

# CHAPTER 3: TERMINAL AREA & SUPPORT FACILITIES

## Introduction

This Chapter of the Targeted Airport Planning Study is focused on the Terminal Area and Support Facilities which includes the aprons, taxilanes, hangars, and access roads. For information on the runways and taxiways, please see **Chapter 2: Runways and Taxiways**, which covers the facilities where primary aircraft movement takes place.

This chapter analyzes the landside requirements necessary to support airport, aircraft, and passenger operations. It will consider the critical design aircraft and forecasted planning activity levels for based aircraft and operations. Alternative choices will be presented based on findings along with preferred alternatives. The following elements are provided for examining terminal area/support facilities:

- [Planning Activity Levels & Critical Design Aircraft](#)
- [Terminal Area Background](#)
- [Aircraft Storage](#)
- [Aircraft Parking & Movement](#)
- [Terminal Building](#)
- [Support Facilities](#)
- [Requirements Summary](#)
- [Alternatives](#)
- [Preferred Alternative](#)

## Planning Activity Levels (PALs)

Before addressing facilities, the forecast information from **Chapter 1** is brought forward to help see the measured need for those facilities. There are various airport activity measures used to determine airport facility requirements including annual operations, peak hour activity, and based aircraft. Airport activity can be sensitive to industry changes, national and local economic conditions. This results in difficulty in identifying a specific calendar year for associated demand-driven improvements.

For this study, PALs are used to identify demand thresholds for many recommended facility improvements. If an activity level is approaching a PAL, then the airport should prepare to implement the improvements. Alternatively, activity levels that are not approaching a PAL can allow improvements to be deferred. The demand forecasts developed in this study correspond to an anticipated planning level calendar year to each PAL (2027, 2032, 2037, 2042) from the preferred aviation forecasts as seen in **Table 3-1**.

*Table 3-1 – Planning Activity Levels (PALs)*

Key Activity Metrics	Base	PAL 1	PAL 2	PAL 3	PAL 4
Forecast Year	2022	2027	2032	2037	2042
Operations	9,000	9,586	10,211	10,876	11,584
Based Aircraft	22	23	24	25	26

Source: KLJ Analysis

## Critical Design Aircraft

Aircraft characteristics relate directly to the design standards on an airport. Planning airport improvements requires the selection of a “design aircraft.” The design aircraft is the most demanding aircraft or family of aircraft operating or forecast to operate at the airport on a regular basis. Each design aircraft relates back to the FAA coding system to determine airfield design standards. The determination of Critical Design Aircraft helps look at the needs for the runway, taxiway, and terminal area system.

As determined in the aviation activity forecasts in **Chapter 1**, the overall existing and future critical design aircraft at RRT will be a family of Airport Reference Code (ARC) B-II aircraft which has an aircraft approach category (AAC) B, airplane design group (ADG) II, and a taxiway design group (TDG) 2A. Annual operations of these aircraft exceed the substantial use threshold of 500 operations to be considered regular use.

There is a single airplane that meets the regular use threshold of 500 operations for the critical design aircraft which is the Beechcraft 1900D turboprop aircraft. This 17,100-pound aircraft is based at Warroad and is operated regularly by Marvin Windows who owns three of these aircraft. In addition, Marvin Windows owns and operates a Cessna Citation Sovereign, a 30,000-pound jet aircraft, which also has AAC-B and ADG-II characteristics. The Citation Sovereign averages about 100 operations annually. An increase from ADG-II to ADG-III is unlikely, but occasional operations including larger aerial firefighting aircraft could use the airfield in the future.

*Table 3-2 – Critical Design Aircraft Summary*

Design Characteristics	Existing	Future
Aircraft Make/Model	Beechcraft 1900D	Beechcraft 1900D
Airplane Approach Category	B	B
Airplane Design Group	II	II
Taxiway Design Group	2A	2A
Wingspan	58'	58'
Length	57' 10"	57' 10"
Height	15' 6"	15' 6"
Wheelbase	23' 9"	23' 9"
Main Gear Width	18' 7"	18' 7"
Approach Speed (1.3 x Stall)	113 knots	113 knots
Maximum Takeoff Weight	17,100 pounds	17,100 pounds
Landing Gear Configuration	Dual Wheel	Dual Wheel

Source: Beechcraft, KLJ Analysis

## Terminal Area Background

Warroad International Memorial Airport serves General Aviation (GA) activity which includes all civil aviation activities except for commercial service. Providing necessary facilities and access for general aviation users at RRT will continue to be important for the vitality of the Warroad community. Current GA activity includes aerial firefighting, business travel, emergency response, tourism, and community access. While the airport does not have a Fixed Based Operator (FBO) or Specialized Aviation Service Operators (SASO) on the airfield, the Airport Manager, and staff, with the City of Warroad provides aeronautical services such as transient aircraft storage and fueling.

The aircraft parking apron and terminal area support these operations by providing the space to load/unload passengers and cargo, park and store aircraft, refueling operation, and safe routing to and from the runways. General aviation facilities evaluated in this section include aircraft storage hangars, aircraft parking apron, fuel farm location, snow removal equipment storage building, and vehicle parking.

The aircraft parking apron and its connection with parallel Taxiway A was a key consideration for this Targeted Planning Study. The apron depth and layout does not provide sufficient space for maneuvering of the larger ADG-II turboprop and business jet aircraft with fueling operations and parked aircraft also occurring on the apron. The removal of direct access to Runway 13-31 and future parallel Taxiway A alignment will also require new connections into the apron, warranting an evaluation of the apron's geometry and layout.

## Aircraft Storage

Aircraft storage requirements are driven by operational requirements, aircraft size, local climate, and owner preferences. For based aircraft, the harsh winters in the upper Midwest drive all owners to seek aircraft storage facilities rather than outdoor parking on an aircraft parking apron. Owners prefer to have covered, secure storage for their aircraft with space for other aeronautical facilities including an office or maintenance/storage areas. All based aircraft at RRT are stored in aircraft storage hangars. Transient aircraft travel to airports for up to a few days at a time. These aircraft typically park on the aircraft apron or seek temporary indoor aircraft storage, especially during adverse weather conditions.

### ***Aircraft Storage Hangars***

Warroad has 22 based aircraft at the airport. All are stored in aircraft storage hangars. Hangar facilities consist of large corporate hangars (greater than 10,000 square feet), small conventional hangars (10,000 square feet or less) and nested T-hangars. The main hangar area development is concentrated in the southeast portion of the airport. It consists of five privately-owned conventional hangars, one privately-owned large corporate hangar, one public conventional hangar, and one public T-hangar.

The City of Warroad owns two hangar facilities at the airport. The first is a 3,600 square foot conventional box hangar (Hangar #4), built in the 1970's. Then in the early 2000's, they constructed a 10-unit nested T-hangar (Hangar #10) which provides 12,800 square feet of aircraft storage space. Marvin Windows also owns two hangars at Warroad. Their original hangar (Hangar #8) was constructed in the early 1980's and provides 3,200 square feet of storage. The larger 18,500 square foot corporate hangar (Hangar #2) was constructed in the early 1990's.

All combined, the hangars at Warroad provide an approximate 51,700 square feet of storage space. The airport currently has a waitlist of 2 serious aircraft owners who would like to lease hangar space for their aircraft. Demand for building new hangars has been modest with occasional interest. Aircraft storage facilities are listed in **Table 3-3** and depicted in **Figure 3-**.

*Table 3-3 – Aircraft Storage Facilities*

Facility Number	Description	Storage Area (SF)
1	Private Hangar	5,000
2	Marvin Hangar	18,500
4	Public Hangar	3,600
6	Private Hangar	4,300
7	Private Hangar	1,500
8	Private Hangar	3,200
9	Private Hangar	2,800
10	T-Hangar (10-Unit)	12,800
<b>TOTAL</b>	<b>Conventional Hangars</b>	<b>20,400</b>
	<b>Corporate Hangars</b>	<b>18,500</b>
	<b>T-Hangars (10 units)</b>	<b>12,800</b>
	<b>Grand Total</b>	<b>51,700</b>

Source: KLJ Analysis

### **Based Aircraft**

All 22 based aircraft are currently stored in approximately 51,700 square feet of available aircraft storage space. A facility space model was developed to estimate aircraft storage hangar size needs. The model uses the based aircraft fleet mix forecast and estimates a size per aircraft type to determine recommended facility space. The following assumptions were made about aircraft storage space requirements:

- Single-Engine Piston/Other/Ultralight: 45' x 35' storage area (1,575 SF)
- Multi-Engine/Turboprop: 60' x 60' storage area (3,600 SF)
- Turbojet: 65' x 75' storage area (4,875 SF)
- Additional 20 percent for general aeronautical storage and supplies

Using these assumptions with based aircraft forecasts, a projected need for based aircraft storage space is determined. It is important to understand that this projection provides a broad estimate of needed space into the future for facility planning. Actual space needs are demand driven.

**Table 3-4 – Based Aircraft Storage Requirements**

Metric	Base	PAL 1	PAL 2	PAL 3	PAL 4
Single-Engine Aircraft	17	18	19	19	20
Storage Sq. Ft.	26,775	28,035	29,295	30,713	32,130
Multi-Engine/Turboprop Aircraft	4	4	4	5	5
Storage Sq. Ft.	14,400	15,120	15,840	16,560	17,280
Turbojet Aircraft	1	1	1	1	1
Storage Sq. Ft.	4,875	4,875	5,363	5,363	5,850
20% Additional Storage	9,210	9,606	10,100	10,527	11,052
<b>Total Storage Space</b>	55,260	57,636	60,597	62,162	66,312
<b>Capacity/(Deficiency)</b>	<b>(3,560)</b>	<b>(5,936)</b>	<b>(8,897)</b>	<b>(10,462)</b>	<b>(14,612)</b>

Source: KLJ Analysis. NOTE: RED indicates a deficiency to existing capacity. Some figures are rounded.

The above analysis suggests that there is insufficient aircraft storage space at Warroad. The recommended hangar types to accommodate aircraft storage depend on airport and aircraft owner preferences and financial position. There are two main hangar types:

- T-Hangar: Nested small aircraft storage units within a rectangular building.
- Conventional Hangar: Commonly known as “box” hangars are square/rectangular.

Hangars are constructed with public or private funds as demand warrants. This facility requirement analysis shows there is a need for approximately 14,600 square feet (28 percent) more hangar space at RRT to accommodate forecasted based aircraft through PAL 4.

### TRANSIENT AIRCRAFT

Transient aircraft storage is utilized on an as-needed basis as aircraft require temporary storage. Aircraft types that require this type of storage are typically larger and more expensive airplanes such as turboprop and jet aircraft. Storage timeframes vary but can be for a few hours to several days.

At Warroad, transient aircraft typically park on the apron or in the city-owned Hangar #4 (Refer to **Figure 3-**) located south of the terminal building. During poor weather conditions, Polaris will divert from Roseau to Warroad due to the lower approach minimums. The city hangar is not large enough to accommodate Polaris’ jet aircraft.

