessening the need to utilize the crosswind runway.

Table 4-7 identifies the C-III design standards for Runway 3/21 with visibility minimums not lower than 1 mile (see Table A7 AC 150/5300-13A).

Table 4-7 – Runway 3/21 Runway Design Standards

AC 150/5300-13A, Table A7-9, Runway Design Standards Matrix			
Visibility Minimums: Not Lower Than 1 Mile			
Airfield Component	**FAA ARC (Civilian) C-III Standard**	**Actual Condition**	**C-III Design Standard Met (✓)**
Runway Width	150’	150’	✓
Runway Shoulder Width	25’	None	(see note)
Runway Blast Pad Width	**200’**	**None**	**No**
Runway Blast Pad Length	**200’**	**None**	**No**
RSA Width	500’	500’	✓
RSA Length Prior to Threshold	600	600	✓
RSA Length Beyond Rwy End	1,000’	1,000	✓
OFA Width	800’	800’	✓
OFA Length Beyond Rwy End	1,000’	1,000’	✓
OFA Length Prior to Threshold	600’	600’	✓
OFZ Width	400’	400’	✓
OFZ Width Beyond Rwy End	200’	200’	✓
Rwy to Twy CL Separation	**400’**	**580’ – 275’**	**No**
Rwy CL to Holdline Separation	**265’**	**170’ – 265’**	No
Rwy CL to Aircraft Parking	500’	600’	✓

Abbreviations:
Rwy – Runway Twy – Taxiway CL – Centerline RSA – Runway Safety Area OFA – Object Free Area OFZ – Obstacle Free Zone
Note: Partial runway shoulder at the Runway 9/27 intersection.

Source: AC 150/5300-13A

As shown in the table above, several design standards are not achieved to meet C-III not lower than 1-mile standards. This includes the lack of a blast pad on both runway ends and insufficient runway centerline to taxiway centerline separation and runway centerline to hold line distance. Taxiway C currently serves as the parallel taxiway for Runway 3/21 and is need of reconstruction in the near term. ***A blast pad should be constructed on both ends of Runway 3/21 and Taxiway C should be relocated to meet the required runway to taxiway separation standards.***

In addition, Taxiway C and Runway 3/21 are utilized as a taxi route for large (ADG IV and V) aircraft to access the 148th Fighter Wing via Taxiway F. The insufficient runway centerline to hold line and taxiway separation also negatively impacts the ability for an efficient taxi route as the ATCT must manage wing tip restrictions in certain areas under certain conditions. Alternatives will be developed to meet C-III standards and are evaluated further in **Section 4.10**.

The runway surface gradients (longitudinal and transverse) that are applicable for Runway 3/21 profile and cross-section design are as shown in Figures 3-22 and 3-23 in FAA Advisory Circular 150/5300-13A (2/26/2014). The FAA has previously provided guidance allowing the superelevation condition over the eastern portion of Runway 9/27 to remain which includes the intersection of Runway 3/21. Runway 3/21 has been tied into the superelevation of 9/27; however, the runway itself is not super elevated.

4.4.2 Runway Length Recommendation

As discussed in **Section 4.3.2**, **t**he purpose of the runway length analysis is to determine if the length of the existing runways are adequate for existing and projected aircraft fleet operations at DLH.

Crosswind Runway 3/21 is currently 5,719 feet long by 150 feet wide. Runway 3/21 has a critical aircraft of C-III and should be designed to C-III standards as outlined in this chapter.

As outlined in FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*, when the design objective o orient primary runways (Runway 9/27 at DLH) to capture 95 percent of the crosswind component perpendicular to the runway centerline for any airplane forecast to use the airport is not achievable, a crosswind runway is recommended. The AC also acknowledges that even when the 95-percent crosswind coverage standard is achieved for the design airplane, a lower crosswind capable aircraft (smaller aircraft) may not be able to utilize the primary runway. A crosswind runway may be built for aircraft with lesser crosswind capabilities, provided there is regular use. For federally funded (AIP funded) projects, the criterion for substantial use applies to the aircraft needing the crosswind runway.

Section 2.13 analyzed the 10-year wind pattern and crosswind limitations of both runways at DLH. This analysis indicated that Runway 9/27 provides adequate wind coverage for crosswind components of 13 knots and higher. Based on the crosswind capabilities of different sizes of aircraft, Runway 9/27 provides adequate crosswind coverage for A/B-II and larger aircraft. Therefore, Runway 3/21 should be classified as a crosswind for A/B-I small aircraft with a crosswind limitation of 10.5 knots.

based on conversations with stakeholders and the Air Traffic Control Tower, Runway 3/21 is utilized for approximately 31% for all arrivals, and 25% of jet operations utilize Runway 3/21. This results in over 1,800 C-III operations annually on Runway 3/21 (see **Table 4-6**). Runway 3/21 should continue to serve the runway length needs of the existing fleet using the runway. Based on runway usage estimated from the Air Traffic Control Tower and stakeholder input, more than 500 C-III operations occur annually to Runway 3/21. Therefore, the critical aircraft for runway length should be determined by evaluating the lengths required for the family of C-III aircraft that DLH normally sees.

4.4.2.1 Runway Length Recommendation

It is recommended that Runway 3/21 be 8,000 feet to accommodate 100% of fleet for GA jets (7,900 feet needed), the family of Delta narrow body jets which also represents the critical aircraft of the Airbus A319 (7,800 feet needed) and the runway length needs of the F-16 fighter jets on a periodic basis.

While the existing runway does not fully meet this need, aircraft including GA jets in the 100% of fleet and the A-319 family of aircraft are capable of operating on the runway in certain conditions as evidenced by the existing operations count. However, the existing length does limit the full usability to these aircraft. For example, during the center section phase of Runway 9/27 reconstruction project, Runway 3/21 was the only available runway. Delta and United both reported that the runway length often restricted their payload, including number of passengers, throughout the construction period due to insufficient runway length. Additionally, Air Canada (which operated A-319 family aircraft at DLH to utilize the MRO facility during 9/27 construction) also stated that the runway length of Runway 3/21 was insufficient to conduct any operations of their A-319 family aircraft.

Because runway 3/21 is larger than the eligible and justified needs for an A-I/B-I aircraft, maintaining the existing crosswind runway infrastructure will need to be justified at the time of reconstruction to utilize AIP funding. While the airport should plan for the runway extension to 8,000 feet, a funding source must be identified to proceed with the extension as the extension is not eligible or justified or AIP (FAA) funding. The runway extension should be depicted on the ALP to ensure the proper planning is in place to complete the extension. However, it should be shown in the ultimate (beyond 20-year) timeframe as a funding source has not been identified.

4.4.3 Runway Width Recommendations

Runway 3/21 is currently 150 feet wide, which meets RDC C-III design standards with visibility minimums not lower than 1-mile standard. ***Runway 3/21's existing width meets the corresponding FAA standards for C-III runways; therefore, no change in runway width is recommended.***

4.4.4 Runway Designation

Aircraft compasses and runway identifiers utilize magnetic north for directional guidance. For this reason, it is important to evaluate an airport's runway number designations every few years to ensure that the numbers painted on the runway truly represent the magnetic heading of the runway. The magnetic forces across the planet are constantly shifting, and therefore a declination must be applied to a compass to arrive at a true north heading. The current declination is used for the runway designation calculations. According to the National Geophysical Data Center, as of March 23, 2020, the current declination for Duluth, MN is 1°1' West with an uncertainty of 0°26' and is changing by 0°2' west per year.

The current true bearing for Runway 3/21 is North 31°32'51.1159" East. Applying the declination of 1°1' west to the true bearing results in a magnetic heading of 30°25'51.12" for Runway 3 and 210°24'51.12" for Runway 21. ***No change in runway designation is recommended for Runway 3/21.***

4.4.5 Runway Pavement Strength

The civilian critical aircraft for DLH is the Airbus A319, which has a Max Takeoff Weight (MTOW) of 166,000 pounds. The military critical aircraft is the F-16, which has a MTOW of 37,500 pounds.

Runway 3/21 has a weight-bearing capacity of 52,000 pounds for Single Wheel Gear (SWG) aircraft, 100,000 pounds for Dual Wheel aircraft and 361,000 pounds for 2 Dual Wheels in Tandem. ***Runway 3/21's pavement strength meets the needs of the Critical Aircraft; no additional strengthening is recommended. At the time of full reconstruction, the use of the runway as a taxi route for large aircraft accessing the 148th Fighter Wing via Taxiway F should be considered when determining the required pavement strength of Runway 3/21 during design***

4.4.5.1 Runway Pavement Condition

Pavement condition ratings were taken from the 2018 MnDOT Airport Pavement Management Study (see **Section 2.9**). The 2018 study found that, in general, runway pavement was either in "Very Good" or "Excellent" condition. Following the reconstruction of Runway 9/27 and Taxiway A5 (reconstructed in phases between 2016 and 2019).

Runway 3/21 received its last major rehabilitation in 2009. The bituminous runway is in "good" to "very good" condition according to the 2018 pavement condition index study completed by the Minnesota Department of Transportation. The runway is experiencing longitudinal and transverse cracking, weathering, and raveling of the bituminous surface. According to the report, the pavement is dropping approximately 2.0 PCI points per year, and a major rehabilitation of the pavement will be required in about 7 years. A major rehabilitation could consist of a mill and overlay of the existing pavement to improve surface condition. By performing this rehabilitation, it is expected the runway will achieve another 10-12 years of useful life and will ultimately require reconstruction around year 2040.

4.4.6 Runway Markings, Signage and Lighting

Runway 3 and Runway 21 are marked with non-precision runway markings, which include centerline, threshold, aiming point and runway designator markings. ***It is recommended that the Airport Authority ensure that any fading, chipping and loss of reflectivity of markings is corrected as soon as practical. No additional recommendations are needed.***

DLH is equipped with a standard airfield signage system which is approached by the FAA through the Airport's Part 139 Certification Inspector. A mix of LED and incandescent lights are used in the existing sign system. ***It is recommended that the sign system be updated to LED lighting as signs are replaced***

Runway 3/21 is equipped with a High Intensity Runway Edge Lighting System (HIRL). The current lighting system is manufactured by ADB and is over 25 years old and. Based on the current and planned instrument approach procedures for Runway 3/21 (visibility minimums > 1 mile), only Medium Intensity Runway Edge Lighting (MIRL) is required. When the lighting system is replaced, the airport should consider installation of MIRLs in place of HIRLs to match the runway category and use. Parts for the existing runway lights are no longer available from the manufacturer. Since the parts for the HIRL lighting system for Runway 3/21 are limited and the lighting system is nearing the end of its useful life, ***it is recommended the Runway 3/21 edge lighting be replaced with LED lighting when funding is available.***

Runway Centerline and Touchdown lighting systems are required for runways with published ILS CAT II and CAT III instrument approaches and for CAT I runways used for landing operations below 2,400' Runway Visual Range (RVR). Based on stakeholder needs and feedback, ***no centerline lights or touchdown lighting system are needed based on the existing and future instrument approach procedures.***

4.4.7 Approach Lighting Systems

The SASP recommends a minimum of an instrument approach, REILs and a VGSI[6] be installed on primary runways for key commercial service airports. Runway 3/21 is not classified as a primary runway at DLH. Both ends of Runway 3/21 are equipped with REILs. The REILs for Runway 21 were replaced in 2020 with LED lights. The Runway 3 REILS are owned and maintained by the FAA. ***The airport should coordinate with the FAA to determine if the Runway 3 REILs should be replaced as part of the Runway 3/21 lighting replacement project.***

Runway 3 and Runway 21 are both equipped with PAPIs which are owned and maintained by the FAA. ***No improvements are needed to the Runway 3 or 21 PAPIs; however, the airport should continue to coordinate with FAA Tech Ops to plan for future replacement when they reach the end of their useful life.***

Stakeholders on the Runway 3/21 TAC indicated that an approach lightning system to one or both ends of Runway 3/21 would be beneficial. ***The TAC recommended planning for approach lighting on one runway end***. While the approach lighting would provide an additional aid to pilots, it will not be eligible or justified for AIP (FAA) funding as it is not needed for the planned instrument approach procedures. An alternate funding source will be needed to implement this improvement. Runway alternatives will include options for the installation of an approach lighting system to one runway end.

4.4.8 MnDOT Clear Zone Requirements

MnDOT Aeronautics requires airports to have adequate Clear Zones in place to restrict land uses that may be hazardous to the operational safety of aircraft and to protect life and property in the runway approach areas. Clear Zone requirements are documented in MnDOT Aeronautics Policy Statement No. 1, Clear Area Requirements. To meet MnDOT Aeronautics' Clear Zone requirements, the recommended Clear Zones for

[6] PAPIs provide color-coded descent guidance to a runway.

existing runway conditions are shown in **Table 4-8** and are shown in **Figure 2-5**. ***The Airport currently owns the land in fee underneath the Clear Zones of each runway,*** it is recommended the Airport have plans to acquire all land through fee within the MnDOT Clear Zones if a runway end is moved or approach minimums change and the land underneath the Clear Zone is not owned in fee.

Table 4-8 – MnDOT Clear Zone Dimesons and Slopes

Runway	MnDOT Clear Zone	Inner Width	Length	Outer Width	Slope
Existing and Future 9/27	Precision Runway	1,000’	2,500’	1,750’	50:1
Existing and Future 3/21	Non-precision instrument other than utility (Greater than ¾-Mile visibility)	500’	1,700’	1,010’	34:1

Source: MnDOT Office of Aeronautics: Clear Zone Requirements

4.4.9 Wind Coverage and Runway Orientation

A runway’s orientation is its alignment in relation to magnetic north. The primary factor when determining runway orientation is the direction of the prevailing winds. Each aircraft has an acceptable crosswind component for takeoff and landing. Generally, the smaller the aircraft, the more it is affected. Per FAA AC 150/5300-13A, *Airport Design*, when the current runway system provides less than 95% wind coverage for any aircraft that use the Airport on a regular basis, a crosswind runway should be considered. The 95% coverage is computed on the basis of the crosswind not exceeding 10.5 knots for RDC A-I and B-I; 13 knots for RDC A-II and B-II; **16 knots for RDC A-III, B-III, and C-I through D-III;** and 20 knots for RDC A-IV through D-VI. For DLH, the runway configuration needs to accommodate, at minimum, a C-III aircraft, having a crosswind component not exceeding 16 knots.

Wind data for this analysis was collected through the National Oceanic and Atmospheric Administration (NOAA) from the ASOS located at DLH from 2009 to 2018 **Table 4-9** shows the wind coverage for the existing runways at DLH.

Table 4-9 – DLH Wind Coverage

		10.5 knots	13 knots	16 knots	20 knots
Runway 9/27[1]	All Weather	91.1%	95.7%	99.04%	99.87%
	VFR	90.95%	95.69%	99.11%	99.89%
	IFR[3]	92.18%	96.06%	98.93%	99.83%
Runway 3/21[2]	All Weather	79.3%	87.85%	96.2%	99.21%
	VFR	80.54%	88.64%	96.58%	99.28%
	IFR[3]	78.09%	86.89%	95.55%	99.09%
Combined	All Weather	96.07%	98.92%	99.79%	99.99%
	VFR	95.93%	98.91%	99.81%	99.99%
	IFR[3]	96.65%	98.98%	99.77%	99.98%

[1]: Calculated based on Runway 9/27 with a true bearing of 92°.

[2]: Calculated based on Runway 3/21 with a true bearing of 32°.

[3]: IFR Weather: Ceilings below 1,000’ AGL and/or visibility less than 3 miles

Source: Duluth International Airport ASOS. 2009 to 2018. Obtained from the National Climatic Data Center.

Adequate crosswind coverage is not provided by Runway 9/27 for A-I/B-I aircraft. However, when both runways are combined, adequate wind coverage is provided. The critical aircraft at DLH is C-III aircraft and the crosswind component should not exceed 16 knots. The combined wind coverage for Runway 9/27 and

Runway 3/21 exceeds the FAA minimum wind coverage of 95%, and therefore, ***no improvement is recommended.***

It should be noted that DLH has a 24-hour air traffic control tower (ATCT) and runway assignments to aircraft are ultimately decided by the ATCT based on the wind at the time of arrival or departure.

4.4.10 Airfield Capacity Analysis

The methodology for computing the relationship between an airport's demand versus its capacity is discussed in FAA Advisory Circular (AC) 150/5060-5, *Airport Capacity and Delay*. The method included in AC 150/5060-5 is derived from computer models used by the FAA to analyze airport capacity and reduce delay at larger air carrier facilities.

4.4.10.1 Theoretical Hourly Capacity

In order to facilitate a comparison, the hourly capacity of the Airport in Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) conditions was calculated. The determinations were made using the assumption recommended in AC 150/5060-5 for the particular airport layout and conditions combined with the forecast operational data generated with this study. For the theoretical airport hourly capacity, it was calculated that about 62% of the aircraft using DLH have a maximum gross takeoff weight of 12,500 pounds or more, and the peak hour movement consists of 50 percent arrivals and 50 percent departures.

The result of this analysis indicates that, with the two-runway configuration, DLH has an airfield theoretical hourly capacity of 77 aircraft in VFR conditions and 56 aircraft in IFR conditions.

4.4.10.2 Annual Service Volume

The Annual Service Volume (ASV) is a calculated estimate of an airport's annual capacity in aircraft operations. FAA AC 150/5060-5, *Airport Capacity and Delay* specifies the method used to calculate ASV, and considers the difference in runway use, aircraft mix, and weather conditions, as well as other factors that be encountered over a year's time.

For this analysis, based on the weather data collected from DLH's AWOS (see **Section 2.13**), it was assumed that weather conditions dictate IFR about 25% of the time, and that the Airport is not usable (weather conditions below published minimums) approximately 1% of the time. Based upon the assumptions stated above, DLH's ASV is approximately 215,000 annual operations.

4.4.10.3 Summary of Airside Demand/Capacity Relationship

The comparison of an airport's demand versus its capacity is critical in determining the need and timing of capacity related improvements. A summary of the airport's demand/capacity relationship is presented in **Table 4-10**.

Table 4-10– Summary of Demand/Capacity Relationship

Year	Annual Operations	Percentage of ASV
2018	62,600	29.1%
2023	67,046	31.2%
2028	71,026	33.0%
2038	78,739	36.6%

Source: SEH

The forecasted operations at DLH in the year 2038 is projected to be 78,739, or 36.6 percent of the current ASV. The FAA has guidelines which dictate when to identify necessary steps as demand reaches the following levels.

- 60 percent of ASV: The threshold at which planning for capacity improvements should begin.
- 80 percent of ASV: The threshold when planning for improvements should be complete and construction should begin.
- 100 percent of ASV: The airport has reached the total number of annual operations (demand) the airport can accommodate, and capacity improvements should be made to avoid costly delays.

By comparing the relationship between the airport's theoretical demand and its capacity, the hourly and annual capacities of the runway system at DLH exceed the operations forecasted for the 20-year planning period. Generally speaking, capacity improvements would need to be planned for when the ASV reaches 60% to 75%. Therefore, ***no airfield improvements are needed on the basis of capacity.***

4.5 Navigational Aid Recommendations

Table 4-11 lists the NAVAIDs that support aircraft operations at DLH. A Memorandum of Agreement (Agreement Number DTFASW-10-L-00092) exists between the FAA and the DAA, which allows the FAA to establish, operate and maintain FAA owned navigation, communication, and weather aid facilities. The Memorandum of Agreement includes facility sites, critical areas, and access routes/roads.

Table 4-11 – Runway NAVAIDs and Ownership

Runway	NAVAID	Ownership
9	ALSF-2	FAA
	Localizer	FAA
	Glide Slope Antenna	FAA
	Inner Markers	FAA
	Outer Marker	FAA
	RVR Visibility Sensors	FAA
	PAPI	DAA
27	MALSR	FAA
	Localizer	FAA
	Glide Slope Antenna	FAA
	Middle Marker	FAA
	Outer Marker	FAA
	PAPI	DAA
3	REIL	FAA
	PAPI	FAA
21	REIL	DAA
	PAPI	FAA
Note: A 2,000' x 400' localizer critical area is designed based on the critical aircraft of an Airbus A320 with a length of 123' and a height of 39'.		

Facility recommendations for runway NAVAID's (PAPI, REIL, MALSR) are discussed in detail in **Section 4.3** for Runway 9/27 and **Section 4.4** for Runway 3/21. This section will discuss facility recommendations for airport NAVAIDs.

4.5.2 Airport Navigational Aids

The MnDOT SASP requires a lighted wind cone and rotating airport beacon at Key Commercial Service Airports. DLH has a rotating airport beacon, which was installed in 2013, and lighted wind cones located near each of the runways, as previously shown in **Figure 2-4**. The wind cones are replaced when needed as fading and tearing occur. ***The airport should continue to maintain the beacon and monitor the need for replacement. Beacon replacement may be needed between 2030 and 2040. The airport should continue to replace wind cones as needed.***

4.5.3 Instrument Approach Procedures

Instrument approach procedures can be broken down into a precision instrument or non-precision instrument approaches. Precision instrument approaches are those approaches that provide both vertical and horizontal guidance to the runway. An Instrument Landing System (ILS) is a common example of a precision approach. Most non-precision approaches have only directional guidance to the runway and can include any combination of the following types of approaches: localizer, RNAV/GPS (area navigation/global positioning system), RNAV/RNP (area navigation/required navigation), NDB (non-directional beacon), and VOR/TVOR (VHF Omni-directional range/terminal VHF Omni-directional range). A TACAN-A (tactical area navigation) is a circling approach with distance measuring (DME) information. The TACAN-A is used by military aircraft, although the DME information is available to civilian aircraft. The newest approach published at airports around the country is a Localizer Performance with Vertical Guidance (LPV) approach. An LPV approach is considered a non-precision approach, yet it provides both horizontal and vertical guidance to pilots. Most LPV approaches require non-precision design standards at an airport.

As previously discussed in **Section 2.11.5** and shown in **Table 4-12** and **Table 4-13**, DLH is currently served by several instrument approach procedures to all runway ends. Instrument approach procedures and associated visibility and ceiling minimums at DLH are summarized below.

Table 4-12 – Runway 9/27 Published Approach Procedures

Runway	Approach	Lowest Available Visibility Minimums[1]	Lowest Available Ceiling Minimums (CM) or Decision Altitude (DA)[2]
9	ILS	½ Mile	200 feet (CM)
	Localizer	½ Mile	600 feet (CM)
	ILS (SA Cat I)	1,400 feet RVR	1,578 feet (DA)
	ILS (Cat II)	1,200 feet RVR	1,528 feet (DA)
	RNAV (GPS)[3]	½ Mile	200 feet (CM)
	HI-TACAN	1 Mile	500 feet (CM)
	TACAN[4]	½ Mile	500 feet (CM)
	ASR	¾ Mile	400 feet (CM)
27	ILS	¾ Mile	200 feet (CM)
	Localizer	½ Mile	500 feet (CM)
	RNAV (GPS) [3]	½ Mile	200 feet (CM)
	ASR	¾ Mile	500 feet (CM)

[1] Forward-looking visibility in miles.
[2] Above Ground Level (AGL) in feet.
[3] Area Navigation (NAV)/Global Positioning System (GPS)
[4] VHF Omni-direction Range (VOR) or tactical area navigation (TACAN) circling approach

Source: U.S. Terminal Procedures October 2019

Table 4-13 – Runway 3/21 Published Approach Procedures

Runway	Approach	Lowest Available Visibility Minimums[1]	Lowest Available Ceiling Minimums (CM) or Decision Altitude (DA)[2]
3	RNAV (GPS) [3]	1 Mile	400 feet (CM)
	VOR or TACAN[4]	1 Mile	400 feet (CM)
	ASR	1 Mile	400 feet (CM)
21	RNAV (GPS) [3]	1 Mile	300 feet (CM)
	VOR/DME or TACAN[4]	1 Mile	500 feet (CM)
	ASR	1 Mile	500 feet (CM)

[1] Forward-looking visibility in miles.
[2] Above Ground Level (AGL) in feet.
[3] Area Navigation (NAV)/Global Positioning System (GPS)
[4] VHF Omni-direction Range (VOR) or tactical area navigation (TACAN) circling approach

The MnDOT SASP recommends that DLH, as a Key Commercial Service Airport, have a precision approach to their primary runway with ½ mile visibility minimums. DLH has several instrument approach procedures to their primary runway and meets the recommended SASP standards for instrument approaches.

As shown in **Table 4-13** the lowest approach minimums for Runway 3/21 are currently 1-mile visibility minimums. Stakeholders indicated that improved approach minimums to Runway 3/21 would not provide meaningful benefit and no improvements to the 3/21 approaches are recommended.

4.5.4 Meteorological Aids

4.5.4.1 ASOS

DLH's existing ASOS is currently located northwest of the Runway 9/27 and Runway 3/21 intersection. The ASOS surrounded by a circular 500-foot Critical Area. The TACAN antenna and the glide slope antenna for Runway 27 sits within the existing 500-foot Critical Area. Below is a list of the **general** siting criteria for an ASOS, per FAA Order 6560.20C, *Siting Criteria for Automated Weather Observing Systems (AWOS)*. **Figure 4-2** depicts the area surrounding the ASOS and associated critical areas.

General Siting Criteria for an ASOS:

- 300-Foot Northern Octant Clear Area: Sensor should be oriented with respect to true north and must have a clear area for 300 feet in the forward octant of the sensor.
- Six-Foot Radius: The area within six feet of sensor is free of all vegetation
- 100-Foot Critical Area: Any grass or vegetation within 100 feet of sensor is clipped to a height of 10" or less.
- 500-Foot Critical Area: All obstructions be at least 15 feet lower than the height of the sensor ***or*** have an occlude angle of 10 degrees or less within 500-foot radius. Also, all obstructions must be no greater than 10 feet lower than the sensor from 500 feet to 1,000 feet from sensor. DLH's ASOS wind sensor is 32' feet above ground (or 1,453.8 feet MSL).

No ASOS improvements are recommended.

4.5.5 Summary of NAVAID Recommendations

- Continue to replace wind cones as needed.
- The Airport Authority should continue to support FAA TechOps staff to ensure that the localizer and ILS are reliable and usable by users of the airport. The alternatives analysis should evaluate alternative localizer locations.
- The Runway 9 glideslope critical area should be paved or otherwise improved to support snow removal equipment
- Correct the non-standard Threshold Crossing Height (TCH) for Runway 27 to 55' and ensure the PAPI and ILS Glideslope is coincidental. If possible, the Runway 27 PAPI should be replaced in a location that will meet this standard.

