CHAPTER 2: RUNWAYS & TAXIWAYS

Introduction

This Chapter of the Targeted Planning Study is focused on the Runway and Taxiway system at the airport which is commonly referred to as the airfield where aircraft takeoff, land, and maneuver on the ground. Please note that **Chapter 3: Terminal Area and Support Facilities** will look at the apron, hangars and other facilities supporting the airport. These two chapters will address existing and future facility needs at Warroad International Memorial Airport (RRT).

As the chapter analyzes various components of the runway and taxiways at RRT, it will review current conditions and any deficiencies that do not meet FAA design standards. It will consider the existing and future critical design aircraft and provide facility requirements to accommodate these aircraft through the planning period. The chapter will further present the alternatives that were considered to meet future needs and the preferred airfield alternative that was chosen. Included in this chapter will be the following elements:

- Meteorological Information
- Runways
- Taxiways
- Alternatives
- Preferred Alternative

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 and taxiway 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.

The heaviest aircraft to regularly use the airport is a dual wheel weighing 17,100 pounds, although there are over 100 annual operations of a 30,000-pound jet aircraft. 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 2-1 – 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

Meteorological

For safety and to maximize performance capabilities, aircraft need to takeoff and land into the wind. In addition, aircraft must often operate in poor weather conditions to deliver passengers and cargo. For these reasons, weather needs to be addressed early in the discussions.

Weather Reporting

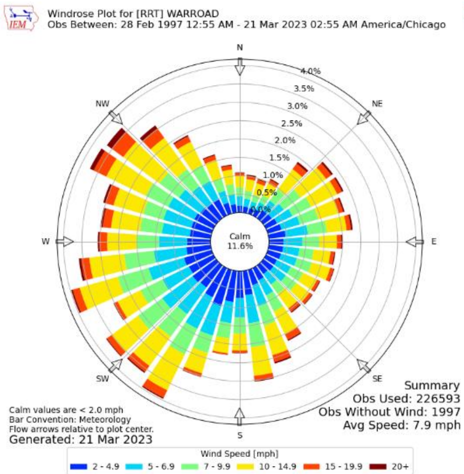
Metrological facilities provide users with up-to-date weather information at the airport to aid in pilot decision making for safe flight operations.

Automated Weather Reporting System.
There are two types of weather reporting systems on an airport. The Automated Surface Observing System (ASOS) program was a joint effort between the Federal Aviation Administration and the National Weather Service (NWS) to deploy a network of high-grade weather monitoring stations across the United States. ASOS serves as a primary climatological observing network in the United States and have equipment that provides weather observations every minute. A second-tier Automated Weather Observation System (AWOS) has varying sets of equipment packages to provide local weather observations.

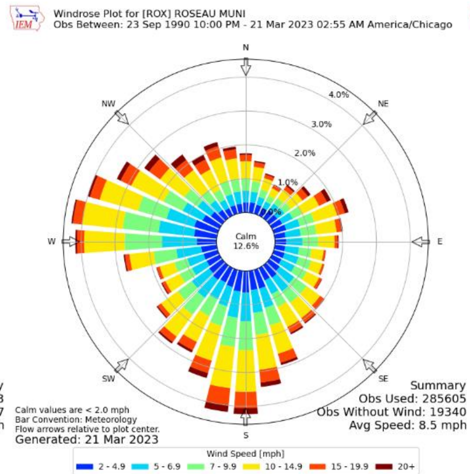
Warroad has an AWOS-III weather observation system located on the airfield. The AWOS-III records and reports metrics such as ceiling and visibility information but is not equipped with precipitation or thunderstorm detection sensors. The unit is nearing the end of its useful life and MnDOT would like to replace the unit soon as parts are no longer available. Additionally, the current location of the AWOS is within the hangar area with many large structures nearby. The nearest of these is a hangar within 100 feet of the wind sensor. These structures could be affecting the wind sensor readings by disrupting airflow. Airport users have expressed suspicions that the weather station is not accurately reporting wind from the north and east.

Yearly wind observations from Warroad were compared with compared with observations from both Roseau and Baudette which are approximately 17 miles west and 36 miles southeast respectively. While both airports are nearby, it can be assumed that the large body of water (Lake of the Woods) likely affects the weather and wind systems at each airport differently. Even so, it was observed that both Roseau and Baudette do have more wind observations reported from the north than Warroad.

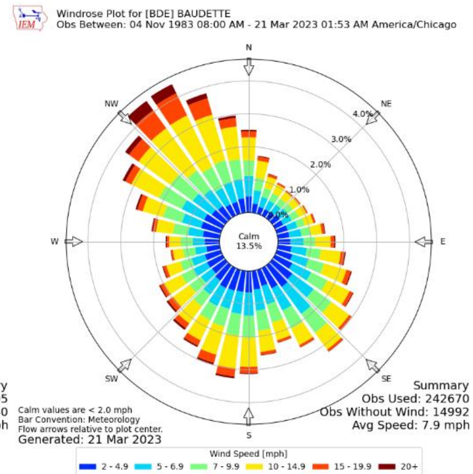
WARROAD



ROSEAU



BAUDETTE

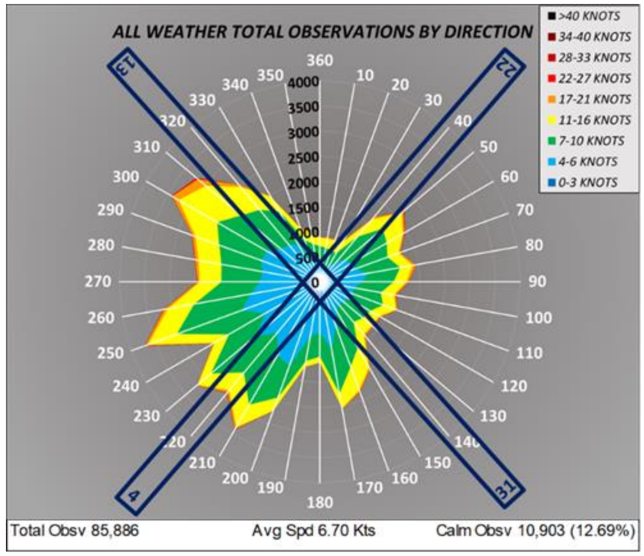


Source: Iowa Mesonet

The placement of an AWOS needs to be in compliance with [Order 6560.20C - Siting Criteria for Automated Weather Observing Systems (AWOS)] which provides siting requirements for the equipment and sensors. The two criteria that most often drive siting are the wind sensor protection and location to primary runway. To protect the wind sensor, vegetation and structures should be lower than 15 feet below sensor height within a 500-foot radius and lower than 10 feet below sensor height within 1,000-foot radius. To report conditions near the touchdown point of the runway, the sensor can either be co-located with the glideslope antenna or reside within a box that is between 750 and 1,000 feet from runway centerline and within 1,000 to 3,000 feet down the runway from Runway 31 threshold.

It is recommended that a new site be identified for the AWOS-III replacement that meets current siting standards and provides adequate protection for the wind sensor.

Meteorological Data



Source: KRRT AWOS (2009-2018, Hourly) National Climatic Data Center. 85.886 Observations

Local weather conditions are a significant factor in the design and development of airport facilities since they affect aircraft performance. Temperature affects runway length, wind direction and speed affect runway orientation, and visibility and cloud ceiling conditions determine the need for runway navigational aids and lighting.

Hourly metrological data was reviewed from the RRT Automated Weather Observation System (AWOS) facility available from the National Climatic Data Center (NCDC). Periodic "special" weather observations within each hour were removed. This method provides considers the true average weather trends at an airport without skewing conditions toward IFR where multiple observations may be taken each hour due to changing conditions. The data takes a snapshot of 10 complete historical years to provide an adequate average. 2009-2018 was chosen as there were many months of data missing during 2019 and 2020.

In addition to wind, temperature affects runway length required. From weather reports over the last 30 years (1991-2020) the average maximum temperature at RRT in the hottest month (July) has been 76.9 degrees Fahrenheit.

Wind Coverage

Small Aircraft Crosswind Landing Diagram (faasafety.gov)

Wind coverage is important to airfield configuration and utilization. Aircraft ideally takeoff and land into a headwind aligned with the runway orientation. Aircraft are designed to land during limited crosswind conditions and pilots are trained to land in those conditions. Small, light aircraft are most affected by crosswinds. To mitigate the effect of crosswinds, FAA recommends runways be aligned so that excessive crosswind conditions are encountered at most 5 percent of the time. This is known as a "95 percent wind coverage" standard. Each aircraft's AAC-ADG combination corresponds to a maximum crosswind wind speed component.

Crosswind or tailwind conditions can be hazardous to aircraft operations if they exceed the operational capabilities of the airplane or flight crew. The smallest aircraft are typically the most affected operationally by crosswinds. Even when the 95 percent wind coverage standard is achieved for the design airplane or airplane design group, cases arise where certain airplanes with lower crosswind capabilities are unable to utilize the primary runway. The maximum crosswind component for different aircraft sizes and speeds are shown in **Table 2-2**.

Table 2-2 – FAA Wind Coverage Standards

AAC-ADG	Maximum Crosswind Component
A-I & B-I	10.5 knots
A-II & B-II	13.0 knots
A-III, B-III & C/D I-III	16.0 knots

Source: FAA AC 150/5300-13B

For all-weather conditions, the B-II design aircraft crosswind component of 13 knots is accommodated on Runway 13-31 during all-weather conditions with airfield wind coverage exceeding 95 percent. For A-I and B-I small aircraft, however, Runway 13-31 was below the 95 percent threshold. Crosswind Runway 4-22 supports these small aircraft by providing a combined wind coverage of 99.29 percent. The current runway configuration meets FAA standards for overall all-weather wind conditions. **Table 2-3** provides the calculated all-weather wind coverage for the airport.

Table 2-3 – All-Weather Wind Coverage

Runway	ARC	Crosswind Component (Wind Speed)		
		10.5 knots	13.0 knots	16.0 knots
Runway 13-31	B-II	93.50%	97.56%	99.37%
Runway 4-22	A/B-I	92.19%	96.85%	99.06%
Combined	-	**99.29%**	**99.84%**	**99.98%**

Source: KRRT AWOS (2009-2018, Hourly) National Climatic Data Center, 85,886 Observations

Wind coverage and weather conditions are evaluated based on the two different flight rules, VFR and IFR. Visual Meteorological Conditions (VMC) are encountered when the visibility is 3 nautical miles or greater, and the cloud ceiling height is 1,000 feet or greater. Conditions less than these weather minimums are considered Instrument Meteorological Conditions (IMC) requiring all flights to be operated under IFR.

Wind coverage during IMC is evaluated to determine the ideal alignment for instrument approach to an airport's runway. As shown in **Table 2-4**, the IMC wind coverage for Runway 13-31 provides 90.87 percent coverage for 10.5 knots and 95.95 percent coverage for 13 knots. The 95 percent wind coverage requirement is met for the design aircraft (B-II) with a maximum crosswind component of 13 knots, however, was below the threshold for the 10.5 knot crosswind component for smaller aircraft. Because instrument approaches are provided for each individual runway end, **Table 2-4** also shows the wind coverage for each runway end.