**It is recommended that the airport increase the size of their transient storage hangar to accommodate the storage of an occasional jet aircraft.**



ID	DESCRIPTION
1	Private Hangar
2	Marvin Hangar
3	Terminal Building
4	Public Hangar
5	Equipment Building
6	Private Hangar
7	Private Hangar
8	Private Hangar
9	Private Hangar
10	Public T-Hangar
11	Equipment Shelter
12	SRE Building
13	MN DNR Trailer

\*Intended for Planning Purposes

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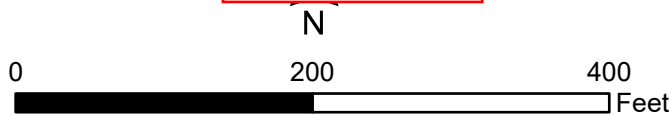


Figure 3-1  
Warroad International Memorial Airport Terminal Area Map

## Aircraft Parking & Movement

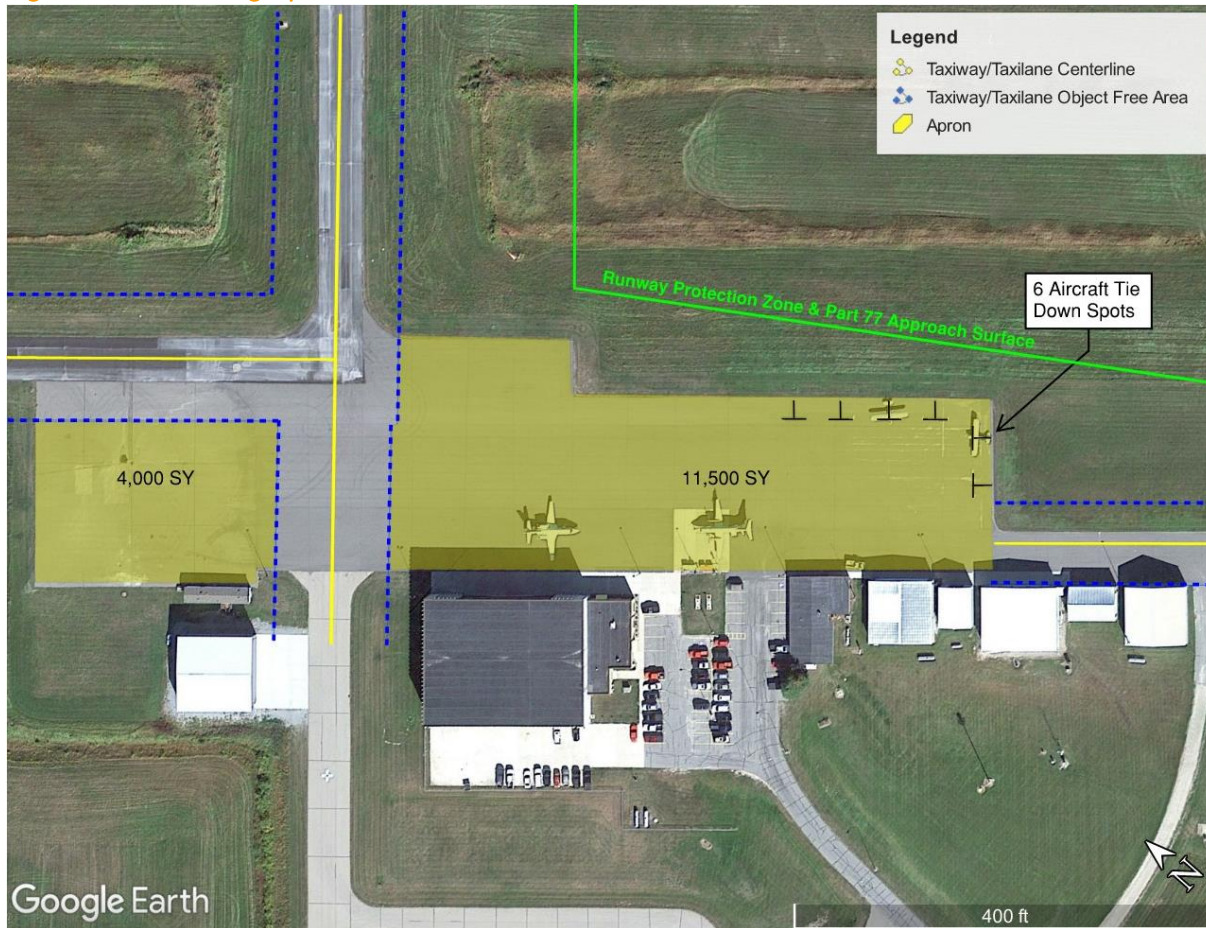
Apron areas serve the loading, unloading, parking and maneuvering needs for aircraft operations. General aviation aircraft parking is utilized by transient or based aircraft. With all the based aircraft at RRT stored in hangars, the necessary aircraft parking is for transient aircraft requiring parking for a short period ranging from a few minutes to a few days. Itinerant aircraft will require either covered aircraft storage (based or transient) or apron parking space.

### EXISTING APRON

The aircraft parking apron at RRT is located on the southeast end of the airfield. The parallel taxiway runs along the northeast edge of the apron with a taxiway connector providing access to Runway 31 from the apron. The apron is approximately 15,500 square yards (SY) in size and is divided into two sections by an unstriped ADG-II taxilane that extends from the T-Hangar to Taxiway A1. Additional details on each section are provided below and depicted in **Figure 3-** .

- **Center Apron** area serves the loading and unloading of aircraft, houses the fuel facility, and provides tie-down parking. The area is roughly 11,500 SY in size and contains six tie-down parking spots for ADG-I aircraft that provide approximately 975 SY of parking area. An ADG-I/TDG-1A taxilane extends to the southeast from the apron for access to the row of privately-owned box hangars. The pavement type is primarily asphalt, except for a 350 SY concrete pad that aircraft park on while refueling. The 2021 Pavement Condition Index (PCI) was reported between 80 and 88 with a rating of very good to excellent. The apron extends beyond the threshold of Runway 31 which constrains apron depth and further development to the southeast due to the Runway Protection Zone (RPZ) and Part 77 Approach Surface that protects the approach to the runway. Taxiway A1 provides direct access to Runway 31 from the apron. This does not meet current design standards and must be reconfigured to require at least one right angle turn from the apron before an aircraft would reach the runway hold line.
- **Northwest Apron** is utilized by the Department of Natural Resources (DNR) for firefighting activity and long-term transient parking. The apron is roughly 4,000 SY of asphalt with a 2021 PCI rating of 67. Approximately 1,600 SY of the apron is used for parking aircraft with the remainder being used to maneuver in and out of parking positions. The parallel Taxiway A runs along the northeast edge of the apron and leads into the connector taxiway to the Runway 31 End.

Figure 3-2 – Existing Apron Area



Source: KLJ Analysis

## AIRCRAFT DEMAND

The apron size is driven by the number and size of parking positions and the type of aircraft using the area. Peak operations should also be considered during apron design to determine the size of aprons during these times of high demand. Based on these factors, an analysis was conducted to determine the triggering point for additional apron space using the aviation activity demand forecasts

Transient aircraft operations regularly utilize aircraft aprons for accessing the terminal building and aeronautical services, loading/unloading of the aircraft, aircraft refueling, and parking. To determine the parking needs for transient aircraft the frequency of arrivals, size and type of aircraft, and utilization of the apron at the same time was evaluated.

Frequency of transient aircraft was determined by calculating the average number of daily transient arrivals during the peak month. Fuel sales were reviewed which found that June was the peak month of activity with 13% of annual fuel sales. Using the Annual Transient Operations from **Table 1-11**, in **Chapter 1**, the peak month and average day transient operations were then determined.

**Table 3-5 – Transient Aircraft Demand**

Key Activity Metrics	Base	PAL 1	PAL 2	PAL 3	PAL 4
Annual Transient Operations	6,000	6,391	6,807	7,250	7,723
Peak Month - June (13%)	780	831	885	943	1,004
Average Day (30 days) in Peak Month	26	28	29	31	33
Transient Arrivals (50% Average Day)	13.0	13.8	14.7	15.7	16.7

Source: KLJ Analysis

Aircraft size also determines the size of parking space needed. The Transient Arrivals from **Table 3-5** was distributed by the percentages from the Fleet Mix Share Breakdown (**Table 1-12** in **Chapter 1**). A standard tie-down position accommodates one small multi-engine aircraft. Larger aircraft occupy additional space and can be accommodated with a nested tie-down configuration. The following aircraft size factors were then applied per Appendix C of [ACRP Report 113, Guidebook on General Aviation Facility Planning](#) to produce the number of equivalent tie-downs.

- Single-Engine/Multi-Engine/Other: 1.00
- Helicopter: 2.00
- Large Piston/Turboprop: 2.50
- Turbojet: 3.00

The percentage of Transient Aircraft that are expected to be parked on the apron at the same time was determined to be 40% for all aircraft types. Transient activity during the peak month of June includes aerial firefighting, lake tourism, and corporate flights which all demand extended apron and parking use. **A total of 9 (rounded from 8.7) equivalent tie-down parking positions for Transient Aircraft will be needed by PAL 4 as depicted in Table 3-6.**

**Table 3-6 – Transient Equivalent Tie-downs**

Aircraft Type	Aircraft Size Factor	Base	PAL 1	PAL 2	PAL 3	PAL 4
Single-Engine	1	3.6	3.8	4.0	4.3	4.5
Multi-Engine	1	0.7	0.7	0.8	0.8	0.9
Turbo Prop	2.5	1.7	1.9	2.1	2.3	2.5
Turbo Jet	3	0.4	0.5	0.5	0.6	0.7
Helicopter	2	0.1	0.1	0.1	0.1	0.1
Ultralight/Other	1	0.0	0.0	0.0	0.0	0.0
<b>Total Transient Tie-downs</b>		<b>6.5</b>	<b>7.0</b>	<b>7.5</b>	<b>8.1</b>	<b>8.7</b>

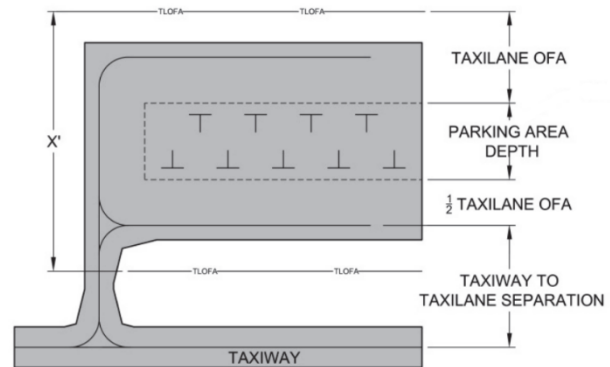
Source: KLJ Analysis

Based aircraft have not historically parked on the aircraft parking apron and currently all based aircraft are stored inside hangars. It is good planning practice to plan for a contingency of additional tie-downs for up to 10% of based aircraft. Being that Warroad experiences severe winters, 1 additional tie-down space is recommended for based aircraft for the planning period beginning in PAL 1.

During the fire season the Minnesota Department of Natural Resources (DNR) conducts their aerial firefighting operations out of Warroad. On average, they run two turboprop aircraft which requires both parking space and loading/staging area. Using the aircraft size factor of 2.5, a total of 5 equivalent tie-down spaces are needed to support these aircraft.

## SIZE & CONFIGURATION

Apron size must accommodate both the required aircraft parking positions and maneuvering standards. Aircraft maneuvering at RRT is required to accommodate safety setbacks for FAA Airplane Design Group (ADG) II wingspans for the design aircraft to access parking positions, fueling area, and loading/unloading area. The current apron depth is not sufficient to meet aircraft maneuvering standards when other aircraft are loading and unloading, fueling aircraft, or certain parked aircraft.



Dual-Taxilane Apron Configuration (ACRP Report 113)

The preferred apron design for Design Group II aircraft is a dual-taxilane configuration to support taxi-in and taxi-out operations like that shown above. Using ADG-I parking position sizing from Table E-1 from [Advisory Circular 5300-13B: Airport Design](#), a factor of 327 SY per aircraft was used per equivalent tie-down space. This does not include pavement in the taxilane object free area (TLOFA).

Table 3-7 – Aircraft Parking Area Sizing

Category	Existing	Base	PAL 1	PAL 2	PAL 3	PAL 4
Transient Parking Tie-downs	975	6.5	7.0	7.5	8.1	8.7
Based Aircraft Parking Tie-downs	-	-	1.0	1.0	1.0	1.0
Aerial Firefighting Tie-downs	1,600	5.0	5.0	5.0	5.0	5.0
Total Equivalent Tie-downs (Rounded)		11.5 (12)	13.0 (13)	13.5 (14)	14.1 (14)	14.7 (15)
<b>Total Parking Area (SY)</b>	<b>2,575</b>	<b>3,924</b>	<b>4,251</b>	<b>4,578</b>	<b>4,578</b>	<b>4,905</b>
<b>Capacity/(Deficiency) (SY)</b>	-	<b>(1,349)</b>	<b>(1,676)</b>	<b>(2,003)</b>	<b>(2,003)</b>	<b>(2,330)</b>

Source: KLJ Analysis. Note: RED indicates a deficiency to existing capacity.