4.6 Airspace and Obstructions Recommendations

DLH is in Class D Airspace which provides Air Traffic Control services to pilots flying in and out of the Airport. The airspace for DLH is circle shaped, beginning at the surface and extends upward to 3,900 feet above mean sea level. Surrounding the Class D airspace is Class E airspace which also provides air traffic control services to pilots in the surrounding area. Class E airspace extends to the west and south of the Class D to provide controlled airspace to the instrument approach and departure corridors.

14 Code of Federal Regulations (CFR) Part 77 defines and establishes the standards for determining obstructions to an airport's imaginary surfaces. Imaginary surfaces are geometric shapes that are in relation to the Airport and each runway, as defined in 14 CFR Part 77. The size and dimensions of these imaginary surfaces are based on the category of each runway for existing and planned airport operations. The five imaginary surfaces are the Primary, Approach, Horizontal, Conical, and Transitional. Objects that penetrate these surfaces are considered an obstruction and therefore affect navigable airspace and should be removed.

4.6.1 Part 77 Imaginary Surfaces

The size and dimensions of each imaginary surface is based on the category of each runway. In respect to 14 CFR Part 77. Both Runway 9/27 and Runway 3/21 have instrument approaches. These surfaces are listed below with definitions. **Table 4-14** shows the dimensions of these surfaces for each runway.

Primary Surface - The Primary Surface is an imaginary obstruction-limiting surface that is specified as a rectangular surface longitudinally centered about a runway. The Primary Surface extends 200 feet beyond each end of the runway.

Approach Surface - The Approach Surface is an imaginary obstruction-limiting surface that is longitudinally centered on an extended runway centerline and extends outward and upward from the primary surface at each end of a runway at a designated slope and distance upon the type of available or planned approach by aircraft to a runway.

Horizontal Surface - The Horizontal Surface is an imaginary obstruction-limiting surface that is specified as a portion of a horizontal plane surrounding a runway and is located 150 feet above the established airport elevation. The perimeter of which is constructed by swinging arcs of specified radii from the center of each end of the primary surface of each runway of each airport and connecting the adjacent arcs by lines tangent to those arcs.

Conical Surface - The Conical Surface is an imaginary obstruction-limiting surface that extends from the edge of the horizontal surface outward and upward at a slope of 20 feet horizontally to 1 foot vertically for a horizontal distance of 4,000 feet.

Transitional Surface - The Transitional Surface is an imaginary obstruction-limiting surface that extends outward and upward at right angles to the runway centerline and the runway centerline extended at a slope of 7 feet horizontally to 1 foot vertically from the sides of the primary and approach surfaces.

Table 4-14 – DLH Part 77 Surfaces

	Runway 9	Runway 27	Runway 3	Runway 21
Primary Surface (L x W)	10,991' x 1,000'		6,119' x 500'	
Approach Surface (IW x L x OW)	1,000' x 50,000' x 16,000'	1,000' x 50,000' x 16,000'	500' x 10,000' x 3,500'	500' x 10,000' x 3,500'
Approach Surface Slope	50:1 for 10,000' 40:1 for 40,000'	50:1 for 10,000' 40:1 for 40,000'	34:1	34:1
Horizontal Surface (Arc Radii)	10,000'	10,000'	10,000'	10,000'

4.6.2 Part 77 Obstructions

Per 14 CFR Part 77, Obstructions are defined as any object of natural growth, terrain, permanent or temporary construction equipment, or permanent or temporary manmade structure that penetrates an imaginary surface. Prior to any airport development, a Part 77 evaluation must be conducted regardless of project scale to verify that there will be no hazardous effect to air navigation due to construction.

Per Grant Assurance 20, the Airport must "*take appropriate action to assure that such terminal airspace as is required to protect instrument and visual operations to the airport […] will be adequately cleared and protected by […] mitigating existing airport hazards and by preventing the establishment or creation of future*

airport hazards." Additionally, the State of Minnesota requires a clear Primary Surface and Approach surface in order to maintain a Public Airport License.

4.6.3 Terminal Instrument Procedures (TERPS)

The Terminal Instrument Procedures (TERPS) (Order 8260.3C) prescribes the criteria for the creation, approach, and publishing of approach and departure procedures to an airport. TERPS criteria specify the minimum elevation for obstacle clearance to supply a satisfactory level of vertical protection for aircraft from obstructions. The standards for a TERPS approach surface were determined using FAA Engineering Brief No. 99A (EB 99A) dated July 24, 2020. Applicable TERPs surfaces for each runway are shown in **Table 4-15**. An obstruction evaluation was conducted in October of 2019 and August 2020, findings from the evaluation are discussed below.

Table 4-15 – Applicable DLH TERPs Surfaces

Runway	EB 99A Row 4 (400' x 3,400' x 10,000) 20:1 Slope	EB 99A Row 5 (800' x 3,400' x 10,000) 34:1 Slope	EB 99A Row 6 (RW+200' x 1,520' x 10,000)[1] 30:1 Slope	EB 99A Row 7[2] (1,000 x 12,152' x 7,512) 40:1 Slope
Runway 9	-	✓	✓	✓
Runway 27	-	✓	✓	✓
Runway 3	✓	-	✓	✓
Runway 21	✓	-	✓	✓

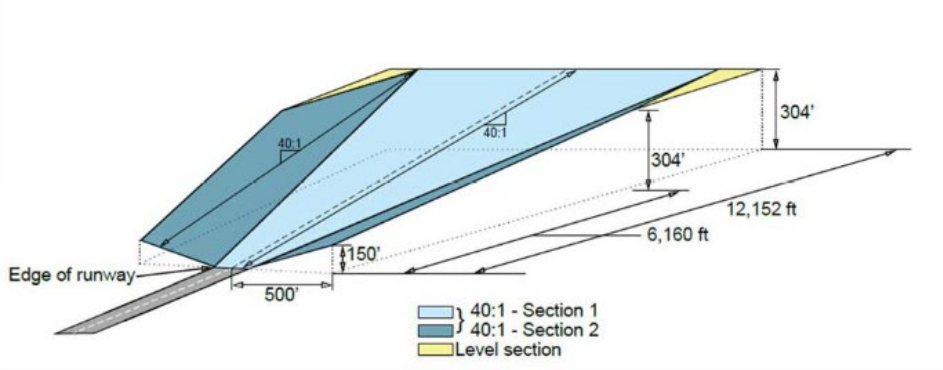
Notes: [1] The inner width of EB 99 Row 6 surface is the runway width +200 feet

[2] Commonly referred to as the TERPs Departure Surface.

Source: FAA Engineering Brief No. 99A

Engineering Brief (EB) 99A revised the dimensions and elevations of the Departure Surface. The new Row 7 Departure surface is depicted in **Exhibit 4-5**.

Exhibit 4-5 – EB 99A Row 7 – Instrument Departure Runway Obstacle Clearance Surface



As part of this Master Plan, obstruction data was analyzed to determine if there are any obstructions to the existing Runway 9/27 and Runway 3/21 TERPS surfaces. The existing TERPS Approach and Departure Surfaces are shown in **Figure 2-10, Figure 2-11, Figure 2-12 and Figure 2-13**.

4.6.3.2 Runway 9 End

Using the 2016 AGIS data, as-built information from the 2017 obstruction removal project and an applied growth rate, the existing Runway 9 end was evaluated for obstructions. The existing approach surface (50:1)

and the tree clearing area is depicted in **Figure 2-10** . 40.6 acres were cleared in the winter of 2017. There are no obstructions to the existing Part 77 Approach Surface and the approach surface. There are no obstructions to the existing applicable TERPs surfaces for Runway 9.

The airport should continue to monitor the Runway 9 end for obstructions and proactively clear vegetation as it grows.

4.6.3.3 Runway 27 End

Using the 2016 AGIS data, as-built information from the 2017 obstruction removal project and an applied growth rate, the existing Runway 27 end was evaluated for obstructions. The existing Approach Surface (50:1) and the tree clearing area is depicted in **Figure 2-11**. 16.75 acres were cleared in the winter of 2017. There are no obstructions to the existing and future Part 77 Approach Surfaces for Runway 27. There are no obstructions to the existing applicable TERPs surfaces.

The existing clearway on the Runway 09 end is recommended to be removed (See **Section 4.3.2.11**). The removal of the clearway will change the location of the TERPs Departure Surface. There are no obstructions to this relocated departure surface.

The airport should continue to monitor the Runway 27 end for obstructions and proactively clear vegetation as it grows.

4.6.3.4 Runway 3 End

Using data from an obstruction survey conducted in 2019, the existing Runway 3 end was evaluated for obstructions. The existing Approach Surface (34:1) is depicted in **Figure 2-12**. There are no obstructions to the existing Part 77 Approach Surface for Runway 3. There are no obstructions to the existing applicable TERPs surfaces.

The airport should continue to monitor the Runway 3 end for obstructions and proactively clear vegetation as it grows.

4.6.3.5 Runway 21 End

Using data from an SEH obstruction survey conducted in 2019, the existing Runway 21 end was evaluated for obstructions. The existing Approach Surface (34:1) is depicted in **Figure 2-13**. There are two obstructions (grouping ID 21-4) to the existing Part 77 Approach Surface for Runway 21. There are no obstructions to the existing applicable TERPs approach surfaces (Row 4 and Row 6); however, there are obstructions to the TERPs departure surface (grouping IDs 21-05, and 21-6).

The airport should clear the Part 77 approach surface and TERPs departure surface obstructions when Runway 3/21 is rehabilitated in the near term. As part of that design process, the airport should re-survey the obstructions to determine accurate clearing limits to clear vegetation that is expected to be an obstruction within 5-years following the clearing project.

As discussed in the alternatives analysis for Runway 3/21 (See **Section 4.10**) stakeholders indicated that the Airport should plan for an extension to Runway 3/21 to a total runway length of 8,000'. This runway extension is outside of the planning period for this Master Plan as there is no current identified funding source for the project. When funding is available and the extension is implemented, it is recommended the airport conduct an obstruction analysis of the approach area for the ultimate Runway 21 end to determine clearing limits.

4.6.4 Obstruction Analysis and Obstacle Action Plan (OAP)

An Obstacle Action Plan (OAP) was developed for all unmitigated obstacles to maintain clearance of existing approach and departure surfaces at DLH, as shown in **Table 4-16**. The OAP summarizes and details unmitigated obstacles and identifies how and when the surfaces will be cleared and maintained cleared. The

OAP identifies obstacles as defined in: Table 3-2 of AC 150/5300-13A, *Airport Design (9/28/2012); FAA Order 8260.3, United States Standard for Terminal Instrument Procedures (TERPS)*; and 14 CFR Part 77 Imaginary Surfaces.

As shown in **Table 4-16**, there are several tree groupings that obstruct Runway 21 existing Part 77 34:1 Approach Surface and the Existing TERPs Departure Surface. The OAP, as presented in **Table 4-16** identifies each obstacle's reference number, type, elevation (MSL), surface penetrated, penetration amount, runway, if the obstacle is on or off the airport, if the obstacle is under Sponsor control, proposed maintenance action, and when each of the obstacles will be cleared (i.e. date) and triggering event, if associated with a particular project. There are several groupings of trees and individual trees that are within five feet of being an obstruction to the 40:1 TERPs Departure Surface. The majority of the trees on the northwest side of the airport are aspens and are capable of growing one foot per year. **Table 4-17** shows these objects and it is recommended they are also removed in the near-term with the next obstruction removal project.

Table 4-16 – Obstacle Action Plan (OAP) – Existing Penetrating Obstructions

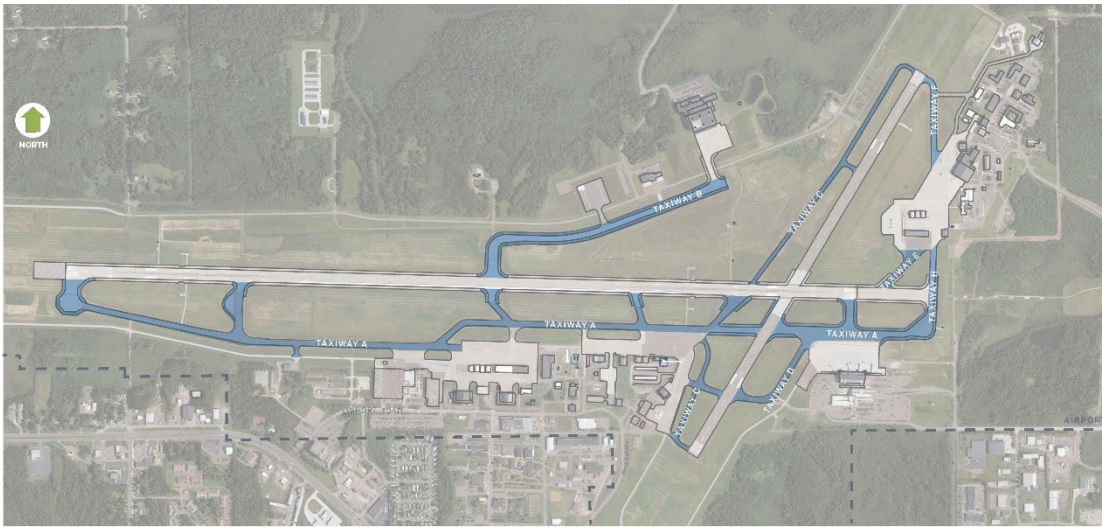
#	Type	Approx. Acres of Grouping	Elevation (Feet, MSL)	Part 77 Surface Penetrated	Part 77 Penetration Amount	EB99A Row 4 20:1 TERPs Penetration	EB99A Row 6 30:1 TERPs Penetration	EB99A 40:1 TERPs Departure Penetration	RW	Off/On Airport	Proposed Action	Clear Date	Triggering Event/ Associated Project
21-04	**Tree Grouping**		**1,466.2'**	**34:1 Approach**	**3.1'**	**(32.7')**	**-**	**(5.2')**	**21**	**On**	**Removal**		Runway 3/21 Rehabilitation
21-05	**Tree Grouping**		**1,471.5'**	**-**	**(1.3')**	**(41.1')**	**-**	**9.4'**	**21**	**On**	**Removal**		Runway 3/21 Rehabilitation
21-06	**Tree Grouping**		**1,466.4'**	**-**	**(6.6')**	**(46.4')**	**(20.8')**	**10.5'**	**21**	**On**	**Removal**		Runway 3/21 Rehabilitation

Table 4-17– Obstacle Action Plan (OAP) – Recommended Removal (Projected future obstructions)

#	Type	Approx. Acres of Grouping	Elevation (Feet, MSL)	Part 77 Surface Penetrated	Part 77 Penetration Amount	EB99A Row 4 20:1 TERPs Penetration	EB99A Row 6 30:1 TERPs Penetration	EB99A 40:1 TERPs Departure Penetration	RW	Off/On Airport	Proposed Action	Clear Date	Triggering Event/ Associated Project
21-01	Tree Grouping		1,449.6'	-	(4.6')	-	-	(2.2')	21	On	Removal		Runway 3/21 Rehabilitation
21-02	Tree Grouping		1,457.4'	-	-	-	-	(2.7')	21	On	Removal		Runway 3/21 Rehabilitation
21-03	Tree Grouping		1,475.2'	-	-	-	-	(4.4')	21	On	Removal		Runway 3/21 Rehabilitation
21-07	Tree Grouping		1,466.2'	-	(8.2')	-	-	(4.4')	21	On	Removal		Runway 3/21 Rehabilitation
21-08	Tree	-	1,430.2'	-	(51.7')	(97.8')	(68')	(4.2')	21	On	Removal		Runway 3/21 Rehabilitation
21-09	Tree	-	1,473.5'	-	-	-	-	(3.5')	21	On	Removal		Runway 3/21 Rehabilitation
21-10	Tree	-	1,474.7'	-	-	-	-	(3.7')	21	On	Removal		Runway 3/21 Rehabilitation
21-11	Tree Grouping		1,478.8'	-	(11.9')	(60.3')	-	(0.6')	21	On	Removal		Runway 3/21 Rehabilitation
21-12	Tree	-	1,477.4'	-	-	-	-	(4.1')	21	On	Removal		Runway 3/21 Rehabilitation

4.7 Taxiway Network Recommendations

Duluth International Airport is currently served by a taxiway network that provides access to all parking areas and runway ends. Taxiway A parallels Runway 9/27 and Taxiway C parallels Runway 3/21. Additional taxiways provide access to other areas of the airfield, including Taxiway B, Taxiway D and Taxiway F. Taxiways throughout the airfield are designed to varying standards. The existing DLH taxiway network is shown below.



Taxiway systems are designed to provide access to and from the runway(s), apron(s), hangars, and other aviation-related areas on an airport. AC 150/5300-13A, *Airport Design*, provides basic taxiway system design principles, which include:

- Whenever possible, taxiways should be designed such that the nose gear steering angle is no more than 50 degrees.
- Turns should be 90 degrees wherever possible. For intersections, the preferred standard angles are 30, 45, 60, 90, 120, 135, and 150 degrees.
- Taxiway systems should use the “three-node concept.” A pilot should have no more than three turn choices at an intersection, ideally, left, right, and straight ahead.
- Minimize runway crossings, and limit the runway crossing to the outer thirds of the runway.
- Avoid wide expanses of pavement. Wide pavements require the placement of signs and edge lighting or marking far from the pilot’s eye and reduce the conspicuity of visual cues.
- Taxiways should not provide direct access from an apron to a runway to reduce the opportunity for human error.

Non-standard design features were identified throughout the taxiway network. Non-standard features are shown in **Figure 4-3.** A Taxiway Technical Advisory Committee (TAC) was convened as part of the Master Plan process to provide feedback on taxiway facility needs and alternatives. The TAC identified several areas of the Taxiway A network that do not meet current FAA design standards. Additional user needs that were documented included improving confusing intersections, maintaining a compass calibration pad, ensuring adequate Airport Rescue and Firefighting (ARFF) access, meeting military aircraft needs and the need for Taxiway A to serve large wingspan aircraft. TAC feedback is summarized in **Figure 4-4**. Additional information on TAC feedback throughout the facility needs and taxiway alternative evaluation process can be found in **Appendix A**.

4.7.1 Taxiway Design Standards

Taxiway system design criteria are based on Airport Design Group (ADG) and Taxiway Design Group (TDG).

ADG is determined by the wingspan and tail height of the critical aircraft and defines the Taxiway Safety Area (TSA), Taxiway Object Free Area (TOFA), and taxiway separation (to runway and parallel taxiway) standards. Taxiway requirements by ADG are listed in **Table 4-18**.

The TDG is determined by the undercarriage dimensions, overall Main Gear Width (MGW) and the Cockpit to Main Gear (CMG) distance, of the most demanding aircraft, projected to use the taxiway. Taxiway requirements by TDG are listed in **Table 4-19**. The majority of DLH taxiways currently meet or exceed TDG 3 standards. Portions of the taxiway system are frequently served by TDG 4 or TDG 5 aircraft.

Table 4-18 – Taxiway Design Standards by Airplane Design Group (ADG)

Item	ADG II	ADG III	ADG IV	ADG V
Taxiway Safety Area (TSA)	79’	118’	171’	214’
Taxiway Object Free Area (OFA)	131’	186’	259’	320’
Taxilane OFA	115’	162’	225’	276’
Taxiway Centerline to Parallel TW/TL Centerline	105’	152’	215’	267’
Taxiway Centerline to Fixed of Movable Object	65.5’	93’	129.5’	160’
Taxilane Centerline to Parallel TW/TL Centerline	97’	140’	198’	245’
Taxilane Centerline to Fixed of Movable Object	57.5’	81’	112.5’	138’
Taxiway Wingtip Clearance	26’	34’	44’	53’
Taxilane Wingtip Clearance	18’	27’	27’	31’

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

Table 4-19 –Taxiway Design Standards by Taxiway Design Group (TDG)

Item	TDG 2	TDG 3	TDG 4	TDG 5
Taxiway Width	35’	50’	50’	75’
Taxiway Edge Safety Margin (TESM)	7.5’	10’	10’	15’
Taxiway Shoulder	-	Recommended	Required	Required
Taxiway Shoulder Width	15’	20’	20’	30’

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

4.7.2 Military Taxiway Design Standards

Section 2.11.3 describes the current military use at DLH. The 148th Air National Guard is based in the northeast quadrant of the airfield and currently operates the F-16 Block D fighter aircraft. Military operations account for approximately 9% of total aircraft operations at DLH. United Facilities Criteria (UFC) 3-260-01, *Airfield and Heliport Planning and Design, With Change 1,* outlines the airfield design requirements for military airports. Military operations and requirements are not eligible for Airport Improvement Program (AIP) funding. **Table 4-20** lists the design standards as outlined in UFC 3-260-01.

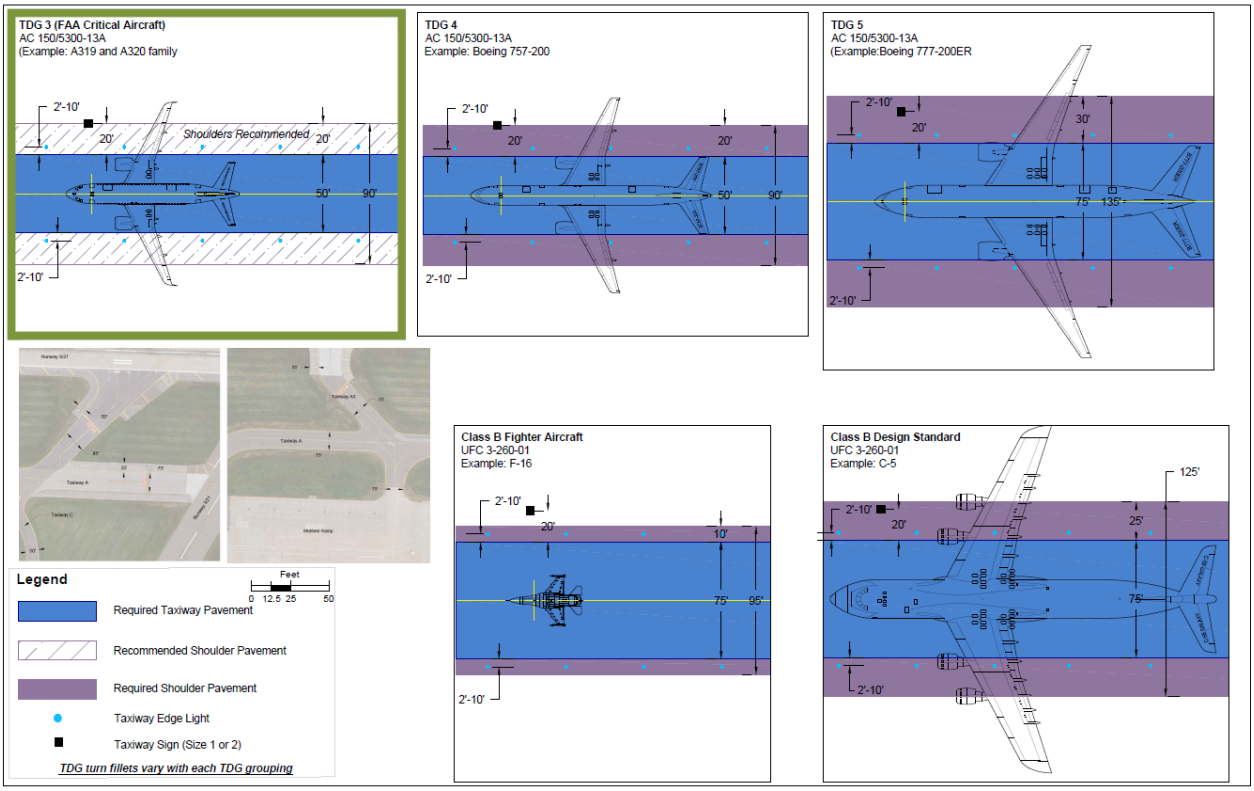
Table 4-20 – UFC Taxiway Design Standards

	UFC Class A	UFC Class B	UFC Class B - Fighter Aircraft
Taxiway Width	50’	75’	75’
Paved Taxiway Shoulder Width	25’	25’	10’
Notes: Class A surfaces are intended to be used by small, light aircraft. Class B surfaces are intended for high-performance and large, heavy aircraft. Fighter Jet aircraft are considered Class B aircraft.			

Source: UFC 3-260-01, Airfield and Heliport Planning and Design, With Change 1

Exhibit 4-6 below shows the differences in military and civilian design standards for taxiway and shoulder pavement. The green box around the TDG 3 design standards indicates the civilian critical aircraft design standards.

Exhibit 4-6 – Taxiway Design Standards



4.7.2.1 Taxiway Design Recommendations

Each taxiway should be designed to accommodate the critical aircraft using that taxiway. Additionally, some taxiway networks or segments of taxiway are used by aircraft larger than the critical aircraft. This includes ADG IV-V and TDG 4-5 civilian and military aircraft. The Taxiway TAC recommended that all taxiways be designed to serve all existing users. As such, there are areas of the taxiway network that should be designed to standards larger than those of the critical aircraft.

As discussed in **Section 2.7** and shown in **Figure 2-8**, the 2018 pavement evaluation study found that the majority of the taxiway and apron network was rated in either fair or poor condition with some portions being very poor.

The following sections discuss recommendations for each taxiway network. Alternatives to meet these taxiway needs are discussed later in **Chapter 4**.

4.7.2.2 Taxiway A Network

As discussed in **Section 2.9**, portions of Taxiway A were last constructed in 1974 while some portions are newer with a last reconstruction date in 1985 and 1992. Pavement maintenance projects have occurred throughout the life of the pavement, but it is nearing the end of its useful life. The 2018 PCI evaluation rated Taxiway A in Fair to Poor condition. A mill and overlay of Taxiway A west of Taxiway A3 was completed in 2020 as a short-term improvement to improve deteriorating pavement condition until Taxiway A could be reconstructed. As the primary taxiway for Runway 9/27, the reconstruction of the Taxiway A network is the highest priority pavement project in the near-term on the airfield. ***It is recommended that Taxiway A be reconstructed in the near-term.*** Taxiway A Phase I (East) is being reconstructed in 2022 and funded with a 2021 AIP grant. As part of the design process for that phase, the life-cycle cost analysis determined that concrete is the preferred pavement type for Taxiway A.

