3.0 DEMAND CAPACITY ANALYSIS AND FACILITY REQUIREMENTS

To plan for future infrastructure improvements, an airport must conduct a facility requirements analysis to measure how well existing facilities are able to meet current and projected demand. The objective of this analysis is to determine the long-term flexibility and growth potential of existing infrastructure elements to respond to changing demand scenarios over a 20-year planning period. Those facilities unable to accommodate demand will be the focus of the alternatives analysis which will identify, review, and evaluate infrastructure improvement options to meet the needs of Bismarck Airport (BIS) users. This chapter provides a summary of the existing conditions of airside and landside facilities at the Airport and provides recommendations for facility improvements that are anticipated to be needed to meet current and future demand. The recommendations developed in this chapter provide a baseline for not only the development of alternatives, but also future Airport staffing, funding, development, and programming decisions. The recommendations from the facility requirement analysis are presented in this chapter and organized by the following sections:

- 3.1 Demand/Capacity Analysis
- 3.2 Wind Coverage
- 3.3 Identification of Design Standards
- 3.4 Runway System
- 3.5 Taxiway System
- 3.6 Aprons
- 3.7 Navigational Aids and Weather Equipment
- 3.8 Terminal Area
- 3.9 General Aviation Facilities
- 3.10 Support Facilities
- 3.11 Airport Traffic Control Tower
- 3.12 Summary of Recommendations

3.1 DEMAND/CAPACITY ANALYSIS

The purpose of the airfield demand/capacity analysis is to assess the capability of the airfield facilities to accommodate projected levels of aircraft operations. The Federal Aviation Administration (FAA) identifies two definitions of airfield capacity in FAA Advisory Circular (AC) 150/5060-5, *Airport Capacity and Delay*. The first definition of airfield capacity pertains to the maximum number of aircraft operations that a specific airfield configuration can accommodate during a period of continuous demand (i.e. an aircraft is always waiting to depart or land). This level of capacity is influenced by weather conditions, number and configuration of exit taxiways, types of aircraft that use a facility, and air traffic control/airspace handling procedures.

The second definition of airfield capacity is the number of aircraft operations that may occur during a specific time that corresponds with a tolerable aircraft delay. An important difference between these two measures of capacity is that one is defined in terms of delay, while the other is not. Among the reasons to determine delay is that each individual airfield has multiple factors that contribute to its ability to accommodate aircraft. Additionally, the relationship between demand and delay is significantly impacted by patterns of peak demand, which is also unique to an airfield.

The following airfield capacity and delay components are used in this evaluation:

Peak hour capacity – The maximum number of aircraft operations that can occur in one hour under specific operating conditions. This is also known as an airfield's maximum hourly throughput capacity.

Annual Service Volume (ASV) – Used by the FAA as an indicator of relative operating capacity, ASV is an estimate of an airport's annual capacity that accounts for differences in runway use, aircraft mix, and weather conditions that are likely to be encountered over a one-year period. ASV assumes an acceptable level of aircraft delay as described in FAA AC 150/5060-5, *Airport Capacity and Delay*.

3.1.1 Factors Affecting Runway Capacity

A number of factors can impact airfield capacity and delay, including:

- Airfield layout and runway configuration
- Number and location of exit taxiways
- Runway use restrictions
- Runway use as dictated by wind conditions
- The percentage of time the airport experiences poor weather conditions
- The level of touch-and-go activity
- Types of aircraft that operate at the airport
- Surrounding terrain/local geography
- Changes in air traffic control procedures

3.1.2 Weather Conditions

Weather conditions can impact an airport's capacity by causing conditions that require the facility to close or slow down aircraft operations. There are two categories for weather conditions related to operating aircraft, instrument meteorological conditions (IMC) and visual meteorological conditions (VMC). VMC weather conditions exist when the cloud ceiling is 1,000 feet or greater and visibility is three statute miles or greater. IMC conditions are those below the stated VMC minimums.