Based on this assessment, the aircraft parking area is not sufficient to accommodate the existing and projected needs. The airport should plan to accommodate an additional 2,330 SY of aircraft parking space by PAL 4. The general aviation apron space will require reconfigured tie-downs, additional parking spaces, aircraft refueling space, and additional apron space to meet ADG-II maneuvering standards. The apron and parking areas should continue to accommodate aircraft weights up to 30,000 pounds (Dual-Wheel gear configuration).

## Taxilanes

RRT is served by various low speed taxilanes providing access from the taxiway to individual aircraft parking areas and hangars.

- An unmarked taxilane transverses the apron from Taxiway A to the southwest T-hangar area. Once off the apron, the taxilane is 40 feet wide and provides a 110-foot taxilane object free area (TLOFA) which meets ADG-II standards. The pavement is in good condition with a PCI ranging from 80 to 77.
- Two taxilanes between hangar buildings provide access to the T-hangar. The pavement width is approximately 22 feet and the OFA meets ADG-I separation standards. An additional 3 feet of

pavement width is needed to meet TDG-1A standards when the pavement is reconstructed. According to the 2021 pavement condition report, it has a PCI of 70.

- An unmarked taxilane extends from the southeast corner of the apron providing access to a row of conventional hangars intended for ADG-I aircraft. Assuming a taxilane width of 25 feet the hangars penetrate the TLOFA by two feet. An additional two feet of pavement width will be necessary to meet current ADG-I separation standards. The PCI for this taxilane is 77.

Aircraft regularly transverse the apron to access parking and fueling services. **It is recommended that the airport stripe apron taxilanes to increase safety for maneuvering aircraft. Additional pavement is needed to ensure the southeast and T-hangar taxilanes meets current design standards.**

## Terminal Building

The general aviation terminal building (also referred to as an Arrival/Departure Building) serves multiple functions for inbound and outbound general aviation passengers. The facility should be located adjacent to the transient aircraft parking apron with good visibility to the airfield and be in close proximity to the automobile parking and waiting area. In most cases the terminal building is located within or near a Fixed Base Operator (FBO) providing aeronautical services.

The terminal building at RRT is owned and maintained by the City of Warroad and is located centrally off the apron parking area. The building provides approximately 1,000 square feet of terminal space usable for passengers. Services provided include a weather briefing computer, telephone, restrooms, waiting area, and access to a city-owned courtesy car. An office for the airport manager and storage/mechanical room is also housed in the building. It was constructed in the 1970s and was later renovated, with a slight expansion, in 2007. The terminal building also features an apartment where the airport manager resides.

The estimated planning-level size of the terminal building is based on peak hour operations as identified in [ACRP Report 113: Guidebook on General Aviation Facility Planning](#). A factor of 2.5 people (pilots and passengers) per peak-hour operation can be assumed. An area of 100 to 150 square feet of space per person was considered adequate to accommodate the peak-hour traffic. These figures provide an estimate of the number of passengers to arrive, depart and generally flow through the GA terminal. **As depicted below in Table 3-8, the existing terminal building meets the existing and future GA passenger needs through the planning period.**

**Table 3-8 – GA Terminal Building Size Requirements**

Category	Existing	Base	PAL 1	PAL 2	PAL 3	PAL 4
<b>GA Terminal Building Size (SF)</b>						
Peak Hour Operations	-	2.9	3.1	3.3	3.5	3.8
Number of Passengers	-	7.25	7.75	8.25	8.75	9.5
Total Building Size	1,000	<b>725</b>	<b>775</b>	<b>825</b>	<b>875</b>	<b>950</b>
<b>Capacity/Deficiency</b>	-	<b>275</b>	<b>225</b>	<b>175</b>	<b>125</b>	<b>50</b>

Source: ACRP Report 113: Guidebook on General Aviation Facility Planning, KLJ Analysis

## ***Customs & Immigration***

Warroad International Memorial Airport is listed as a Port of Entry for U.S. Customs and Border Protection (CBP). On call inspection services are available for RRT users with a one-hour notice to CBP. Flights are cleared on the apron in front of the general aviation terminal with processing done planeside. During the planning study meetings, CBP indicated that the existing space and facilities are adequate for their operations and they do not foresee additional facilities being required for CBP in the future.

## **Support Facilities**

Support facilities are necessary to run the airport supporting aircraft operations and the travelling public safely and efficiently.

### ***Airport Maintenance & Snow Removal***

The City of Warroad has a dedicated facility to store airport maintenance equipment which is located just south of the airport access road as you enter the facility. The facility is approximately 3,000 SF in size, has 3 equipment bay doors, and a vehicle maintenance bay. An additional smaller building (1,200 SF) along the apron is used to store the airport pickup trucks and miscellaneous storage. The buildings are currently near capacity, and the airport is also in the process of acquiring a new mid-size wheel loader with attachments for an anticipated delivery in 2025.

The airport currently has the following equipment:

- Sterling Truck Plow
- Sweepster Broom
- Tractor/Snowblower
- 15-foot brush mower
- Mower – 72” Zero-Turn
- Skid-steer Loader
- Utility Task Vehicle (UTV) with plow

Total general maintenance equipment storage (MES) space needs are determined by type of equipment planned to be stored. Per [ACRP Report 113, Guidebook on General Aviation Facility Planning](#), the following space assumptions are made to estimate the size of an MES building:

- At 602 acres, RRT is evaluated as Large Airport (500-750 acres)
- 6 equipment bays (truck plow, broom, tractor, mowers, skid-steer)
- 2 support bays for general storage and attachment
- 600 SF for each equipment storage bay
- 600 SF for each support equipment bay

**As summarized in Table 3-9, the existing airfield maintenance and snow removal equipment building does not meet the existing and future storage needs for the airport. It is recommended an additional 1,800 SF of storage be added to accommodate the equipment.**

**Table 3-9 – Mechanical Equipment Storage Building Size Requirements**

Category	Existing	Base	PAL 1	PAL 2	PAL 3	PAL 4
<b>MES Building Size (SF)</b>						
Equipment Storage Bays	-	6	7	7	7	7
Equipment Bay Size	-	3,600	4,200	4,200	4,200	4,200
Support Bays	-	2	2	2	2	2
Storage Bay Size	-	1,200	1,200	1,200	1,200	1,200
Total MES Building	3,000	4,800	4,800	4,800	4,800	4,800
<b>Capacity/Deficiency</b>	-	<b>1,800</b>	<b>1,800</b>	<b>1,800</b>	<b>1,800</b>	<b>1,800</b>

Source: ACRP Report 113: Guidebook on General Aviation Facility Planning, KLJ Analysis. Note: **RED** indicates a deficiency to existing capacity.

### **Fueling Facilities**

The City of Warroad owns the airport fuel facility and provides storage of both 100 low-lead aviation gasoline (100LL) and jet fuel (Jet A). The fuel facility is along the apron between the terminal building and Marvin’s hangar. Aircraft access fuel from a designated spot on the apron. Self-serve fueling of both 100LL and Jet A is available 24/7 and the system accepts credit cards.

### **FUEL STORAGE**

The fuel system consists of two underground tanks with a capacity of 10,000 gallons for Jet A and 6,000 gallons for 100LL. In 2022, fuel sales totaled approximately 103,000 gallons for Jet A and 4,400 gallons of 100LL. This equates to a new resupply load of Jet A fuel every 3-5 weeks depending on season and one load of 100LL annually. The current tank capacities are adequate for the existing activity. **As airport operations are expected to increase by 28 percent in PAL 4 it is recommended the Jet A storage capacity increase to at least 12,000 gallons.**

The age of most major components of the system are greater than 20 years except for the credit card and self-service system which was installed in 2013. The system is described to be in in good working order. It is expected the system will need to be replaced within the next 10-20 years. When this occurs, a new location is desired by the airport as current space is needed for additional vehicle parking. The future location will be evaluated in the Alternatives section below and should be compatible with any configuration changes to the apron.

### **FUEL DISPENSING**

RRT already offers 24-hour self-service fuel pumps for 100LL and Jet A. This design is sufficient for the planning period and meets the State’s minimum system objectives. The City of Warroad provides full service fueling upon request. During the planning study, the airport evaluated the addition of a fuel truck to provide mobile aircraft fueling, however due to parking locations and additional expenses, the airport decided not to pursue it further.

### **Fencing, Security & Wildlife**

#### **WILDLIFE CONTROL & MITIGATION**

Controlling wildlife on or near the airport helps mitigate existing and prevent the creation of potential new hazards to aircraft. In 2012, the USDA conducted a Wildlife Hazard Evaluation and recommended that depredation permits be obtained for migratory birds and the airfield be fully enclosed by a 10-foot fence. The airport completed construction of the wildlife fence in 2017.

## SECURITY & FENCING

Security is an important consideration when operating a safe airport. Transportation Security Administration (TSA) published a [Security Guidelines for General Aviation Airport Operators and Users](#) document in 2021 providing recommended airport design guidelines.

The first line of security protection for infrastructure is a perimeter fence. Perimeter fencing is not a requirement for non-certificated airports such as RRT. A perimeter fence helps prevent unauthorized persons from entering the airfield. A minimum 6-foot-high fence with added barbed wire is generally recommended at a minimum for security. Airfield access points should be minimized, however those that are needed should be controlled.

The airport has a 10-foot-tall fence surrounding the airfield. There is an opening in the fence with no gate that allows access to the apron from the parking lot. **During its routine airport inspection, MnDOT recommended the addition of a gate between the parking lot and the apron.**

### *Utilities*

There are two septic systems on airport property. One system serves Marvin Window's facility and is located south of the parking lot and west of airport drive. The septic tank that serves the airport terminal is located just south of the terminal. Additionally, there is a well located south of the city owned Hangar #4.

The main power feed for the airport comes in from the county road and shares the transformer on the north side of the electrical vault.

The alternatives will consider the location of these utilities when planning for future development.

### *Other Facilities*

## AIRCRAFT DEICING

Aircraft deicing operations are critical to ensuring safe flight operations during winter weather. Deice fluid runoff has potential environmental implications when discharged into airport stormwater. This activity is regulated through Federal and State stormwater discharge permits.

No aircraft deicing operations occur today; aircraft are stored in a heated transient hangar. No larger-scale deicing operations are expected based on fleet mix and expected airport businesses. Any new deicing operations would have to be incorporated into an approved airport stormwater permit for compliance to be achieved.

## GROUND ACCESS & CIRCULATION

Public airport access is provided by County Road 13. This road connects with Minnesota Highway 313 on the east side of the airport property to provide access to the Warroad central business district. A paved access road leading from County Road 13 provides public access to the automobile parking lot and public airport facilities. The access road runs north dividing the existing hangar development at a 45-degree angle. Realignment of the access road should be evaluated to maximize hangar development in the future. Existing conventional box hangars and T-hangars can be accessed from the paved airport access road.

## AUTOMOBILE PARKING

The main automobile parking lot is located between the public terminal building and the Marvin Windows hangar. There are 32 public parking spots available for airport users. An additional 48 parking spots are allocated specifically for Marvin and their passengers. These are the spots immediately next to the Marvin hangar and the expanded parking lot to the west. Marvin transports an average of 15,000 passengers annually. During this planning study, Marvin noted they would like to increase their available parking spots by 25%, which equates to 12 additional spots. As additional hangars are constructed and operations increase, the airport should make plans to increase available automobile parking as well. ACRP Report 113 provides a method which can be used to calculate the additional parking spaces needed. It is important to note that additional parking for Marvin is considered exclusive use and therefore not eligible for federal funds. **Table 3-10** depicts the existing and ultimate parking needs based on aircraft storage needs calculated using ACRP methodology.