Taxiway A has a critical aircraft of ADG III (1,608 annual operations in 2018) and TDG 3 (724 annual operations in 2018). However, there are occasional operations by ADG IV-V and TDG 4-5 aircraft. Annual operations by these larger aircraft are depicted in **Table 4-21**.

Table 4-21 – ADG IV and V and TDG 4 and 5 Operations

Year	ADG IV	ADG V	TDG 4	TDG 5
2017	323	0	14	16
2018	418	10	33	16
2019	324	2	20	6
2020	387	2	10	2
2021 (Jan-June)	247	2	0	2

Source: FAA TFMSC

Taxiway A is eligible and justified for AIP (FAA) funding for ADG III and TDG 3 standards. However, the airport and stakeholders wish to ensure that Taxiway A is capable of serving all existing aircraft. Taxiway A should therefore be designed to ADG V and TDG 5 standards.

Additional funding opportunities may be available from the 148th Fighter Wing to fund the additional pavement beyond what is deemed eligible and justified for FAA funding. The 148th Fighter Wing participated in funding the additional taxiway and shoulder width for Taxiway A5 through a National Guard Bureau Military Construction Cooperative Agreement (MCCA) when it was relocated as part of the Runway 9/27 reconstruction project. Similarly, the 148th Fighter Wing is funding the FAA ineligible portions of the 2021 Taxiway A reconstruction Phase 1 project through an MCCA. Preliminary conversations with the 148th Fighter Wing conducted as part of this Master Plan process indicated support for continued funding of the future FAA ineligible pavement of Taxiway A during future reconstruction phases.

It is recommended that Taxiway A be reconstructed in the near-term and that Taxiway A be designed to ADG V and TDG 5 standards. This includes a 75 foot wide taxiway. Because the UFC requirement for Class B airfield requires 25 foot wide shoulders, compared to 30 feet for TDG 5, the TAC, including the 148th Fighter Wing, determined that ***Taxiway A should have 25 foot shoulders.***

It is also recommended that some areas of Taxiway A and its connectors be realigned during reconstruction to meet design standards and improve sight lines for both aircraft and the air traffic control tower. The alternatives analysis in **Section 4.9** evaluates alternatives to improve taxiway geometry.

4.7.2.2.2 Taxiway A5 and Taxiway A Intersection

Since the introduction of new taxiway geometry in 2019, the air traffic control tower has reported multiple pilot deviations at or near Taxiway A5. The ATCT has reported pilots taxing east on Taxiway A taxiing past A5 instead of turning from Taxiway A left to A5 to hold short of Runway 27. Pilots continue onto Taxiway H which is a military-only use taxiway and is marked with signage as such. The military infrastructure beyond Taxiway H is restricted to military use only and is limited in its ability to accommodate aircraft larger than ADG I or II.

Taxiway H, located east of Taxiway A5 at the approach end of Runway 27, was designated for military aircraft only following the multi-year multi-phase reconstruction of Runway 9/27. As part of this project, in-pavement taxiway centerline lights were installed to "lead" aircraft onto Taxiway A5 when traveling east on Taxiway A. These in-pavement lights do not extend straight on Taxiway A onto Taxiway A.

According to the Air Traffic Control Tower (Spring, 2021), there have been 4 incidents officially filed. When incidents initially started occurring, the ATCT was not documenting pilot deviations. The tower estimates that this typically occurs once or twice a month, with no distinguishable pattern in type of aircraft or operator (general aviation/commercial or aircraft size). However, based on conversations with airport staff and the Air Traffic Control Tower, it appears primarily transient pilots miss their instructed turn from Taxiway A to A5 and continue their taxi onto Taxiway H.

The Airport Authority has taken several initial cost-effective steps to mitigate the problem, including updating the Airport Layout Diagram to include a hatch over the Air National Guard base, including Taxiway H, noting 'RESTRICTED ACCESS (148TH ANG)'. Additionally, stakeholder outreach and education have occurred as part of RSAT, tenant meetings, and other outreach efforts. The FAA published a SPARKs[7] page in April of 2021 to bring awareness to pilots about this intersection.

An action item from the June 8, 2021 RSAT meeting is for the ATCT to collect more data on aircraft that pass A5. The ATCT is logging data through July 31, 2021. On August 1, 2021 the ATCT will add verbiage to the ATIS for 60 days to advice pilots of the A5 geometry to determine if it lowers occurrences. The ATCT is now issuing pilot deviations; however, substantive data is not yet available.

Several alternatives have been identified, ranging from simple to more complex.

- **Completed Actions**
  - Demarcation of Taxiway H and military area with hatching on AF/D – Completed in 2020
  - FAA publication of a SPARKs page – Completed in Spring 2021
- **Preliminary (Next Step) Actions (cost-effective)**
  - Installation of a 12" wide taxiway centerline on the radius that guides aircraft from Taxiway A to Taxiway A5 (see **Exhibit 4-7**). This is included in the Taxiway A Phase 1 (east) reconstruction project being constructed in summer 2022.
  - Adding information to the ATIS when Runway 27 is in use (being completed August 1 through September 30, 2021). Data should be evaluated once the 60-day trial is complete to determine if the additional ATIS information is an effective action.
  - Adding information to the AF/D describing the Military Aircraft Only Designated Taxiways

[7] https://spark.adobe.com/page/QUxS5x8omOKZf/

- Installation of dashed taxiway edge marking leading from Taxiway A to Taxiway A5. The dashed taxiway edge marking is used where there is an operational need to define the edge(s) of a taxi route. AC 150/5340-1M does note that the dashed taxiway edge markings are not used on entrance taxiways that enter a runway. This is proposed on Taxiway A, prior to entering Taxiway A5 (taxiway leading to a taxiway). (see **Exhibit 4-7**)

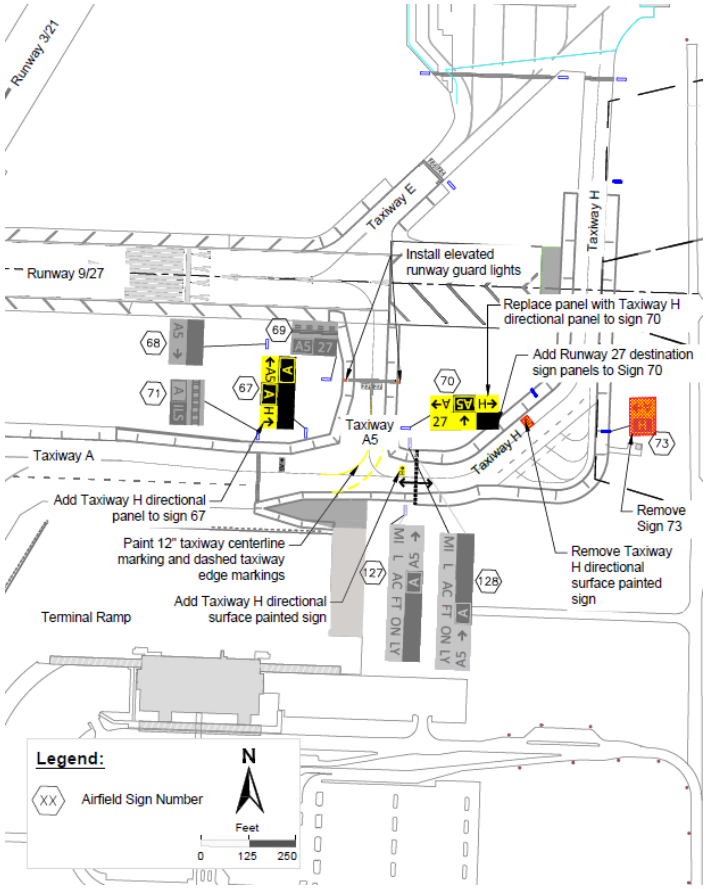
- **Secondary Actions**
  - Installation of outbound designation signs on Taxiway A5 on sign 70. This includes the addition of a 27 + straight arrow on the back of sign 70. Outbound designation signs direct a pilot to the beginning of a takeoff runway. (see **Exhibit 4-7**)
  - Installation of Runway Guard Lights (RGL) / Wigwags on Taxiway A5, noting the runway entrance. Preliminary discussions with FAA ADO and Part 139 Certification Inspector have indicated that RGLs need to be a recommendation at an RSAT prior to implementation at this location.
  - Installation of additional taxiway directional signage and surface painted markings
  - Add Taxiway H directional panel to Sign 67. (see **Exhibit 4-7**)
  - Add Taxiway H surface painted sign prior to beginning of Taxiway H. (see **Exhibit 4-7**)
  - Replace panel on Sign 70 with Taxiway H directional sign.

- **Tertiary Actions (most complex/costly)**
  - Removal of Taxiway H and construction of additional access route for the 148th. Section 5-10.1 of UFC 3-260-01 discusses the number of required access points for an apron. It states that three apron access points should be provided for aprons with over 24 parked fighter aircraft. The MnANG currently has 20 F-16 aircraft assigned to the 148th Fighter Wing and currently has two access points for F-16 use.

Alternatives will evaluate options that may allow for the construction of an alternate route from the Ramp to Runway 27 (between Taxiway E and 3/21). However, implantation of these alternatives are costly and could be considered in the future if deemed needed and if funding were available.

It is recommended that the above options continue to be explored, starting with the more cost-effective solutions, to mitigate pilot deviations. It is further recommended that the pilot deviations and options listed above continue to be presented and discussed at the annual RSAT meeting

Exhibit 4-7 – Taxiway A5 and Taxiway H Intersection Recommendations

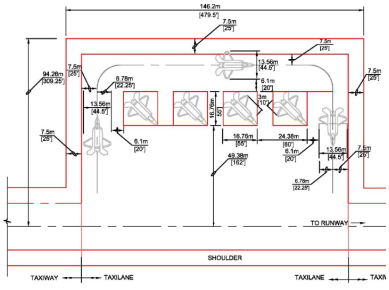


4.7.2.2.3 Taxiway A Aircraft Holding Bay and Arm/Dearm Pad

Taxiway A1 is marked as an arm/dearm pad for military aircraft use. The wide expanse of pavement and pavement markings are non-standard. The 148th currently operates using a safety waiver to perform arm/dearm operations on their apron prior to taxiing to Runway 9 in lieu of using the existing arm/dearm pad.

An arm/dearm pad is used for arming aircraft before takeoff and for dearming weapons from aircraft that were not used. These pads are located near the end of a runway. A nonstandard arm/dearm pad is currently located at Taxiway A1.

The arm-dearm pad (military) is critical to the 148th's mission. The UFC design for an arm-dearm pad utilized by F-22's is shown to the right. The 148th Fighter Wing indicated that an arm/dearm pad is required on the Runway 9 end. Because of the proximity of the Runway 27 end to their apron, an arm/dearm pad is not needed on that end. Although the 148th Fighter Wing currently operates F-16 aircraft, they indicated that any future holding bay should be design to F-22 aircraft to ensure that it meets the needs of any potential future fleet.



Source: UFC 3-260-01, February 2019

Although the existing expanse of pavement on Taxiway A1 does not meet design standards for a holding bay, civilian aircraft will utilize this area as a holding bay in the event they have a release time from ATC into Minneapolis-St. Paul Airport (MSP) or Chicago's O'Hare (ORD) airport or for pre-departure safety checks.

The purpose of a holding bay (civilian) is to provide space for aircraft to park while awaiting clearance to depart. A holding bay is also used to permit those aircraft already cleared for departure to move to their runway takeoff position. AC 150/5300-13A, *Airport Design* specifies that holding bays should be designed to allow aircraft to bypass one another to taxi to the runway.

Holding bays should not be designed with a wide expanse of pavement adjacent to the taxiway with no markings to ensure wingtip clearance. This design can cause aircraft entering the holding bay to stack up nose to tail without being able to exit independently. Holding bays should be designed to allow aircraft to bypass one another to taxi to the runway by providing clearly marked entrances/exits. Each parking area is independent, with the ability for aircraft to bypass others both on entrance and exit. This can be accomplished with islands between the parking positions which provide additional cues to pilots.

Table 4-22 – Civilian Peak Hour Operations

Year	Total Operations	Peak Day Operations (0.82% of total)	Total Peak Hour Operations[1]
2018	58,426	479	36
2023	62,549	513	38
2028	66,182	542	41
2038	73,117	599	45

Notes: [1]Peak hour operations are calculated by taking 90% of the peak day to account for operations occurring between 7 a.m. and 7 p.m. and calculating an hourly rate.

Source: L&B Forecast, SEH

Holding bays are recommended when runway operations reach a level of 30 per hour. DLH currently has a civilian peak hour activity level of 36 aircraft and is forecasted to have a civilian peak hour activity of 45 aircraft in 2038. When wind conditions favor Runway 9/27 on the peak day, there are over 30 operations per hour.

As a result, it is recommended that a holding bay be added at the departure end of Runway 9. The holding bay should be designed to also accommodate military needs for an arm/dearm pad. At the time of construction of the holding bay and arm/dearm pad, coordination with the 148th should be conducted to ensure the sizing for the F-22 still meets their needs.

A holding bay for the Runway 27 end is not recommended as the terminal ramp is available or commercial aircraft to hold and all aircraft can hold on other taxiway and apron infrastructure near the Runway 27 end, if needed.

4.7.2.3 Taxiway C Network

Taxiway C is a full-length parallel taxiway on the west side of Runway 3/21. The 2018 pavement condition report indicates the taxiway is in fair to poor condition with a PCI of 22 to 79. Taxiway C is a full-length parallel taxiway that serves of Runway 3/21. Taxiway C does not meet standards for a C-III runway with 1-mile approaches. This non-standard feature can restrict aircraft movement on the airfield when Runway 3/21 is in use.

Taxiway C is designed to ADG III and TDG 3 standards. Because these aircraft utilize Runway 3/21, it is recommended that Taxiway C continue to be designed to these standards.

When large (ADG IV-V and TDG 4-5) military aircraft taxi to the guard base, they currently taxi on Runway 3/21 to Taxiway F since Taxiway C is not designed to accommodate these aircraft. The Taxiway TAC discussed the future need for Taxiway C to be improved to accommodate the needs of these larger aircraft. The TAC recommended that Runway 3/21 continue to be utilized as a taxiway and that Taxiway C continue to be designed to ADG III and TDG 3 standards. The 2018 PCI report found Taxiway C, north of Runway9/27 to be in very poor condition and will require reconstruction in the near-term.

It is recommended that Taxiway C be reconstructed and that it be relocated to the standard 400' runway centerline to taxiway centerline separation when reconstructed.

The development of taxiway designations is outlined in FAA Advisory Circular (AC) 150/5340-18F, "Standards for Airport Sign Systems" (8/16/10), and FAA Engineering Brief (EB) 89, "Taxiway Nomenclature Convention" (3/29/12).

AC 5340-18F provides guidance that the "designation of taxiways should start at one end of the airport and continue to the opposite end, e.g., west to east or north to south." The clarified guidance provided by EB 89 is intended to replace Paragraph 4, "Developing Taxiway Designations" in the next update to AC 5340-18F. The FAA recommends that the language of EB 89 be used in revisions to airport signage plans, airport layout plans, and for new development projects. Existing airport signage conditions are not required to be updated. The existing taxiway designations are shown on **Figure 2-1**.

AC 5340-18F provides guidance that "for a major taxiway having numerous stub exits, such as a taxiway parallel to a runway…the short taxiways could be designated A1, A2, A3, etc." A clarification to this interpretation has been included in EB 89, which states that "for a runway with a parallel taxiway, the entrance and exit taxiways located at the ends and along the runway must use alphanumeric designators and follow an increasing, sequentially numbered pattern from one runway end to the other runway end…"

Using this guidance, the current taxiway naming for the Taxiway C connectors is non-standard as the taxiways connecting to the Runway 3 and 21 ends are not alphanumeric. Additionally, the connector between the Runway 3 end and Taxiway A is currently named as Taxiway D. It should be revised to be an alphanumeric connector for Taxiway C (ie. Taxiway C2). ***The taxiway connector naming convention should be revised to all be alphanumeric when the taxiway is reconstructed.***

4.7.2.4 Taxiway D Network

Taxiway D, which connects Taxiway A to a connector near the approach end of Runway 3 was rated in poor condition in the 2018 Report. Taxiway D is currently 510' from the runway centerline and located at the very western edge of the terminal apron, limiting future development of the terminal building and apron. ***It is recommended that Taxiway D, south of Taxiway A be relocated to the standard 400' from runway centerline when it is reconstructed.***

Similar to Taxiway C, the current taxiway naming for the Taxiway D connector is non-standard as the taxiway connecting to the Runway 3 is not alphanumeric. ***The connector taxiway should be renamed D1 when Taxiway D is reconstructed.***

Taxiway D is currently in poor condition with a PCI of 34 (rated in 2018). As with all pavements, extending the useful life with maintenance and rehabilitations will save on cost in the long run and will reduce overall impacts to airport users. ***Taxiway D should be reconstructed during the planning term when funding becomes available and other primary taxiway pavement repair needs are met. If funding is not available in the near term, a mill and overlay and/or joint and crack sealing should be completed as a***

short-term improvement until full reconstruction is feasible. Because AIP funding may be directed to higher priority projects in the near-term, the annual pavement maintenance grant from MnDOT may be appropriate to fund interim pavement maintenance on Taxiway D.

When Runway 3/21 is ultimately extended to 8,000 feet, the traffic utilizing Taxiway D to reach the Runway 3 end is expected to increase. In addition, the 148th Fighter Wing will need to have access from their ramp to the Runway 3 end, necessitating the extension of Taxiway D for this purpose. When the runway is extended, Taxiway D should be extended to the Runway 3 end. Additionally, when the runway is extended, the taxiway design standards should be increased to accommodate the 148th Fighter Wing needs (75 feet wide and 25-foot shoulders) as fighter aircraft will utilize this taxi route.

4.7.2.5 Taxiway B Network

Taxiway B provides access from the midpoint of Runway 9/27 to the north side of the airfield including the North Business Development Area (NBDA), the ARFF building and the MRO facility. The MRO facility has historically served narrowbody jets (ADG III/TDG 3); however, it can accommodate larger aircraft. The NBDA will likely serve ADG II/TDG 2 aircraft when it is fully developed (it has the ability to accommodate ADG III depending on ultimate building layout).

Taxiway B is currently 75 feet wide with 35-foot-wide shoulders, meeting the needs of ADG V and TDG 5. It was constructed in 1994. The 2018 PCI investigated rated the pavement (concrete) at a PCI of 86. The PCI is projected to drop 0.6 per year. Pavement preventive maintenance measures are appropriate, to include crack sealing, joint repair, spall repair, and minor patching. As the pavement deteriorates, panel replacement may be prudent to maximize the longevity of the Taxiway B network in years 10-20.

The TAC recommended that Taxiway B continue to be designed to accommodate ADG V/TDG 5 aircraft to ensure full usability of the MRO facility to all potential aircraft in the future.

Once Runway 3/21 is extended, Taxiway B should be extended to provide a route from the north side of the airfield to the Runway 21 end that limits runway crossings. In addition to providing improved runway access to the north development area, Taxiway B would provide an alternate route for general aviation aircraft from the southwest quadrant to access the Runway 21 end.

4.7.2.6 Taxiway E and F (Military Taxiways)

Taxiway E and F are military use taxiways providing access to the 148th Fighter Wing. These taxiways are expected to remain military use only throughout the planning period. The 148th Fighter Wing maintains these taxiways. As they are reconstructed, the UFC Class B standards will be used for their design.

Taxiway E connects to Runway 27 at an angle. This taxiway meets military design standards and provides efficient runway access. Because it is military use only, it is not required to be realigned at 90 degrees. The alternatives analysis later in this chapter evaluates opportunities for Taxiway E to be constructed as a partial parallel taxiway to Runway 9/27 with the opportunity to provide two access points to the Runway 27 end.

Taxiway F connects to Runway 21 at an angle and provides access for large aircraft to the 148th Fighter Wing. The grade of Taxiway F exceeds the military standards, and it is unavailable for us to fighter (F-16) aircraft. The development plans on the existing ALP depict Taxiway F being realigned to be parallel with 90-degree connector taxiways. This realignment project should ensure that the standard taxiway grades are met. At the time of reconstruction, Taxiway F should be realigned to enter Runway 21 at 90 degrees.

The airport should continue to coordinate with the 148th as future development is planned and implemented on these military taxiways.

4.7.3 Taxiway Lighting

DLH has MITLs installed on all taxiways. Advisory Circular (AC) 150/5340-30J, *Design and Installation Details for Airport Visual Aids* recommends Medium Intensity Taxiway Lights (MITLs) for taxiways and aprons at airports where a runway lighting system are installed. MITLs provide increased visibility to taxiing aircraft during nighttime and low visibility weather conditions. **Table 4-23** shows the existing taxiway lighting, age and general condition. The taxiway lighting infrastructure at DLH is in poor-fair condition, with the exception of lighting associated with Taxiway A5 which was constructed in 2019.

Taxiway C and Taxiway D have shown low MEG readings. This could indicate a problem with the insulation of the circuit and decrease the reliability of the lighting system. ***It is recommended that the circuit be evaluated for insulation problems. It is recommended the taxiway lighting be replaced with LED lighting throughout all taxiway networks as the corresponding taxiway pavement is reconstructed.***

Table 4-23 – Taxiway Lighting Conditions

Taxiway Circuit	Age (Years)	Condition	Wiring	Lighting Type
A	> 25	Fair	Direct burial in cans	Incandescent
A-West	> 25	Fair	Direct burial in cans	Incandescent
A-Center	> 25	Fair	Direct burial in cans	Incandescent
A-East	> 25	Fair	Direct burial in cans	Incandescent
A-1	> 25	Fair	Direct burial in cans	Partial LED and partial incandescent
A-2	> 25	Fair	Direct burial in cans	Partial LED and partial incandescent
A-3	> 25	Fair	Direct burial in cans	Partial LED and partial incandescent
A-4	> 25	Fair	Direct burial in cans	Incandescent
A-5	2019	Good	Conduit in cans	Incandescent
B	1992	Fair	Direct burial in cans	Partial LED and incandescent
C-North	> 25	Poor	Direct burial with stake mounted lighting	Incandescent
C-Center	2010	Fair	Direct burial in cans	LED
C-South	> 25	Poor	Direct burial in cans	Incandescent
D	> 25	Poor	Direct burial with stake mounted lighting	Incandescent
E	> 25	Fair	Direct burial in cans	Incandescent
F	> 25	Fair	Direct burial in cans	Incandescent
H	> 25	Fair	Direct burial in cans	Incandescent

Source: DAA Staff

4.7.4 Taxiway Signage

Taxiway signage should be replaced with LED signage as the corresponding pavement and lighting systems are replaced. In addition, it is recommended that DLH monitor the condition of airfield signage for any fading, cracking, or light leakage to ensure pilot situational awareness is maintained.

Following the multi-year, multi-phase Runway 9/27 reconstruction project and relocation of Taxiway A5, additional signs are required to protect certain approach and departure surfaces on the east end of Runway 9/27 to comply with guidance released after completion of the project. Implementation of the Approach/Departure Holding Position signs (APCH/DEP) is directly related to the location of the TERPS Approach and Departure surfaces. Implementation of the APCH/DEP sign will follow the updates to the Aeronautical Information Manual (AIM), FAA Job Order 7110.65 and FAA Job Order 7210.3[8]. The FAA Advisory Circular states that the FAA will indicate to the airport the need for a conditional APCH/DEP Sign and a conditional hold line.

The Airport should continue to monitor Advisory Circulars for the implementation schedule and guidance on the Approach/Departure holding positions signs. Additionally, the airport should coordinate with stakeholders and the Air Traffic Control Tower prior to the installation of the Approach/Departure sign.

4.8 Aprons, Aircraft Parking and Hangar Recommendations

4.8.1 General Aviation Public Aircraft Parking Apron and Tiedowns

DLH has several aircraft parking aprons that are available for public use, the Midfield Ramp, Monaco Ramp and the Tower Ramp. The cargo ramp (utilized by FedEx) located south of the Tower Ramp is leased to a tenant and is not available to the public. The aprons (ramps) should be designed to the critical aircraft using the apron.

4.8.1.1 Monaco Ramp

The Monaco Ramp can accommodate a wide range of aircraft parking capacity depending on the layout and mix of aircraft. While there are in-pavement anchors throughout the ramp, there are no marked tiedown locations. The ramp is frequently used by ADG I and II aircraft which utilize both the taxilane and parking locations. The taxilane that travels through the ramp is utilized by aircraft up to ADG III as large GA aircraft frequently utilize Monaco for passenger services and Customs. The critical aircraft of the taxilane is ADG III and the critical aircraft for parking is ADG II.

The capacity of the ramp varies depending on the size of parked aircraft. Example capacity includes approximately 10 ADG I aircraft or approximately 4 ADG I aircraft and 6 ADG II aircraft with the required 10-foot spacing between aircraft. The FBO frequently serves ADG III aircraft for tech-stops and clearing Customs, however the ADG III aircraft cannot park on the Monaco Ramp without blocking the taxilane due to the Taxilane OFA that runs the length of the Monaco Ramp. The FBO will use the Tower Ramp and the taxilane that leads directly south from the Monaco Ramp during peak demand. Aircraft parking on the tower ramp is expected to be relocated in the near-term due to the RVZ and the Taxilane that is currently used for overflow parking does not meet OFA requirements to safely park aircraft. Additionally, this taxilane, although frequently used for parking, is not designed to serve as an aircraft parking area. Hangars are ultimately planned to be constructed along this taxilane which will preclude continued use for parking. When aircraft are parked along the Taxilane south of the FBO, aircraft are under tug buy FBO staff.

The ramp is constructed of concrete and was last reconstructed in 1957. The 2018 PCI evaluated rated the Monaco Ramp in Good condition (PCI 62) with some small areas being Excellent condition. ***The Monaco Ramp should be rehabilitated in the near-term. If rehabilitation is not possible due to funding constraints in the near-term, it should be reconstructed between years 5 and 10.***

The existing apron meets ADG II separation standards; however, ADG III aircraft frequently utilize the Monaco ramp to utilize Customs services and to load and unload passengers. ***It is recommended that a***

[8] FAA Advisory Circular 150/5340-18G, *Standards for Airport Sign Systems*, December 23, 2020

taxilane be designated to accommodate the ADG III aircraft without the need to relocate parked ADG I and II aircraft.