It is important to differentiate IMC and VMC conditions because greater separation distances are required between aircraft under IMC conditions. According to the wind and weather analysis in the following sections, VMC conditions occur approximately 91.5 percent of the time, and IMC conditions occur approximately 8.5 percent of the time.

3.1.3 Touch-and-Go Operations

Touch-and-go operations are defined as those conducted by a single aircraft that lands and departs on a runway without taxiing. Such operations are typically associated with training or proficiency exercises. Typically, airfield capacity increases with the ratio of touch-and-go operations as aircraft are within the local traffic pattern and available for approaches. According to Airport Traffic Control Tower (ATCT) records, touch-and-go operations account for about 22 percent of all operations at BIS.

3.1.4 Identification of Design Standards

The size and type of aircraft that operate at an airport have a significant impact on airfield capacity. As shown in **Table 3-1**, aircraft are categorized according to their individual size and approach speed.

Table 3-1. Aircraft Classifications

Aircraft Classification	Take-off Weight (pounds)	Types of Aircraft	Estimated Approach Speed (knots)
A	12,500 or less	Small single engine aircraft	80
B	12,500 or less	Small multi-engine aircraft	110
C	12,500-300,000	Large aircraft	130
D	300,000 or more	Heavy aircraft	150

Source: FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*.

The classifications shown in the table above form the basis for the Mix Index, which is a mathematical expression utilized in airfield capacity analysis. The Mix Index is the percent of Class C aircraft plus three times the percent of Class D aircraft. Utilizing operational fleet mix projections presented in Chapter Two, Aviation Activity Forecasts, the mix index is estimated to be 28 percent during VMC conditions and 61 percent during IMC conditions. Peaking characteristics from the aviation forecast chapter are used to identify design hour demand at the Airport.

3.1.5 Peak Hour Capacity

Peak hour capacity is defined as the measure of the maximum number of aircraft operations that can be completed on a runway system in one hour. This calculation incorporates runway use configuration, dimensional spacing criteria, fleet mix, touch and go activity, and runway exit factor. Utilizing guidelines contained within the FAA AC 150/5060-5, Airport Capacity and Delay, the capacities for the airport's primary operating configurations were determined. There are two primary configurations available at BIS, these include the simultaneous use of two intersecting runways, and the use of only a single runway. **Table 3-2** summarizes the hourly capacities of these two primary configurations for both VMC and IMC weather conditions. Although instrument approaches exist for all four runway ends at BIS, simultaneous use of the intersecting runways generally does not occur during IMC conditions.

Table 3-2. Peak Hour Airfield Capacity

Airfield Configuration	Weather Conditions	Hourly Capacity
Simultaneous Use of Intersecting Runways	VMC	77
	IMC	n/a
Single Runway In Use	VMC	63
	IMC	56

Source: FAA Advisory Circular 150/5060-5 *Airport Capacity and Delay*, Mead & Hunt

Existing and projected peak hour operational demand was presented in Chapter Two. Demand ranged from 22 peak hour operations in 2015 to a projected demand for 28 peak hour operations in 2035. Therefore, given the capacities identified above, the existing configuration of the airfield is anticipated to satisfy projected peak hour demands throughout the 20-year planning period.

3.1.6 Annual Service Volume

ASV is a reasonable estimate of an airport's annual practical capacity. It accounts for differences in runway use, aircraft mix, weather conditions, pattern of demand (peaking), and other factors that impact capacity at an airport. The formula for calculating ASV contains three variables that are multiplied to obtain the ASV for the Airport:

ASV = Cw * D * H

Weighted hourly capacity (Cw), as calculated from the above hourly capacities and in accordance with FAA AC 150/5060-5, *Airport Capacity and Delay*, was found to be 63 operations per hour.

The Daily Demand Ratio (D) is the ratio of annual demand to average daily demand in the peak month (December). As described in Chapter Two, the number of Peak Month Average Day (PMAD) operations in 2015 was 201. The ratio of annual demand (56,721 total operations) to the average daily demand (231 operations) results in a D value of 283.