Table 2-4 – IMC Wind Coverage

Runway	ARC	Crosswind Component (Wind Speed)		
		10.5 knots	13.0 knots	16.0 knots
Runway 13-31	B-II	90.87%	95.95%	98.70%
Runway 13 Only	B-II	49.67%	52.01%	53.09%
Runway 31 Only	B-II	56.20%	58.94%	60.61%

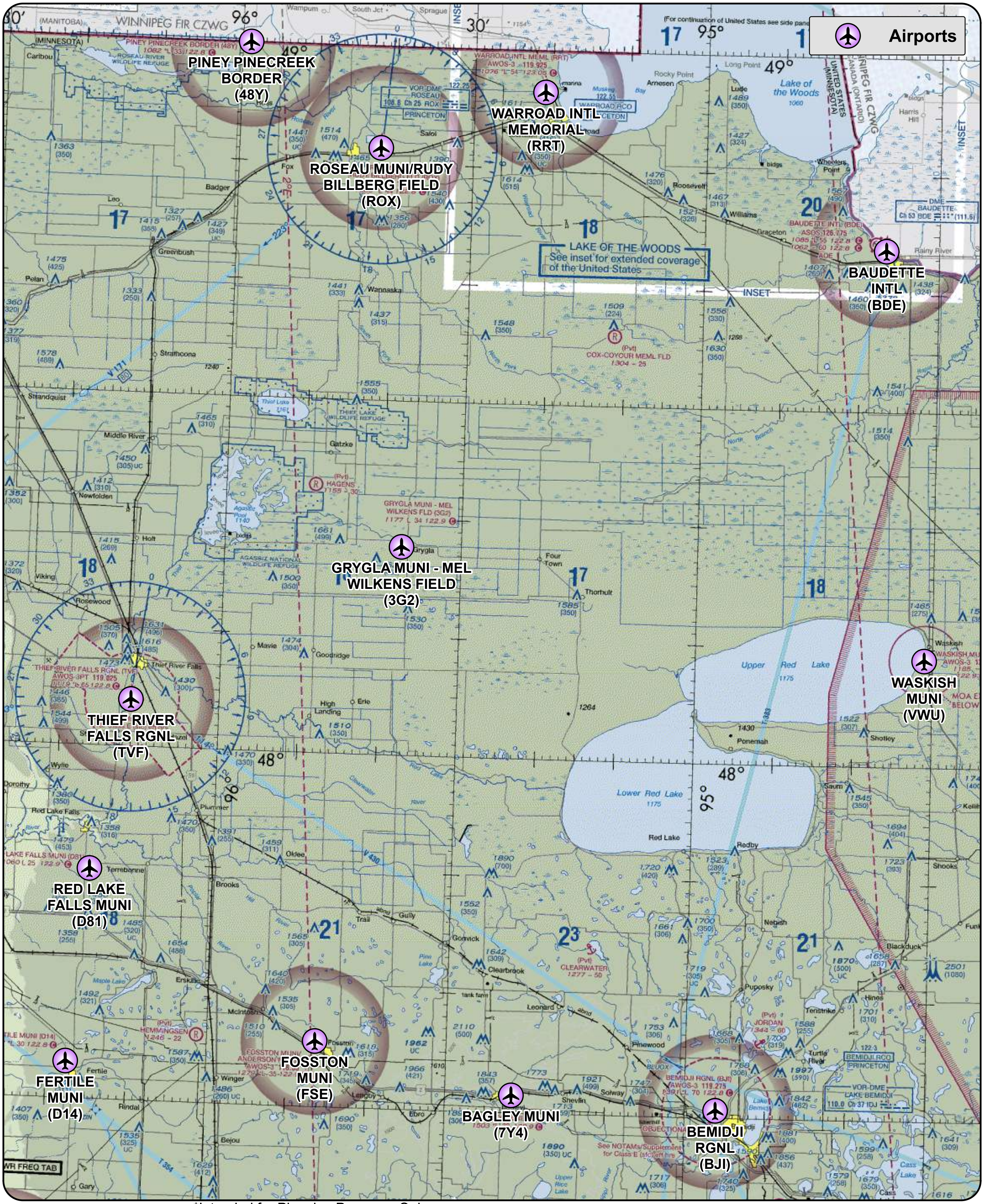
Source: KRRT AWOS (2009-2018, Hourly) National Climatic Data Center, 7,358 Observations

Based on true hourly weather data summarized in **Table 2-5**, the airport experiences IMC weather conditions 8.57 percent of the time. When considering the current instrument approach weather minimums of 200-foot cloud ceiling and ½-mile flight visibility for Runway 31 and 200-foot cloud ceiling and ¾-mile flight visibility for Runway 13, the airport has weather conditions below this criterion 4.3 days per year where the airport is not usable.

Table 2-5 – Meteorological Analysis

Weather Condition	Percentage	Days per Year	Hours per Year
VMC	91.43%	333.7	8,010
Usable IMC	7.40%	27.0	648
Usability	**98.83%**	**360.7**	**8,658**
Below Weather Minimums*	1.17%	4.3	102
Total	***100.0%***	*365.0*	***8,760***

Source: KRRT AWOS (2009-2018, Hourly) National Climatic Data Center, 85,886 Observations
**Current IFR minimums are 200-foot cloud ceiling and ½ mile flight visibility for Runway 31 approach & 200-foot cloud ceiling and ¾-mile flight visibility for Runway 13 approach.*



*Intended for Planning Purposes Only

N

0 10 20 40 Miles

Figure 2-2
Warroad International Memorial Airport Airspace & Surrounding Airports

Runways

Though the runways where not a primary focus of this study, elements of the runway impact other facilities on the airport and thus require an abbreviated overview. There are currently two runways at Warroad. Runway 13-31 is the Airport's primary runway and Runway 4-22 is the crosswind turf runway. Details on these runways are listed below in **Table 2-6.**

Runway 13/31: Runway 13-31 is the primary runway at RRT for takeoffs and landings. The runway is bituminous pavement with a Porous Friction Course surface and is 5,400 feet long and 100 feet wide. The runway is designed to meet FAA Runway Design Code (RDC) B-II standards with approach visibility minimums as low as ½ mile. The parallel taxiway separation is 575 feet, therefore the Approach and Departure Reference Codes are D/VI/2400 and D/VI respectively. The runway serves aircraft weighing 40,000 (Dual Wheel) pounds. The runway was reconstructed in 1995 and underwent major rehabilitation in 2008 and is in good condition. This runway is equipped with High Intensity Runway Lighting (HIRL) and has precision instrument pavement markings. Runway 31 is served by an instrument Landing System with 200-foot cloud ceiling and ½ mile visibility minimums. Runway 13 is served with an RNAV (GPS) approach with 200-foot cloud ceiling and ¾ mile visibility.

A Runway Safety Area (RSA) Determination for Runway 13-31 was completed as part of this planning study. The purpose of this analysis is to determine that the RSA meets design standards by evaluating the grades of the RSA and identifying objects and/or roads within the RSA. The survey of the RSA was collected at the beginning of the study referencing the D-II design standards (500 feet wide and 1,000 feet beyond threshold) from the previous ALP. Three NAVAID access roads that connects to (or near) the runway was identified as non-standard within the RSA. These include one at the Runway 13 threshold serving the localizer and 13 MALSR, another serving the glideslope antenna near Runway 31 aiming point, and the third serving the 31 MALSR near Runway 31 threshold. With the RDC for runway 13-31 being B-II standards the RSA is now reduced to 300 feet wide and 600 feet beyond threshold. This removes a sizable portion of the access roads within the RSA. Future access road layouts will be evaluated and depicted on the ALP

Runway 4/22: Runway 4-22 is the turf crosswind runway. It is a turf surface 3,000 feet long and 150 feet wide. The runway is designed to meet FAA runway Design Code (RDC) A-I Small standards with visual approaches. The runway serves "small" aircraft with a maximum takeoff weight of 12,500 pounds. The runway edges are marked with yellow cones. The surface is in good condition.

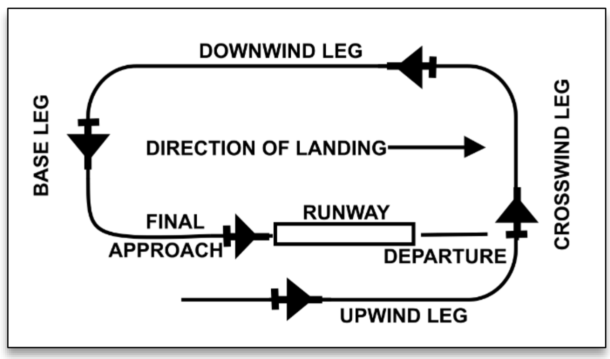
The airport is able to meet the design standards as they currently exist and as they are expected through the planning period. Information on Runway Design Codes and Design Standards can be found in **Appendix B: General Aviation Airports 101**.

Table 2-6 – Runway Facility Summary

Component	Runway 13/31	Runway 4/22
Runway Length (feet)	5,400’	2,987’
Runway Width (feet)	100’	150’
Runway Surface Material	Bituminous	Turf
Pavement Strength	30,000 lbs. (SW) 40,000 lbs. (DW)	12,500 lbs.
Runway Design Code	B-II-2400	A-I(Small)-VIS
Approach Reference Code	D/VI/2400	-
Departure Reference Code	D/VI	-
Runway Safety Area	6,600’ x 300’	3,467’ x 120’
Runway Object Free Area	6,600’’ x 800’	3,467’ x 250’
Runway Obstacle Free Zone	5,600’ x 400’	3,387’ x 250’
Runway Protection Zone	2,500’ x 1,750’ x 1,000’	1,000’ x 450’ x 250’

Source: KLJ Analysis

APPROACH/DEPARTURE PROCEDURES



Standard VFR Airport Traffic Pattern (Source: FAA)

Aircraft operate under either Visual Flight Rules (VFR) or Instrument Flight Rules (IFR) depending on weather conditions and/or operational standards.

Visual Approach/Departure Procedures

Under VFR, pilots are advised to utilize a standard rectangular traffic pattern around the runway to approach or depart an airport. Standard traffic pattern legs include upwind, crosswind, downwind, base, and final. Departures are typically straight-out from a departing runway, a 90-degree crosswind, or 180 degree downwind. Arrivals typically enter a traffic pattern 45 degrees to a downwind leg for landing. RRT has standard VFR traffic patterns for all runway ends.

Instrument Approach Procedures

Pilots operating under IFR intending to land at an airport must navigate aircraft on published Instrument Approach Procedures (IAP). Instrument approach procedures to a runway end are used by landing aircraft to navigate to the airport during instrument conditions when the cloud ceiling is less than 1,000 feet and/or visibility is less than 3 miles. Establishing approaches with the lowest possible weather minimums allow the airport to maximize its operational utility. Each approach type requires differing infrastructure and navigational aids. Types of approach procedures include non-precision approach (NPA), approach with vertical guidance (APV) and precision instrument approach (PA). See **Appendix B: General Aviation Airports – 101** for details on the requirements of different levels of instrument approach procedures.

Table 2-7 is a list of the major approach categories and associated capabilities.

Table 2-7 – Instrument Approach Procedure Visibility Minimums

Typical Categories of Approaches					
Approach	Category	Vertical Guidance	Lowest Ceiling	Lowest Visibility	Ground Based Aids
Visual			1,000’	3 miles	
RNAV LNAV	NPA	No	250’	¾ mile	MIRL, VGSI*
RNAV LNAV/VNAV	APV	Yes	250’	¾ mile	MIRL, VGSI*
RNAV LPV**	APV	Yes	250’	¾ mile	MIRL, VGSI*
VOR	NPA	No	250’	¾ mile	VOR, MIRL, VGSI*
ILS CAT I	PA	Yes	200’	½ mile	GS, LOC, MIRL, MALSR
ILS CAT II	PA	Yes	100’	¼ mile	GS, LOC, HIRL, ALSF-1 or ALSF-2, TDZ/CL

*Source: KLJ Analysis; * Recommended; ** Often the best RNAV minimums but requires aircraft equipped with WAAS receiver*

Instrument Approach Procedures are available for Runways 13 and 31 at Warroad based on both ground-based and satellite-based NAVAIDS. Instrument approach weather minimums are a result of the approach type, airport infrastructure, and any prevailing airspace obstructions. Coordination with FAA Flight Procedures Office is recommended to review the feasibility of implementing any new approach procedure. See **Table 2-8 – Instrument Approach Procedures** for details on the IAPs available at the Airport.