4.8.1.2 Midfield Ramp

The Midfield Ramp is constructed of concrete and utilized for overflow parking by the FBO and all large (ADG III and larger) aircraft parking. There are no marked tiedowns on the midfield ramp. Transient military aircraft also utilize the Midfield ramp. The Midfield ramp provides the ability to separate parking for jet and heavy jets from lighter propeller powered aircraft parked on the Monaco Ramp (as recommended in AC 150-5300-13A). The critical aircraft for the midfield ramp is ADG III and TDG 3. However, because the ramp is frequently used by ADG V and TDG 5 aircraft (civilian and military), it should be designed to accommodate those aircraft (taxilanes and parking capabilities).

Similar to the Monaco Ramp, the capacity of the ramp varies depending on the size of aircraft. Example capacity includes 5 ADG III aircraft; 3 ADG III and 2 ADG IV aircraft; or 2 ADG V aircraft such as a C-17. It is important to maintain two access points into and out of the Midfield Ramp to maintain efficient movements for large aircraft. When aircraft use the Midfield Ramp, FBO staff will marshal aircraft into a spot and provide wing walkers to ensure safety is maintained. Currently there is no taxilane centerline or tiedowns marked on the Midfield Ramp.

According to the 2018 PCI evaluation, the pavement condition ranges from Good, Fair, Poor, Very Poor to Failed conditions. ***It is recommended that the Midfield Ramp be reconstructed in the near-term***.

4.8.1.3 Monaco-Midfield Ramps Connection

Aircraft being relocated from the Monaco to the Midfield Ramp are required to enter the movement area on Taxiway A to travel from one ramp to the other. This is a frequent occurrence as large ADG II and III aircraft load and unload passengers while stopped on the taxilane in front of Monaco but park on the Midfield ramp. Often, the aircraft are relocated from one ramp to the other while under tow. ***It is recommended that a taxilane connector that meets ADG III design standards, be constructed in the near term between the Monaco and Midfield Ramps.*** This connector should plan for potential future aircraft parking expansions, snow storage and future building area development which will be discussed in **Section 4.8.1.5.**

4.8.1.4 Tower Ramp

The Tower Ramp is constructed of asphalt and is primarily utilized by helicopter aircraft (based Lake Superior Helicopters (flight training, sightseeing and other various operations) and transient medical helicopters). Currently, there are 3 marked helicopter tiedown locations on the Tower Ramp.

The Tower Ramp is in mostly Poor condition according to the 2018 PCI evaluation. Lake Superior Helicopter (LSH) indicated that during hot summer days, the helicopter landing skids can sink into the pavement as the heat makes the asphalt more flexible. LSH stated that it is a safety concern, and that they operate on the Tower Ramp with extra caution in the summer. Portions of the tower ramp where LSH parks their helicopters was reconstrued in the summer of 2021. ***It is recommended that the pavement be reconstructed.***

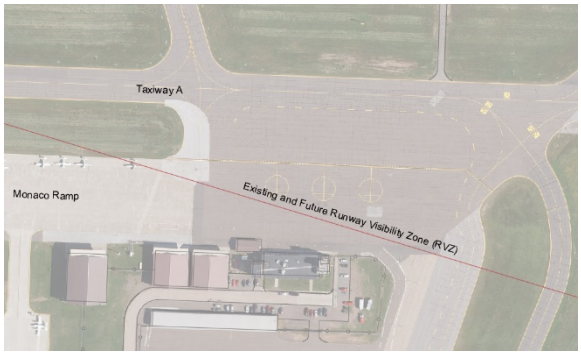
The runway visibility zone (RVZ) allows departing and arriving aircraft to verify the location and actions of other aircraft and vehicles on the ground that could create a conflict. The RVZ is created by connecting points along the centerlines of intersecting runways. Any point five feet above runway centerlines within the RVZ must be mutually visible with all other centerline points inside the RVZ and have an unobstructed view. An air traffic control tower is considered to be an added safety factor for aircraft operations; however, the RVZ standards must still be met.

The Tower Ramp is located at the eastern edge of the southwest quadrant, near the intersection of the existing Taxiway A and Taxiway C. This large expanse of pavement is located within the RVZ. Currently,

there are three helicopter parking locations on the Tower Ramp. Additionally, this area is used as overflow parking by the FBO and occasionally for large aircraft parking.

Aircraft parking is not allowed within the RVZ as it impacts the line of sight. The existing and future RVZ is shown in **Exhibit 4-8**. Because the Runway 9 and Runway 3 ends will not change in the future condition, the parking is non-standard in both the existing and ultimate conditions.

Exhibit 4-8 – Tower Ramp Existing and Future Runway Visibility Zone (RVZ)



A Modification to Standards (MOS) is used to gain temporary FAA approval where existing features do not meet current FAA design standards. A MOS to this standard may be approved by the FAA if an acceptable level of safety is maintained through a 24-hour control tower that is expected to remain in operation. A MOS request was submitted as part of this Master Plan process to allow aircraft parking to remain for an interim period. The MOS was approved on XX.XX.XXXX, the case number is XXX.XXX.XXXX.XX. MOS are approved for five years, and it is likely the FAA will require the Airport to begin to correct this non-standard parking within the five-year period. The removal of aircraft parking should be completed as part of the multi-year project for the reconstruction of Taxiway A. The Taxiway TAC expressed a desire to accommodate helicopter parking in a separate location from fixed wing parking if feasible.

When the adjacent Taxiway A or the Tower ramp is reconstructed, the aircraft parking located on the Tower Ramp should be relocated. The alternatives analysis later in this chapter will evaluate ultimate Tower Ramp layouts.

4.8.1.5 General Aviation Parking Needs

Table 4-25 includes the recommended total number of aircraft tiedowns. These recommendations include accommodating transient aircraft, based aircraft that may be parking on the apron for passenger pickup or flight training purposes, FBO services, etc. and accounting for cargo operations (Bemidji Air) that also utilize the Monaco ramp general aviation parking.

Table 4-24 – Aircraft Operations Requiring General Aviation Parking

	2018	2023	2028	2038
Itinerant Operations				
GA Jet and Air Taxi	2,447	2,597	2,689	2,799
Cargo – (Bemidji Air Only) (.9% CAGR)	510	533	558	610
General Aviation	24,917	25,356	25,803	26,720
Total Itinerant Operations	**27,874**	**28,487**	**29,050**	**30,129**
Local Operations				
Total Local Operations	24,122	26,141	29,491	36,055
Minus 98% of Local Ops that do not utilize GA parking ramps	-23,640	-25,618	-28,901	-35,334
Local Ops utilizing GA ramps	482	523	590	721
Total Operations Requiring Aircraft Parking	**28,356**	**29,010**	**29,640**	**30,850**

Table 4-25 – Tiedown Parking Demand

	Existing (2018)	2023	2028	2038
Annual Aircraft Requiring Tiedown	28,356	29,010	29,640	30,850
Peak Month Transient Operations	3,043	3,113	3,180	3,310
Peak Day Transient Operations	101	104	106	110
Peak Day Transient Aircraft	51	52	53	55
Minus aircraft that are quick turns (remain on taxilane)	-10	-10	-11	-11
TOTAL TIEDOWN DEMAND	**41**	**42**	**42**	**44**
ADG I Tiedowns Demand	28	28	29	30
ADG II Tiedowns Demand	8	9	9	9
ADG III Tiedown Demand	1	1	1	1
Helicopter	3	3	3	4

Source: SEH

It is recommended that aircraft parking layouts be able to accommodate the required aircraft parking. The existing Monaco ramp can currently only accommodate 10 ADG I tiedowns or a lesser amount of mixed sized tiedowns. The Midfield ramp can accommodate additional parking capacity with capacity varying depending on aircraft size.

4.8.2 Terminal Parking Ramp

The Terminal Apron is constructed of concrete and is available for aircraft utilizing the terminal to load and unload passengers into the terminal building. The terminal apron has four (4) marked parking spaces that provide access to a passenger boarding bridge, and two remain overnight (RON) spots that can accommodate smaller commercial passenger aircraft. Based on the commercial forecasts approved for this Master Plan, these parking spaces are anticipated to be adequate for the 20-year planning term. The terminal ramp can reach capacity during diversion events; however, additional parking is available on the Midfield Ramp to accommodate that need.

Should a terminal ramp expansion be needed, some eastward expansion may be feasible; however, the ability to expand is limited by location of the geothermal field for the terminal building. Westward expansion is possible once Taxiway D is relocated. If Taxiway D remains designed to ADG III standards (as recommended until Runway 3/21 is extended), expansion capabilities are maximized).

The main area of the terminal ramp was last constructed in 2014 as part of the terminal construction. The eastern portion of the ramp was constructed in 2020 and the area from Taxiway A to just inside the non-movement line will be reconstructed in 2022. As of 2018, the apron area last constructed in 2014 had a PCI of 98. ***Routine maintenance, such as joint repair and crack sealing should be performed on a scheduled basis to extend the life of the pavement. No other surface improvements to the terminal ramp.***

4.8.3 Building Area Needs

4.8.3.1 Hangars

DLH's hangar area consists of a mix of large box hangars, t-hangars and ranch hangars as discussed in **Section 2.14.5** . The existing ranch and t-hangars, located south of the Air Traffic Control tower, are in poor condition and the size does not meet the existing needs of tenants. The door size of these hangar bays do not accommodate many of the ADG I aircraft on the hangar waiting list. These hangars are the only available hangars that are owned by the Airport. These hangars are currently full, and the Airport has a hangar waiting list of approximately 19 aircraft. This waiting list is actively managed by the Airport. Additionally, the FBO, Monaco Air, currently manages additional hangar storage for both transient and based aircraft. Monaco and the Taxiway TAC expressed a need for additional large transient aircraft storage space, particularly in winter months.

The MnDOT SASP recommends enough hangars to accommodate 100% of based jet and turboprop aircraft and 95% of based single- and multi-engine aircraft. For planning purposes, hangar demand for the 20-year planning period was determined using the SASP recommendation and is shown in **Table 4-26**. By 2038, it is forecasted that a total of 85 aircraft will be based at DLH. Several based aircraft at DLH are owned by Cirrus Aircraft and Lake Superior College (LSC) – for the purpose of these facility recommendations, these aircraft were taken out of the hangar capacity needs calculation. Through the 20-year planning period, DLH will require approximately 50 hangar spaces to support the growing based aircraft demand (see **Chapter 3** for the aviation activity forecasts). It should be noted that northern Minnesota currently has a high demand for based aircraft hangar storage, primarily for ADG I aircraft. It may be beneficial to prioritize T- and Ranch hangar development.

Table 4-26 – Hangar Capacity Needs

	2018 Existing	Forecast		
		2023	2028	2038
Based Aircraft - Single & Multi	31	33	34	40
Based Aircraft –Turboprop	5	5	6	6
Based Aircraft – Jet	5	5	6	6
Based Aircraft – Helicopter	8	9	9	10
Estimated Hangar Demand	**49**	**52**	**55**	**62**

Source: SEH

It is recommended that additional hangar spaces (box, ranch or T-hangar) be constructed to accommodate additional aircraft by 2038. Room for approximately 19 additional aircraft should be provided in the near term (18 ADG I and 1 helicopter) and room for an additional 20 should be

provided by the end of the 20-year planning term. It is expected that hangar needs will grow for all types of aircraft, including ADG II and potentially ADG III. Some of this hangar space is expected to be needed to accommodate transient users.

4.8.3.2 Hangar Area Pavement

The pavement throughout the various building areas is Excellent to Very Poor condition (see **Figure2-8**)). With the exception of the taxilane in the GA development area south of Monaco and the North Business Development Area (NBDA), all building area pavement should be rehabilitated or reconstructed when funding becomes available. Because of the significant amount of airside pavement reconstruction needs in the first 10-years of the planning term, it may be difficult to utilize FAA funding to reconstruct these pavements. Alternative funding sources such as MnDOT Aeronautics should be considered for these pavements. The airport requests approximately $150,000 in pavement maintenance funds from MnDOT annually. These funds can be utilized to maintain hangar area pavement throughout the planning term.

4.8.4 Air Cargo Building Area

DLH experiences a significant amount of air cargo operations by Bemidji Air and Mountain Air which serve UPS and FedEx, respectfully. These carriers support the region and growing medical industry which rely on air cargo services. Bemidji Air (UPS) operates on the Monaco Ramp and Mountain Air (FedEx) operates on the FedEx Ramp. The existing facilities for cargo operations are capable of handling the existing and forecasted demand of cargo operations.

The existing FedEx development (buildings and apron) is leased to a tenant. While there are no current expansion plans, the site can accommodate an expansion to the south. The southward expansion will continue to be shown on the ALP. The future cargo development facilities should be designed to accommodate expansion for ADG III aircraft in the future as there is potential for ADG III air cargo operations.

4.9 Airside Alternatives Analysis 1 - Taxiway A

As discussed in **Section 4.7.2.2**, Taxiway A should be designed to ADG V and TDG 5 standards to meet the needs of existing users including the 148th Fighter Wing and occasional large transient aircraft. The non-standard features of Taxiway A discussed in this section should also be eliminated in the future Taxiway A layout.

4.9.1 Taxiway A Alignment

Most parallel taxiways are aligned to be parallel to the runway it serves. There has been an increase in wrong surface landings by pilots in the National Airspace System where pilots align to a parallel taxiway mistakenly thinking they are aligned with the runway. Maintaining a slight jog in Taxiway A meets FAA design standards and it may assist in mitigating wrong surface landings.

The Taxiway A evaluated several alignment options for Taxiway A. These options included three main alternatives:

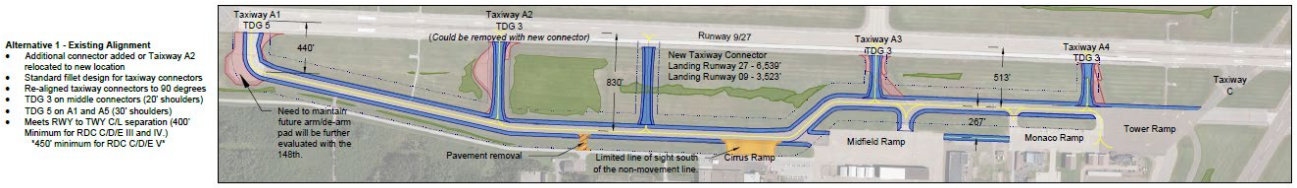
- Existing Alignment
- Parallel to Runway 9/27
- Hybrid including a partial realignment

4.9.1.1 Alternative 1 – Maintain Existing Alignment

Alternative 1 (See **Exhibit 4-9**) maintains the existing alignment along Taxiway A which includes a jog to the south that begins at the west end of the Midfield ramp. This alternative does not provide opportunities for the line-of-sight issues to be resolved as the ATCT will continue to not have adequate line of sight for vehicles entering Taxiway A from the perimeter road east of Taxiway A2. Additionally, the existing geometry near the west entry point to the Midfield ramp can be confusing to pilots and can result in loss of situational awareness.

There have been instances where aircraft traveling east on Taxiway A have inadvertently entered the Midfield Ramp instead of continuing on Taxiway A.

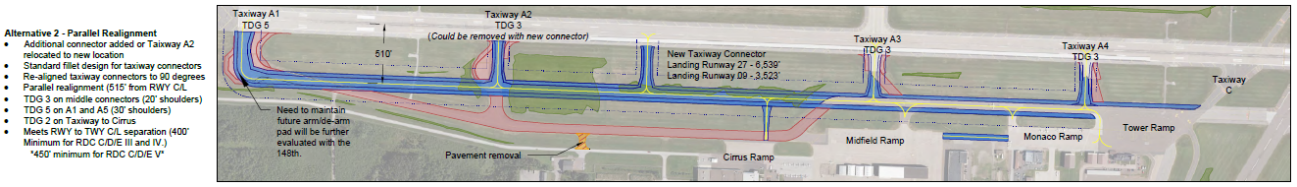
Exhibit 4-9 – Taxiway A Alternative 1



4.9.1.2 Alternative 2 – Realign Taxiway A to be Parallel to Runway 9/27

Alternative 2 (See **Exhibit 4-10**) realigns Taxiway A to be parallel to Runway 9/27 as shown on the existing ALP. This alternative improves line of sight and provides the maximum future building area development space as additional aircraft manufacturing expansion would be possible between the existing Cirrus complex and Taxiway A. This alternative results in increased construction costs due to the fill needed and the construction of a new alignment. In addition, this alternative results in large areas of wetland impacts and fill required for taxiway construction.

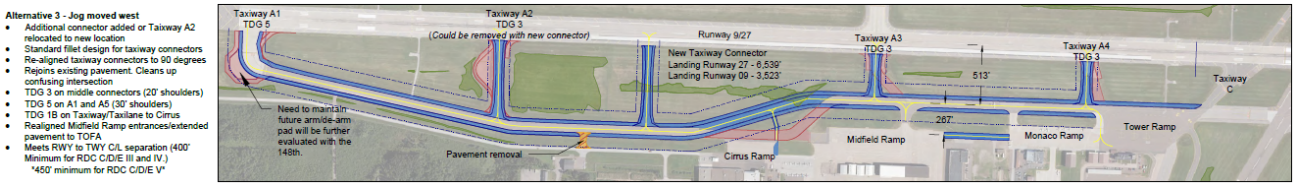
Exhibit 4-10 – Taxiway A Alternative 2



4.9.1.3 Alternative 3 – Hybrid Alternative with a Slight Realignment

Alternative 3 (See **Exhibit 4-11**) blends Alternatives 1 and 2 by realigning Taxiway A near the midfield ramp to improve pilot situational awareness but maintains much of the existing Taxiway A alignment. This alternative improves line of sight and minimizes impacts to wetlands as well as overall construction costs. The Taxiway TAC supported the selection of Alternative 3 as the alternative that best meets the needs while minimizing project costs and environmental impacts. Alternative 3 is the recommended Taxiway A alignment.

Exhibit 4-11 – Taxiway A Alternative 3



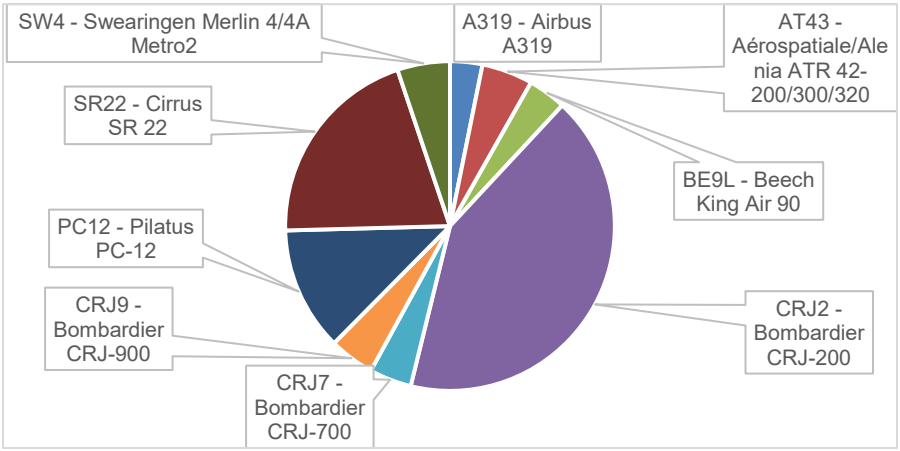
4.9.2 Connector Taxiway Alignments and Locations

4.9.2.1 Taxiway A2

The Taxiway TAC indicated that Taxiway A2 is not located in an ideal location as it is unusable for aircraft landing on Runway 9 due to the short distance from the runway threshold. Additionally, for aircraft landing on Runway 27, some may not be able to exit at A3 near the midpoint of the runway and the distance between A3 and A2 is sometimes too long. Since Taxiway A will be reconstructed in the near-term, an analysis was completed to determine the ultimate siting of Taxiway A2 was completed.

The FAA, in conjunction with Virginia Tech, developed the Runway Exit Design Interactive Model (REDIM) tool. The REDIM is a computer model developed to locate and design runway exits at airports. The model uses equations to characterize aircraft landing distances. This tool was used to identify a location for a relocated Taxiway A2. The fleet mix utilized is shown in **Chart 4-1**.

Chart 4-1 – Taxiway A2 Siting Fleet Mix



Since military aircraft were not evaluated in the REDIM tool analysis, the 148th Fighter Wing provided feedback on their usability of Taxiway A2 at various locations for aircraft landing on Runway 27.

Using this tool and feedback provided by stakeholders, ***it is recommended that Taxiway A2 be located to provide a landing distance on Runway 9 of 3,230' and a landing distance on Runway 27 of 6,772'.*** This location maximizes usability and minimizes impacts to wetlands located between Taxiway A and Runway 9/27. The military also indicated that their F-16's would be able to use this exit landing Runway 27 and potential fleet changes of the 148th would also be able to utilize this runway exit.

4.9.2.2 Taxiway A3 and A4

Both Taxiway connectors A3 and A4 are not aligned at 90 degrees to Runway 9/27. Taxiway A3 should remain in is existing location as it provides access across Runway 9/27 to Taxiway B, and it is utilized by approximately 45% of aircraft that land on Runway 9 and nearly 30% of aircraft landing on Runway 27. Taxiway A4 provides an exit for over 40% of aircraft landing on Runway 9 and should be reconstructed in its existing location. Both connectors should be realigned to 90 degrees as part of the Taxiway A reconstruction project.

4.9.2.3 Compass Calibration Pad

method of calibrating an aircraft's compass is to use a compass calibration pad to align the aircraft on a known magnetic heading and make adjustments to the compass to accurately reflect the direction the aircraft is pointing while on the calibration pad. The existing compass calibration pad is located on Taxiway A2. One Cirrus frequently uses the compass calibration pad to calibrate compasses on their aircraft. Additionally, the former tenant in the MRO facility frequently used the pad to calibrate compasses in A-320 family aircraft. Lake Superior College is another user of the compass calibration pad.

Siting for a compass calibration pad needs to meet separation requirements, but also needs to be at least 600' from magnetic objects such as large parking lots and high voltage transmission lines. The center of the calibration pad should also be 300' from aircraft arresting gear, fuel lines and communication/electrical conduits when they contain magnetic materials. It should also be 150' from taxiway or runway light cans,

airfield signs and ducts/grates that contain iron, steel or, ferrous[9] materials. Because Cirrus is a frequent user of the compass calibration pad, the Taxiway TAC indicated that a location in the southwest quadrant of the airport would be beneficial to limit runway crossings.

With the future relocation of Taxiway A2, the existing A2 location provides an opportunity for a compass calibration pad to be located in the infield area between Taxiway A and Runway 9/27. This location is over 500 feet from the arresting gear and can be an adequate distance from runway lights and signs. The compass calibration pad should be designed to accommodate an Airbus A-320 aircraft to accommodate the aircraft size of a future tenant of the MRO facility (it is assumed that a future MRO would service similar sized aircraft). It is anticipated that the compass calibration pad will be eligible for FAA funding (see AIP Handbook, Appendix I) as it is not anticipated to be exclusively used by any one user.

The future compass calibration pad at the existing A2 location is shown on **Figure 4-5**. The compass calibration pad should be constructed as part of the Taxiway A reconstruction project concurrent with or just after the Taxiway A2 relocation.

4.9.3 Taxiway A Reconstruction

The final recommended layout of Taxiway A is shown in **Figure 4-5**.

Taxiway A will be reconstructed in multiple phases over multiple years. The final phasing and schedule will be dependent upon FAA, MnDOT, DAA and 148th Fighter Wing funding availability. Phase 1 of Taxiway A reconstruction (the east end) received an FAA grant in summer 2021 and construction will occur in 2022. Construction of the remaining phases will occur in 2023 and beyond.

Preliminary phasing was identified as part of this Master Plan process. The phasing plan was developed with a goal of limiting the FAA investment in any particular phase to $7-$8 million dollars or less. Preliminary conversations with the FAA ADO indicated that the $7-$8-million-dollar level was what would likely to be successful as a maximum amount when requesting a discretionary grant for this multi-phase project. A secondary goal of the phasing plan was to develop phases that provide opportunities for alternate taxi routes that do not require back taxi on the runway. Eliminating back taxi is not only important for safe operations, but a taxi route the full length of the runway allows Runway 9/27 to maintain use of the ILS with likely no impacts to weather minimums. Airport stakeholders have indicated that maintaining ILS capability and minimums during construction is important.

If opportunities for additional funding become available through the FAA or military sources, the phasing should be reconsidered to determine if one or more phases can include larger areas in order to complete the project in fewer phases and construction seasons. Because Taxiway A is in poor condition, the airport should evaluate the pavement annually to determine if interim pavement maintenance projects should be completed. It is anticipated that the 148th Fighter Wing will participate in FAA ineligible pavement areas in each phase through an MCCA. The preliminary phasing is summarized below and depicted in **Figure 4-6**.

Phase 1 – (2021 grant, 2022 construction) – This phase includes reconstruction of Taxiway A east from the terminal ramp to Taxiway C. This phase also includes reconstruction of a portion of the terminal ramp between Taxiway A and the terminal apron that was constructed in 2014. As part of the design process, a life cycle cost analysis concluded that concrete is the appropriate pavement type. The 148th Fighter Wing will be funding the FAA ineligible pavement areas through an MCCA.

Phase 2 – (2022 Grant, 2023 construction) – This phase includes reconstruction of Taxiway A in front of the Tower Ramp as well as realignment of Taxiway A4. As part of this phase, pavement between Taxiway A and the non-movement line on the tower ramp can be removed or painted as unusable. This phase can also

[9] Containing of or consisting of iron.

include the addition of a new ARFF access road, something that was recommended by the Taxiway TAC, particularly the ARFF staff. Back taxi operations can be eliminated during this phase through utilization of a taxi route through the Monaco and Tower ramps.

Phase 3 – (2023 grant, 2024 construction) – This phase includes reconstruction of Taxiway A between the limits of Phases 1 and 2. This phase also includes the realignment of Taxiway C from Runway 9/27 south to Taxiway D along with pavement removal in the former Taxiway C alignment. This phase, along with Phase 2, removes Hot Spot 1 through removal of the wide expanse of pavement and complex geometry. During this phase, an alternate taxi route can be provided via Taxiways G and D for much of construction. While Taxiway D connector (west of Runway 3/21) is reconstructed, Taxiway A can be available for use. Using this phasing, back taxi operations can be eliminated during this phase.

Phase 4 – (2024 grant, 2025 construction) - This phase is an enabling phase for the follow-on Phase 5. This phase includes construction of a taxilane and aircraft parking area between the Monaco Ramp and Midfield Ramp. This pavement area will provide additional needed parking and improved traffic flow; but more importantly related to Taxiway A phasing, it will provide a bypass taxi route when Phase 5 is under construction. Taxiway A usability will not be impacted during this phase.