**Table 3-10 – ACRP Recommended Parking Per Type of Facility**

Facility Type	Criteria	Existing		PAL 4	
		Metric	Spaces	Metric	Spaces
Terminal/Airport Admin Building	• 2.5 Spaces per peak-hour operation	2.9 peak-hour operations	8	Forecasted 3.8 peak-hour operations	10
MES Building	• 1 space per 750 SF shop space – 5 minimum • AND 1 space per vehicle bay	3 vehicle bays and 750 SF shop space in SRE Building	8	4,800 SF building with 6 bays and 1,200 SF shop space	11
T-Hangar	• 1 space for 50% of units	10-unit T-hangar	5	10-unit T-hangar	5
Box Hangar	• 1 space per 1,000 SF of hangar floor space	20,400 SF	21	35,000 SF – additional 14,600 SF storage needed	35
<i>Existing Public Parking Stalls</i>		32		32	
<b>Total Automobile Parking Needs</b>		<b>42</b>		<b>61</b>	
<b>Capacity/Deficiency</b>		<b>10</b>		<b>29</b>	

Source: ACRP Report 113: Guidebook on General Aviation Facility Planning, KLJ Analysis. Note: **RED** indicates a deficiency to existing capacity. Figures are rounded up to the next whole integer.

The current number of public parking stalls does not meet the existing and future needs. **It is recommended the airport plan for an additional 29 public parking spaces and 12 additional spaces exclusive for Marvin Windows by PAL 4.**

### Public Transportation

There is not significant demand for public transportation for users of RRT. The use of Paul Bunyan Transit is available for on-demand transportation throughout Roseau County. The airport does provide a courtesy car on a first come first serve basis. The 2022 MnSASP emphasizes the importance of “Last Mile Connectivity” and encourages airports to continue to provide courtesy cars in good working condition to passengers when other forms of public transportation are not easily accessible. Doing so allows non-local visitors to support local hospitality related industries in Warroad and the surrounding community.

## Requirements Summary

This section summarizes safety, capacity, and development needs for the Warroad International Memorial Airport based on forecasted activity levels. These recommendations provide the basis for formulating development alternatives to adequately address recommended improvements. The following summarizes the facility recommendations:

### ***Hangars***

- Plan to accommodate an additional 14,600 SF of hangar storage space by through PAL 4.
- Increase size of transient storage hangar to accommodate storage of occasional jet and turboprop aircraft.

### ***Apron/Taxilanes***

- Expand and reconfigure apron to accommodate ADG-II / TDG-2A aircraft maneuvering.
- Expand aircraft parking areas by 1,349 SY to meet existing parking needs. The airport should plan to accommodate a total of 4,905 SY of aircraft parking space by PAL 4.
- Add additional two feet of pavement width on southeast taxilane to meet current ADG-I separation standards.
- Stripe taxilane centerline on apron to provide visual cues to pilots on taxi routes.
- Proactively add taxilanes and appropriate utilities to allow for hangar development.

### ***Support Facilities***

- An additional 1,800 SF is needed for airfield maintenance and snow removal equipment storage.
- Increase storage capacity of Jet A to at least 12,000 gallons and relocate fuel system when it reaches end of useful life and needs to be replaced.

### ***Landside Facilities***

- Add 10 additional public automobile spaces to meet current demand and plan for 29 additional parking spaces by PAL4.
- Plan for space to accommodate 12 additional parking spaces exclusive to Marvin Windows by PAL 4.

# Alternatives

A wide range of alternatives are evaluated to determine the best solution for the airport to meet facility needs. In many cases the process is iterative to react to new information and input. Please refer to the alternative analysis process in **Chapter 1** for details on the factors considered.

## *Terminal Area Alternatives*

A range of initial alternatives were presented to the Planning Advisory Committee for consideration and to create a narrower slate of alternatives for further evaluation. This was followed by a review of refined alternatives with more in-depth analysis. In the end a preferred alternative was selected and is portrayed at the end of this chapter.

All of the alternatives focused on different arrangements of the aircraft parking apron, connector taxiways, ADG-I and ADG-II hangar development, corresponding taxilanes, and access roads. Below are specific components considered in each of the alternatives presented.

- ADG-II and TDG-2A aircraft maneuvering space on the apron
- Removal of direct access from apron to runway to meet design standards
- Apron configuration and aircraft parking locations
- Fuel system locations
- Airport access road realignment
- Expansion of vehicle parking area
- ADG-I and ADG-II hangar development areas
- SRE equipment building expansion
- Septic system locations
- Drainage ditch locations

## INITIAL ALTERNATIVES:

Four initial alternatives were drafted for the terminal area and presented to the Planning Advisory Committee. **Figure 3-3** shows all four of the initial alternatives presented.

**Alternative 1:** Apron depth is expanded with nested tie-downs and dual taxilanes. Access to the taxiway is provided by two taxiways in the north corner to prevent conflict of entering and exiting aircraft and remove direct access to the runway. The access road is realigned perpendicular to the runway/taxiway to expand ADG-I hangar development on the south end. ADG-II hangar development is positioned on the northwest area.

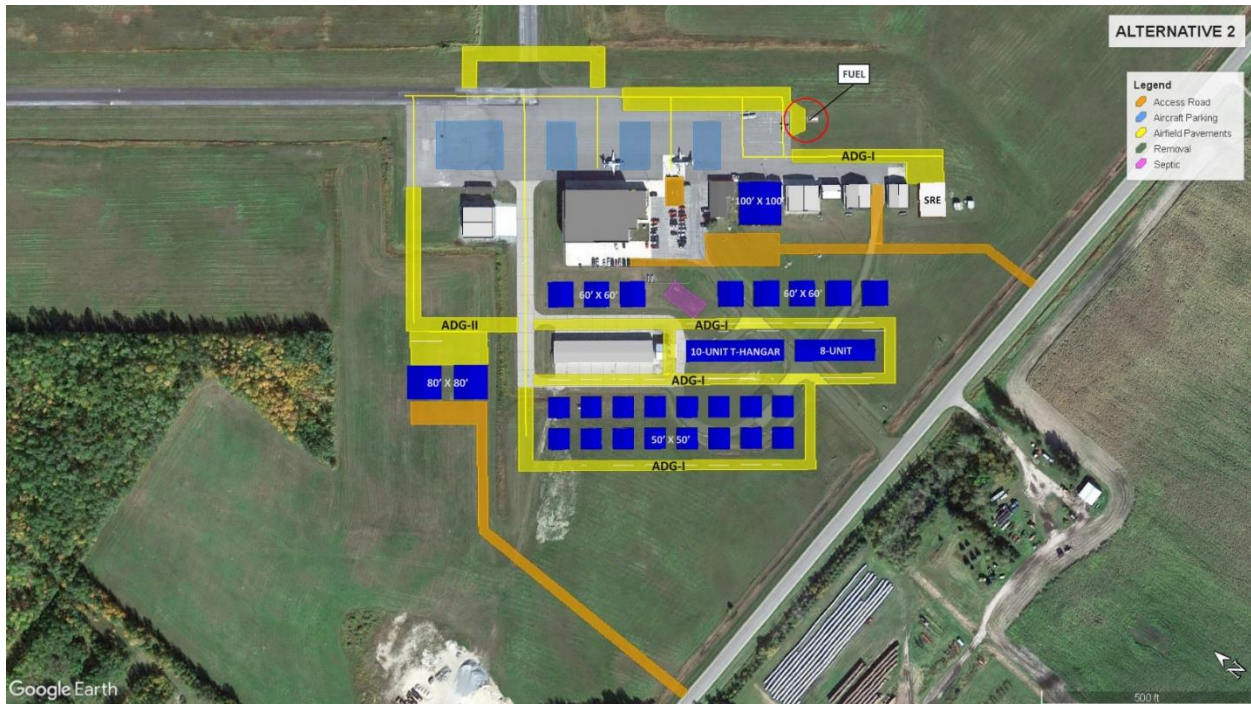
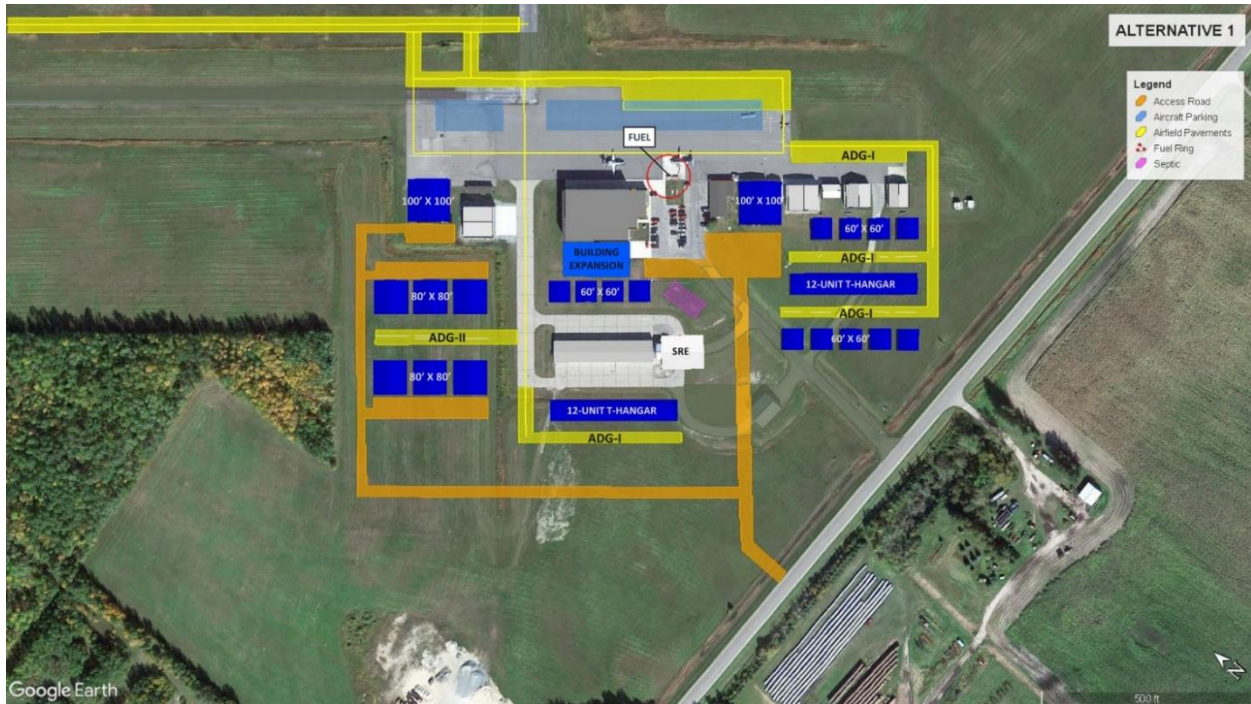
**Alternative 2:** The apron remains at existing depth and carried through to the south. The main apron taxilane runs along the northeast edge with parking positioned perpendicular to runway/taxiway. To remove direct access, the connector taxiway is set to a separation of 425' and provides two routes to the apron, with one going past the runway threshold (with intent to avoid the precision obstacle free zone (POFZ)). Fuel system is relocated to the south end of the apron. The access road is realigned parallel to the runway/taxiway to maximize development to the west. Limited new ADG-II hangar development accommodated.