Table 2-8 – Instrument Approach Procedures

Approach Procedure	Approach Type	Lowest Cloud Ceiling Minimum (HAT)	Lowest Visibility Minimum (n.m.)
ILS or LOC RWY 31	Precision Approach (Category I ILS)	S-ILS: 200 feet S-LOC: 484 feet	S-ILS: ½ mile S-LOC: ¾ mile
RNAV (GPS) RWY 31	Non-Precision Approach with Vertical Guidance	LPV: 250 feet LNAV/VNAV: 375 feet LNAV MDA: 404 feet	LPV: ½ mile LNAV/VNAV: ¾ mile LNAV MDA: ½ mile
RNAV (GPS) RWY 13	Non-Precision Approach with Vertical Guidance	LPV: 200 feet LNAV/VNAV: 289 feet LNAV MDA: 364 feet	LPV: ¾ mile LNAV/VNAV: 1 mile LNAV MDA: 1 mile

Source: FAA Airport Data and Information Portal
Note: Based on B approach category (Design Aircraft), HAT = Height Above Touchdown, n.m. = nautical miles (reported), ILS = Instrument Landing System, LPV = Localizer Performance with Vertical Guidance, LNAV = Lateral Navigation, VNAV = Vertical Navigation,

The approaches available at the airport have provided great accessibility into Warroad. Approximately 1. 17 percent of the time (or 4.3 days) is the airport unavailable due to weather being poorer than the current approaches allow. Future improvements to the approaches would require significant investment with minimal gains to accessibility. The current instrument approach procedures provide sufficient accessibility to Warroad for the planning period.

RUNWAY APPROACH/DEPARTURE SURFACES

FAA identifies sloping approach surfaces that must be cleared at an absolute minimum for safety for landing aircraft. These surfaces are identified in paragraph 3.6 of FAA AC 150/5300-13B.

The departure surface applies to runways with instrument departures available. It begins at the end of the takeoff distance available and extends upward and outward at a 40:1 slope. No new penetrations are allowed unless an FAA study has been completed and a determination of no hazard has been issued.

It is important to note the significant impact obstructions can have on the functionality of an airport. This importance has been recently emphasized for the lines of business within FAA and with Airports with the issuance of a Policy Guidance letter dated 9/19/2022 regarding Approach and Departure Surface Protection. In summary, it is imperative that airports be proactive when it comes to obstructions so that the usefulness of the airport is not unnecessarily impeded.

The applicable approach/departure surface standards are identified in **Table 2-9**.

Table 2-9 – Approach/Departure Surface Requirements

Runway End(s)	Par. 3.6 Surface	Description	Slope
4, 22	2	Approach end of runways expected to serve small airplanes with approach speeds of 50 knots or more (visual, day/night)	20:1
13	5	Approach end of runways providing ILS or localizer type directional aid with glidepath (LPV, LNAV/VNAV) ≥ ¾ mile visibility	20:1
31	5	Approach end of runways providing ILS or localizer type directional aid with glidepath (LPV, LNAV/VNAV) < ¾ mile visibility	34:1
13, 31	6	TERPS Vertical Guidance Surface (VGS)	30:1
13, 31	7	Departure runway ends for all instrument operations	40:1

Source: FAA AC 150/5300-13B, KLJ Analysis
Note: Most critical row(s) shown.

VISUAL NAVIGATION AIDS

Visual aids are installed to provide airport usability during periods of darkness and/or low visibility. Pavement markings and lighting systems available at the airport are summarized in the following sections.

Identification Lighting

The airport beacon serves as the airport identification light so approaching pilots can identify the airport location from sunset to sunrise. RRT has a clear and green rotation beacon which is a two-sided light that indicates a lighted land airport. The airport beacon is located in the southern portion of the hangar development area and operates sunset to sunrise.

Runway Lighting

Runway edge lights are placed off the edge of the runway surface to help pilots define the edges and end of the runway during night and low visibility conditions. Runway edge lights are white (bi-directional), except for the final 2,000 feet of the runway where the lights change color to yellow to warn pilots approaching the end of the runway for instrument runways. The runway end threshold lights (bi-directional) are green when viewing down the runway at the start of takeoff roll and red when approaching the end of the runway.

The airport has High Intensity Runway Lighting (HIRL) which are activated using pilot-controlled lighting on the Common Traffic Advisory Frequency (CTAF). The HIRL lighting is on Runway 13-31. Runway 4-22 has cones but no lighting.

Pilot-Controlled Lighting

Airfield lighting systems allow for pilots to control the complexity and intensity of lights thorough the use of CTAF. RRT has the approach lighting (MALSR) for Runway 13 and 31 as well as the edge lighting for Runway 13-31 controlled on the pilot-controlled lighting system during night hours.

Visual Approach Slope Lighting

Visual approach slope lighting provides vertical descent guidance to pilots for a specific runway end. These approach aids enable the pilot to acquire and maintain the correct glide path for landing. Precision Approach Path Indicator Lights (PAPI) are the current FAA standard equipment installed for this purpose.

The PAPI has red and white lights that are used by the pilot to indicate whether they are too high, too low, or on the appropriate glidepath. Precision approach path indicators project light along a standard glide path to a runway end, with red and white colored lights indicating the aircraft's vertical position (above, below, or on glide path) relative to the defined glide path. Warroad has four box PAPIs on both ends of Runway 13-31. The PAPIs are set to a standard 3.00-degree glide path angle and remain on continuously.

Approach Lighting System

An approach lighting system provides extended runway centerline alignment information near the runway's end for pilots to transition from instrument flight to visual flight for landing in low visibility conditions.

Typical Approach Lighting System (FAA)

Both Runway 13 and 31 ends at Warroad have a MALSR (Medium-intensity Approach Lighting System with Runway Alignment Indicator Lights). This full ALS consists of seven rows of lights, five flashing lights and a row of steady burning green lights prior to runway threshold. The system is 2,400 feet in total length. This is required for a Category I precision instrument approach.

Airfield Guidance Signs

Guidance signs provide location, direction, and guidance information to pilots on the ground to enhance awareness. Signs are placed around the airfield to identify runway and taxiway intersections, runway hold positions, and other guidance. Mandatory signs are red and identify an intersection with a runway or critical safety zone. Other types of signs include location, direction, destination, and distance remaining signs. RRT has all the required lighted mandatory signs for the runways.

Pavement Markings

Pavement markings help airport users visually identify important features on the airfield. FAA has defined numerous different pavement markings to promote safety and situational awareness as defined by FAA AC 150/5340-1, *Standards for Airport Markings*. Runway markings vary in complexity depending on the type of approach served. Runway 13-31 at RRT is marked with precision markings which include landing designator, centerline, threshold, aiming point, touchdown zone, edge markings.

NAVIGATIONAL AIDS

Electronic navigational aids are installed to provide critical guidance information when operating in the airport environment. These navigational aids often provide horizontal and/or vertical guidance in conjunction with published navigation procedures. The Instrument Landing System (ILS) on Runway 31 is the only electronic navigational aids that is in place at RRT.

Instrument Landing System (ILS)

An Instrument Landing System is installed for a runway end to allow pilots to capture a horizontal and vertical radio beam to the runway threshold to assist in landing. Components of an ILS include the glideslope antenna, localizer antenna, approach lighting system and marker beacons. The glideslope antenna is located alongside the runway providing vertical guidance, the localizer antenna is installed beyond the opposite runway end providing horizontal guidance, the approach lighting system provides visual guidance to the runway end, and the marker beacons provide aural cues for pilots flying the approach. The localizer and glide slope require critical areas that are sufficiently graded and do not contain certain objects.

Runway 31 has an ILS installed containing all the required components. The system is at the end of its useful life and MnDOT is currently in the process of replacement the localizer and glide slope components to new equipment.

PAVEMENT CONDITION

Airport pavements are basic infrastructure components at airports. Airfield pavements need to be maintained in a safe and operable condition for aircraft operations. Pavement condition is comprehensively evaluated by the State every three years and measured on a 0 to 100 scale known as the Pavement Condition Index rating. Pavement evaluation includes runway, taxiway, and apron pavements. A summary of the latest PCI rating (2021 most recent study year) for the runway and taxiway pavements are tabulated in **Table 2-10** and depicted in **Figure 2-2.**

The runway pavement has a 2021 Pavement Condition Index (PCI) value of 80 which is rated Very Good. The taxiway PCI values range from 65-67 which is rated as Good. Major rehabilitation is recommended when PCI reaches 60 which is expected around 2026 for the taxiway. When the taxiway pavement undergoes reconstruction, the system will need to be brought to current design standards.

Table 2-10 – Pavement Condition Summary (2021)

Component	Surface Type(s)	LCD	PCI Range
Runway 13-31	AC	2008	80
Parallel Taxiway A	AC	1991	65-67
Connecting Taxiways	AC	1991	66-67
Taxilanes	AC	2003	70

Source: MDT (2021) & KLJ Analysis
PCI = Pavement Condition Index rating (0-100), LCD = Last Major Construction Date, AC = Asphalt Concrete,

Figure 2-2 – Pavement Condition Map

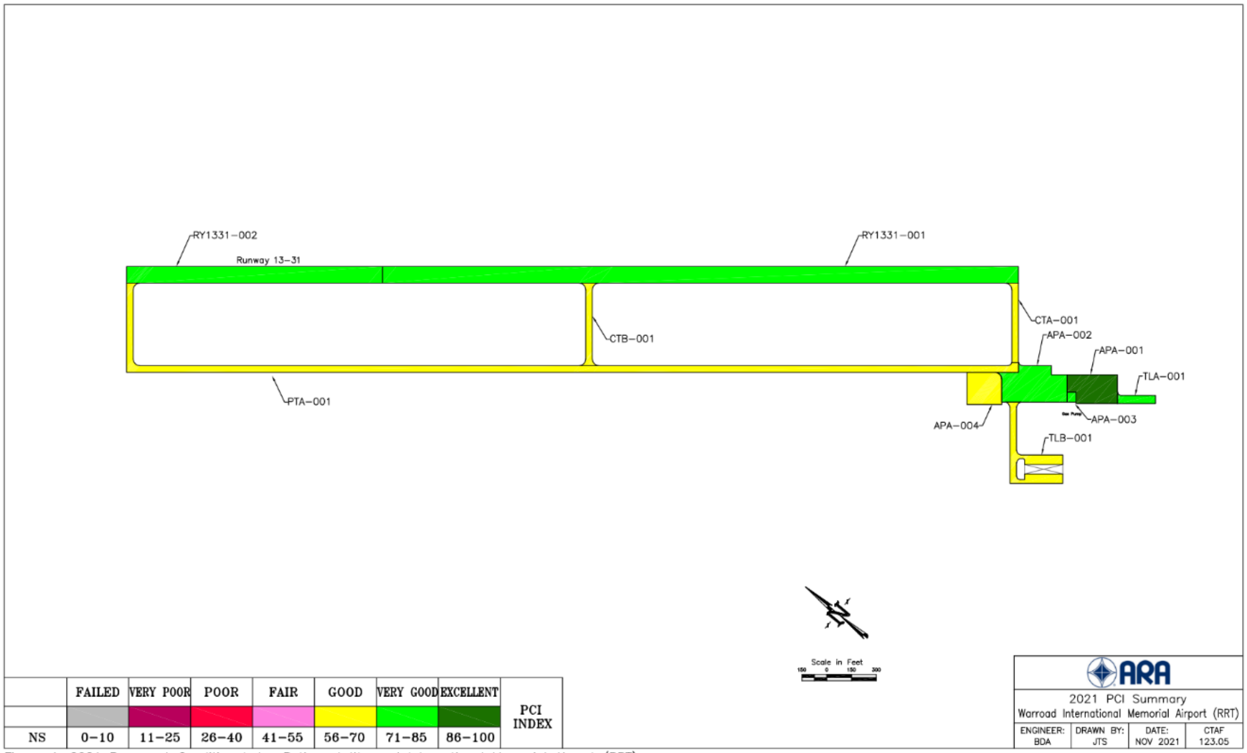


Figure 4. 2021 Pavement Condition Index Rating at Warroad International Memorial Airport (RRT).