Phase 5 – (Year TBD) – This phase reconstructs the portion of Taxiway A in front of the SRE building and Midfield Ramp as well as realigns Taxiway A3. This phase also includes the construction of two new connectors to the midfield ramp. During this phase, aircraft can utilize the Midfield Ramp and new SRE ramp as a bypass taxiway, eliminating the need for back taxiing during the majority of this phase.

Phase 6 – (Year TBD) – Phase 6 includes the realignment of the segment of Taxiway A west of the Midfield ramp, reconstruction of Taxiway A to the new Taxiway A2 location and the construction of the new Taxiway A2.

Phase 7 – (Year TBD) – Phase 7 includes reconstruction of Taxiway A from Future Taxiway A2 to the midpoint between Taxiway A1 and existing A2. This phase also includes the removal of existing Taxiway A2 and construction of the new compass calibration pad on the existing Taxiway A2 alignment. The perimeter road will also be relocated in this phase to enable construction of the holding bay/arm-dearm pad in Phase 8. Because Phase 7 includes wetland impacts that exceed the threshold for a CatEx, an Environmental Assessment (EA) will be needed for this phase. Both Phases 7 and 8 should be evaluated in the EA.

Phase 8 – (Year TBD) – This phase includes the reconstruction of Taxiway A1, removal of excess pavement, the reconstruction of Taxiway A to the limits of Phase 7, and the construction of a new holding bay/arm-dearm pad.

Phase 9 – (Year TBD) – Phase 9 includes the expansion of the midfield ramp to accommodate and expanded parking area for large aircraft. If funding is available, this phase would be beneficial to complete earlier, concurrent with Phase 4, to provide additional space for a bypass taxiway while maintaining some parking capacity on the Midfield Ramp. The airport should re-evaluate funding opportunities annually to determine if this phase can be completed sooner.

4.10 Airside Alternatives Analysis 2A – Runway 3/21 Proposed Alternative

Section 4.4 discussed the recommended facility improvements to Runway 3/21. As part of the Master Plan a Technical Advisory Committee (TAC) was established with stakeholder to develop preliminary runway alternatives based on these facility recommendations and to evaluate the presented alternatives. Facility recommendations for Runway 3/21 were developed with input from the TAC and the TAC participated in

evaluating the proposed alternatives. The following assumptions and goals, based on stakeholder feedback, were considered in the development and selection of the preferred Runway 3/21 alternative.

Runway Length

- The airport should plan for a 8,000 foot long Runway 3/21
  - 148th Fighter Wing: The 148th Runway length requirements are 7,000 feet as an emergency runway and 8,000 feet for a secondary use runway. Arresting gear is needed on the departure end of a runway.
  - Commercial Air Service: The preliminary runway length needed to serve existing air service aircraft is 7,800 feet.
  - General Aviation: The runway length needed to serve the existing critical general aviation aircraft is 7,900 feet.
  - Cirrus indicated that a longer Runway 3/21 would be beneficial to their operations at DLH.
  - A longer Runway 3/21 would provide value for those, including Lake Superior College, who conduct flight training operations at DLH.
  - A funding source is needed prior to a Runway 3/21 extension being implemented.

Instrument Approaches

- Runway 3/21 should be designed for 1-mile visibility minimums.
  - Improvements to instrument approaches were considered. Wind analysis indicated that improved approach minimums would have limited added benefit as the wind typically favors Runway 9/27 during poor weather conditions. Additionally, the 148th's weather minimums for training are 1-mile visibility (equal to the current weather minimums on Runway 3/21).
  - It was indicated that instrument approach lighting would be beneficial as they provide an extra navigational aid to pilots. However, they would not be used to lower visibility minimums to a runway end in this case.
  - The 148th currently cannot utilize GPS approaches, but general aviation and many commercial service aircraft can. Future 148th aircraft may have GPS capabilities.

Taxiway Network

- The taxiway network for Runway 3/21 should be improved to meet FAA design standards.
  - The separation of Taxiway C from Runway 3/21 should be widened. It is currently too close to the runway.
  - Taxiway C at the Runway 3 end and the Runway 9/27 intersections has non-standard geometry and should be redesigned when pavement is reconstructed.
  - Taxiway D should intersect Runway 3/21 at 90 degrees.
  - Taxiway F currently does not connect to Runway 3/21 at a standard angle and is unavailable for fighter jet use because it exceeds grade standards.
- The Taxiway TAC recommended that large aircraft continue to utilize Runway 3/21 to access the 148th Fighter Wing (Taxiway F) in lieu of improving Taxiway C to large aircraft standards.
- If Runway 3/21 is extended to serve the needs of the 148th, a UFC Class B taxiway system (75' wide taxiway) is needed to connect the ANG facilities to Runway 3/21. This could be accomplished via improved Taxiway F, Taxiway D or Taxiway C.

Environmental and Land Use

- Environmental and land use impacts of the proposed alternatives should be considered and minimized.

- Improvements to Runway 3/21 may impact aircraft parking and building areas and was considered in the selection of the preferred alternative.

The following goals were ranked, in order of importance, by TAC members and priority was given to these goals when evaluating the final recommendation for Runway 3/21.

1. Meet military runway length needs
2. Meet taxiway design standards
3. Meet civilian runway length needs
4. Improve instrument approach minimums
5. Minimize zoning impacts to surrounding communities
6. Minimize impacts to natural resources

As part of the evaluation of Runway 3/21 extension options, an extension to the Runway 3 (southern) end was evaluated. Any extension to the south would shift the Runway Protection Zone (RPZ) over Air Base Road. Under FAA policy, roads are not an allowable use in an RPZ and the road would require relocation. In addition, depending on the amount of extension, relocation of Airport Approach Road may also be needed. Additionally, RPZs should be owned in fee by the airport and property acquisition would be required with any extension amount. For this reason, extensions to the Runway 3 end were not considered.

Using the main goals and assumptions developed by TAC members, eight (8) alternatives were evaluated which met all or some of the goals to improve the runway. The initial alternatives developed and evaluated by the TAC are summarized in **Table 4-27** below. All extension alternatives assume an extension to the north.

Table 4-27 – Runway 3/21 Alternatives Evaluation

Alternative	Runway Dimensions	Runway 3 Approach Minimums	Runway 21 Approach Minimums	NAVAID	Wetland Impacts	Estimated Costs (2020 dollars)
Alternative 1A (No changes)	5,719' x 150'	1-Mile	1-Mile	-	-	$0.00
Alternative 1B (Improvements only to Taxiway C)	5,719' x 150'	1-Mile	1-Mile	-	-	$23,000,000
Alternative 2A (8,000’ with 1-mile approaches)	8,000' x 150'	1-Mile	1-Mile	-	34.2	$72,000,000
Alternative 2B (8,000’ with 3/4-mile approaches)	8,000' x 150'	1-Mile	3/4-Mile	-	34.2	$75,000,000
Alternative 2C (8,000’ with 1/2-mile approaches)	8,000' x 150'	1-Mile	1/2-Mile	MALSR	38.1	$77,500,000
Alternative 3A (7,000’ with 1-mile approaches)	7,000' x 150'	1-Mile	1-Mile	-	9.3	$55,000,000
Alternative 3B (7,000’ with 3/4-mile approaches)	7,000' x 150'	1-Mile	3/4-Mile	-	9.3	$58,000,000
Alternative 3C (7,000’ with 1/2-mile approaches)	7,000' x 150'	1-Mile	1/2-Mile	MALSR	13.2	$60,500,000
Notes						

Stakeholders indicated that improved instrument approaches would also add benefit to users of DLH and Runway 3/21. Any improvement to instrument approaches to Runway 3 would increase the size of the RPZ, requiring the relocation of Air Base Rd and at least a small portion of Airport Approach Road. Often, a displaced threshold can be considered in lieu of relocating roads when there are incompatible land uses in an RPZ. In the case of the Runway 3 end, a displaced threshold to remove the roads from the southern-most areas of the RPZ also pulls additional segments of Airport Approach Rd into the RPZ and may also limit the use of the FedEx cargo ramp.

A seasonal and monthly wind and weather analysis was conducted to evaluate the benefits of improved instrument approach procedures to Runway 3/21 (**See Section 2.13.4**). This analysis concluded that when DLH has poor visibility, Runway 9/27 is the preferred runway for aircraft operations (winds favor 9/27 or it is during periods of low wind speed such as fog). Additionally, Runway 9/27 has ILS approaches and approach lighting systems on both runway ends. Stakeholders echoed the findings of the seasonal wind analysis and indicated that when visibility was poor winds favored Runway 9/27, and pilots preferred the published ILS approaches and longer runway provided by Runway 9/27.

Following the evaluation of the alternatives listed in **Table 4-27**, the preferred Runway 3/21 alternative that was selected is Alternative 2A, shown on **Figure 4-6**. This alternative extends Runway 3/21 to the northeast to a total length of 8,000’ while maintaining the existing 1-mile approach minimums.

The runway length was selected to meet the needs of both the civilian critical aircraft, which is represented by the Airbus A319 and the 148th Air National Guard (F-16 aircraft). This extension is not justified for FAA funding and a funding source has not been identified. It is recommended that this extension be shown in the ultimate conditions (beyond the 20-year planning term).

Stakeholders indicated that approach lighting would add benefit if approach minimums were not improved. An approach lighting system could be added if funding was available; however, approach lightning is not required to meet FAA or MnDOT standards based on the approach minimums to Runway 3/21, and a funding source has not been identified within the planning period of this Master Plan. The Airport Layout Plan (ALP) will depict the approach lighting on the Runway 3 end in the ultimate conditions (beyond the 20-year planning term).

4.11 Airside Alternative Analysis 2B - Runway 3/21 Taxiway Network Proposed Layout

The future and ultimate taxiway network needs for Runway 3/21 were evaluated by the Taxiway TAC. Improvements to the network in the west side (Taxiway C) and east side (Taxiways D and F) were evaluated. The future conditions will evaluate needs for the existing Runway 3/21 length while the ultimate conditions will evaluate needs for the extended Runway 3/21 (8,000 feet).

4.11.1 Taxiway C

Taxiway C is the existing full-length parallel that serves Runway 3/21. Taxiway C is located on the west side of Runway 3/21 and is at a non-standard distance from the runway centerline. Relocation of Taxiway C also allows for relocation of the glideslope antenna to a location that provides a standard threshold crossing height (TCH) for Runway 27. If Taxiway C is the parallel taxiway to Runway 3/21, it should be relocated to the standard runway centerline to parallel taxiway centerline distance of 400' for RDC C-III, not lower than one-mile standards. The Taxiway TAC recommended that the large aircraft that need to access the 148th Fighter Wing (via Taxiway F) continue to back taxi on Runway 3/21 instead of improving Taxiway C to UFC Class B standards. (The 148th indicated that, on average, 20 operations of large aircraft (larger than ADG III) need to access that Guard ramp via Taxiway F on the north end of the guard apron.) A full-length alternative for Taxiway C was developed and presented to the Taxiway TAC for evaluation.

4.11.2 Taxiways D and F

As part of this analysis, Taxiway D, on the east side of Runway 3/21 was evaluated to determine if a full-length Taxiway D would be beneficial for Runway 3/21 in place of a full-length Taxiway C. This alternative would also allow for the Runway 27 glideslope to be relocated to provide a standard TCH; however, a glideslope study will be needed to evaluate the feasibility of Taxiway D being located within the glideslope critical area. A high-level feasibility analysis was completed to identify constructability challenges associated with extending Taxiway D to serve as a full-length parallel taxiway for Runway 3/21 and the ability to provide access to the Guard Ramp. The analysis generally shows that this is a feasible alternative, but not without design challenges as outlined below.

The Taxiway Network and Aircraft Parking TAC members indicated that, due to the condition of Taxiway C and the need to reconstruct Taxiway C in the near term, it was preferred to reconstruct Taxiway C and leave the 148th Guard Access in its current condition for the planning period. Generally, the useful life of pavement is 20 years, and the Master Plan was not able to identify a funding source for the Runway 3/21 extension to 8,000' within the 20-year planning period. While there may be a benefit to Taxiway D becoming the parallel taxiway for Runway 3/21, priority was identified to reconstruct Taxiway C and to meet standards requirements. Prior to the Runway 3/21 extension the Airport should reevaluate the needs of the airport, the forecast and Taxiway D as the parallel taxiway. There may be an opportunity to share funding with the 148th for the taxiway construction to the north end of Runway 3 if the taxiway is used by both military and civilian

aircraft. Additionally, Taxiway C will be nearing the end of its useful life and will require reconstruction around 2046.

148th Ramp Access Connector Taxiway

The 148th's existing access to Runway 21, Taxiway F, does not meet the longitudinal grade requirements of UFC 3-260-0-1 (1.5% maximum), with estimated grades ranging from 1.5% to greater than 2.0%. As a result, this taxi route is currently unusable for F-16 aircraft. The difference in elevation between Runway 21 and the guard ramp will be a challenge for any future connector taxiways to an ultimate full-length Taxiway D, or ultimate Taxiway F as designed on the current ALP.

Notwithstanding, a preliminary feasibility study found that this connector could ultimately be accomplished within UFC grade requirements, provided that the addition of the ramp connector taxiway is *carefully coordinated with both the future reconstruction of Runway 3/21 as well as the construction of the full-length parallel Taxiway D*. This alternative is best achieved if the portion of Taxiway D north of Runway 9/27 is constructed after Runway 3/21 is reconstructed. Design considerations that will need to be coordinated will include adjustment of the ultimate profile of Runway 3/21, and careful siting of Taxiway D's connector taxiways in the vicinity of the ramp access taxiway to meet FAA vertical curve requirements.

148th "Arm/Dearm" Ramp Impacts

With the ultimate location of Taxiway D being 400' from the centerline of Runway 3/21, a small portion of the existing 148th Arm/Dearm ramp would be located within the Taxiway Object Free Area (TOFA). Additionally, with the guard ramp being generally higher in elevation than a future Taxiway D, a minimal amount of further pavement removal or relocation may need to be further investigated to meet FAA and UFC safety area grading requirements. Preliminary conversations with the 148th Fighter Wing indicate that this may be feasible.

Alternate F-16 Access to Full-Length (Or Partial) Taxiway D

Taxiway F could be extended in two phases. Phase 1 could provide an additional access route to the 148th Guard Ramp (See **Figure 4-5**) and Phase 2 would ultimately extend Taxiway D full length to the north after Runway 3/21 were reconstructed. If Taxiway D was not fully extended, Taxiway F would continue to provide access (in existing or reconfigured layout) to the guard ramp for large aircraft and access to the Runway 21 end for the F-16's use of the recommended 8,000' Runway 3/21.

The ability to access the Guard Ramp near the alert hangar through a partial parallel Taxiway D provides opportunities for ultimate removal of Taxiway H as this new connector provides the required second access point to Runway 9/27, as required by the UFC standards. The section of future Taxiway D between Runway 9/27 and the proposed ramp connector does not have as significant of grade concerns as the northern portion.

4.11.3 Recommended Runway 3/21 Taxiway Network

The Runway 3/21 Taxiway network recommendations are summarized for the planning term, and beyond the planning term. The Runway 3/21 taxiway network layout is depicted in **Figure 4-5**.

4.11.3.1 Planning Term Recommendations (Future)

As part of this alternative analysis, ***it is recommended that Taxiway C be reconstructed to a standard runway centerline to taxiway centerline separation in the near-term*** to serve the existing Runway 3/21 length. Because Runway 3/21 is not expected to be extended during the 20-year planning term, it was determined that maintaining the Taxiway C infrastructure was the preferred alternative for the planning term. Taxiway C should be designed to ADG III and TDG 3 standards.

Taxiway D, south of Taxiway A, should be reconstructed at the standard runway to taxiway separation and designed to accommodate ADG III and TDG 3 aircraft. While an extension to Taxiway D could be considered, it is not recommended for the planning term as aircraft accessing the Runway 3 end are often coming from the west side of the airfield and not the terminal ramp.

The 148th Fighter Wing is responsible for Taxiway F. When it is reconstructed, it should be realigned to be a partial parallel taxiway to Runway 3/21 with a connector aligned at 90 degrees. The taxiway should be designed to meet UFC standards.

4.11.3.1.1 Future Runway 3/21 Exit Taxiways

During the development of these taxiway alternatives, an evaluation was conducted to identify ideal location for runway exits for the fleet mix that DLH currently sees and is forecasted to see in the 20-year planning period. The REDIM tool was utilized to site the recommended runway exits for future Taxiway C on Runway 3/21. It is important to note that this evaluation does account for human preference such as commercial aircraft landing long to exit closer to the terminal.

4.11.3.2 Beyond-Planning Term Recommendations (Ultimate)

Taxiway D could be constructed as a full-length parallel taxiway in 20+ years when Runway 3/21 is extended to 8,000 feet. If Taxiway C is at the end of its useful life when Taxiway D is constructed, a full-length Taxiway D could replace Taxiway C.

Once Runway 3/21 is extended to 8,000 feet, a taxiway network meeting UFC Class B standard will be needed. A full-length Taxiway D should be constructed to Class B standards in order to provide F-16 aircraft access to both ends of Runway 3/21. Additionally, Taxiway D should be extended to the Runway 3 end in order to provide access to that runway end. Taxiway C is currently used by large aircraft accessing the 148th Air National Guard base.

4.12 Airside Alternatives Analysis 3 – Air Traffic Control Tower

The existing Air Traffic Control Tower (ATCT) is owned and maintained by the DAA. The FAA leases space in the tower building and provides ATC services. FAA Tech Ops leases space in the terminal building as well as an adjacent garage. Additional tenants lease office space in the building as well. **Section 2.11** provides an in-depth explanation of the significant role that air traffic controls services play for DLH and the surrounding airspace and discusses the existing air traffic control tower facilities.

The tower was built in 1954 and is nearing the end of its useful life and replacement is recommended. The building condition assessment completed as part of this Master Plan rated the building with a score of 2 out of 5 with improvements needed to the building shell, roofing, electrical, and mechanical systems.

In addition to the poor building condition, the existing ATCT has line of sight challenges near where the Cirrus ramp intersects Taxiway A, and the tower cab height is below what is recommended to meet line of sight requirements to each runway end using analysis from the FAA's Air Traffic Control Visibility Analysis Tool.

As part of this Airport Master Plan an Air Traffic Control Technical Advisory Committee (TAC) was developed to evaluate alternatives for a new ATCT. This alternatives analysis included consideration of remote tower concepts and a preliminary control tower siting study for a traditional brick-and-mortar facility.

4.12.1 Remote Air Traffic Control Tower

A remote tower is a concept where certified controllers, in an on-site or remote location, utilize video cameras and radar displays to safely control air traffic in and around an airport. As part of the FAA Reauthorization Act of 2018, Congress directed the FAA to establish a remote tower program for rural and small communities, which included three non-primary airports that are not towered, one non-hub airport, one airport with a contract tower and two different vendors for the remote tower systems. There are currently two pilot program sites – Leesburg Executive Airport (JYO) and Northern Colorado Regional Airport (FNL).

Remote Air Traffic Control Tower

Source: Colorado Department of Transportation Aeronautics

As part of this Master Plan, representatives from the Colorado Department of Transportation (CDOT) Aeronautics and the Northern Colorado Regional Airport participated in a panel discussion with the TAC members where they shared their experience with the pilot program and gave an overview of the technology (see ATCT TAC Meeting #1 summary).

Ultimately, the TAC did not recommend pursuing a remote tower option at DLH (see ATCT TAC Meetings 2-4 summaries in **Appendix A** for additional background information on stakeholder feedback, alternatives analysis and recommendations). When asked to rank what type of tower DLH should pursue, remote or brick and mortar, responding TAC members strongly supported pursuit of a brick and mortar tower on a scale of 0-5 (0 being 'Do not support' and 5 being 'strongly support') with an average score of 4.9.

4.12.2 Air Traffic Control Tower Preliminary Siting Study

A preliminary siting study for an Air Traffic Control Tower (ATCT) was conducted to identify possible locations on the airfield that should be preserved for the development of a future ATCT. This siting study identified locations that may be suitable for an ATCT at DLH and were presented to the TAC for their evaluation of sites. This siting study followed applicable FAA Job Orders available to the project team. However, once funding is secured for a future air traffic control tower siting study, the FAA would conduct their own siting study to determine the preferred future ATCT location.

FAA Job Order 6480.4B, *Airport Traffic Control Tower Siting Process,* defines the process to site a new ATCT to ensure a safe, efficient, and secure aviation system. The job order was used to find and evaluate alternatives as part of the Airport Master Plan. As mentioned above, the FAA will ultimately determine the final location of the control tower; however, completing this process in the Master Plan will ensure that areas of the airport are developed and redeveloped in a way that ensures the highest and best use of airport land and preserves space for an ATCT.

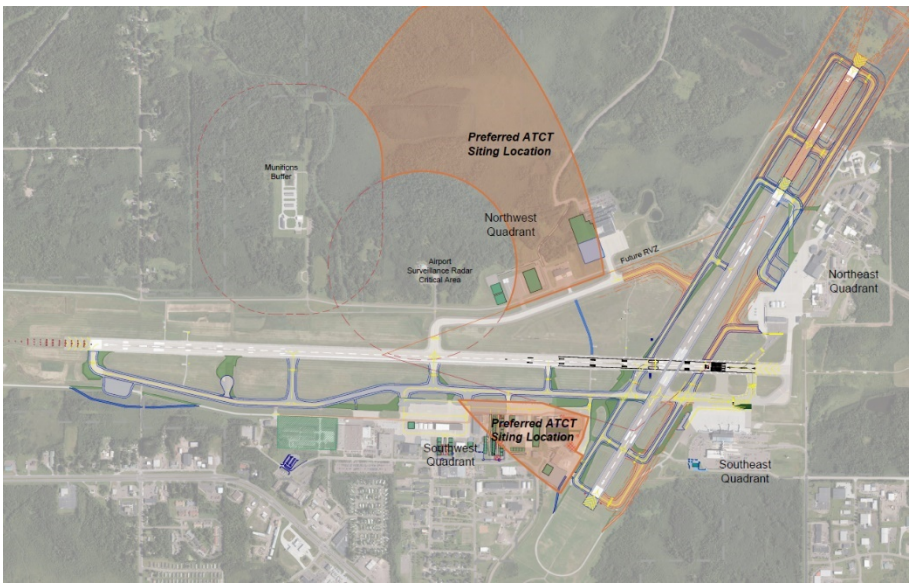
JO 6480.4B lists several factors that should be considered while siting a new Air Traffic Control Tower. The factors below, with greater emphasis in descending order, were considered while evaluating sites.

- Limit impacts on instrument approach procedures
  - All runways have several imaginary surfaces that protect aircraft on approach and departure to the runway. Consideration should be given to these protected surfaces to ensure aircraft safely operate in all weather conditions.
- Limit impacts on communication, navigation and surveillance equipment
- Visibility performance
  - The ATCT must have an unobstructed view of all runways, landing areas and air traffic in the vicinity of the airport.

  - The probability of an observer (controller) can detect an object on all airport surfaces must be at least 95.5%.
  - The minimum line of sight angle of incidence should be equal to or greater than 0.80 degrees.
- Operational requirement
  - Orientation – Orientation of the ATCT should have the primary view facing north, or alternatively east, west and then south. Where snow often accumulates in the northern hemisphere, a southern orientation should be avoided.
  - Visibility of all airport surface areas should be considered. Priority should be given to taxilanes in non-movement areas.
- Economic considerations
  - Economic considerations should be used to determine an ultimate site including the height of the tower, land use, utilities and cabling, site access and security.

DLH can be separated into four quadrants using Runway 9/27 and Runway 3/21 as diving lines. The Northwest, Northeast, Southeast and Southwest quadrants were all evaluated at a high-level for an ATCT.

Exhibit 4-12 – ATCT Siting Study Locations



Northwest Quadrant – North Business Development Area

This area was evaluated for an air traffic control tower and would meet siting criteria for line of site capability. However, an ATCT in this quadrant would create a south facing primary view for controllers and is the least preferred orientation by the FAA's Siting JO. This area was not considered further.

Northeast Quadrant – 148th Air National Guard Base Area

This quadrant was not evaluated for an Air Traffic Control Tower due limited developable space, the 148th Air National Guard Base, existing environmental features, and the distance to the approach end of Runway 9.

Southeast Quadrant – Commercial Service Terminal Area

This quadrant was not evaluated for an Air Traffic Control Tower due to the existing development of the commercial service terminal and the distance to the Runway 9 end. Similar to the Northeast Quadrant, the minimum height for a control tower in this quadrant would need to be approximately 200’ AGL. Representatives from the exiting control tower indicated that it would be challenging to see the approach end of Runway 9 from this location.

Southwest Quadrant

After evaluating the other three quadrants, the southwest quadrant was identified as being the best location for the development of the future control tower. This quadrant is centrally located, meets the FAA JO for siting an air traffic control tower and has the infrastructure to support the facility. Eleven different sites in the southwest quadrant were initially evaluated and are shown in **Figure 4-8.** These alternatives were presented to the TAC during Meeting #4. Following that meeting, three other sites were also considered; however, they did not meet the standards described in the FAA’s JO for siting a new Air Traffic Control Tower.

Table 4-28 – Southwest Quadrant Air Traffic Control Tower Siting Comparison

Alternative	Location	Approximate Height	Building Area Restrictions[1]	Meets FAA Design Standards
Alternative 1A	South of the existing Vault	100’	Yes	Yes
Alternative 1B	Align with the existing Vault	85’	Yes	Yes
Alternative 1C	South of Monaco ramp along taxilane to Fuel Farm	85’	Yes	Yes
Alternative 1D	Existing Tower Location	85’	No	Yes
Alternative 1E	Existing Ranch and T-Hangar area location	110’	Yes	Yes
Alternative 1F	North of Hangar 2, along the tower ramp	120’	Yes	Yes
Alternative 1G	South of the Cargo (FedEx) Ramp	180’	Yes	Potential instrument approach and departure impacts to Runway 3/21
Alternative 1H	South of the fuel farm	130’	Yes	Yes
Alternative 1I	Hydrosolutions Site	110’	Yes	Yes
Alternative 1J	West of Hydrosolutions and Southeast of the SRE	110’	Yes	The probability of identifying operations and maintenance vehicles at the approach end of Runway 21 is below the minimum requirement
Alternative 1K	Located on top of the SRE building	130’	Yes	Yes
Alternative 1L	Old CAF Hangar site	125’	Yes	The probability of identifying operations and maintenance vehicles at the approach end of Runway 21 is below the minimum requirement
Alternative 1N	Hydrosolutions site	110’	Yes	Yes

Note:[1] Building height restrictions are possible for the proposed tower height in certain alternatives and are listed on each alternative’s figure. The preferred control tower alternative will be analyzed with the preferred future building area and taxiway and taxilane to ensure future aeronautical development and redevelopment areas are not negatively impacted by the proposed ATCT height.