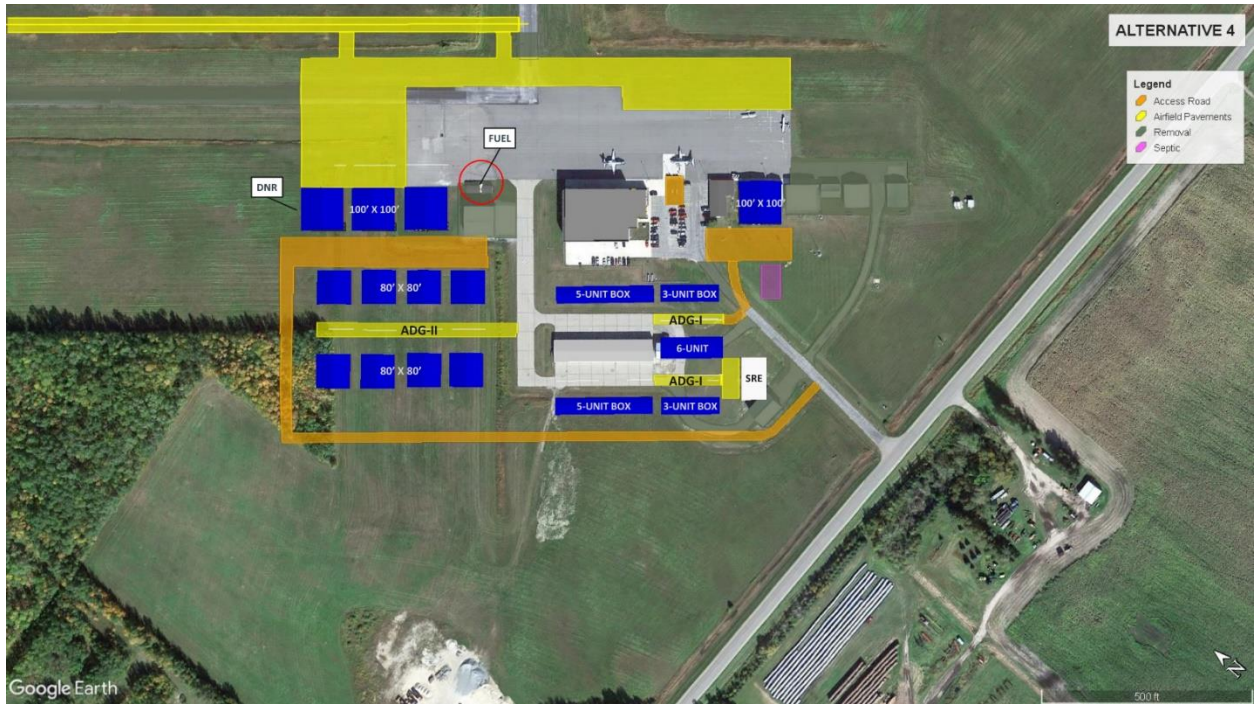
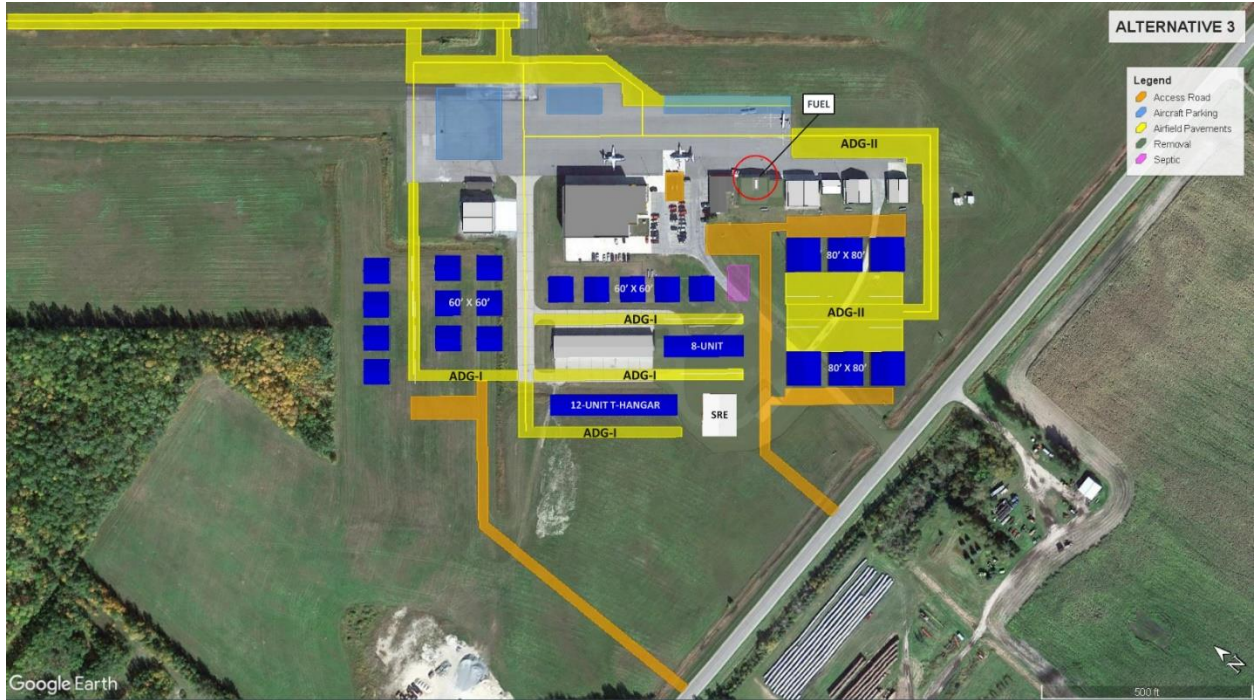
**Alternative 3:** Apron depth is expanded by the parallel taxiway and then steps down shallower moving south to avoid the Runway Protection Zone (RPZ). Two areas of nested tie-downs and a single row of tie-

downs are provided. Direct access to the runway is removed by providing two access routes to the parallel taxiway with wider separation. The fuel system is relocated to the south of the terminal building requiring the removal of the airport-owned hangar and equipment building. The access road is realigned perpendicular to the runway/taxiway to expand ADG-II hangar development on the south end. ADG-I hangar development is positioned on the northwest side.

**Alternative 4:** Example of maximum apron depth build out and expansion to the northwest. The apron has more significant penetration into the RPZ, Part 77 Approach Surface, and MnDOT Clear Zone. There are two access taxiways to the parallel taxiway with the widest separation of the examples. The fuel system is relocated to the north side of taxilane. Airport access road remains in place with ADG-I development occurring around the existing T-hanger and ADG-II development provided north of the taxilane.

Figure 3-3 Initial Alternatives





## CONSOLIDATED ALTERNATIVES

After receiving feedback from the airport and Planning Advisory Committee on the initial alternatives, two new alternatives were prepared. These alternatives featured concepts and components from the initial alternatives that were carried forward. One component that carried forward on both of the new alternatives was the airport users wanted to maintain the existing access road alignment. As a result, future hangar development to the south of the access road did not carry forward. Additionally, further expansion of the apron to the northwest was dismissed due to wetland impacts and the existing apron frontage is sufficient to accommodate future development. While the northwest expansion of the apron is not depicted going forward, consideration of this expansion is given to the alternatives below to ensure they are compatible should the aeronautical demand in the future warrant an expansion.

Information regarding each refined alternative will be divided into the following sections (Apron, Connector Taxiways, Northwest Development Area, Central Development Area, Southeast Development Area, and Support Facilities).

### **Alternative 5:**

**Apron** – The apron depth is expanded to allow for a dual perimeter ADG-II/TDG-2A taxilanes with nested tie-downs in the middle of the apron. The pavement depth is approximately 250 feet at the narrowest point and runs the length of the existing apron at 910 feet. The depth is set by two ADG-II taxilanes with a 66-foot-deep parking area beginning at the existing fuel system.

**Connector Taxiways** – Two ADG-II/TDG-2A taxiways will access Taxiway A from the north corner of the apron. These taxiways are positioned to resolve the direct access to the runway by requiring aircraft to make a 90 degree turn before reaching the runway hold line.

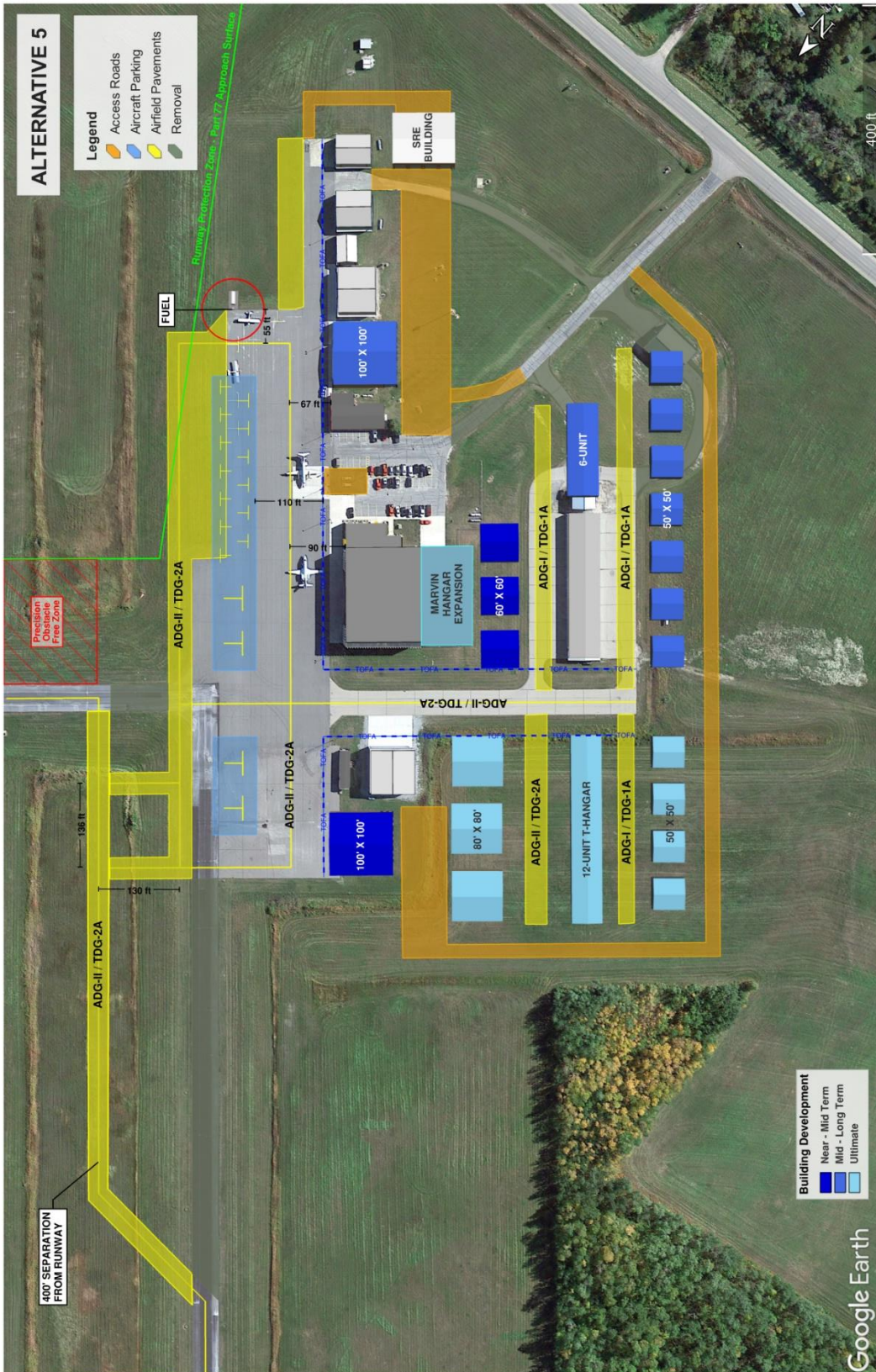
**Northwest Development Area** – ADG-II storage includes 100'x100' hangar site along the northwest corner of the existing apron and three 80'x80' box hangars behind this site. An ADG-II/TDG-2A taxilane will provide access to the three box hangars. Additional ADG-I storage includes a 12-unit T-hangar and four 50'x50' box hangars with an ADG-I/TDG-1A taxilane providing access.

**Central Development Area** – An 80-foot by 160-foot space is reserved for expansion of Marvin Windows facility. The area behind Marvin Windows is designed for ADG-I development with three 60'x60' box hangars, an additional 6-unit T-hangar, and seven 50'x50' box hangars. ADG-I/TDG-1A taxilanes will serve the new hangars.