Taxiways

A system of taxiways facilitates the movement of aircraft from the runway environment to other airport facilities including hangars and parking aprons. The taxiway system should provide critical links to airside infrastructure, increase capacity, and reduce the risk of an incursion with traffic on the runway. The taxiway system should meet the standards design requirements identified in FAA AC 150/5300-13B. Locations of the taxiway system is depicted in **Figure 2-1– Airfield Facilities Map**.

- **Taxiway A** is a parallel taxiway for Runway 13-31 and crosses Runway 4-22. The southern portion of the taxiway ties into the main parking apron. Separation from the parallel taxiway to the runway is 575 feet. This taxiway is paved (bituminous) and is 40 feet wide.
- **Connecting Taxiway A1, A2 and A3** are connectors from the parallel Taxiway A to Runway 13-31. A1 provides connection from the apron to the runway 31 end, A2 is a midway connector, and A3 connects to the Runway 13 end. All these connectors are 40 feet wide.

SYSTEM DESIGN

FAA has placed a renewed emphasis on taxiway design in their updated airport design standards. Fundamental elements help develop and efficient system to meet demands, reduce pilot confusion and enhance safety. Considerations include:

- Design taxiways to meet FAA design standards for existing and future users considering expandability of airport facilities.

- Design taxiway intersections so the cockpit is over the centerline with a sufficient taxiway edge safety margin.
- Simplify taxiway intersections to reduce pilot confusion using the three-node concept, where a pilot has no more than three choices at an intersection.
- Eliminate “hot spots” identified by the FAA Runway Safety Action Team where enhanced pilot awareness is encouraged.
- Minimize the number of runway crossings and avoid direct access from the apron to the runway.
- Other considerations include avoiding wide expanses of pavement and avoiding “high energy intersections” near the middle third of a runway.

In general, the entire taxiway layout at RRT was constructed with taxiways perpendicular to each other. All intersections on the airfield intersect at a 90-degree angle except for the intersection of Runway 4-22 with Taxiway A. This taxiway to runway intersection angle is 83 degrees and provides an acceptable field of view. A risk of runway incursions rises if the intersection angle is less than 75 degrees. A 90-degree angle is the most desirable for aircraft safety and pilot awareness of other moving objects on the airfield (vehicles, other aircraft, etc.). Perpendicular intersections provide optimal visibility.

Taxiway A2 connects the parallel taxiway to Runway 13-31 in the middle third of the runway, and is designed as a runway exit, to reduce the occupancy time on the runway, and not for crossing the runway. For a runway of this length, a single exit at midpoint is inefficient and only usable for small aircraft. Airport users noted two connectors located between 3,600’ and 4,000’ on rollout for each runway end would provide an exit for a wider range of aircraft. The ultimate location of these exit taxiways will be evaluated and depicted on the ALP. One taxiway provides “direct access” from the apron to the runway environment. **Direct access taxiways should be reconfigured to require at least one right angle turn from the apron to the runway hold line.**

Another element to look at is the separation distance between the parallel taxiway and runway. While the current distance of 575’ meets and exceeds the standards for the B-II design aircraft (300’ required) and the D-II design standards (400’ required). Also, the parallel taxiway connection into the apron restricts apron depth and the realignment of the direct access taxiway to the runway warrants a review of the future location and its separation distance to Runway 13-31.

DESIGN STANDARDS

FAA identifies the design requirements for taxiways. The design standards vary based on individual aircraft geometric and landing gear characteristics. The Taxiway Design Group (TDG) and Airplane Design Group (ADG) identified for the design aircraft using a particular taxiway. Some of the safety standards include:

- Taxiway Width
- Taxiway/Taxilane Safety Area (TSA)
- Taxiway Edge Safety Margin (TESM)
- Taxiway/Taxilane Object Free Area (TOFA)

Other design standards include taxiway shoulder width to prevent jet blast soil erosion or debris ingestion for jet engines and required separation distances to other taxiways/taxilanes. More information can be found in **Appendix B: General Aviation Airports 101**.

The existing taxiway meets the ADG-II and TDG-2A design standards. **Table 2-11** and **Table 2-12** describes the specific FAA taxiway design standards for various ADG and TDG design aircraft, respectively. As discussed in the Critical Design Aircraft section, the occasional operations of a De Havilland Dash 8 (ADG-III) aircraft may occur in the future for the aerial firefighting operations. While this will not exceed the regular use threshold, and will not be the design aircraft, it would be prudent to ensure that the operations can be accommodated safely. This would mean maintaining an ADG-III TOFA to ensure wingtip protection and larger fillets on the end connector taxiways to meet Taxiway Edge Safety Margins (TESM) for the TDG-3 aircraft.

For Key General Aviation airports, MnDOT has supported 40-foot wide taxiways rather than the standard 35 feet for TDG-2A aircraft. This provides more flexibility for the airport to accommodate the occasional larger aircraft like noted above. It is important to note that this additional five feet of width is not eligible for FAA funds. If acceptable, the airport and MnDOT will be responsible for this additional pavement. More details will be discussed in **Chapter 4 – Implementation.**

The Airport's taxilane system and design standards will be reviewed and addressed in **Chapter 3 – Terminal Area & Support Facilities**.

Table 2-11 – FAA Taxiway Design Standards Matrix (ADG)

Design Standard	Airplane Design Group (ADG)		
	ADG-I	ADG-II	ADG-III
Taxiway Safety Area	49 feet	79 feet	118 feet
Taxiway Object Free Area	89 feet	124 feet	171 feet
Taxilane Object Free Area	79 feet	110 feet	158 feet
Taxiway Centerline to Parallel Taxiway/Taxilane Centerline	70 feet	101.5 feet	144.5 feet
Taxiway Centerline to Fixed or Movable Object	44.5 feet	62 feet	85.5 feet
Taxilane Centerline to Parallel Taxiway/Taxilane Centerline	64 feet	94.5 feet	138 feet
Taxilane Centerline to Fixed or Movable Object	39.5 feet	55 feet	79 feet
Taxiway Wingtip Clearance	20 feet	22.5 feet	26.5 feet
Taxilane Wingtip Clearance	15 feet	15.5 feet	20 feet

Source: FAA AC 150/5300-13B, KLJ Analysis
NOTE: Taxiways include respective entrance taxiways to runways

Table 2-12 – FAA Taxiway Design Standards Matrix (TDG)

Design Standard	Taxiway Design Group (TDG)			
	TDG-1A	TDG-1B	TDG-2A	TDG-3
Taxiway Width	25 feet	25 feet	35 feet	50 feet
Taxiway Edge Safety Margin (TESM)	5 feet	5 feet	7.5 feet	10 feet
Taxiway Shoulder Width	10 feet	10 feet	15 feet	20 feet

Source: FAA AC 150/5300-13B, KLJ Analysis

VISUAL NAVIGATION AIDS

Visual aids are installed to provide airport usability during periods of darkness and/or low visibility. Pavement markings and lighting systems available at the airport are summarized in the following sections.

Taxiway Lighting

Taxiway edge lighting delineates the taxiway and apron edges. There is no taxiway lighting at RRT. Taxiway A and its connectors have blue reflectors installed along the edge of pavement. **It is recommended the airport install a Medium Intensity Taxiway Lighting (MITL) system on the airfield when the taxiway is reconstructed.**

Airfield Guidance Signs

Guidance signs provide location, direction, and guidance information to pilots on the ground to enhance awareness. Signs are placed around the airfield to identify runway and taxiway intersections, runway hold positions, and other guidance. Typical signs on taxiway systems are location, directional, and destination which are yellow and black in color. There are no location or directional guidance signs on the taxiway system. **It is recommended the Airport evaluate the installation of location and directional signs on the taxiway system.**

Pavement Markings

Taxiway and taxilane markings are important for directional guidance for taxiing aircraft and ground vehicles. FAA has defined numerous different pavement markings to promote safety and situational awareness as defined by FAA AC 150/5340-1M, Standards for Airport Markings. RRT taxiways and taxilanes have centerline marking. Markings are in good condition.

Holding Position

Holding position markings are a visual reference to prevent aircraft and vehicles from entering critical areas such as an active runway environment. The minimum distance between a holding position marking and runway centerline varies based on the RDC of the runway. For Runway 13-31, which has approach minimums down to ½-mile, both the B-II and D-II require 250 feet. All hold position markings on the taxiway intersection with Runway 13-31 are set at 250 feet and meet the separation standards. For Runway 4-22, which is a visual turf runway, the distance required is 125 feet. There are no hold position markings on the taxiway at the intersection to Runway 4-22. **It is recommended the airport install hold position markings on the taxiway at the intersection of Runway 4-22.**

Airfield Summary

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

Airside Facility Requirements

- Identify future location for the AWOS-III that meets current siting standards and provides adequate protection for the wind sensor
- Evaluate Taxiway to Runway separation distance to allow for more room around on aircraft parking apron
- Evaluate the installation Taxiway Location and Directional guidance signs
- Install Hold Position Markings on Taxiway at Runway 4-22 intersection
- Install a Medium Intensity Taxiway Edge Lighting (MITL) on Taxiway A

Runway Data Tables

The following tables provide summary data of the facility requirements and recommendations associated with each of the runways at RRT through the planning period(s) identified in this study.