The highest ranked sites from stakeholders included the existing ATCT site (Location 1D) and a site east of the existing SRE building. Because the airport wants to maximize and reserve these sites for aeronautical development, location 1E was selected as the preferred site for a future ATCT building. This site will require the relocation of the DAA owned T-hangar and ranch hangar buildings. These hangars can be constructed in the future hangar area development space east of the SRE building. Space between Taxilane G and the

future tower site would be available for development and could be considered prime development areas as they face Taxilane G and Taxiway C.

Based on feedback from stakeholders and the opportunity for aeronautical development i***t is recommended that an area south of the existing air traffic control tower be preserved for the development of a future control tower.***

Creative funding opportunities will be needed for the ATCT replacement project as it is not currently eligible for FAA (AIP) funding since the facility is owned by the airport and not FAA. Funding opportunities include State of Minnesota bonding and public-private-partnerships. The airport should plan to continue leasing space to FAA Tech Ops in the tower building. In addition to being beneficial to collocate all federal activities in one building, this will generate additional revenue from the additional tenant.

FAA Order 6480.4B outlines the requirements for determining site location, tower height and cab orientation of a proposed new or replacement tower. The order also outlines the FAA process for siting a tower utilizing the Airport Facilities Terminal Integration Laboratory (AFTIL). As part of this Master Plan process, the airport had an early coordination meeting with the FAA to gain an understanding of the steps and timeline in the formal siting study process. A Reimbursable Agreement (RA) will be needed to complete a formal siting study for the new air traffic control tower. The FAA indicated that establishing the RA will take approximately 8 months. Once the RA is established, the FAA indicated that the modeling, analysis, and reporting process would take approximately 2-2.5 years. ***The airport should enter an RA with the FAA to initiate the tower siting study process. Because FAA funding is not available for this study, the airport should collaborate with MnDOT Aeronautics to determine if state funding is available to support this effort.***

Following the multi-year process and once funding is obtained, NEPA review in the form of an Environmental Assessment will be required. Once the NEPA process is complete, design and construction will take place, likely over multiple years.

Building areas alternatives discussed in **Section 4.13** were developed using an estimated site size of a similar footprints of Control Towers with a Terminal Area Approach Control (TRACON) facility. The size of development is only estimated; ***therefore, the FAA siting study should be completed prior to initiating or approving development around the Tower Ramp or Taxilane G.***

DAA owned T-Hangar that will require relocation for the development of the Air Traffic Control Tower Site. This hangar is approximately 30-40 years old

4.13 Airside Alternatives Analysis 4 – Aircraft Parking, Apron and Building Area Facility Recommendations

Identifying opportunities for aeronautical development is a key focus of this master planning effort. The majority of the aircraft parking and hangar development at DLH is in the Southwest quadrant of the airport. This area is heavily developed with a mix of aeronautical and non-aeronautical uses. Aeronautical uses in this area are mixed and include uses such as aircraft manufacturing, helicopter operations, transient jet parking, military aircraft parking, FBO type operations and higher education/flight training.

Identifying locations for non-aeronautical and aeronautical use was a priority of two Technical Advisory Committees (TAC). These technical advisory committees provided feedback on how the future and ultimate building area layout should be developed. The Taxiway Network and Aircraft Parking TAC focused on the

taxiway layout and the building area layout and needs. The Economic Development TAC, which met separately from the Taxiway TAC, focused on prioritizing areas for economic development, both aeronautical and non-aeronautical. It is also important to note that the Air Traffic Control Tower (ATCT) TAC (See **Section 4.12**) had an influence on the development sites identified.

Several goals were identified by the stakeholder group and Airport for development of alternatives, and non-standard features of the taxilane and apron layout were also identified. These high-level goals are outlined below, additional feedback from the TAC Members is included in **Figure 4-4**.

1. Keep similar type of aircraft operations together when developing aircraft parking and hangars (i.e. small aircraft with small aircraft).
2. Develop a designated rotary wing area separate from fixed wing aircraft operations. This development site should be easily accessible from the landside to promote air tourism.
3. ADG III business jet aircraft frequent the FBO and the collocated CBP General Aviation Facility. An access route from the movement area to the FBO, where CBP facilities are located, should designed to meet ADG III requirements.
4. Draft FAA Advisory Circular 150/5300-13B, *Airport Design* was issued on July 20, 2020. This draft Advisory Circular proposes to reduce object free areas (OFA) for certain Airplane Design Groups (ADG). The standards proposed in this draft advisory circular should be considered in this master planning process to identify if the potential new guidance allows for greater flexibility and improves safety on the existing and future apron taxilanes. Although the new AC may not be adopted during this master planning process, this Master Plan may document opportunities for future changes if the standards are adopted.

This alternative analysis will discuss the alternatives developed for hangar development areas and aircraft parking and which alternatives were selected as the preferred alternative by the stakeholder group. This analysis seeks to accommodate the anticipated hangar demand and aircraft parking demand documented in **Section 4.8**.

4.13.1 Hangar 101 Site

The Hangar 101 site, located south of the Midfield ramp, was most recently the home of the Commemorative Air Force Museum. The building was constructed in the early 1950's. The hangar has been vacant since 2018 and has been condemned by the Airport due to the deteriorating and unsafe condition.

As part of this Master Plan, a Phase I Environmental Site Assessment was completed on the hangar to identify Recognized Environmental Conditions (RECs), Controlled RECs (CRECs) and Historical RECs (HRECs) in connection with the hangar. Multiple HRECs (multiple nearby leak sites) were identified in connection with or nearby to the hangar. In addition to the Phase I ESA, an Architectural History Reconnaissance Survey was completed on the hangar as part of this Master Plan. The results of this survey indicated that the hangar is potentially eligible for listing on the National Register of Historic Places (NRHP). Sufficient information was not readily available to determine that it is or is not eligible.

Separate from this Master Planning effort, the DAA is moving forward with design of a hangar demolition project to remove the deteriorating and unsafe structure. As part of this process, a Regulated Materials Assessment was completed in 2021 which identified regulated materials throughout the structure that must be

considered during demolition. The demolition design effort also included an Intensive Architectural History Assessment in 2021 to determine if the building is eligible for listing on the NRHP. This assessment recommended that the building is Eligible for Listing on the NRHP. The airport is proposing the remove the structure and leave the concrete pad in place. The concrete pad can be available for lease to airport tenants. The FAA has determined that the hangar removal and reuse of the concrete pad constitute a federal action. As such, a NEPA review is needed prior to moving forward the demolition project. An Environmental Assessment will be required as the appropriate NEPA review document.

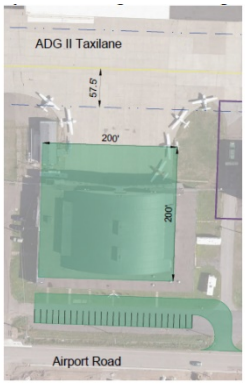
The ramp area near this hangar is included in a USACE Formerly Used Defense Site (FUDS) project. Because of the former military use of this hangar, the USACE will finalize an assessment of the potential and/or actual releases of contamination related to past Department of Defense (DOD) use. The USACE has indicated that this assessment can commence once the hangar structure is removed. The assessment will determine if any future projects are recommended for further investigation or response action. If future projects are recommended, they must be added to the USACE financial plan and budget. The USACE indicated that it may take up to 4.5 years for a Decision Document identifying any remedial action to be issued following award of an investigation contract. Therefore, although the hangar is likely to be removed in the near term, it is not likely that this site will be available for redevelopment prior to 2026. The USACE did acknowledge that there may be opportunities to accelerate the investigation and reporting schedule, and the airport should continue to coordinate to explore those options to best support future aeronautical development in this area.

Note to reviewer: The section above will be updated in to reflect ongoing FAA coordination on the appropriate NEPA review and schedule.

4.13.1.1 Site Development Alternatives

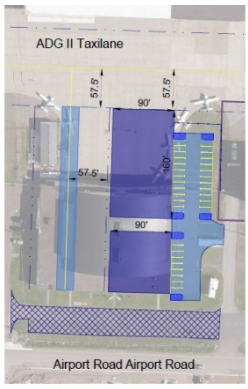
This site has been identified by the stakeholder group as being best suited for aeronautical redevelopment due to its existing access to the Midfield Ramp. Existing utilities are provided to this site as shown on **Figure 2-19**. The taxilane leading to this redevelopment site is restricted to Airplane Design Group (ADG) II aircraft due to the existing hangars and required Object Free Area (OFA) dimensions. On the west side of the site there is a roadway and airfield gate that is used by Cirrus Aircraft to transport aircraft from their Completion Center across Airport Road into the airfield. To the east of the hangar is Jet Duluth a large corporate hangar. It is expected that these uses, and facilities will remain throughout the planning term.

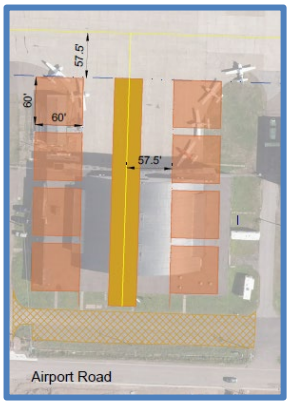
Several alternatives were developed for the Hangar 101 site and are discussed below. Overall, it is recommended that this site be developed to meet the needs for existing and future general aviation hangar demand. Consolidating general aviation aircraft storage and activity from the Lake Superior Collage facility (Hangar 103) to the east in this quadrant helps to keep like-activities together. It is expected that manufacturing expansion continue to be best suited for westward development.



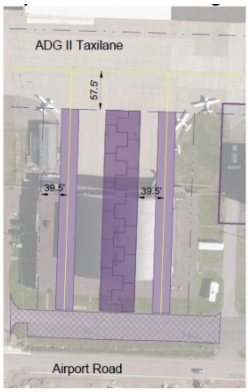
Alternative 1includes site redevelopment for a 40,000 SF (200'x200') box hangar. Due to the OFA requirements of the taxilane providing access, aircraft accessing this hangar would be restricted to ADG II or smaller. Vehicle parking can be provided on the south side of the hangar adjacent to Airport Road. Additional parking could be accommodated by shifting the hangar further to the north, adjacent to the ADG II TOFA. A hangar of this size would be best suited for a corporate hangar with ADG II aircraft. Alternatively, a large hangar or structure of this size could be constructed in this location for aircraft manufacturing purposes.

Alternative 2 shows a potential layout for two larger ADG II hangars. The taxilane providing access to these hangars is designed for ADG II aircraft. This option would be intended for the development of corporate hangars that could potentially hold two to four aircraft each. This area provides limited parking for these facilities due to the leased area to the east and the access roadway to the west.





Alternative 3 includes multiple box hangars for ADG II aircraft. Access is provided by a single ADG II taxilane with hangars on both sides. Landside parking is not depicted in this layout however it could be accommodated if it is needed on the south side of the development. The future fence line is recommended to extend to Airport Road to maximize the available space for snow storage between the end of the taxilane and Airport Road.



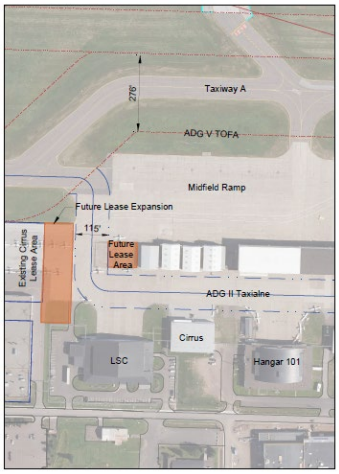
Altenrative 4 is shown to the right. This layout includes two ADG I taxilanes providing access to a 13-unit T-Hangar. This option maximizes aircraft storage for small aircraft. This entire site would be located inside the future fence line with snow storage potential between the hangar and Airport Road.

Stakeholder feedback initially supported a large corporate hangar similar to Alternative 1 as the best use of this area; however, because the taxilane is designed to ADG II standards, it was determined that a large corporate hangar in this location may not be fully utilized. A group of ADG II box hangars or a multi-unit hangar were better suited for this area after further evaluation and would maximize aircraft hangar storage. This site is anticipated to be ready for re-development around 2026 (pending any needed USACE environmental clean-up) and will provide the airport with additional revenue opportunities as the airport currently has a waiting list for hangar space. Although taxilane development may be eligible or FAA funding, it is unlikely to compete well as the airport has several other higher priority projects anticipated in the first 10 years of the CIP. MnDOT Aeronautics funding should be pursued for taxilane development.

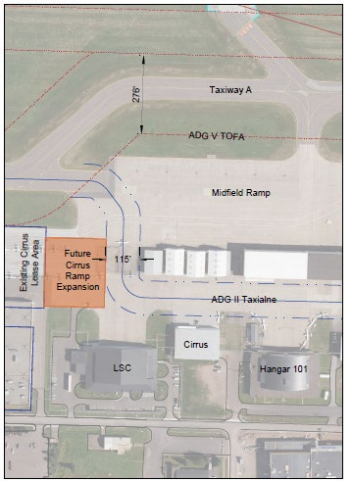
For this planning study, the third layout (orange) discussed above will be shown on the Airport Layout Plan (ALP). Although this option will be depicted on the ALP, any one of these sites could be developed to accommodate demand. If the development interests changed from what is depicted on the ALP, the airport would need to submit an ALP sheet update prior to the construction of another development layout.

4.13.2 Midfield Ramp Western Redevelopment

The western end of the Midfield ramp has a hangar slab that is above the grade of the ramp. The slab is remnants of a former Air Force hangar that was removed and relocated to the 148th Fighter Wing in the northeast quadrant. It is recommended that the slab be removed, and the area be repurposed into a usable area. The area could be reposed as apron or for a hangar. Depending on demand, a phased approach may be beneficial. Alternatives 1A and 1B depict options that could be considered prior to the realignment of Taxiway A near the Midfield ramp. Alternatives 2A and 2B depict options that could be considered after the Taxiway A realignment project.

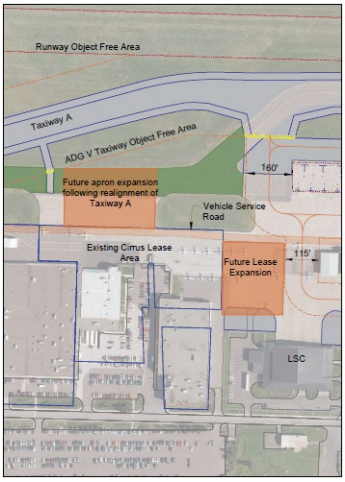


Alternative 1A includes maintaining the existing north-south taxilane in its existing alignment and repurposing the slab area into aircraft parking or other surface use space that would be made available to a tenant as a ground lease.

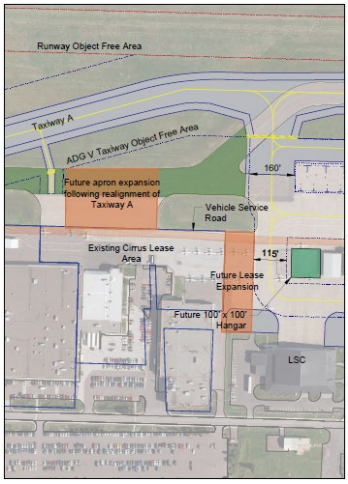


Alternative 1B includes slab removal and shifting the north-south taxilane to the east, allowing the Cirrus parking ramp on the west side of the taxilane to expand to the east.

Alternative 2A includes the same layout as Alternative 1A but aligns the north-south taxilane into the new taxilane connecting the Midfield Ramp to Taxiway A.



Alternative 2B includes the same layout as Alternative 1B but aligns the north-south taxilane into the new taxilane connecting the Midfield Ramp to Taxiway A.



Alternative 2C has the same taxilane layout as Alternatives 1A and 2A but repurposes the ground lease area as a hangar. When demand warrants, a hangar could be constructed in the slab location. This is the only site currently available for lease from DAA that would accommodate a larger hangar (100' x 100' in this case).

4.13.3 Monaco and Tower Ramps Aircraft Parking and Hangar Development

The Monaco Ramp is in the middle of the airfield with access onto Taxiway A. This Ramp provides aircraft parking, fueling and has a designated area for aircraft requiring CBP services at the FBO. Much of the hangar facilities surrounding the Monaco Ramp are under lease by the FBO (Monaco Air). The FBO leases the land and has the development rights for building development along the Monaco Ramp. The lease area ends immediately west of the existing Air Traffic Control Tower. Immediately west of the FBO's main building is a DAA T-Hangar that is recommended to be removed as part of this master plan as the building is past the end of its useful life. The FBO indicated that additional hangar storage is needed, therefore a box hangar (approximately 80' x 80') facing the Monaco ramp is recommended in this location. If something other than the 80' x 80' box hangar is proposed in the future, an ALP sheet update will be needed.

The tower ramp begins near the western edge of the tower building and extends south from the east side of the tower towards the FedEx apron. The Tower Ramp is mostly used for helicopter parking and occasional

large aircraft parking. The area of the Tower Ramp that is located adjacent to Taxiway A is located with the Runway Visibility Zone (RVZ), it is recommended that the Tower Ramp be reconfigured, including the removal of unusable pavement, and to remove aircraft parking within the RVZ (See **Section 4.8**) The proposed taxilane layout and pavement configuration of the Tower and Monaco Ramps is further discussed in **Section 4.13.8**.

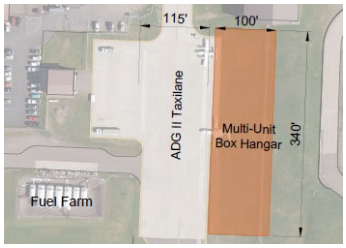
Section 4.12, discussed the alternatives analysis for the relocation of the ATCT. The existing t-hangar and ranch hangar site is being reserved for a future ATCT facility. The relocation of the ATCT provides opportunity for hangar storage and building redevelopment in this area. An existing small single-unit T hangar located on the eastern side of the Tower ramp is anticipated to be removed by the tenant in 2021. Hangar 2 (vacant, DAA owned) is in this area and should be removed to meet TOFA standards and maximize redevelopment opportunities.

Several different development opportunities can be located along the apron area adjacent to the proposed ATCT site. These site options include a designated helicopter site with three to four helicopter parking locations, an FBO type facility with apron parking and hangar storage and box hangar development. There is also an opportunity to develop additional apron parking in the 20+ year planning period as demand dictates, the parking location as shown in the Exhibit below could be used for snow storage seasonally.

A reserved development area will be depicted on the ALP as the size and limitations of the development is dependent upon the final layout, design and restrictions of the air traffic control tower development site. Once the layout of the ATCT site is determined there is potential for any one of the options discussed above to be modified to fit in this area, while still providing for a vehicle service road.

4.13.4 South of the Monaco Ramp

public use ADG II Taxilane leads south of the Monaco ramp where additional aircraft parking is available and two shovel ready hangar development sites are located.



One of these shovel ready sites is located along the eastern edge of the taxilane. Monaco Air, the FBO, currently leases this area. The FBO indicated that additional hangar storage that can accommodate large aircraft was needed. A large multi-aircraft storage hangar will be depicted on the ALP for development in this area. This multi-unit hangar is shown to the right. Alternatively, box hangars could be constructed on this site within the footprint of the multi-unit hangar depicted. As Monaco leases this site, development schedule and layout is dependent on tenant plans and needs.

The second shovel ready site is at the far south end of this taxilane, directly south of the existing fuel farm. This is the single shovel ready hangar site that is not leased or under development rights. An existing taxilane exists in this area and the current ALP depicts two future ranch hangars (on the north and south side of the taxilane, see Option 3). Although two ranch hangars can be accommodated, they would be limited in size. Many of the ADG I aircraft on the existing hangar waiting list are looking for wider door sizes (accommodating wingspans similar to a Cirrus SR-22) and a larger hangar would better accommodate that demand. By redesigning the pavement area to shift the taxilane centerline south, larger ADG I hangars (box or ranch) can be accommodated as shown in Option 1 and 4. Option 2 includes a single ADG II hangar facing east, eliminating the taxilane to the east. The various layout options for this site are depicted in **Exhibit 4-13**.

Exhibit 4-13 – South of the Fuel Farm Hangar Development

The airport selected Option 4 as the preferred layout to depict on the ALP as it allows for near-term revenue generating opportunities and meets the needs of many aircraft on the hangar waiting list. If the development interests changed from what is depicted on the ALP, the airport would need to conduct an ALP sheet update prior to the construction of another development layout. This site provides an opportunity for an airport owned revenue generating hangar. The 5-unit ranch hangar would provide units slightly deeper (50 feet) and wider (45 feet) than the current DAA owned ranch hangars. MnDOT Aeronautics funding could be sought to support site preparation and taxilane construction. It is anticipated that DAA may fund the construction of the hangar; however, additional funding sources such as the MnDOT Hangar Loan program could be considered. While the hangar loan program may provide financing assistance, there is a waiting list and the timing of funding availability may not match the DAA desired development timeline. As discussed above, this site is shovel ready, there is a hangar waiting list, and the site and hangar could be constructed when funding is made available.

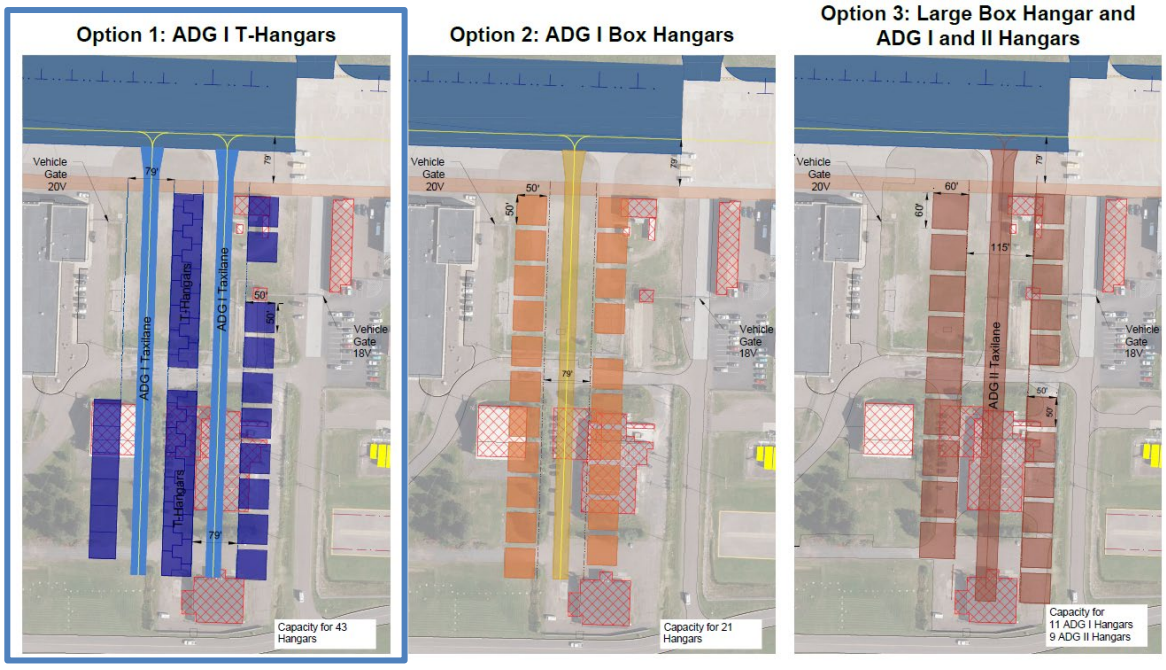
4.13.5 Area between the SRE Building and Monaco Ramp

The area located between the SRE Building and the Monaco Ramp is currently vacant except for the electrical vault building located on the northeast side of the area. The area outside of the perimeter fence in this area is a mix of occupied and unoccupied buildings. As discussed above, a goal of the Taxiway and Aircraft Parking TAC was to identify sites on the airfield that would support the development of aircraft hangars and aircraft parking and to provide the airport with aeronautical development opportunities. In addition, there is a goal to group comparable size and uses of aircraft in the same area. In previous planning efforts, this location had been identified as a preferred location for a future ATCT. The southwest quadrant where this area is located is mostly developed and has limited space for future hangar development. The area between the Monaco Ramp and Midfield ramp will be developed as a future taxilane, connecting the two aprons and also providing airside access to this area. It should be noted that this area is currently used for snow storage. Future layouts will impact the snow storage plans for DAA.

The TACs recommended that this area be preserved or hangar development due to its direct access to the airfield, large available space for development and the availability of existing utilities around the site. Several alternative layouts were developed for this area and were evaluated by the stakeholder group. Even though this site is large, it is also very narrow which makes developing this area for larger ADG II aircraft challenging while maximizing hangar space. Therefore, this area is recommended to be designed for ADG I aircraft, which maximizes the aircraft storage opportunity. In making this recommendation, it was acknowledged that ADG II hangar development opportunities exist along the taxilane south of Monaco and in the North Business Development Area. Additionally, the majority of the hangar waiting list is ADG I aircraft. Grouping ADG I aircraft in this area helps keep similar sized aircraft together. **Exhibit 4-14** shows three layout options that were developed from feedback provided by the TAC. **Option 1** and **Option 2** are both designed for ADG I aircraft which require a 79' wide Taxilane Object Free Area (TOFA). **Option 3** includes an ADG II taxilane (113' TOFA) with a mix of ADG I (east side) and II (west side) hangars. The development of each of these alternatives was designed to maintain the existing Monaco gate (east of the development, and an emergency access route) and SRE gate (west of the development) in their current locations. The electrical vault building must be relocated in each of these alternatives. However, the relocation could be delayed in Option 2 as it could remain until the north easternmost hangar is developed.

Option 1 was selected as the preferred alternative as it provides hangar space for 43 aircraft compared to Option 2 (also designed for ADG I aircraft) which only provides space for 21 aircraft. The ability of Option 1 to accommodate T-hangar and ranch hangar development provides opportunities for relocating the existing T-hangar and ranch hangar tenants when the ATCT is constructed. Depending on the ultimate funding source for the ATCT, there is potential that this connected hangar development could be funded as part of the ATCT project. Additionally, MnDOT Aeronautics funding could be pursued for site development including taxilane construction. Constructing T-hangar and ranch hangars was also identified as a priority as it provides additional aeronautical revenue opportunities for DAA.