The Hourly Demand Ratio (H) is the ratio of average daily demand to average peak hour demand during the peak month. As was noted in Chapter Two, the number of peak hour operations was estimated at 25. The ratio of average daily demand (201) to peak hour demand (25) results in an H value of 8.02.

As a result of the identified values for the variables, ASV for BIS is defined as follows:

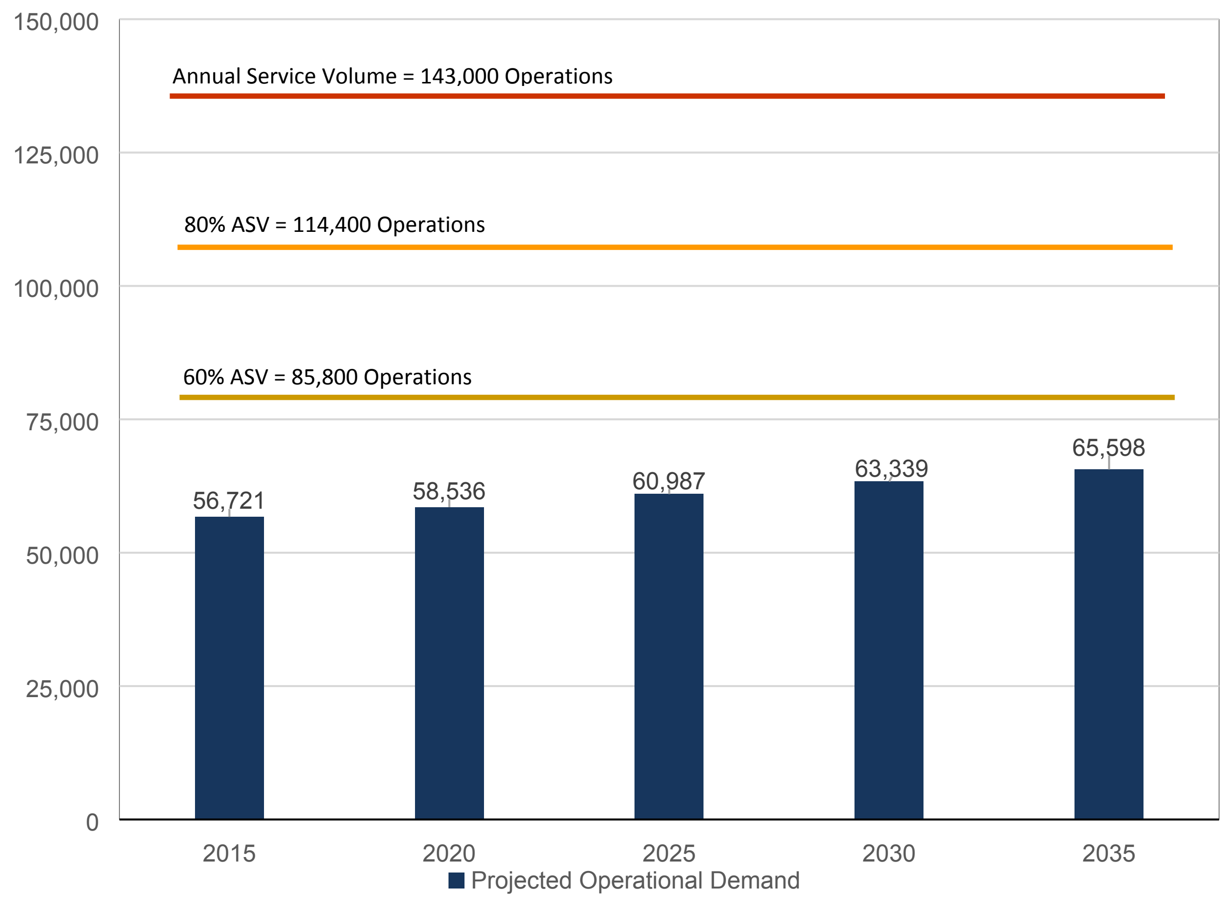
ASV = Cw* D * H

ASV = 63 * 283 * 8.02

ASV = 143,000 operations (rounded)