**Southeast Development Area** – A 100'x100' transient storage hangar site will be available next to the terminal building following the removal of the two city-owned buildings. The southeast taxilane will be expanded to serve ADG-II/TDG-2A should the existing hangars be replaced by ADG-II hangars.

**Support Facilities** – Aircraft fueling facilities are placed on the southeast corner of the apron. Fuel trucks will require airside access to resupply the tanks. A vehicle access road will serve the northwest ADG-II development with vehicle parking. Additionally, existing vehicle parking is expanded into the former fuel facility site and to the southeast. A new SRE building with drive through bays is located at the edge of the new parking lot.

Figure 3-4 - Alternative 5



## **Alternative 6:**

**Apron** – The apron depth is expanded in steps to avoid penetrating the RPZ and Part 77 Approach surface. The northwest portion of the apron has dual perimeter ADG-II/TDG-2A taxilanes with nested tie-downs while the southeast portion has a single ADG-II/TDG-2A taxilane with single row tie-downs. The maximum depth of the apron is 300 feet and runs the existing length of 910 feet. The western taxilane is set 43 feet at the narrowest point from the hangars to allow aircraft to stage in front of the hangars without blocking the taxilane.

**Connector Taxiways** – Two ADG-II/TDG-2A taxiways will access Taxiway A from the north corner of the apron. These taxiways are positioned to resolve the direct access to the runway by requiring aircraft to make a 90 degree turn before reaching the runway hold line.

**Northwest Development Area** – ADG-I hangar development includes six 60'x60' box hangars and one six-unit T-hangar served by an ADG-II/TDG-1A and ADG-I/TDG-1A taxilanes. The additional wingtip separation of the taxilane allows for development flexibility beyond the planning period.

**Central Development Area** – ADG-I hangar development includes a five-unit executive box hangar and a 12-unit T-hangar. An additional ADG-I/TDG-1A taxilane will provide access to the new T-hangar.

**Southeast Development Area** – The southeast taxilane is expanded to serve ADG-II/TDG-2A should the existing hangars be replaced by ADG-II hangars.

**Support Facilities** – The fuel system is relocated to the south of the terminal building requiring the removal of the airport-owned hangar and equipment building. Vehicle parking is expanded into the former fuel facility site and partially to the southeast. A new SRE building is located at the edge of the taxilane with direct access to the airfield.



## REFINED ALTERNATIVES

Following the review of the two consolidated alternatives, Alternative 5 was selected to proceed for final evaluation with two alterations.

1. The SRE building location in Alternative 6 was selected as the preferred location as its simple design and direct access to the taxiway.
2. The hangars lots behind the Marvin facility were changed to 50'x50' allowing the taxilane to remain and switch the southwest most hangars to 60'x60'.

Key factors in the decision to proceed forward with Alternative 5 are listed below.

- The dual perimeter taxilane with nested tie-downs allowed larger transient airplanes to park closer to the terminal building and maximized the amount of available aircraft parking.
- Locating the fuel system to the south end of the apron and removing the existing buildings allowed for a large transient hangar to be located next to the terminal building near the center of activity.
- The hangar development areas provided flexibility for different hangar types and maximized development with existing facilities.

Further analysis was needed for the connector taxiways and the layout of taxilanes and tie-downs to evaluate impacts to the design standards and apron sizing needs. Four variations of Alternative 5 were created showing various apron layouts and taxiway connectors incorporating the appropriate TDG turning radius and fillet design. They are described briefly below with additional details provided in **Table 3-11**. Exhibits of these alternatives begin on the next page.

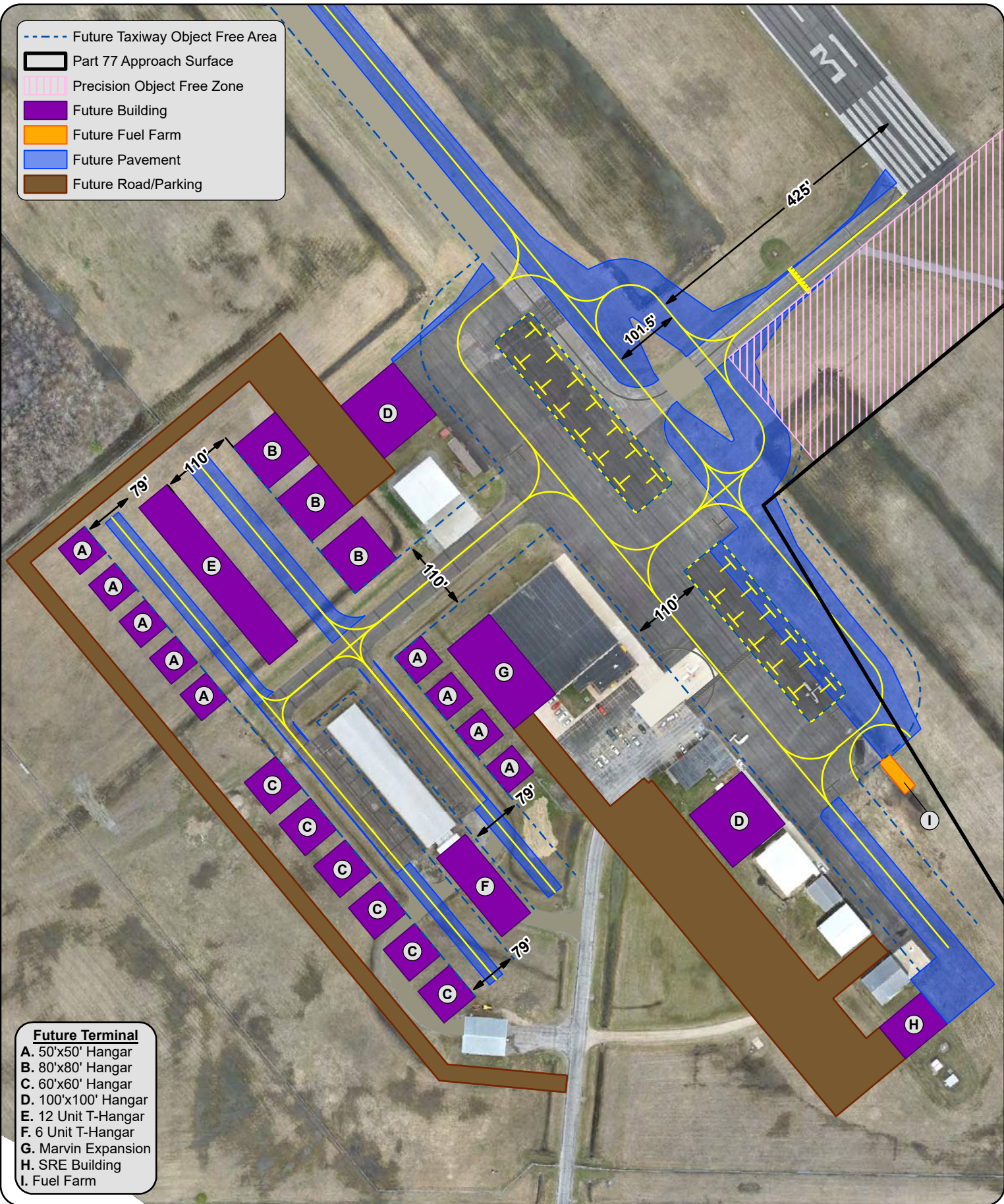
**Alternative 5A:** Dual access connector set at a 425-foot runway to taxiway separation with one extending beyond threshold. Turning aircraft would penetrate the POFZ. Maximum aircraft parking area of 4,600 SY. Aircraft that are refueling would be within the TOFA. The southeast corner of the apron would be within the RPZ, Part 77 Approach Surface, and MnDOT Clear Zone. See **Figure 3-6**.

**Alternative 5B:** Dual access connector set at a 425-foot runway to taxiway separation with one extending beyond threshold. Turning aircraft would penetrate the POFZ. Moderate aircraft parking area size at 4,400 SY. Dedicated refueling area outside the TOFA. Southeast corner of the apron would be within the RPZ, Part 77 Approach Surface, and MnDOT Clear Zone. See **Figure 3-7**.

**Alternative 5C:** Dual access connector with paved island set at a 400-foot runway to taxiway separation. Taxiways are clear of POFZ. Moderate aircraft parking area size at 4,030 SY. Dedicated refueling area outside of the TOFA. Southeast corner of apron would be within the RPZ, Part 77 Approach Surface, and MnDOT Clear Zone. See **Figure 3-8**.

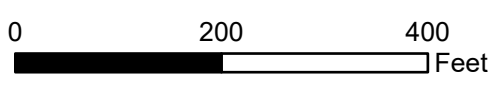
**Alternative 5D:** Single access connector with tie-in to existing taxiway. Outside perimeter apron taxilane slants inward toward the buildings with the Taxiway Safety Area along the RPZ boundary. The taxiways and apron are clear of the POFZ, RPZ, Part 77 Approach Surface, and MnDOT Clear Zones. Limited aircraft parking area size at 2,800 SY. Fuel system shifted northwest. Dedicated refueling area is outside the TOFA. See **Figure 3-9**.

- - - - Future Taxiway Object Free Area
- Part 77 Approach Surface
- Precision Object Free Zone
- Future Building
- Future Fuel Farm
- Future Pavement
- Future Road/Parking



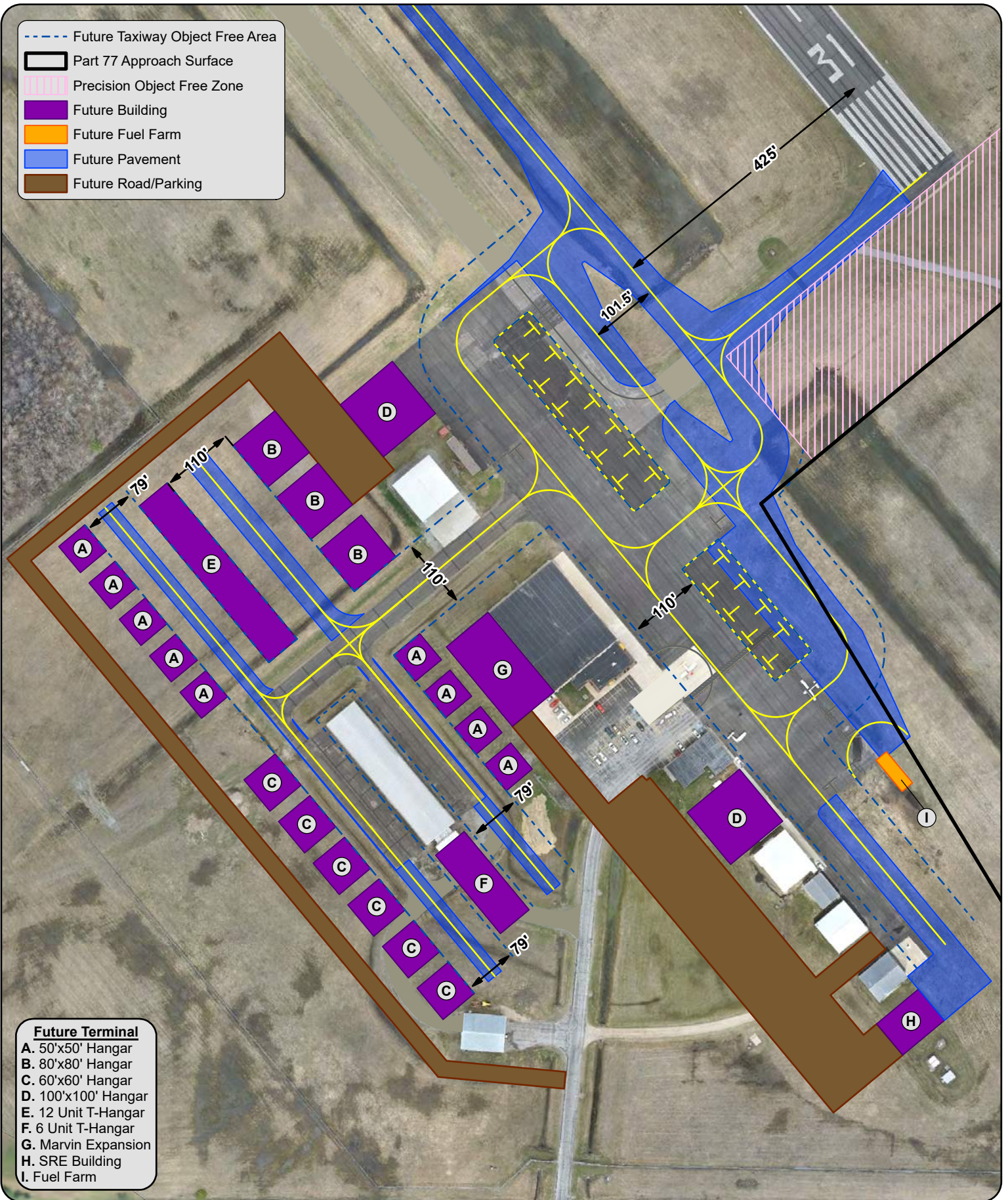
- Future Terminal**
- A. 50'x50' Hangar
  - B. 80'x80' Hangar
  - C. 60'x60' Hangar
  - D. 100'x100' Hangar
  - E. 12 Unit T-Hangar
  - F. 6 Unit T-Hangar
  - G. Marvin Expansion
  - H. SRE Building
  - I. Fuel Farm