Exhibit 4-14 – Area between Monaco and the SRE Hangar Development Options



It is recommended that the airfield electrical vault be relocated prior to the development of this site, ideally as part of a phase of the Taxiway A reconstruction and lighting replacement project.

Additionally, several landside buildings will need to be demolished to accommodate this full expansion. There is an opportunity for this area to be developed in phases as demand increases for hangar storage. These phases should be considered when developing this site. Phase 1 development will likely expand south to require the removal of the Hydrosolutions building (Building 305, DAA owned and leased to a tenant on a month-to-month basis) and the DHL building (DAA owned, used for DAA cold storage). A Phase 1 ESA was completed for the Hydrosolutions building as part of this Master Plan. Multiple HRECs (nearby leak sites) were identified in connection with the building. A facility condition assessment of the Hydrosolutions building was also completed as part of this Master Plan. The assessment rated the building in poor condition and concluded that the magnitude of needed repairs warranted consideration of demolition in lieu of any future repairs. The DHL building was also evaluated in the facility condition assessment and was rated a 2 out of 5 in the condition rating (fair-poor). A Regulated Materials Assessment should be completed prior to demolishing the buildings. When feasible and when funding is available, the Hydrosolutions building and DHL building should be demolished in preparation for this development.

Phase 3 development (final southward expansion) would likely require the removal of the Civil Air Patrol building (building 308) (owned by DAA, leased by Civil Air Patrol). If demolition is not feasible or desired in the near term, the development could be limited to not impact the building in the near-term.

Direct auto access to this hangar site is not provided from Airport Road in an attempt to continue to limit access points to the airfield (per TSA recommendations). Auto access can be achieved through the existing Monaco and SRE gates and using the vehicle roadway on the southern edge of the apron.

For this planning study, Option 1 in **Exhibit 4-14** will be shown on the Airport Layout Plan (ALP). Although this option will be depicted on the ALP, any one of these sites could be developed. If the development interests change from what is depicted on the ALP, an ALP sheet update will be needed prior to construction.

4.13.6 Southwest Quadrant Western Expansion

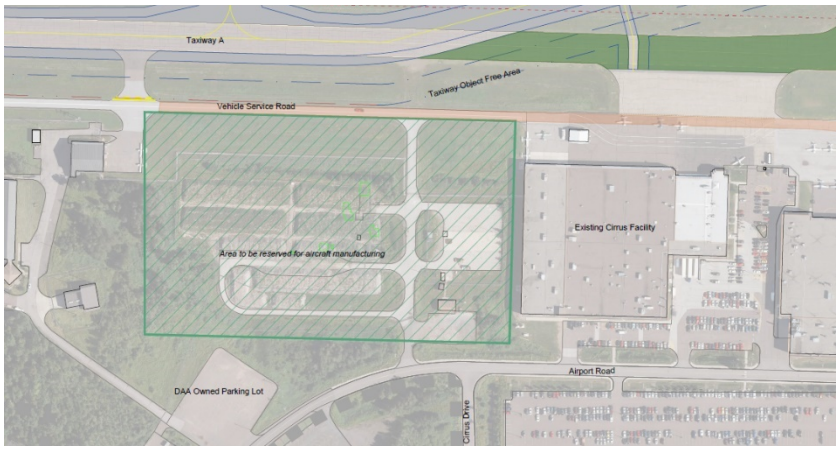
The western developed area in the Southwest Quadrant is primarily used for aircraft manufacturing. Historically, westward expansion has been reserved for aircraft manufacturing expansion. Cirrus is a major tenant, occupying many of the buildings in the southwest quadrant, primarily on the western side. Cirrus operated buildings are depicted on **Exhibit 4-15**.

Exhibit 4-15 – Cirrus Operated Facilities

At the western edge of Airport Road is the Defense Reutilization and Marketing Office (DRMO) site. DRMO is responsible for the disposal of excess property owned by the military. This site was previously owned by the Unites States Air Force and was released to the airport for aeronautical use following the required clean-up which is near completion. The site is directly west of Cirrus's existing manufacturing building and the site is expected to be ready for development in the near term.

Exhibit 4-16 depicts the western limits of the Cirrus manufacturing complex and shows the area that is recommended for aircraft manufacturing expansion. This proposed future expansion is located west of the existing Cirrus buildings. This site can accommodate significant expansion opportunities. Vehicle parking is an existing and future challenge for Cirrus as their workforce increases with expansion. Future parking opportunities may exist so the south of the expansion site on the existing DAA owned lot along Airport Road. This paved area is currently leased to a tenant, experiences low usage and is in fair condition (per landside PCI evaluation). It needs reconstruction prior to any increased use to support parking needs for aircraft manufacturing. This site could provide limited apron space in front of the future buildings. With the realignment of Taxiway A, Cirrus has the capability to expand their apron space towards the existing Taxiway A. Their existing apron has capacity for 10-20 aircraft, depending on parking configuration.

Exhibit 4-16 – Proposed Western Airport Road Development Layout



The TAC committee members indicated that, prior to the COVID-19 pandemic, parking was a challenge when Cirrus was fully staffed and there was little room to expand employee parking elsewhere in the Southwest Quadrant. When evaluating this location, and others on the airfield, accommodating parking in other areas would be particularly challenging.

It is recommended that the area west of Cirrus continue to be reserved for aircraft manufacturing development.

4.13.7 North Business Development Area (NBDA)

The North Business Development Area (NBDA) is approximately 12 acres of development ready sites located along Taxiway B, north of Runway 9/27. Public road access to the NBDA is available from Stebner Road on the north side of the airport. A 120,000 square foot apron is connected to the taxiway network and can accommodate the development of buildings and hangars. The NBDA is also located adjacent to the ARFF Station and the MRO Facility. Early on in this master planning process, stakeholders recommended that the NBDA may not be best suited for a customer facing facility due to the long drive from Highway 53 and the business area along Miller Trunk Highway.

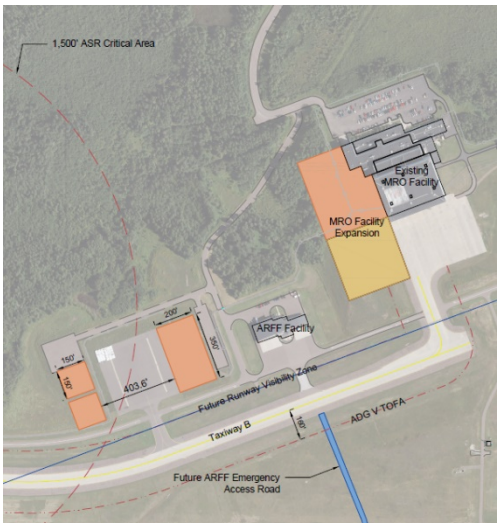
The Airport Surveillance Radar (ASR) is located directly west of the NBDA. The ASR has a critical area that restricts the height and types of development located within this protected area to ensure the development does interfere with aircraft operations. The restrictions on the height of types of development within the critical area can be found in **Section 2.14.4**.

The NBDA has the ability to accommodate aircraft up to ADG III. This area is currently under lease by the FBO for future development. While it may be developed under this lease, the agreement does expire around 2026. The proposed recommended development in the NBDA includes multiple large aircraft hangars that have the ability to provide additional storage capacity for turboprop or business jet aircraft or a non-customer facing facility like higher education flight training. Aircraft up to ADG II are the likely users of this development. While not identified as the preferred alternative, a helicopter exclusive development could also be considered in the NBDA.

Exhibit 4-17 depicts the recommended layout for the NBDA which includes larger general aviation hangars, located along the existing shovel ready apron just north of Taxiway B. The site provides approximately 150,000 square feet of additional hangar space. Depending on the ultimate type of facility that is constructed in the NBDA, a tenant could construct a fuel farm could be in this general area.

The exhibit below also depicts a future westward expansion to the existing MRO facility, which is currently owned by the Duluth Economic Development Authority (DEDA) (see **Section 2.14.4**). This facility is currently vacant, however with size of this facility and the design standards for Taxiway B, this facility could expand if a new tenant was found, and additional space is needed. It is anticipated that this expansion (building and apron) would be tenant funded and no DAA project will be included in the CIP.

Exhibit 4-17 – Proposed North Business Development Area layout



For this planning study, the layout above will be shown on the Airport Layout Plan (ALP). Although this option will be depicted on the ALP, additional hangar layouts along the NBDA apron could be considered if the demand dictated. An ALP sheet update would be needed prior to construction.

4.13.8 Southeast Quadrant General Aviation Building Area

The area east of Runway 3/21, adjacent to Taxiway D, and southwest of the Terminal Facilities is currently vacant. During several Taxiway and Apron TAC Meetings stakeholders indicated that a development in this area would be ideal for future hangar development. This site could accommodate large box hangars, a helicopter designated area or a small GA aircraft development site. There are grading challenges and an adjacent delineated wetland to this area. Hangar development areas discussed above are able to be developed through the planning period and can accommodate the forecasted hangar demand. Taxiway D would need to be extended full length to accommodate this growth.

For the purpose of this master plan an area will be reserved for ultimate (20+ years) aeronautical development east of Taxiway D. **Exhibit 4-18** below shows a potential layout for a mix of ADG I and ADG II aircraft hangars. Additionally, this area could also be developed for a designated helicopter area which is also depicted below.

Exhibit 4-18 – Proposed Southwest Quadrant General Aviation Development Area layout

4.13.9 General Aviation Aprons and Aircraft Parking

Aircraft apron areas provide space for aircraft parking, tiedowns, fueling, CBP services and access to hangars. Aprons at DLH are in the non-movement area and are not under direct control of the Air Traffic Control Tower. Design of general aviation aprons and their associated taxilanes should be designed for the critical aircraft or a combination of aircraft to be using the facility. Aprons designed to handle jet aircraft should consider the effects of jet blast and allow extra room for safe maneuvering. Most tiedowns at an airport are usually designed for ADG I and ADG II aircraft.

Vehicles use the aprons at DLH to travel from one point on the airport to the other, the area surrounding the FBO can be busy with vehicle serving aircraft and traveling from the FBO to the Terminal Building. Currently, there is no marked vehicle roadway except for around the existing Control Tower and the Midfield Ramp. The perimeter road discontinues at the Cirrus Ramp on the west side of the apron area and begins again south of the FedEx apron. ***It is recommended that a painted vehicle service roadway be properly marked and located outside of the taxilane object free area for the Midfield, Monaco and the existing Tower ramps.***

At DLH, the FBO and general aviation ramps see a mix of ADG I, II and III aircraft requiring services and aircraft parking. Additionally, the military will sometime park their large ADG III to ADG V aircraft on the Midfield ramp due to the lack of space on the 148th apron. Civilian use of the Midfield ramp also includes aircraft up to ADV V.

Figure 4-9 depicts the proposed taxilane and apron layouts discussed below.

Cargo Aprons

Cargo operations are conducted on the Monaco and the FedEx Ramps. FedEx utilizes their 46,000 SF apron to load and unload the ATR 42-300 (ADG III) which is currently operated by Mountain Air. UPS cargo operations are conducted by Bemidji Air on the Monaco Ramp. Bemidji Air operates a Fairchild Dornier (ADG

II Aircraft). FedEx did not indicate any unmet needs as part of outreach during this Master Plan process. Bemidji Air indicated that operating on the Monaco Ramp meets their existing and expected needs and appreciates the coordination with the FBO staff. ***No cargo apron recommendations are included in this Master Plan.*** However, the expansion opportunities for the FedEx development that have historically been shown on the ALP will remain. While there are no existing plans or demand for this opportunity, the ALP will depict the expansion capacity should the demand arise in the future. The FedEx apron and the corresponding facilities are under a long-term lease and not controlled by the Airport

Tower Ramp

Most of the tower ramp is located within the Runway Visibility Zone (RVZ) where aircraft parking is prohibited. Aircraft parking should be removed from the RVZ and opportunities to reconfigure the tower ramp for hangar development and aircraft parking should be considered following the relocation of the Air Traffic Control Tower. The FAA has indicated that an update to the Airport Design Advisory circular, Draft AC 150/5300-13B, is expected to be published in the fall of 2021. This advisory circular provides an opportunity to move taxiway and taxilane centerlines closer to fixed objects when compared to the existing Design AC.

For the purpose of this master plan the design standards discussed in AC 150/5300-13B will be used for the Tower and Monaco Ramps to safely provide access for ADG III aircraft transiting the aprons as it is expected that improvements to these ramps will occur after adoption of this AC. Utilizing these design standards will allow of the tower ramp to efficiently provide an ADG III access route to the General Aviation (FBO) Apron, which is where ADG III GA jet aircraft generally go to clear customs. Using these design standards also provides an opportunity to reduce the Object Free Area (OFA) on Taxiway A, which will continue to be designed to ADG V aircraft. These reductions in OFA dimensions allow for sufficient aircraft parking along the GA apron which is not currently achieved with the existing Design AC.

Table 4-29 outlines the changes in design standards from AC 5300/13A and the Draft AC 5300-13B. Additionally, the Draft Design AC now provides standards for parallel taxiways/taxilanes serving dissimilar ADGs and how to calculate the appropriate OFAs for this unique circumstance. The Tower Ramp can be designed for an ADG III aircraft and safety allow an ADG V aircraft to pass by on Taxiway A. This will have a impact on how the Tower Ramp is designed following the removal of helicopter parking locations and realignment of the pavement.

Table 4-29 – Airport Design Advisory Circular OFA Standards

	ADG II		ADG III		ADG IV		ADG V	
Design Standard	Design AC 5300-13A[1]	Draft AC 5300-13B[2]	Design AC 5300-13A[1]	Draft AC 5300-13B[2]	Design AC 5300-13A[1]	Draft AC 5300-13B[2]	Design AC 5300-13A[1]	Draft AC 5300-13B[2]
TSA	79’	79’	118’	118’	171’	171’	214’	214’
TWY OFA	131’	**124’**	186’	**171’**	259’	**243’**	320’	**285’**
TWY or TXL C/L to TWY C/L	105’	105’	152’	**144’**	215’	**207’**	267’	**249’**
TXL OFA	115’	**110’**	162’	**158’**	225’	**224’**	276’	**270’**
TXL C/L to TXL C/L	57.5’	**55’**	81’	**79’**	112.5’	**112’**	138’	**135’**
Notes: TSA – Taxiway Safety Area, TWY – Taxiway, TXL – Taxilane, OFA – Object Free Area, C/L – centerline								

Source: [1]AC 150/5300-13A, Airport Design Change 1, September 28, 2012; [2]Draft AC 150/5300,13B, Airport Design, July 20, 2020

FBO/ General Aviation Aprons

The Monaco Ramp is the main parking apron for itinerant aircraft. The Midfield Ramp is used mostly for large aircraft (ADG III and larger) and overflow parking. Due to the limited space on the FBO Ramp, the ramp is limited to smaller aircraft or a single larger aircraft with reduced taxilane access and aircraft parking capacity to property protect for the wingtip clearances. The edge of the Monaco Ramp currently ends at the ADG V OFA (160' centerline to fixed or moveable object) for Taxiway A. This limits the ability to expand the parking apron to the north, towards Taxiway A, to accommodate longer aircraft. With the change in Design Standards in AC 150/5300-13B, there is an opportunity to implement these standards to provide for an ADG III Taxilane through the Monaco Ramp and extend aircraft parking towards Taxiway A using the ADG V OFA (142.5' centerline to fixed or moveable object for Taxiway A using the Draft Design AC to accommodate longer aircraft on the ramp.

The FBO will frequently move aircraft between the Monaco Ramp and the Midfield Ramp. Aircraft, or vehicles, must obtain clearance from ATC to use Taxiway A to move aircraft between these ramps. The Midfield ramp is also used to accommodate large aircraft, which occasionally will remain overnight. It is recommended that additional apron pavement be constructed between the Monaco and Midfield Ramps to alleviate the aircraft parking space shortage that occurs during peak operating periods, especially when large tech stop aircraft occupy the Midfield Ramp area. As discussed above, parking on the Tower Ramp is recommended to be removed as aircraft parking is prohibited within the RVZ. The additional ramp space will help replace the parking lost as well as meet the current unmet parking demand. Additionally, this additional pavement will eliminate the need for aircraft to enter the movement area to transition aircraft between the Monaco and Midfield ramps.

As discussed previously in the chapter, the existing tiedown demand is approximately 41 tiedown locations and is expected to grow to 44 by the end of the planning term. While the demand varies on a day-by-day basis, projected quantities of tiedown by aircraft size and planning term are shown in **Table 4-30**.

Table 4-30 – Tiedown Parking Demand

	Existing (2018)	2023	2028	2038
TOTAL TIEDOWN DEMAND	**41**	**42**	**42**	**44**
ADG I Tiedowns Demand	28	28	29	30
ADG II Tiedowns Demand	8	9	9	9
ADG III Tiedown Demand	1	1	1	1
Helicopter	3	3	3	4

Source: SEH

The ultimate Monaco, SRE and Midfield ramp layouts are depicted on **Figure 4-9**. The tiedown spacing and sizing combinations can vary, but for demonstration purposes, this figure depicts the following capacities:

Table 4-31 - Future Tiedown Capacity

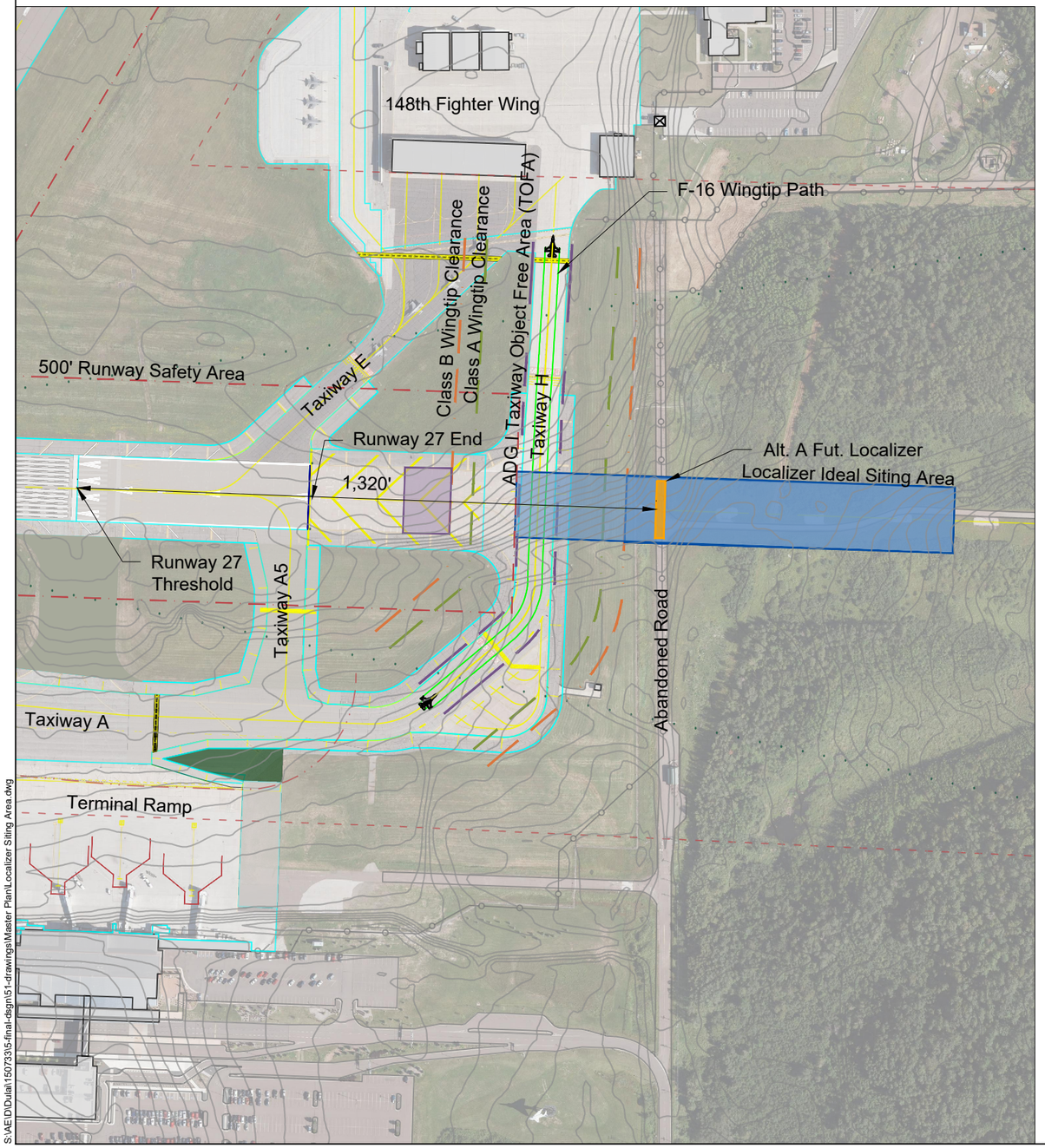
	Monaco Ramp	SRE Ramp (new ramp expansion)	Midfield Ramp	Total
ADG I	3	6	18	**27**
ADG II	2	2	13	**17**
Total	**5**	**8**	**31**	**44**

The Midfield ramp is frequently used by aircraft larger than ADG II, including a mix of ADG III, IV and V aircraft. The taxilane located south of the nested aircraft parking is able to accommodate an ADG III. The area outside of the taxilane TOFA on the Midfield layout can accommodate up to five ADG III parked business jet type aircraft, similar to the Gulfstream G650, which has a wingspan of 99.61 feet. If the taxilane closest to Taxiway A, which is designed for ADG II aircraft, is closed, the area can be flexed to accommodate four ADG IV aircraft or two ADG V aircraft. It is assumed the aircraft would enter under their own power and wing walkers would be present to marshal in, and park larger aircraft.

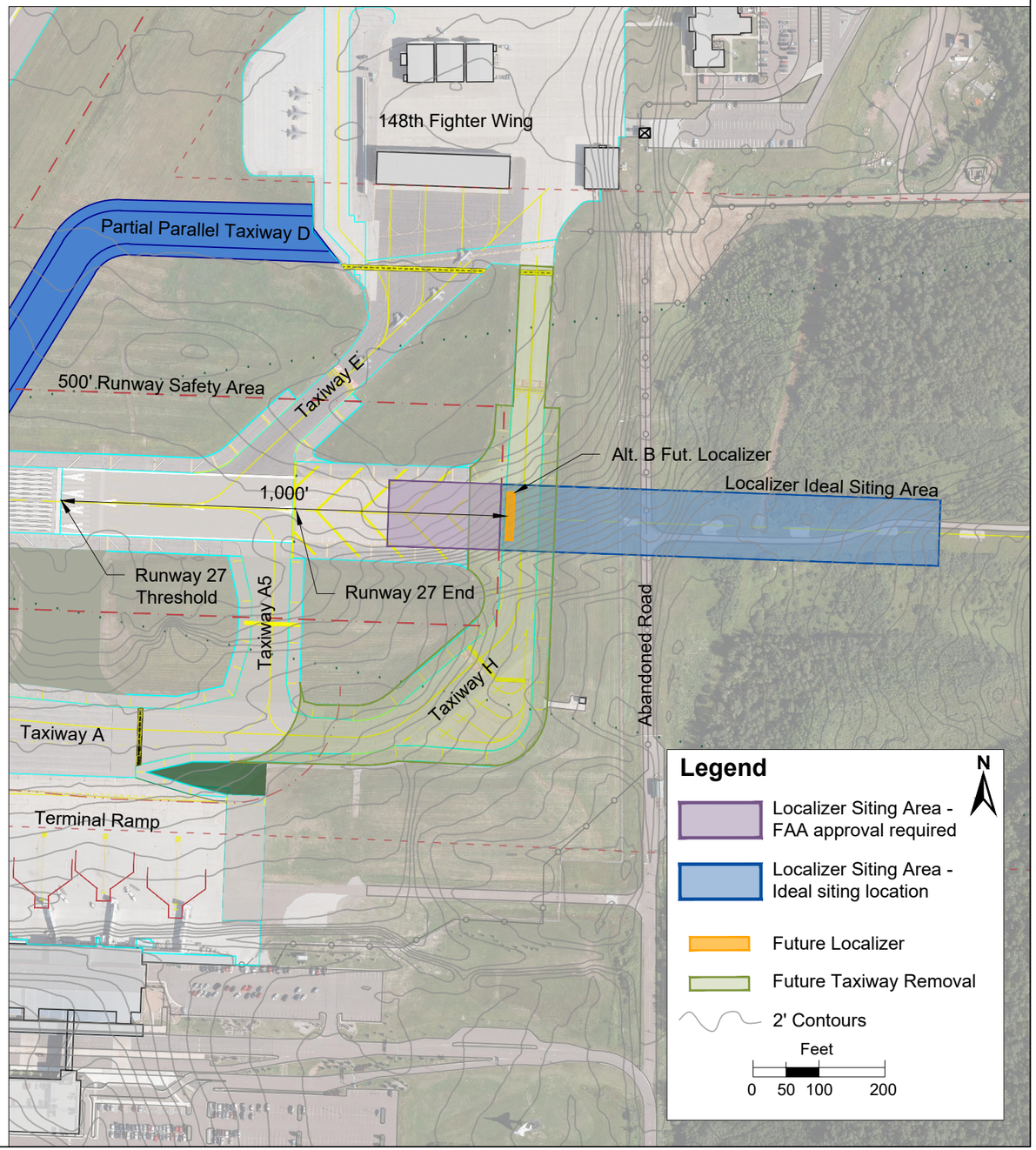
Cirrus Ramp (non-public)

With the realignment of Taxiway A, currently unusable pavement between the existing non-movement line and Taxiway A can be repurposed into usable apron space as the non-movement line will shift with the Taxiway A realignment. If Cirrus has demand for additional apron space, this pavement can be maintained and transitioned to usable apron.