FAA Order 5090.3C, Field Formulation of the National Plan of Integrated Airport Systems (NPIAS) recommends that when an airport's annual operations reach 60 percent of its ASV, additional airfield facilities to increase capacity should be planned. This threshold is set low to allow time to complete a thorough investigation of alternatives and required environmental evaluations. When annual operations reach 80 percent ASV, new airport facilities should be programmed, or demand management strategies should be implemented. This is also meant to provide adequate time for planning and project implementation before demand exceeds capacity. **Exhibit 3-1** presents the projected number of total airport operations and the ASV capacity thresholds.

Exhibit 3-1 Operational Demand and Annual Service Volume



As shown above, operations at BIS are projected to remain below the 60 percent capacity planning threshold through the planning period. Therefore, the need for an additional runway to provide additional capacity is not anticipated within the 20-year planning period.

3.2 WIND COVERAGE

Airport runway layouts are typically aligned to an area's prevailing winds. Historical wind data is compiled and sorted into direction and velocity. The periodic reports that are most frequent are the ones that should determine the preferred configuration of the runway. The FAA recommends that the primary runway offer 95 percent coverage of all-weather wind conditions. Whether this is possible is based upon the type of aircraft that frequent the airfield. Due to the fact that smaller aircraft are more susceptible to crosswinds, the larger the aircraft, the larger the crosswind component that is used for a specified runway.

In evaluating wind coverage at an airport, FAA guidance notes this assessment be computed on a basis that crosswinds not exceed the maximum allowable velocities for the following aircraft categories:

- 10.5 knots for Airport Reference Code A-I and B-I aircraft
- 13 knots for Airport Reference Code A-II and B-II aircraft
- 16 knots for Airport Reference Code A-III, B-III, and C-I through D-III aircraft
- 20 knots for Airport Reference Code A-IV through D-VI aircraft

Data for BIS was taken from the on-site Automated Surface Observing System (ASOS) and includes the last 10 years of hourly observations. After sorting and analyzing this information, it was noted that the primary Runway 13/31 has an all-weather coverage of 92.85 percent at 10.5 knots. As **Table 3-3** shows, the primary runway alone does not have sufficient crosswind coverage for small aircraft. This shortfall requires a crosswind runway to service those aircraft that apply to the 10.5 knot crosswind component. With the addition of the crosswind runway, combined wind coverages are above the 95 percent threshold for all three weather variables including all weather, VFR, and IFR as well as all four aircraft crosswind categories.

Table 3-3. BIS Wind Coverage							
Crosswind Component	**Rwy 13**	**Rwy 13/31**	**Rwy 31**	**Rwy 3**	**Rwy 3/21**	**Rwy 21**	**Combined 13/31 & 03/21**
All Weather Conditions							
10.5 knots	59.02%	92.85%	67.16%	65.19%	79.48%	54.92%	97.86%
13 knots	61.11%	96.47%	69.22%	70.47%	86.88%	58.91%	99.42%
16 knots	62.75%	99.00%	70.76%	75.78%	94.15%	63.08%	99.89%
20 knots	63.25%	99.78%	71.27%	78.81%	98.16%	65.10%	99.99%
Visual Flight Rules (VFR)							
10.5 knots	58.73%	93.53%	68.14%	64.34%	79.56%	56.32%	98.10%
13 knots	60.70%	96.90%	70.04%	69.47%	86.99%	60.57%	99.51%
16 knots	62.17%	99.17%	71.42%	74.68%	94.33%	65.01%	99.90%
20 knots	62.57%	99.83%	71.85%	77.56%	98.30%	67.19%	99.99%
Instrument Flight Rules (IFR)							
10.5 knots	61.36%	89.04%	61.57%	70.53%	79.50%	47.67%	96.57%
13 knots	64.18%	93.92%	64.51%	76.36%	86.46%	50.16%	98.93%
16 knots	66.83%	97.91%	66.91%	82.06%	93.22%	52.80%	99.84%
20 knots	67.90%	99.50%	67.93%	85.87%	97.47%	53.96%	99.97%

Note: Single runway end coverage calculated with a three-knot tailwind

Source: FAA AGIS wind analysis tool

Period of Record: 2005-2015 based on 107,173 observations

VFR = Ceiling greater than or equal to 1,000 feet and visibility greater than or equal to three statute miles

Table 3-4 depicts the true bearing for the primary and crosswind runways at BIS. True bearings represent the actual latitudinal and longitudinal coordinates for each runway end. This information is used in the calculation of wind coverage depicted in Table 3-3.