\*Intended for Planning Purposes Only



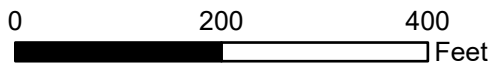
**Warroad International  
Memorial Airport  
Terminal Area  
Alternative 5A  
Figure 3-6**

- - - - Future Taxiway Object Free Area
- Part 77 Approach Surface
- Precision Object Free Zone
- Future Building
- Future Fuel Farm
- Future Pavement
- Future Road/Parking



- Future Terminal**
- A. 50'x50' Hangar
  - B. 80'x80' Hangar
  - C. 60'x60' Hangar
  - D. 100'x100' Hangar
  - E. 12 Unit T-Hangar
  - F. 6 Unit T-Hangar
  - G. Marvin Expansion
  - H. SRE Building
  - I. Fuel Farm

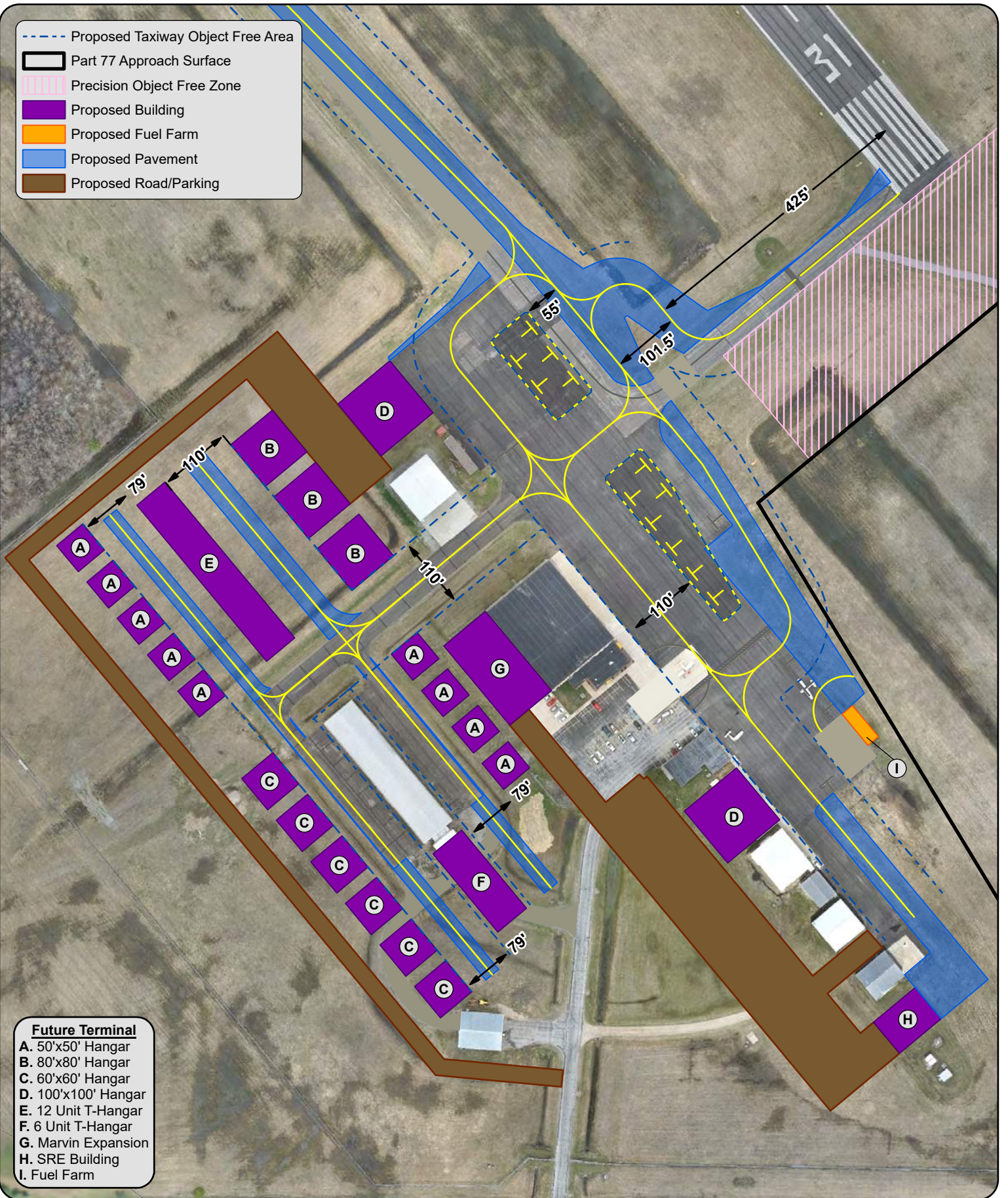
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**Warroad International  
Memorial Airport  
Terminal Area  
Alternative 5B  
Figure 3-7**

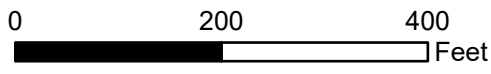


- - - - Proposed Taxiway Object Free Area
- Part 77 Approach Surface
- Precision Object Free Zone
- Proposed Building
- Proposed Fuel Farm
- Proposed Pavement
- Proposed Road/Parking



- Future Terminal**
- A. 50'x50' Hangar
  - B. 80'x80' Hangar
  - C. 60'x60' Hangar
  - D. 100'x100' Hangar
  - E. 12 Unit T-Hangar
  - F. 6 Unit T-Hangar
  - G. Marvin Expansion
  - H. SRE Building
  - I. Fuel Farm

\*Intended for Planning Purposes Only



**Warroad International  
Memorial Airport  
Terminal Area  
Alternative 5d  
Figure 3-9**

**Table 3-11 Terminal Area Alternatives Summary Table**

Metric	Alternatives			
	Alternative 5A	Alternative 5B	Alternative 5C	Alternative 5D
<b>Taxiway Connector</b>	Dual - Split	Dual - Split	Dual – Paved Island	Single
Penetrate Runway Protection Zone	Yes	Yes	Yes	No
Penetrate Precision Obstacle Free Zone	Yes	Yes	No	No
Refueling Area Inside TLOFA	Yes	No	No	No
Aircraft Tie-downs	24 Tie-downs	21 Tie-downs	20 Tie-downs	12 Tie-downs
Aircraft Parking Area	4,600 SY	4,400 SY	4,030 SY	2,800 SY

Source: KLJ Analysis

### **RUNWAY PROTECTION ZONE CONSIDERATIONS**

As identified in the table above, the Runway Protection Zone (RPZ) for Runway 31 contains a portion of apron taxilane in three of the four refined Alternative 5 options. The FAA provides AC 150/5190-4B Land Use Compatibility for guidance to consider land use compatibility within the runway protection zone. The primary impact of eliminating the apron taxilane within the RPZ is the significant decrease in tie-downs with 8 to 12 fewer tie-down positions (up to 50% less parking space) between Alternative 5D and the other alternatives. Larger aircraft such as those in the fleet of DNR and Marvin Windows can take up multiple parking spaces in an already constrained parking area. Additionally, Alternative 5D places the aircraft parking further from the terminal building requiring crew and passengers to travel greater distances across an active apron and taxilane.

While not drafted as an alternative, there were a few RPZ changes that could also be made. These RPZ changes would be:

**Reduce RPZ Size** – As mentioned before, the current approach RPZ is 2,500 feet long with an inner width of 1,000 feet and an outer width of 1,750 feet for a runway design code (RDC) B-II-2400. To reduce the RPZ size that would not impede the terminal area alternatives, the RDC would be reduced to B-II-5000. This would reduce the RPZ size to 1,000 feet long with an inner width of 500 feet and an outer width of 700 feet. This would change the visibility from ½ mile to 1-mile which would negatively impact the accessibility for the operators of the airport and was dismissed.

**Extend Runway** – To accommodate future development of the terminal area, without impacting the Runway 31 End RPZ, and keeping the RDC, the runway end would have to be extended by 425 feet. This would bring the total length of the runway to 5,825 feet. This introduces a longer section of public roads into the RPZ, and additional easements needed for control of the land within the RPZ. The runway extension would also require relocating the Glide Slope antenna and MALSR requiring an additional road crossing of the MALSR. Due to these elements, further consideration was dismissed.

It is important to note that with alternatives 5A, 5B, and 5C, no fueling will take place within the RPZ. In these alternatives the apron has also been cut back on the eastern edge so that there is no more apron than is necessary to taxi and maneuver aircraft. This will help the airport ensure that no aircraft are parked or linger within the RPZ.

## Preferred Development

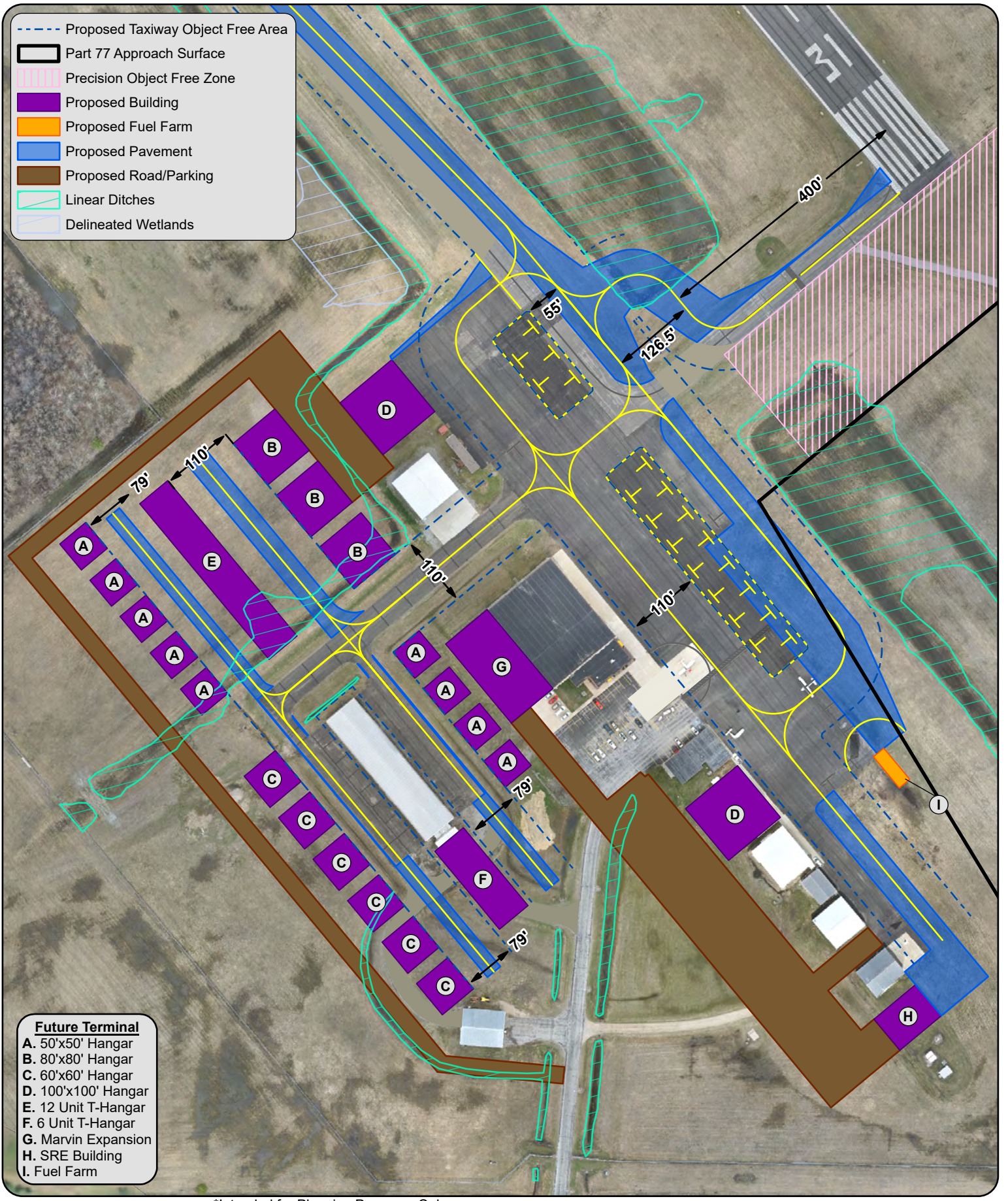
Following a review and discussion of the refined alternatives with the planning advisory committee, MnDOT and the FAA, a combination of elements from Alternatives 5D and 5C were selected as the preferred alternative with a few minor changes.