Alternative A - Taxiway H Remains



Alternative B - Removal of Taxiway H



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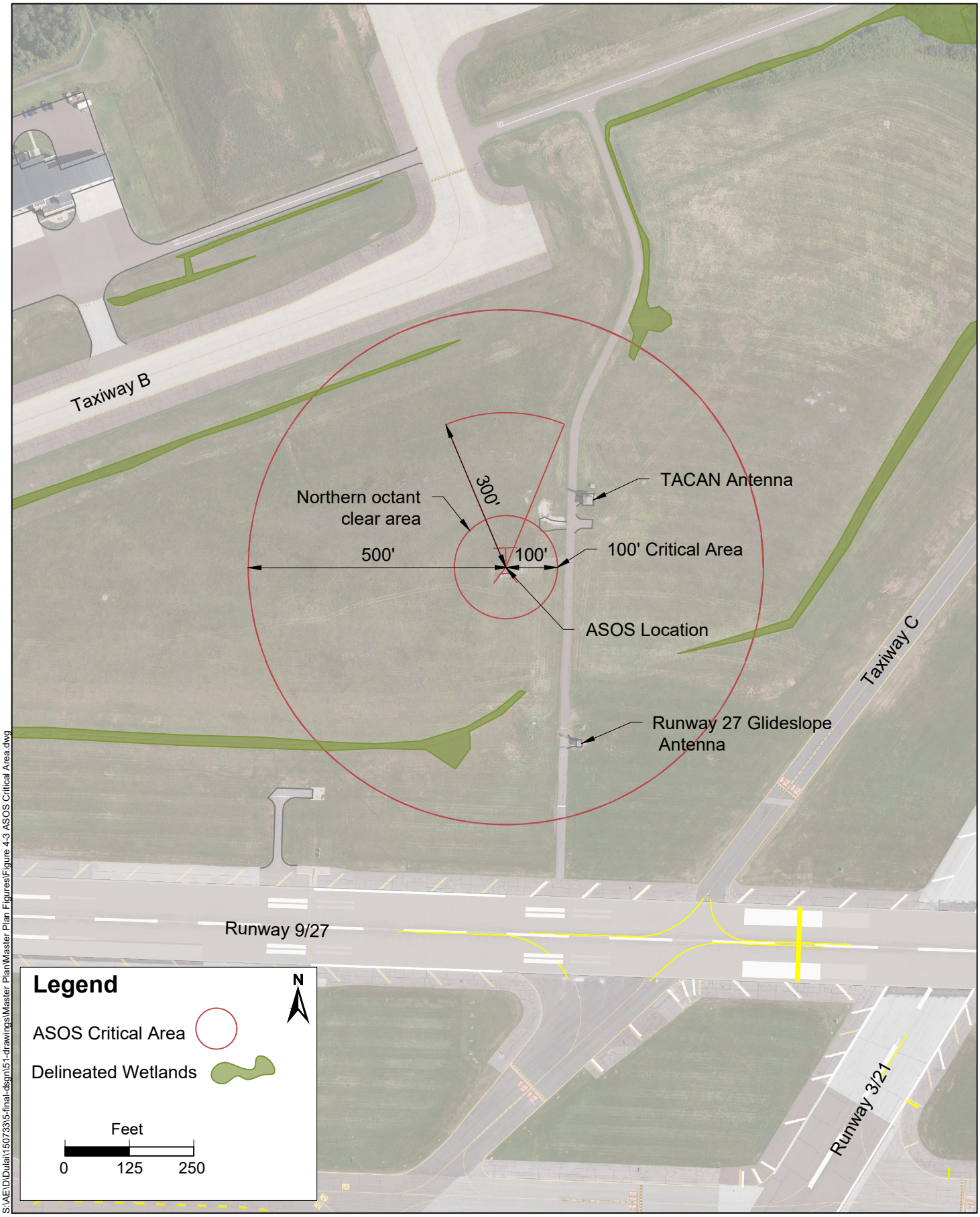

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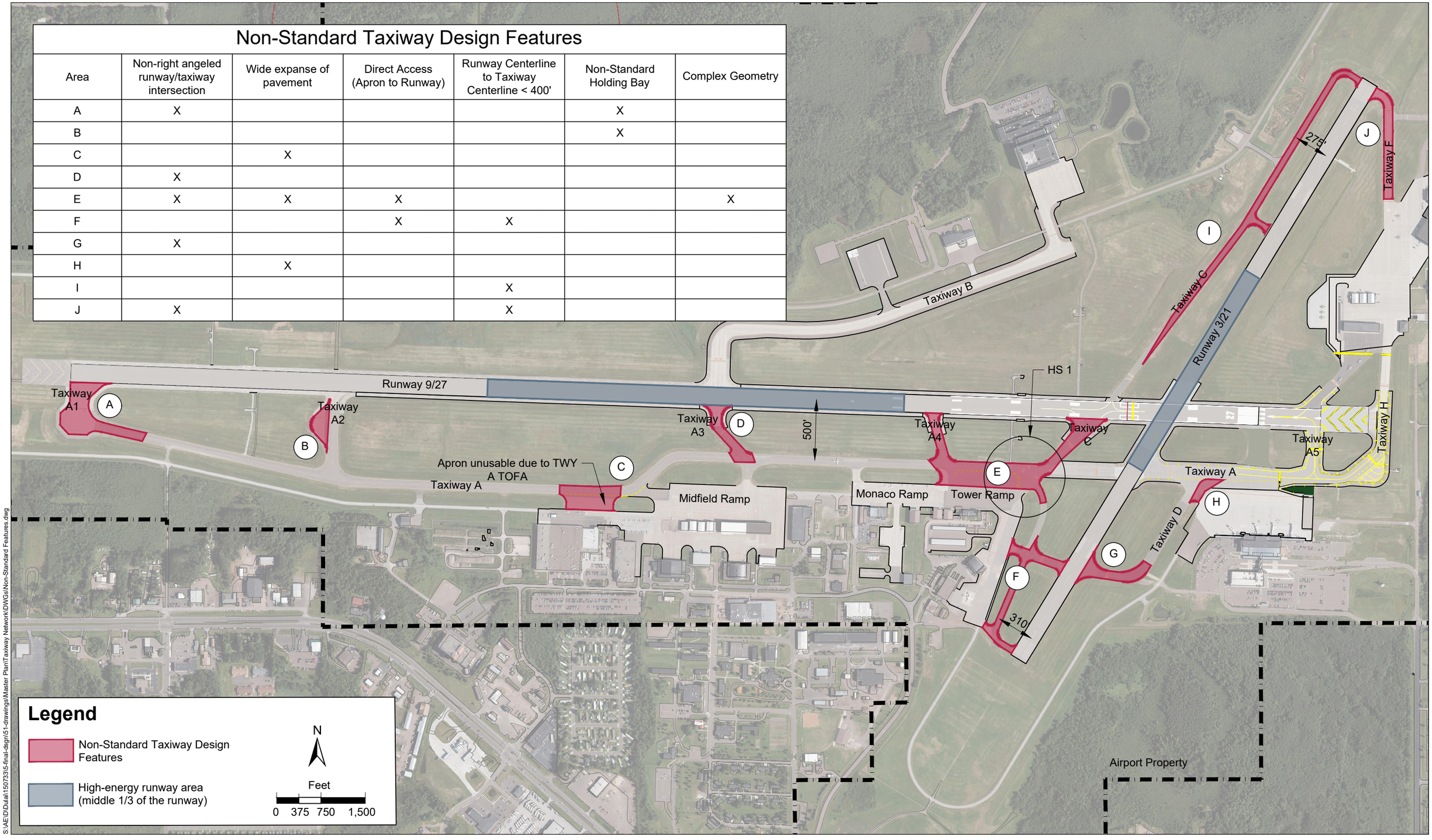
Non-Standard Taxiway Design Features

Area	Non-right angeled runway/taxiway intersection	Wide expanse of pavement	Direct Access (Apron to Runway)	Runway Centerline to Taxiway Centerline < 400'	Non-Standard Holding Bay	Complex Geometry
A	X				X	
B					X	
C		X				
D	X					
E	X	X	X			X
F			X	X		
G	X					
H		X				
I				X		
J	X			X		



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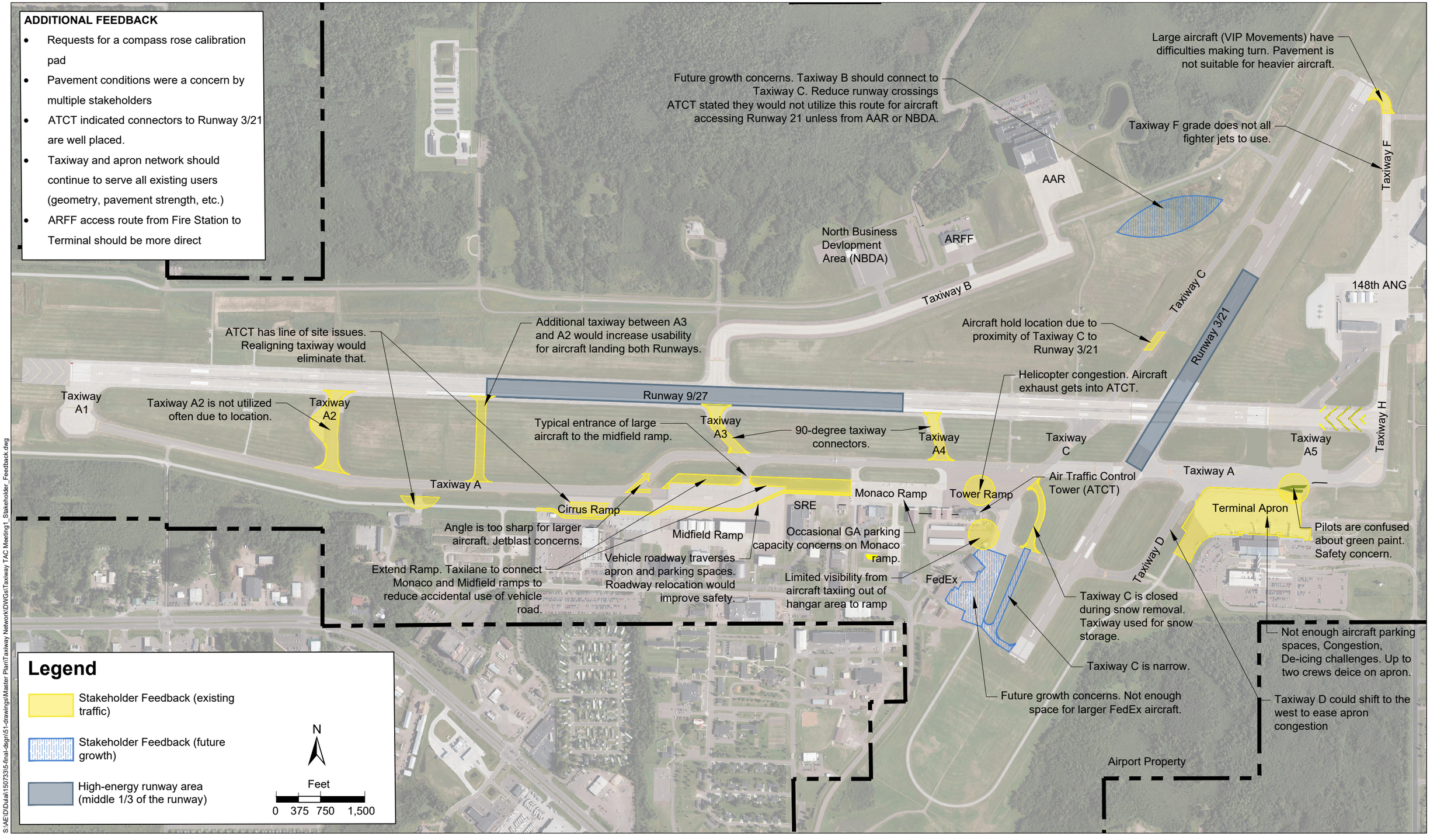
Airport Master Plan

Figure A

Duluth International Airport
Duluth, Minnesota

Stakeholder Feedback - Taxiway Network Design
6/2021; DULAI 150733



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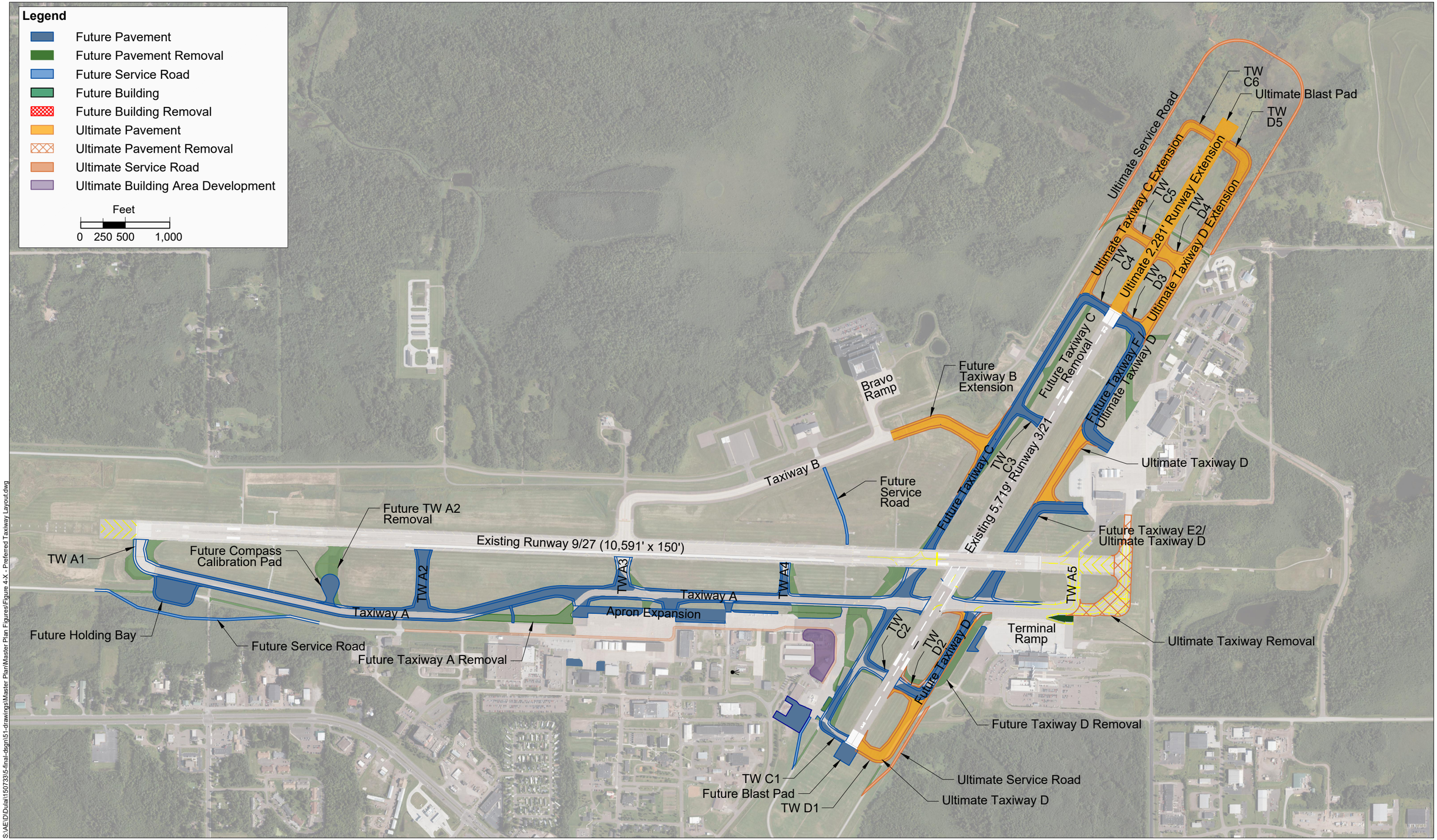
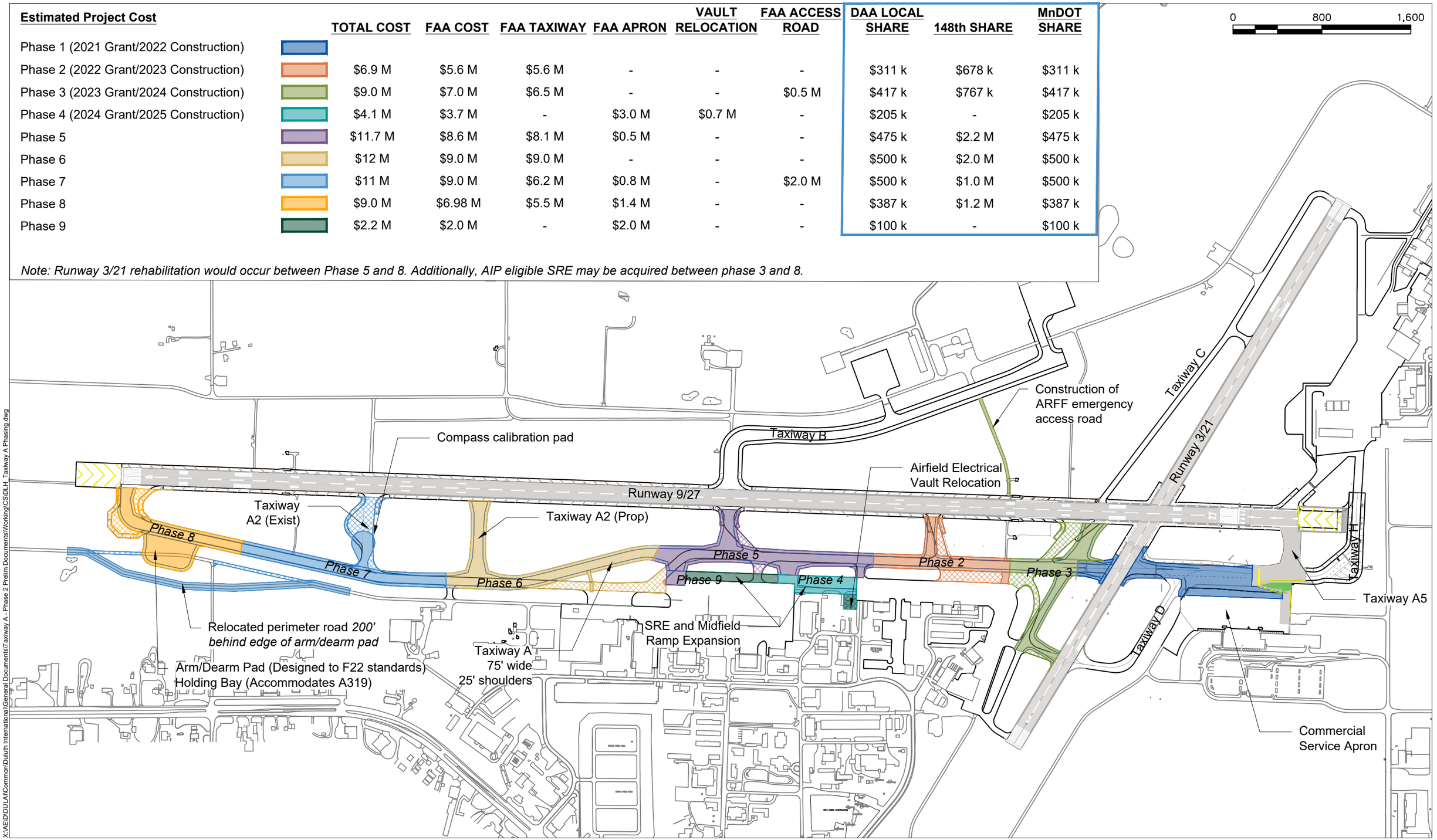


S:\AE\D\Dulai\150733\5-final-dsgn\51-drawings\Master Plan\Master Plan Figures\Figure 4-X - Preferred Taxiway Layout.dwg

Estimated Project Cost

	TOTAL COST	FAA COST	FAA TAXIWAY	FAA APRON	VAULT RELOCATION	FAA ACCESS ROAD	DAA LOCAL SHARE	148th SHARE	MnDOT SHARE
Phase 1 (2021 Grant/2022 Construction)									
Phase 2 (2022 Grant/2023 Construction)	$6.9 M	$5.6 M	$5.6 M	-	-	-	$311 k	$678 k	$311 k
Phase 3 (2023 Grant/2024 Construction)	$9.0 M	$7.0 M	$6.5 M	-	-	$0.5 M	$417 k	$767 k	$417 k
Phase 4 (2024 Grant/2025 Construction)	$4.1 M	$3.7 M	-	$3.0 M	$0.7 M	-	$205 k	-	$205 k
Phase 5	$11.7 M	$8.6 M	$8.1 M	$0.5 M	-	-	$475 k	$2.2 M	$475 k
Phase 6	$12 M	$9.0 M	$9.0 M	-	-	-	$500 k	$2.0 M	$500 k
Phase 7	$11 M	$9.0 M	$6.2 M	$0.8 M	-	$2.0 M	$500 k	$1.0 M	$500 k
Phase 8	$9.0 M	$6.98 M	$5.5 M	$1.4 M	-	-	$387 k	$1.2 M	$387 k
Phase 9	$2.2 M	$2.0 M	-	$2.0 M	-	-	$100 k	-	$100 k

Note: Runway 3/21 rehabilitation would occur between Phase 5 and 8. Additionally, AIP eligible SRE may be acquired between phase 3 and 8.



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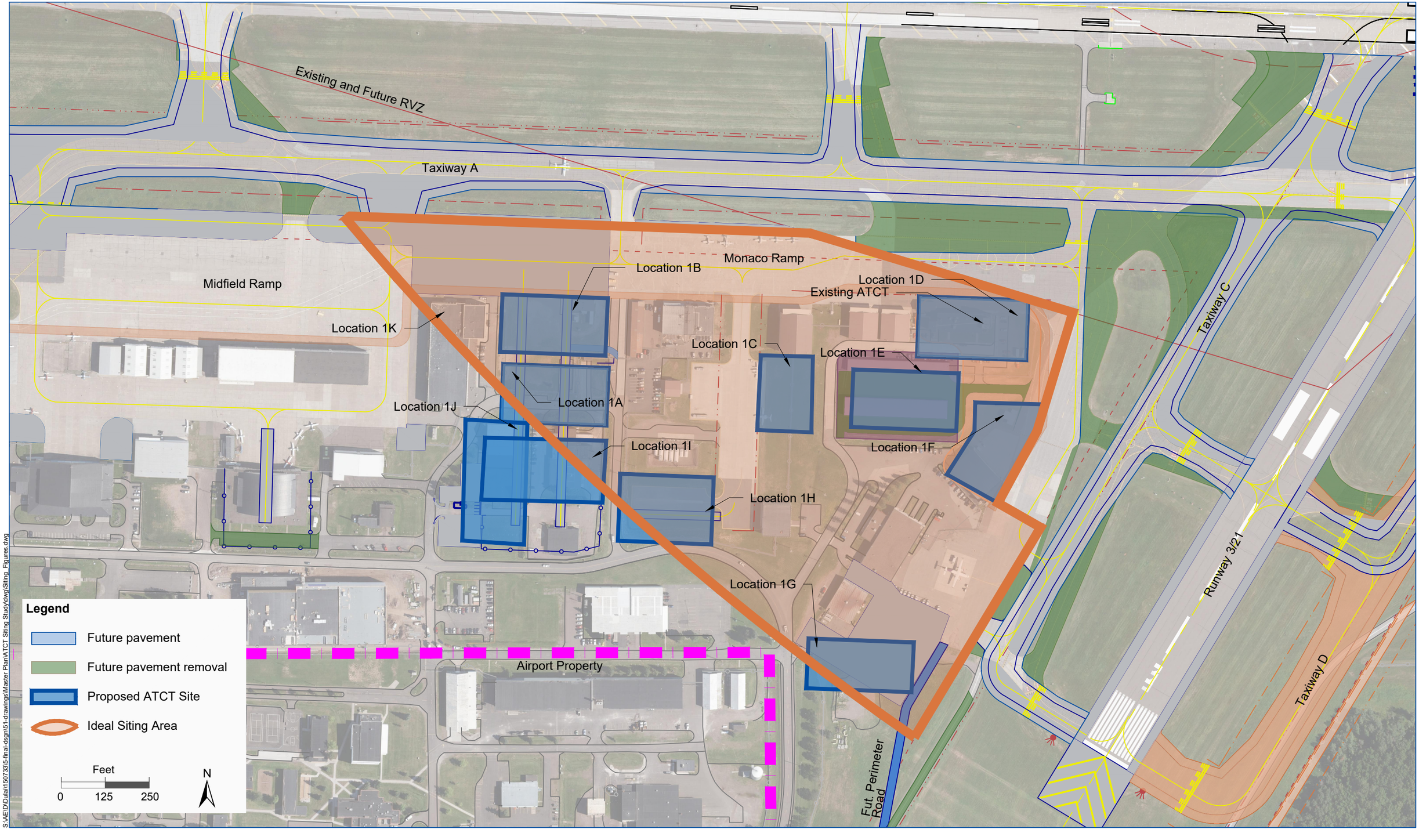

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Figure 4-9
Future Apron Parking and Taxilane Layout
09/2021; DULAI 150733

Taxiway A3 (ADG V)
Runway Visibility Zone (RVZ)
Taxiway A4 (ADG III)
Taxiway A (ADG V)
190'
ADG II Aircraft Parking
ADG II Taxilane
55'
Midfield Ramp
ADG I Aircraft Parking
158'
ADG III Taxilane
162'
ADG II GA Jet Parking
79'
ADG III Taxilane
ADG II Aircraft Parking
141'
165'
79'
Monaco Ramp and CBP
221.5' Taxiway (ADG V) to Taxilane (ADG III) Separation - Draft AC 150/5300-13B
267'
ADG III Taxilane
Future snow storage
Future Cirrus Ramp (Leased)
Cirrus Ramp (Leased)
Monaco Air
Self Fueling
DAA SRE Building
ADG I Taxilane
ADG I Taxilane
115'
Proposed Air Traffic Control Tower Site
Future Aeronautical Development Site
115'
ADG II Taxilane
ADG III Taxilane
Future Sand and Chemical Storage Building
79'
ADG II Taxilane
Cirrus
Cirrus
LSC
ADG I Taxilane
Airport Road
Cirrus
Cirrus
Cirrus
Airport Property
Future Cargo Expansion

Legend
N
- Future building
- Future pavement
- Future tie down
- Future Object Free Area
- Taxialne centerline removal
- Future removal
- Air Traffic Control Tower development site
- Future aeronautical development site
- Future non-aeronautical development site

Feet
0 75 125 250

S:\AE\D\Dulai\150733\5-final-dsgn\51-drawings\Master Plan\Master Plan Figures\Figure 4-X Future Building Area and Taxilane Layout.dwg