Table 3-4. True Bearing Calculation				
	Runway 13	**Runway 31**	**Runway 3**	**Runway 21**
Latitude	46-47-02.2295 N	46-45-58.1454 N	46-45-45.4201 N	46-46-36.0191 N
Longitude	100-45-42.4312 W	100-44-17.231 W	100-44-54.2937 W	100-43-54.5867 W
True Bearing	137.6725	317.6897	38.9400	218.9519

Source of Coordinates: Federal Aviation Administration National Flight Data Center database
Calculated using NOAA NGS inverse computation model, NAD83 ellipsoid

Table 3-5 identifies the magnetic declination of each runway end at BIS. Magnetic declination represents the angle on the horizontal plane between magnetic north and true north. Calculating magnetic declination is necessary to determine the runway end numbers at BIS remain the same over the 20-year planning period. As shown in the table below, the magnetic declination calculation for both runways at BIS will remain unchanged; therefore, the runway end identification numbers remain current and meet FAA guidelines.

Table 3-5. Magnetic Declination Calculation				
	Runway 13	**Runway 31**	**Runway 3**	**Runway 21**
True Bearing	137.6725	317.6897	38.9400	218.9519
Declination	6° 5' E	6° 5' E	6° 5' E	6° 5' E
Magnetic Bearing	131.5892	311.6064	32.8567	212.8686
Runway Designation	13	31	3	21

Note: Magnetic declination calculated for October 31, 2016, using World Magnetic Model (WMM)

3.3 IDENTIFICATION OF DESIGN STANDARDS

The design of airport infrastructure such as runways, taxiways, and aprons is based on design standards established by the FAA. FAA AC 150/5300-13A, *Airport Design*, categorizes design standards that relate to airport infrastructure components based on a variety of factors including the approach speed, wingspan, and undercarriage dimensions of an aircraft. The following describes the two coding systems identified in FAA AC 150/5300-13A, *Airport Design*, that are used in the design and planning of airfield surfaces. **Exhibit 3-2** and **Table 3-6** show the various safety areas and dimensions associated with the RDC.