The taxiway connectors from the apron to the parallel taxiway and Runway 31 from Alternative 5D were selected as they minimized impacts to delineated wetlands, avoided the POFZ, and maximized the use of the existing parallel taxiway. The apron layout in Alternative 5C was selected as it best balanced providing sufficient aircraft parking near the terminal building while minimizing impacts to the Part 77 Approach Surface and Runway Protection Zone. To increase cockpit visibility of the apron taxilane, the runway centerline to taxiway centerline separation was decreased to 400 feet allowing aircraft to approach the apron at a near perpendicular angle after making their 90 degree turns from the runway. The Preferred Alternative can be seen in **Figure 3-10**.

Airspace studies were submitted to evaluate penetrations to the Part 77 Approach Surface while aircraft were maneuvering on the apron taxilanes. A 21-foot tail height was used for the evaluation which represents the tail height of a Cessna Citation Sovereign, determined to be the most demanding tail height which routinely serves Warroad. Three points were evaluated along the taxilane centerline and three points were evaluated along the edge of the taxilane pavement. The determination of the airspace studies found there was no objection to the proposed alternative provided that the RPZ alternatives and considerations documented above were provided. **Figure 3-11** below shows the points that were evaluated. The Aeronautical Study Numbers for the cases are 2024-AGL-11171-NRA through 2024-AGL-11173-NRA and 2024-AGL-11338-NRA through 2024-AGL-11340.

The apron pavement along the northeast corner of the preferred alternative was angled from the edge of the taxilane pavement to the edge of the 50' ring from the future fuel system. This was done to minimize unnecessary pavement development in the RPZ. The remaining pavement in the RPZ is needed for aircraft to safely maneuver while entering or leaving the fueling area enroute to intercept the taxilane centerline. This is demonstrated by modeling the movements of a Cessna Citation Sovereign, which is based at the airfield, and frequently utilizes the fuel system. **Figure 3-12** below depicts the safety margins for both the main gear and nose gear of the aircraft as it maneuvers around the future fueling system. The future fuel system is positioned to allow ADG-II aircraft to utilize the system while remaining clear of the Taxilane Object Free Area (TLOFA). Adjusting the position of the fuel system to the southwest, further away from the RPZ, is not recommended as ADG-II aircraft using the system may penetrate the TLOFA. This additional pavement in the RPZ also provides the airport an opening to push and stockpile snow efficiently during the winter season, and the design aides in reducing the heights of snowbanks and windrows near pavement edges.

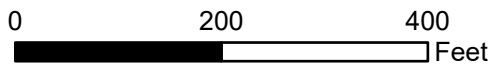
The preferred development strategy identified in **Table 3-12** outlines the overall development sequence for the preferred alternatives based on airport sponsor priorities. The implementation plan in **Chapter 4** will identify a realistic project sequencing based on available funding.



- - - Proposed Taxiway Object Free Area
- Part 77 Approach Surface
- Precision Object Free Zone
- Proposed Building
- Proposed Fuel Farm
- Proposed Pavement
- Proposed Road/Parking
- Linear Ditches
- Delineated Wetlands

- Future Terminal**
- A. 50'x50' Hangar
  - B. 80'x80' Hangar
  - C. 60'x60' Hangar
  - D. 100'x100' Hangar
  - E. 12 Unit T-Hangar
  - F. 6 Unit T-Hangar
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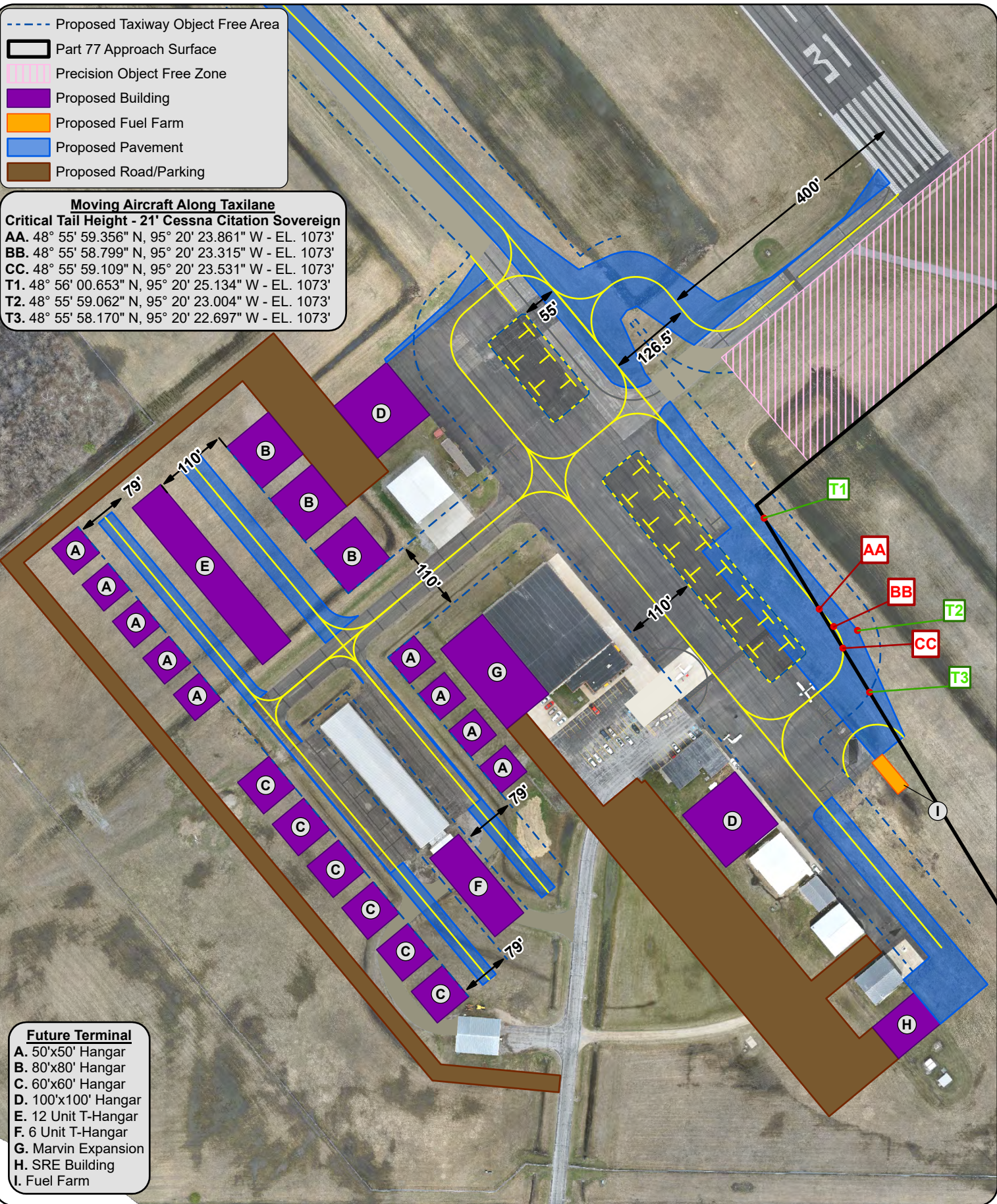
\*Intended for Planning Purposes Only



**Warroad International  
Memorial Airport  
Terminal Area  
Preferred Alternative  
Figure 3-10**

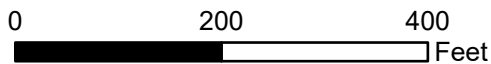
- - - - Proposed Taxiway Object Free Area
- Part 77 Approach Surface
- Precision Object Free Zone
- Proposed Building
- Proposed Fuel Farm
- Proposed Pavement
- Proposed Road/Parking

**Moving Aircraft Along Taxilane**  
**Critical Tail Height - 21' Cessna Citation Sovereign**  
**AA.** 48° 55' 59.356" N, 95° 20' 23.861" W - EL. 1073'  
**BB.** 48° 55' 58.799" N, 95° 20' 23.315" W - EL. 1073'  
**CC.** 48° 55' 59.109" N, 95° 20' 23.531" W - EL. 1073'  
**T1.** 48° 56' 00.653" N, 95° 20' 25.134" W - EL. 1073'  
**T2.** 48° 55' 59.062" N, 95° 20' 23.004" W - EL. 1073'  
**T3.** 48° 55' 58.170" N, 95° 20' 22.697" W - EL. 1073'



- Future Terminal**
- A. 50'x50' Hangar
  - B. 80'x80' Hangar
  - C. 60'x60' Hangar
  - D. 100'x100' Hangar
  - E. 12 Unit T-Hangar
  - F. 6 Unit T-Hangar
  - G. Marvin Expansion
  - H. SRE Building
  - I. Fuel Farm

\*Intended for Planning Purposes Only



**Warroad International  
 Memorial Airport  
 Apron Taxilane  
 Airspace Analysis  
 Figure 3-11**

Figure 3-12 Citation Sovereign Apron Maneuvering Model



Source: KLJ Analysis

**Table 3-12 Preferred Development Strategy**

	Near-Term 0-5 Years PAL 1	Mid-Term 6-10 Years PAL 2	Long-Term 11-20 Years PAL 3 & 4
Hangars			<ul style="list-style-type: none"> <li>Remove existing airport-owned buildings and construct transient storage hangar next to Terminal Building</li> <li>Construct 6-Unit T-Hangar</li> </ul>
Apron & Taxilanes	<ul style="list-style-type: none"> <li>Expand apron to accommodate ADG-II/TDG-2A aircraft</li> <li>Add additional pavement on southeast taxilane to meet ADG-I separation standards</li> </ul>		<ul style="list-style-type: none"> <li>Extend taxilanes along T-Hangar to allow for additional hangar development</li> <li>Construct Taxilanes for Hangar development to northwest</li> </ul>
Support Facilities		<ul style="list-style-type: none"> <li>Remove existing fuel system and construct fuel facility in new location</li> <li>Construct SRE Storage Building</li> </ul>	
Landside		<ul style="list-style-type: none"> <li>Expand public parking lot</li> </ul>	<ul style="list-style-type: none"> <li>Expand parking exclusive to Marvin Windows</li> </ul>

Source: KLJ Analysis