Table 2-13 – Runway 13/31 Design Standard Matrix

Design Standard	Actual Condition	Facility Requirement or Recommendation
Runway Identification	13/31	13/31
Runway Design Code (RDC)	D-II-4000 (13) D-II-2400 (31)	B-II-4000 (13) B-II-2400 (31)
Approach Reference Code (APRC)	D/VI/4000 (13) D/VI/2400 (31)	D/VI/4000 (13) D/VI/2400 (31)
Departure Reference Code (DPRC)	D/VI	D/VI
Pavement Strength (Wheel Loading)	40,000 (DW)	40,000 (DW)
Pavement Surface Type	Asphalt	Paved
Runway Length	5,400’	5,400’
Runway Width	100’	100’
Runway Safety Area (RSA) Width	500’	300’
RSA Length Past Departure End	1,000’	600’
RSA Length Prior to Threshold	1,000’	600’
Runway Lighting Type	HIRL	HIRL
Approach RPZ[1] Start from Runway	200’	200’
Approach RPZ Length	1,700’ (13) 2,500’ (31)	1,700’ (13) 2,500’ (31)
Approach RPZ Inner Width	1,000’ (Both)	1,000’ (Both)
Approach RPZ Outer Width	1,510’ (13) 1,750’ (31)	1,510’ (13) 1,750’ (31)
Runway Marking Type	Precision	Precision
14 CFR Part 77 Approach Category	34:1 (13) 50:1 (31)	34:1 (13) 50:1 (31)
Approach Type	NPI (13) PIR (31)	NPI (13) PIR (31)
Visibility Minimums	¾ mile (13) ½ mile (31)	¾ mile (13) ½ mile (31)
ROFA Width	800’	800’
ROFA Length Past Departure End	1,000’	600’
ROFA Length Prior to Threshold	1,000’	600’
ROFZ Length Past Runway	200’	200’
ROFZ Width	400’	400’
Inner Approach OFZ	Yes (31)	Yes (31)
Inner Transitional OFZ	Yes (31)	Yes (31)
Precision OFZ Length	200’ (31)	200’ (31)
Precision OFZ Width	800’ (31)	800’ (31)
5300-13B Approach Surface*	Surface 5	Surface 5
Approach - Start from Runway End	200’	200’
Approach - Length	10,000’	10,000’
Approach - Inner Width	400’	400’
Approach - Outer Width	3,400’	3,400’
Approach - Slope	20:1 (13)	20:1 (13)

[1] A portion of Highway 313 and County Road 13 are in the RPZ for Runway 31. There are no other incompatible uses inside the RPZ and no changes planned to the size of the RPZ therefore in accordance with Paragraph 2.2.5 of AC 150/5190-4B there is no action needed at this time.

	34:1 (31)	34:1 (31)
Departure Surface Slope	40:1	40:1
Departure Surface Dimensions	1,000' x 7,512' x 12,152'	1,000' x 7,512' x 12,152'
Vertical Guidance Surface (Surface 6)	30:1	30:1
Vertical Guidance Surface (Surface 6) Dimensions	300' x 1,520' x 10,200'	300' x 1,520' x 10,200'
Visual and Instrument NAVAIDs	GS (31), LOC (31), PAPI, MALSR	GS (31), LOC (31), PAPI, MALSR
Runway and Taxiway Separation	575'	300'
Runway and Hold Line Separation	250'	250'

*Note: RED indicates a known deficiency to existing minimum design standards, * Paragraph 3.6 of AC 150/5300-13B*
Source: FAA AC 150/5300-13B, KLJ Analysis

Table 2-14 – Runway 4/22 Design Standard Matrix

Design Standard	Actual Condition	Facility Requirement or Recommendation
Runway Identification	4-22	4-22
Runway Design Code (RDC)	A/B-I (Small) -Visual	A/B-I (Small) -Visual
Approach Reference Code (APRC)	-	-
Pavement Strength (Wheel Loading)	12,500 (SW)	12,500 (SW)
Pavement Surface Type	Turf	Turf
Runway Length	2,987'	2,987'
Runway Width	150'	150'
Runway Safety Area (RSA) Width	120'	120'
RSA Length Past Departure End	240'	240'
RSA Length Prior to Threshold	240'	240'
Runway Lighting Type	Cones	Cones
Approach RPZ[2] Start from Runway	200'	200'
Approach RPZ Length	1,000' (Both)	1,000' (Both)
Approach RPZ Inner Width	250' (Both)	250' (Both)
Approach RPZ Outer Width	450' (Both)	450' (Both)
Runway Marking Type	-	-
14 CFR Part 77 Approach Category	20:1 (Both)	20:1 (Both)
Approach Type	Visual (Both)	Visual (Both)
Visibility Minimums	Visual (Both)	Visual (Both)
ROFA Width	250'	250'
ROFA Length Past Departure End	240'	240'
ROFA Length Prior to Threshold	240'	240'
ROFZ Length Past Runway	200'	200'
ROFZ Width	250'	250'
5300-13B Approach Surface*	Surface 2	Surface 2
Approach - Start from Runway End	0'	0'
Approach - Length	5,000'	5,000'
Approach - Inner Width	250'	250'
Approach - Outer Width	700'	700'
Approach - Slope	20:1	20:1
Visual and Instrument NAVAIDs	-	-
Runway and Taxiway Separation	150'	150'
Runway and Hold Line Separation	125'**	125'

*Note: RED indicates a known deficiency to existing minimum design standards; * Paragraph 3.6 of AC 150/5300-13B;*
*** No holdlines currently exist, but will be noted on ALP for correction with taxiway project.*
Source: FAA AC 150/5300-13B, KLJ Analysis

[2] A portion of Highway 313 is in the RPZ for Runway 22. There are no other incompatible uses inside the RPZ and no changes planned to the size of the RPZ therefore in accordance with Paragraph 2.2.5 of AC 150/5190-4B there is no action needed at this time.

Alternative Evaluation Process

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.

A range of alternatives were prepared for consideration and those initial alternatives were reviewed by the Planning Advisory Committee to create a narrower slate of alternatives for further review. In the end a preferred alternative was selected and portrayed at the end of this chapter

Alternatives

The recommended development identified in this chapter includes the following:

- Identify future location for the AWOS-III that meets current siting standards and provides adequate protection for the wind sensor.
- Evaluate Taxiway to Runway separation distance to allow for more room on the aircraft parking apron.
- Evaluate future parallel taxiway layout, removal of direct access to runway, and apron access layout.

Parallel Taxiway Separation

The separation distance between the parallel taxiway and runway is currently 575 feet. While this meets and exceeds the standards for the B-II design aircraft (300' required) and the D-II design standards (400' required), the parallel taxiway connection into the apron restricts apron depth. Also, when reconstructed, the taxiway connecting to Runway 31 end will need to be realigned to remove direct access to the apron. Because of the parallel taxiway's relationship to these two features, an evaluation is provided to compare how each separation distance impacts the other airfield components.

See **Table 2-15** for a summary of key items under consideration and **Figures 2-3, 2-4,** and **2-5** for depictions of each taxiway to runway separation alternative.

No Change (Existing 575' Separation): The Parallel Taxiway would remain in approximately the same position at 575' separation distance from the runway. Realignment of the taxiway on the south end would likely be needed to remove direct access from the apron and allow for maneuvering space on the apron.

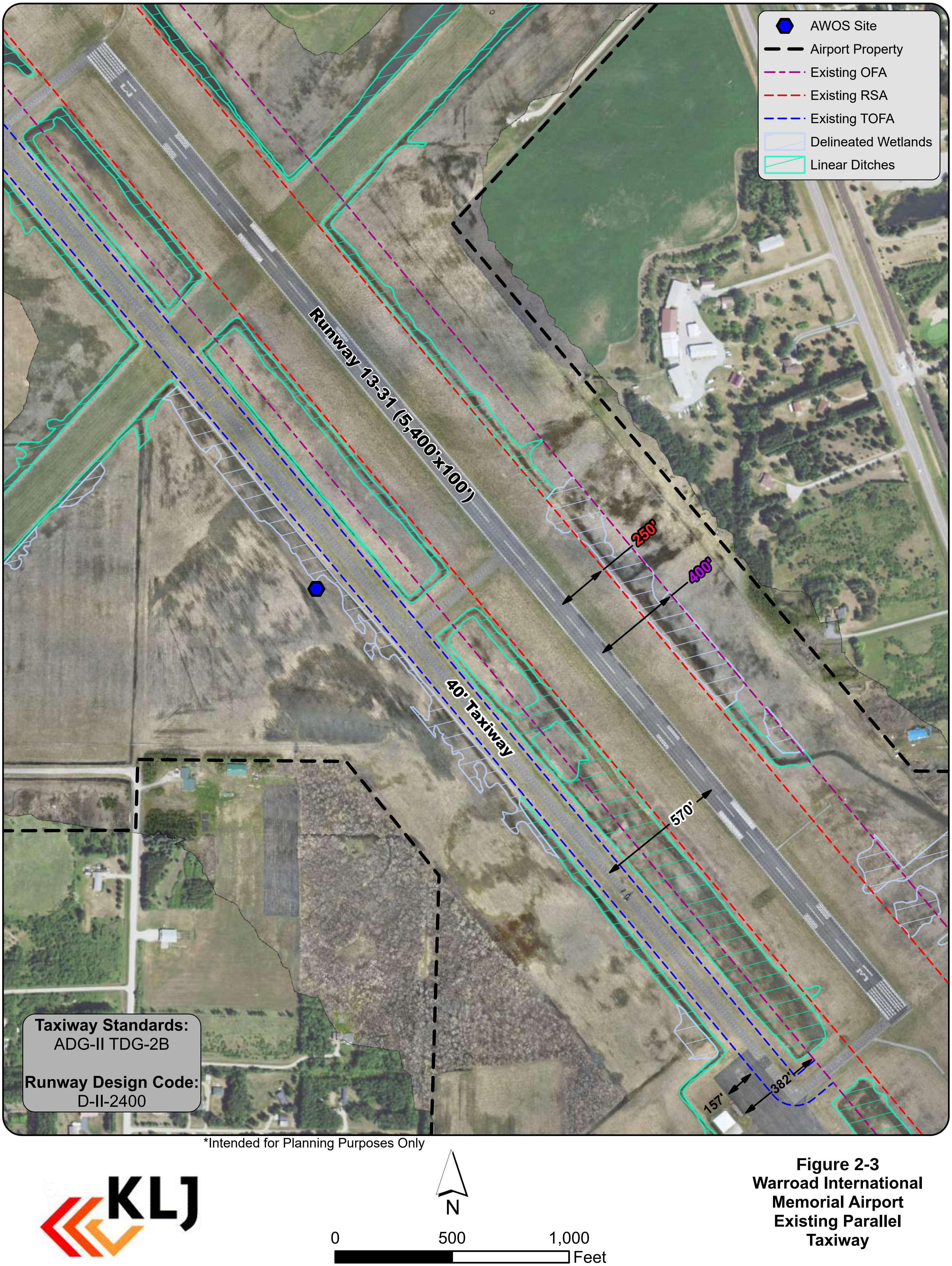
300' Taxiway to Runway Separation: The Parallel Taxiway would shift closer to the runway at a separation distance of 300'. This would meet the critical design aircraft standards and provide the most apron depth available.

400' Taxiway to Runway Separation: The Parallel Taxiway would shift closer to the runway at a separation distance of 400'. While providing more apron depth space, this would also position the taxiway to preserve the ability for a future AAC C and D aircraft design should a fleet change occur.

Table 2-15 – Parallel Taxiway Separation Summary Table

Metric	Parallel Taxiway Separation Summary		
	Maintain Existing	300-Foot Separation	400-Foot Separation
Taxiway to Runway Separation	575’	300’	400’
Runway Design Standards	Exceeds Highest Standards (E-VI)	B-II-2400	C/D-II-2400
Allowable Apron Depth	157’	382’	327’
Wetlands Impacts*	Potential (South Realignment)	Yes (Linear Ditch, approximately 7 acres)	Yes (Linear Ditch, approximately 4.5 acres)
Advantages	• Preserves capability for AAC C and D Aircraft • Lowest Cost • Likely least wetland impacts	• Maximizes apron depth available • Shortest connectors needing less pavement	• Substantial apron depth available • Preserves capability for AAC C and D Aircraft should fleet change
Disadvantages	• Least apron depth available • Longer connectors needing more pavement	• Restricts to Ultimate B-II capability • ROFA restricts apron depth • Likely most wetland impacts	• Less apron depth than 300’ separation

*Source: KLJ Analysis. *Note that these figures are rough estimates as the configuration of direct access removal and apron connections will change these numbers.*



*Intended for Planning Purposes Only

Figure 2-3
Warroad International Memorial Airport Existing Parallel Taxiway

*Intended for Planning Purposes Only

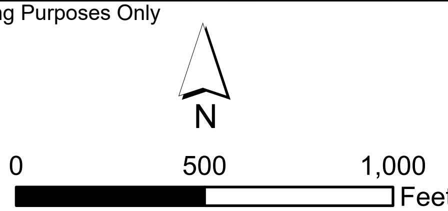


Figure 2-4
Warroad International Memorial Airport Proposed Parallel Taxiway 300-Foot

*Intended for Planning Purposes Only

N

0 500 1,000 Feet

Figure 2-5
Warroad International Memorial Airport
Proposed Parallel Taxiway 400-Foot Separation

Taxiway and Apron Access

The following alternatives were developed showing different configurations of the parallel taxiway with a 400-foot, 425-foot and the existing 575-foot taxiway to runway separation from the primary runway. The 300-foot separation was not carried forward as this would limit the airport's flexibility and ability to respond if the fleet mix changed to a C or D Aircraft Approach Category in the future. Although not planned, if Marvin Windows were to change their fleet to an aircraft with a higher AAC, the frequency of operations would drive a change to the critical design aircraft.