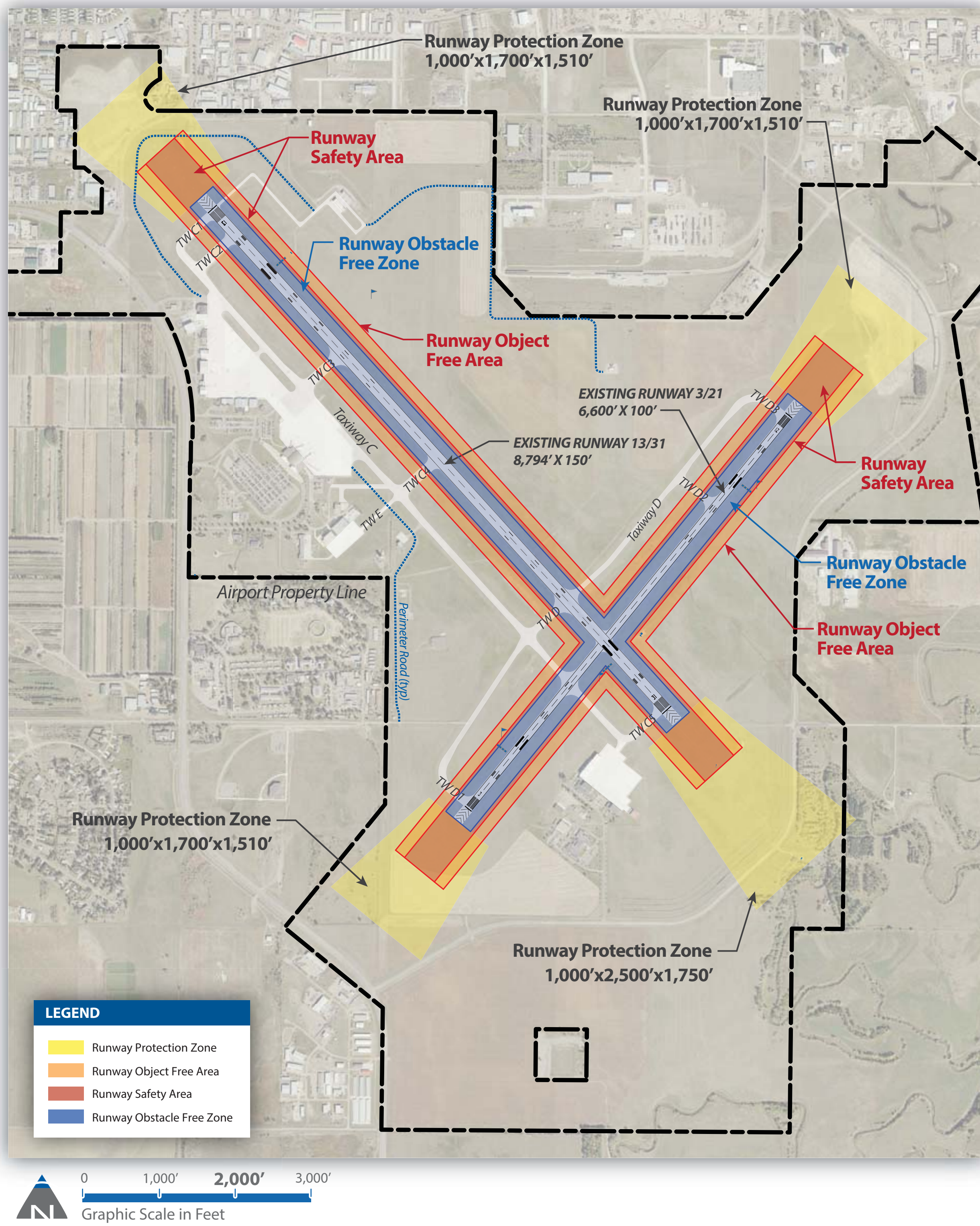


Exhibit 3-2 **Runway Surfaces**

Table 3-6: Runway Design Standards				
Criteria	13/31		03/21	
	Existing	Standard	Existing	Standard
Design				
Runway Width	150	150	100	100
Shoulder Width	25	25	20	20
Blast Pad length	200	200	200	200
Blast Pad Width	150	200	140	140
RSA				
Length	1,000	1,000	1,000	1,000
Width	500	500	500	500
ROFA				
Length	1,000	1,000	1,000	1,000
Width	800	800	800	800
ROFZ				
Length	200	200	200	200
Width	400	400	400	400
RPZ	**31**		**03**	
Length	2,500	2,500	1,700	1,700
Inner Width	1,000100	1,000100	1,000	1,000
Outer Width	1,750	1,750	1,510	1,510
RPZ	**13**		**21**	
Length	1,700	1,700	1,700	1,700
Inner Width	1,000	1,000	500	500
Outer Width	1,510	1,510	1,010	1,010
Approach Slope				
Width Beginning	1,000	1,000	1,000	1,000
Width Ending	4,000	4,000	4,000	4,000
Length	10,000	10,000	10,000	10,000
Slope	5030:1	5030:1	34:1	34:1
Departure Slope				
Width Beginning	1,000	1,000	1,000	1,000
Width Ending	6,466	6,466	6,466	6,466
Length	10,200	10,200	10,200	10,200
Slope	40:1	40:1	40:1	40:1

Source: FAA Threshold Siting Surface (TSS)