During the planning study, the US Army Corps of Engineers reviewed the aquatic resources between Runway 13-31 and Parallel Taxiway A identified as linear ditches and determined they are likely jurisdictional under Section 404 of the Clean Water Act. This means that future development and improvements will need to be evaluated to first avoid, then minimize disturbances and impacts to these aquatic resources. Finally, mitigation would be required to offset any permanent unavoidable impacts. As a result, two of the alternatives developed were designed to tie into the existing parallel taxiway with the least amount of impact to the linear ditches while meeting design standards.

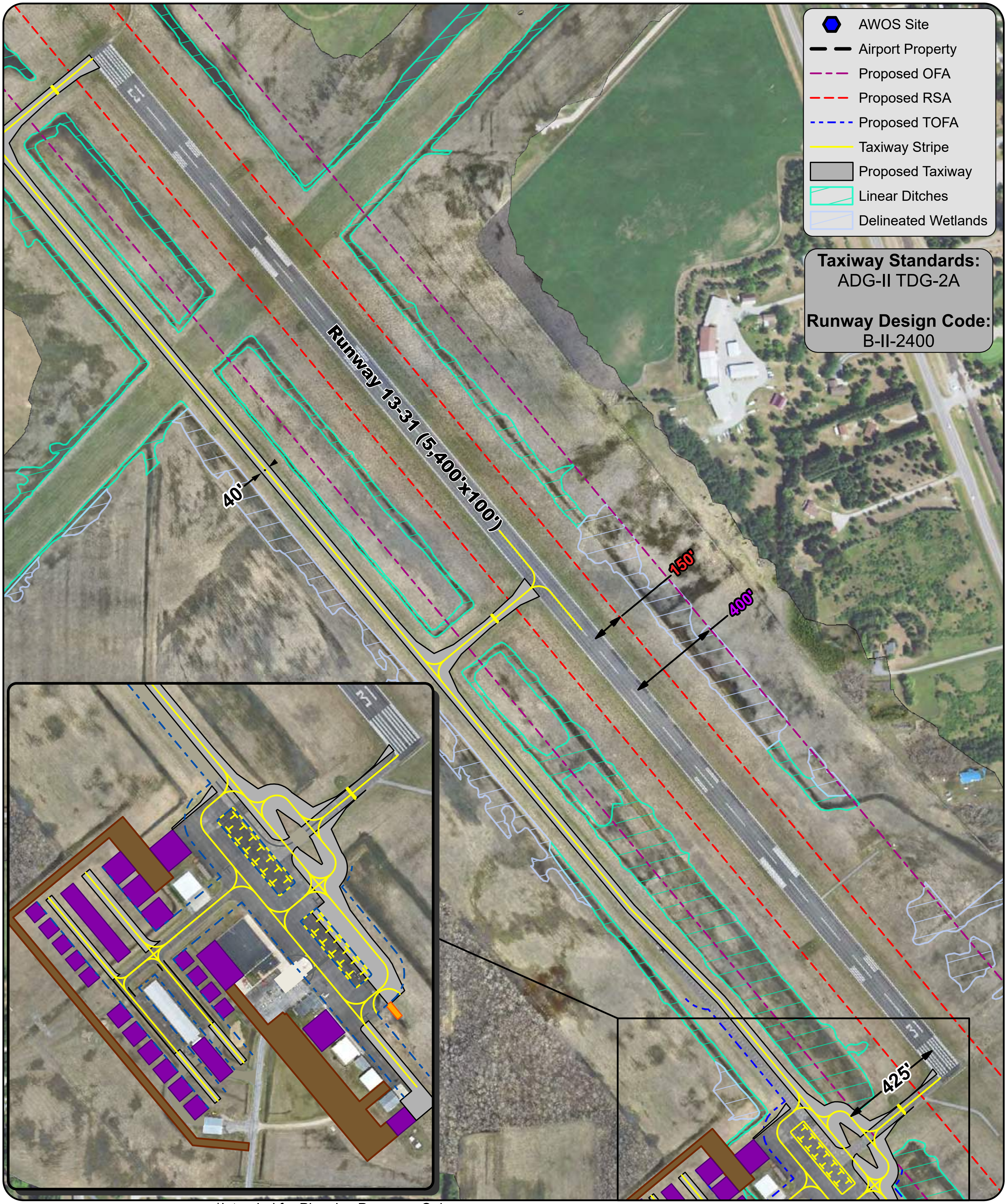
Each of these alternatives evaluates potential layouts of the parallel taxiway, access to the aircraft parking apron and removal of direct access to the runway from the apron. Impacts of each alternative including wetlands, design standards, cost, and future development were considered. Considerations were also made to utilize existing pavement when possible. Please refer to **Table 2-16 Parallel Taxiway Alternatives Summary Table** for a list of details and specific impacts for each alternative. For additional information on the apron and hangar area portions of the alternatives, please reference Chapter 3.

Alternative 5A: Parallel taxiway exits the apron in line with the perimeter taxilane and extends for another 500 feet before connecting into the existing Taxiway at a 575-foot separation. This is to accommodate apron expansion to the northwest in the future while reducing linear ditch impacts. Dual access connector is set at a 425-foot runway to taxiway separation with one extending beyond the threshold. Turning aircraft would penetrate the POFZ. Dual entry to the apron area is provided. Depicted in **Figure 2-6.**

Alternative 5B: Parallel taxiway stays at 425-foot separation for the length of the runway. Apron expansion and future development to the northwest would not be impeded by the taxiway. Taxiway A1 splits into two connectors accessing the apron with one extending beyond the threshold. Turning aircraft would penetrate the POFZ. Depicted in **Figure 2-7.**

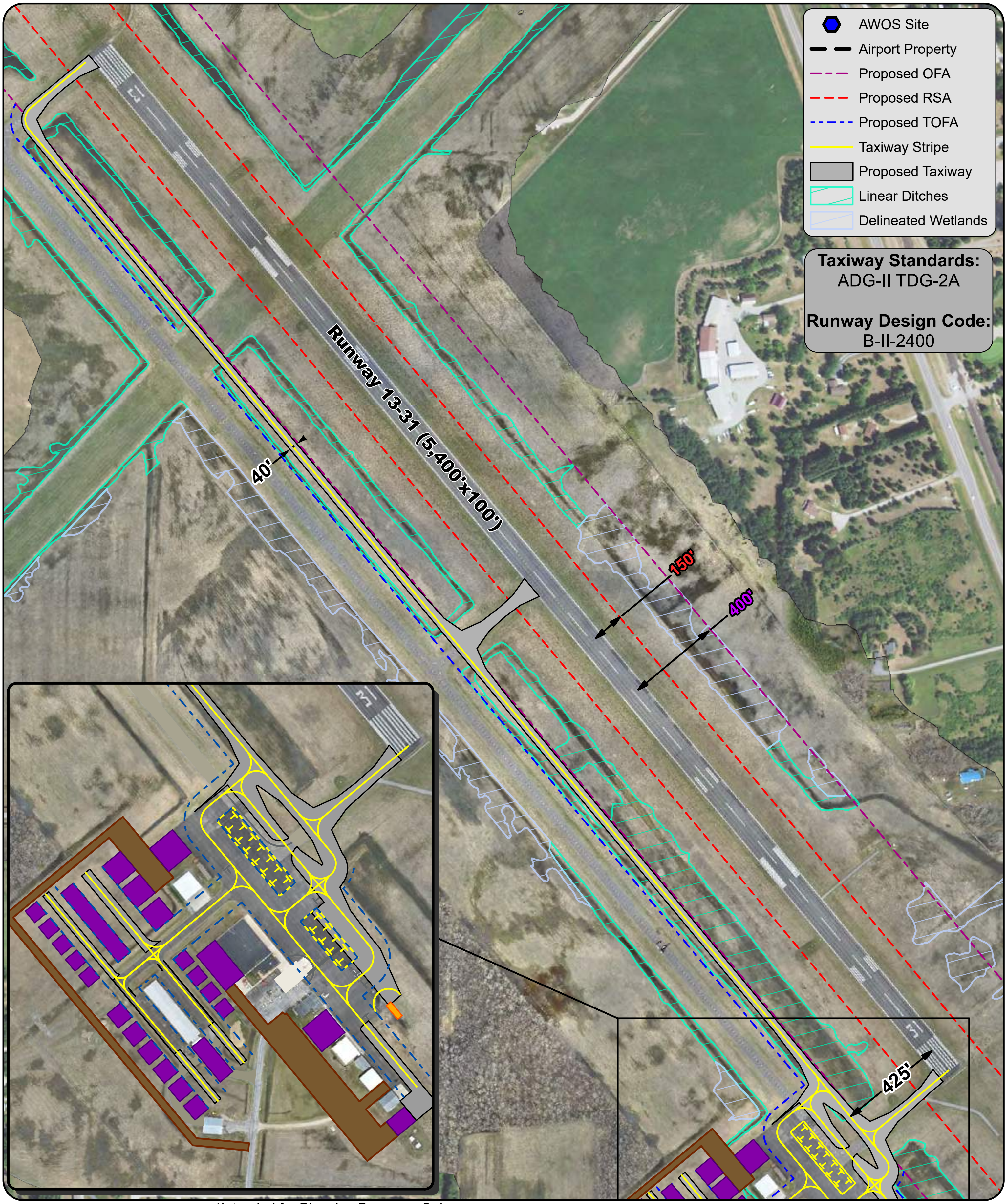
Alternative 5C: Parallel taxiway stays at 400-foot separation for the length of the runway. Apron expansion and future development to the northwest would not be impeded by taxiway. Dual entry into the apron is provided by two taxiways with a paved island northwest of Taxiway A1. Depicted in **Figure 2-8.**

Alternative 5D: Parallel taxiway exits the apron and immediately connects into the existing taxiway at 575-foot separation. This shows the minimum development and impact to linear ditches while meeting design standards. Taxiway may need to be reconfigured if future apron expansion or development were to occur to the northwest. Single access connector from Taxiway A1 with two 90-degree turns resolves the direct access to the runway. Depicted in **Figure 2-9.**



*Intended for Planning Purposes Only

Figure 2-6
Warroad International Memorial Airport
Proposed Parallel Taxiway
425-Foot Separation
Terminal Area Alternative 5a

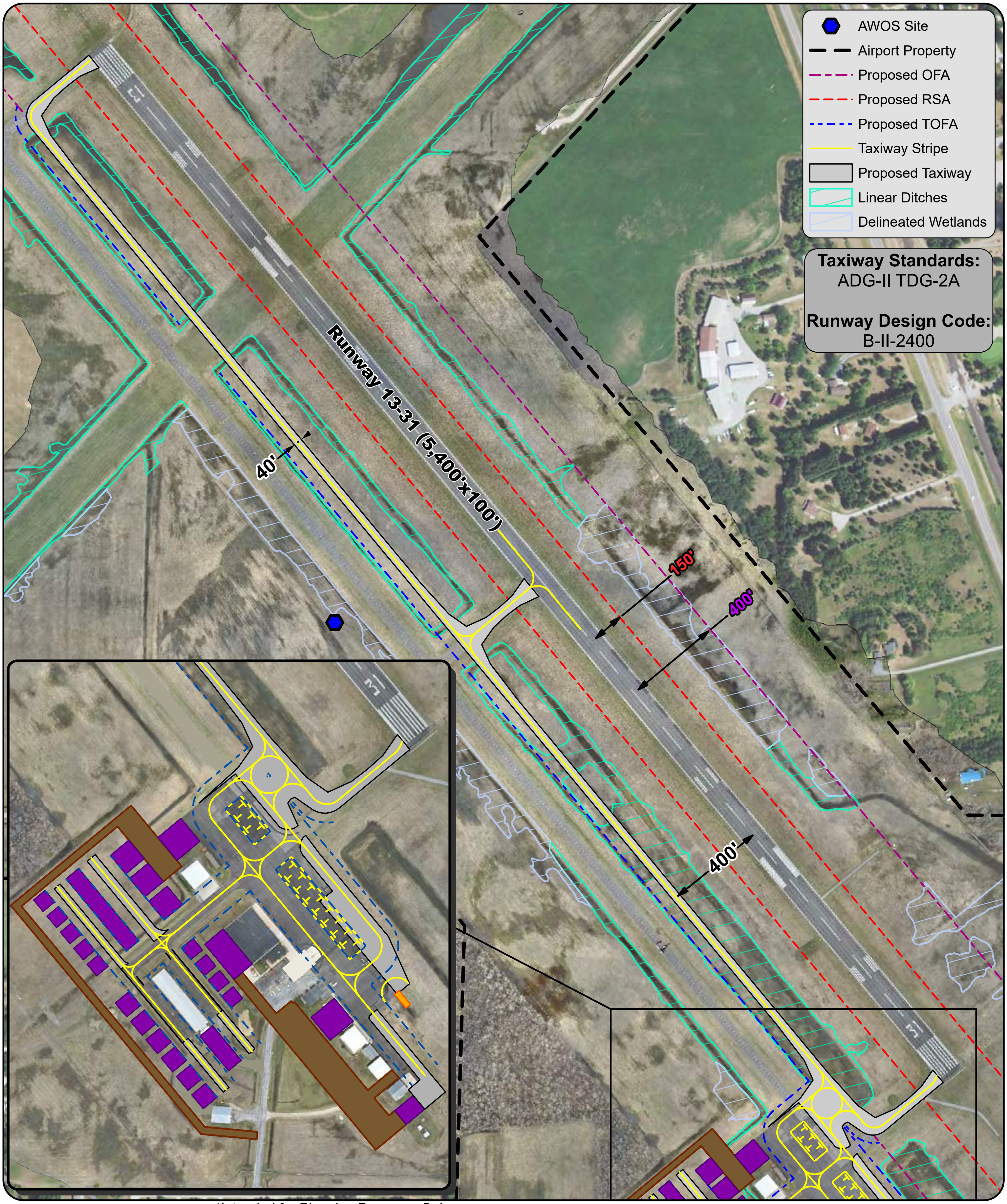


*Intended for Planning Purposes Only

N

0 500 1,000 Feet

Figure 2-7
Warroad International Memorial Airport
Proposed Parallel Taxiway
425-Foot Separation
Terminal Area Alternative 5b

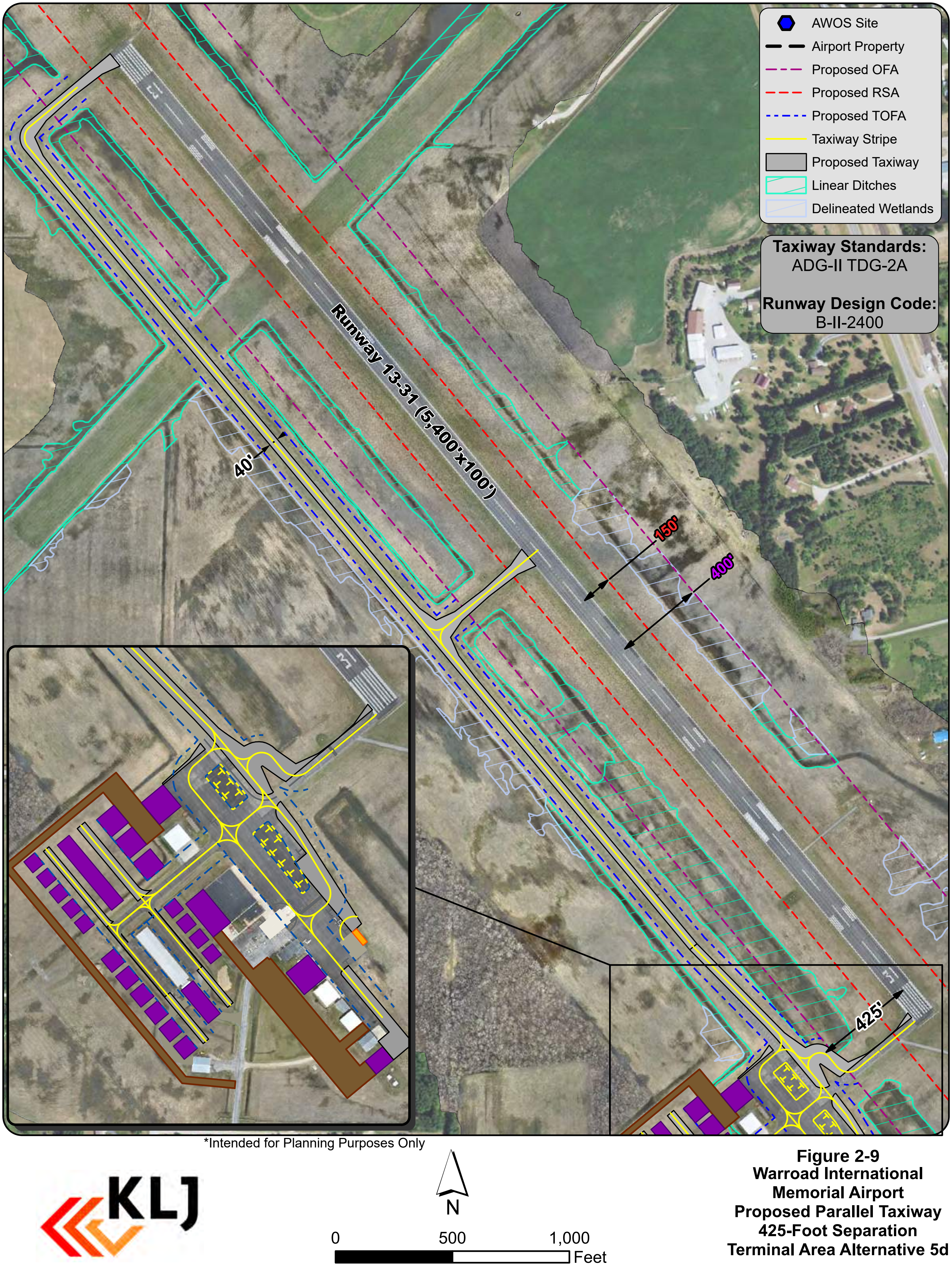


*Intended for Planning Purposes Only

N

0 500 1,000 Feet

Figure 2-8
Warroad International Memorial Airport
Proposed Parallel Taxiway
400-Foot Separation
Terminal Area Alternative 5C



*Intended for Planning Purposes Only

KLJ

Figure 2-9
Warroad International Memorial Airport
Proposed Parallel Taxiway
425-Foot Separation
Terminal Area Alternative 5d

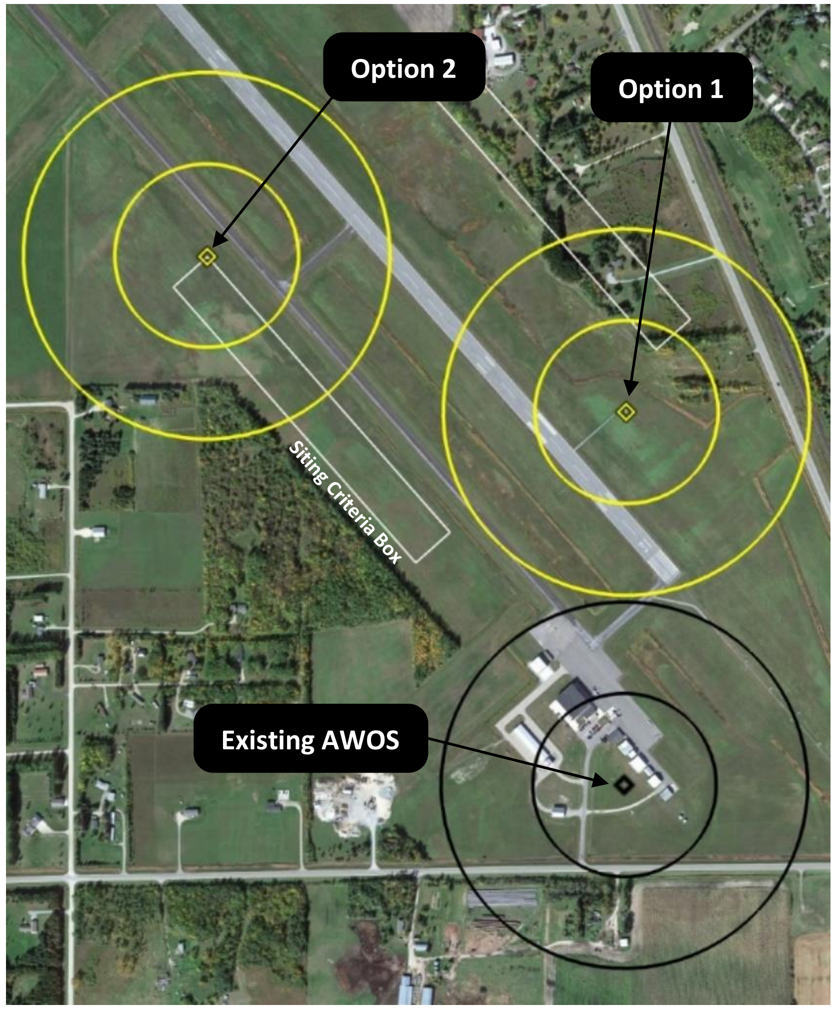
Table 2-16 Parallel Taxiway Alternatives Summary Table

Metric	Alternatives			
	Alternative 5A	**Alternative 5B**	**Alternative 5C**	**Alternative 5D**
Taxiway Configuration	Extended Tie-in to Existing Taxiway	Relocated Parallel Taxiway - 425' Separation	Relocated Parallel Taxiway - 400' Separation	Immediate Tie-in to Existing Taxiway
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
Tiedowns / Parking Area	24 Tiedowns (4,600 SY)	21 Tiedowns (4,400 SY)	20 Tiedowns (4,030 SY)	12 Tiedowns (2,800 SY)
Apron Expansion (NW) Considerations	Potential Taxiway Regrading May be Needed	Taxiway Does Not Impede Apron Expansion	Taxiway Does Not Impede Apron Expansion	Reconstruction of Taxiway Tie-in Will be Needed
Water Resource Impacts - Linear Ditch	0.59 Acres	6.01 Acres	5.41 Acres	0.30 Acres
Environmental Documentation	EA	EA	EA	CATEX
Total Estimated Cost	**$6,665,000***	**$6,635,000**	**$6,495,000**	**$5,810,000****

Source: KLJ Analysis.
**$3,650,000 – If existing taxiway is mill and overlay rehabilitation instead of limited frost protection reconstruction*
*** $2,770,000 – If existing taxiway is mill and overlay rehabilitation instead of limited frost protection reconstruction*

New AWOS Siting

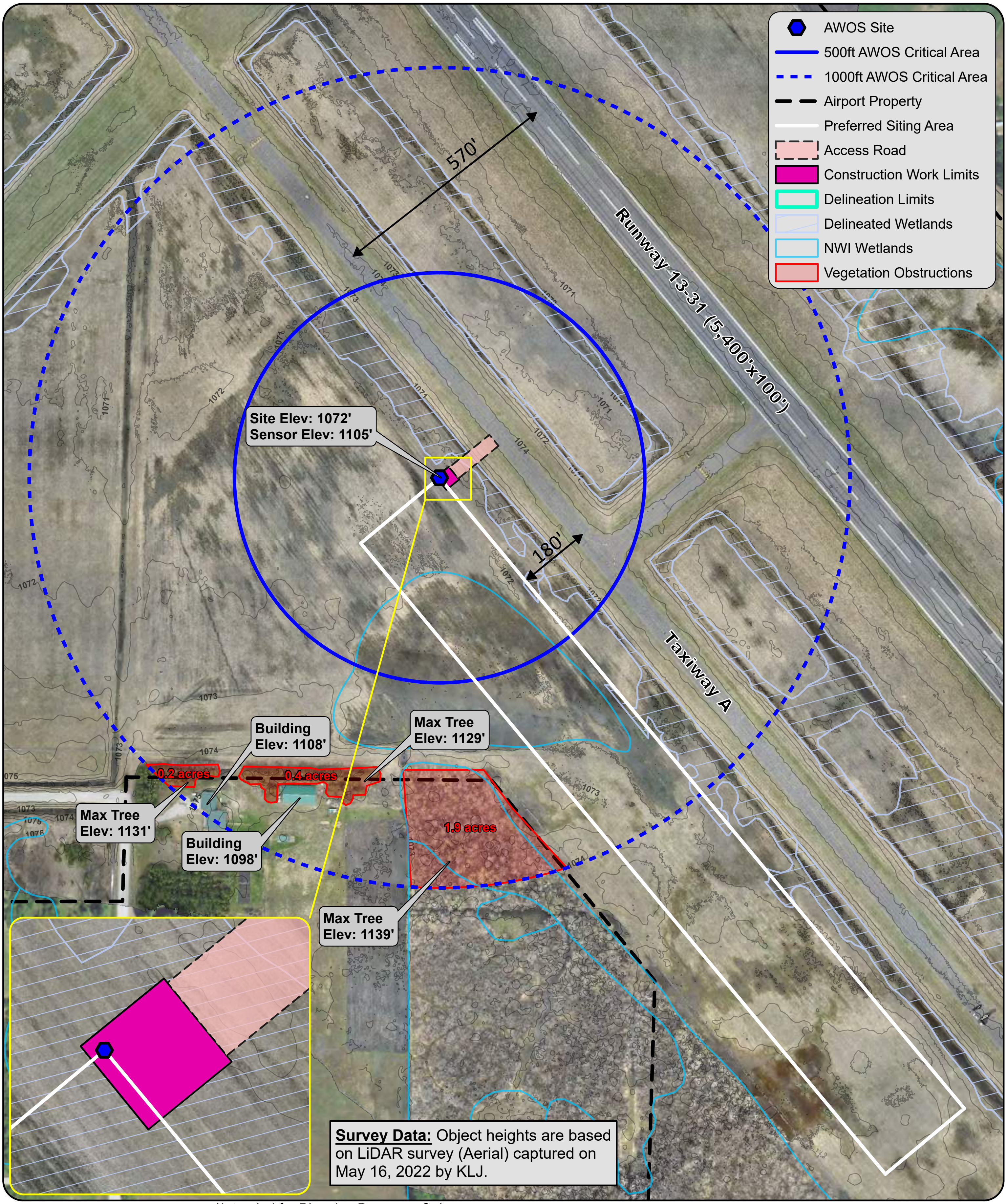
Figure 2-10 – AWOS Locations



The AWOS is nearing the end of its useful life and MnDOT would like to replace the unit soon as parts are no longer available. The location of the unit does not meet current AWOS siting standards, so a new location needs to be identified before the unit is replace. Additionally, the current location of the AWOS is within the hangar area with many large structures nearby. These structures could be affecting the wind sensor readings by disrupting airflow. Airport users have expressed suspicions that the weather station is not accurately reporting wind from the north and east.

Two locations were evaluated. Option 1 evaluates co-locating the unit with the Glide Slope for Runway 31 as this would provide as close to touchdown information as possible. However, the wind sensor protection rings had many impacts with vegetation, residential structures and the golf course. Within the 500-foot radius, there was approximately 1.2 acres of vegetation and 1 structure present. Within the 500-foot to 1,000-foot radius, approximately 5.4 acres of vegetation and 3 structures were present. All but .75 acres of vegetative impacts were off airport. Due to these impacts Option 1 was dismissed.

Option 2 fits inside the far northern edge of the siting criteria box and is located more towards midfield. The sensor would be located 180 feet from existing taxiway centerline and 430 feet from the intersection Taxiway A and A2. The sensor is well outside the range of breakaway jet blast from the largest aircraft likely to use the airport. The 500-foot radius is clear of all obstructions. 2.5 acres of vegetative obstructions and 2 structures exist within the 500-foot to 1,000-foot radius outside of airport property. The height of these objects would not be considered sheltering obstructions as they fall below the slope defined in Order JO 6560.20C. While there are some vegetation and structures within the wind sensor protection rings, these are outside the 500' foot ring and should have minimal impact to readings. Approximately 4.15 acres of off-airport property are within the 1,000-foot radius. Acquiring easement may be needed to maintain control of object height and protect the AWOS investment. See **Figure 2-11** for depiction of future AWOS site.



*Intended for Planning Purposes Only

KLJ

Figure 2-11
Warroad International Memorial Airport
AWOS Proposed Site

Preferred Development

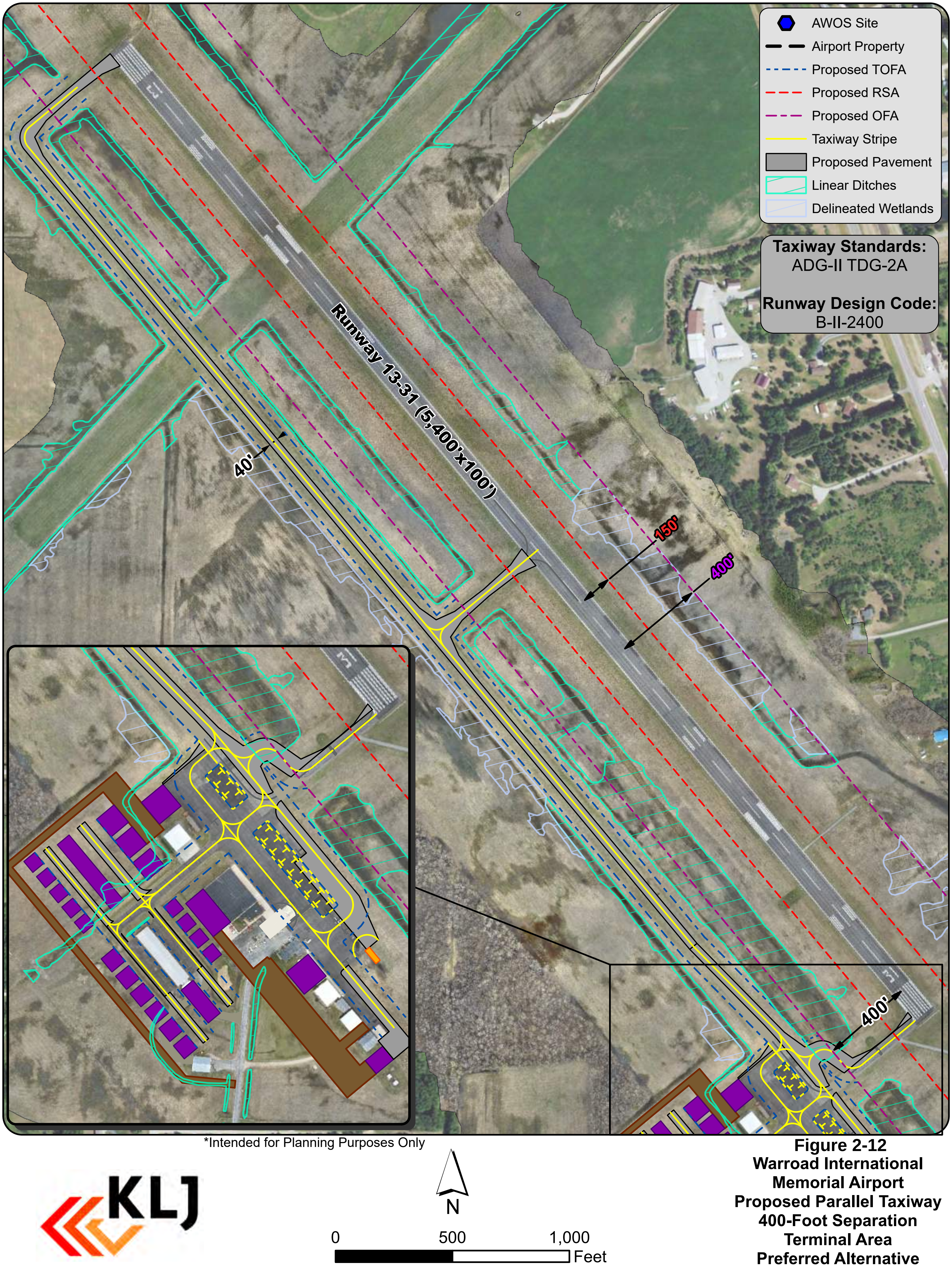
Following a review and discussion of the refined alternatives with the planning advisory committee, MnDOT and the FAA, Alternative 5D was selected as the preferred taxiway alternative. This alternative was selected as it had the least impact to delineated wetlands, avoided the POFZ, maximized the use of the existing parallel taxiway infrastructure, and was the lowest cost. A slight change was made to the runway to taxiway separation for the taxiway connector from the apron to Runway 31. To increase cockpit visibility of the apron taxilane, the 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. See **Figure 2-12** for a graphical depiction of the preferred alternative.

The preferred development strategy identified in **Table 2-17** 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.

Table 2-17 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
Runway	• Relocate Hold Position Markings on Taxiway at Runway 4-22 intersection		
Taxiway	• Construct new taxiway connectors from apron to Taxiway A and Runway 31 to remove direct access and maximize apron depth		• Install MITL on Taxiway A and connectors
Airfield Support	• Relocate and construct new AWOS-III		

Source: KLJ Analysis



*Intended for Planning Purposes Only

Figure 2-12
Warroad International Memorial Airport
Proposed Parallel Taxiway 400-Foot Separation Terminal Area Preferred Alternative