3.3.1 Runway Design Code

As many of the aircraft restrictions for airport facilities are based on the operating criteria of a given aircraft, it is first necessary to establish how aircraft are categorized. These categorizations will be used throughout this section when discussing existing restrictions and further expounded upon later in this chapter when incorporating the use of the critical aircraft identified in Chapter Two. In order to identify the appropriate design parameters for a runway and many associated facilities, aircraft are categorized by their Runway Design Code (RDC). The RDC uses the approach speed, wingspan, and tail heights of relevant aircraft. Current RDCs for both runways are identified in this section as well as the recommended future RDCs for each runway over the 20-year planning period.

The RDC is broken into separate parts: the Aircraft Approach Category (AAC), the Aircraft Design Group (ADG) and the Runway Visual Range (RVR). The AAC is designated by a letter that corresponds to the approach speed of an aircraft. AAC categories are shown by the relevant approach speeds identified in **Table 3-7**. The second component, the ADG, is represented by a Roman numeral dependent on the aircraft tail height and wingspan width. When there is a conflict between the tail height and the wingspan, the greater, or more restrictive, group identifier is used. Specific ADG dimensions can be seen in **Table 3-8**. According to the 2007 ALP, the Runway 13/31 RDC is D-IV while the Runway 3/21 RDC is C-III. It is important to note that these designations were based on the selection of a critical aircraft during the previous airport master plan. For the purposes of this analysis, the selection of the future RDCs for both runways is based on the critical aircraft identified in Chapter Two as well as the projected fleet mix anticipated to operate at BIS throughout the planning period. The sections below provide a detailed description of the RDCs recommended through 2035.

Table 3-7. Aircraft Approach Category (AAC)	
AAC	**Vref / Approach Speed**
A	Approach speed less than 91 knots
B	Approach speed 91 knots of more but less than 121 knots
C	Approach speed 121 knots or more but less than 141 knots
D	Approach speed 141 knots or more but less than 166 knots
E	Approach speed 166 knots or more

Source: FAA Advisory Circular 150/5300-13A, *Airport Design*

Table 3-8: Airplane Design Groups (ADG)		
Group	**Tail Height**	**Wingspan**
I	Less than 20 feet	Less than 49 feet
II	20 feet to less than 30 feet	49 feet to less than 79 feet
III	30 feet to less than 45 feet	79 feet to less than 118 feet
IV	45 feet to less than 60 feet	118 feet to less than 171 feet
V	60 feet to less than 66 feet	171 feet to less than 214 feet
VI	66 feet to less than 80 feet	214 feet to less than 262 feet

Source: FAA Advisory Circular 150/5300-13A, *Airport Design*

The third and final component of the RDC, the RVR, relates to the visibility minimums of an approach to a runway. Visibility restrictions often help determine the width of the pavement and the dimensions of protection surfaces. The RVR is a description of visibility minimums as defined by FAA AC 150/5300-13A, *Airport Design*, and is used in conjunction with the AAC and ADG to determine the dimensions of runway design surfaces. The RVR for each runway is shown below in **Table 3-9**.

Table 3-9: BIS Instrument Approaches			
Approach	**Visibility**	**Ceiling Limit**	**RVR**
ILS or LOC RWY 13	3/4	200	N/A
ILS or LOC RWY 31	1/2	200	2400
RNAV (GPS) RWY 13	3/4	200	N/A
RNAV (GPS) RWY 31	1/2	200	–*
RNAV (GPS) RWY 3	3/4	200	N/A
RNAV (GPS) RWY 21	3/4	250	N/A
VOR-A	1	579	N/A
ASR 31	½	500	2400
ASR 13	1	500	N/A
ASR 03	1	500	N/A
ASR 21	1	500	N/A

Note: *As these are not the most restrictive approaches, an RVR was not assigned.
ASR: Surveillance Approach Radar
All ASR approaches are given for category A.
Source: FAA Digital Terminal Enroute Procedures, 2016.

Runway 13/31 RDC

The most prominent aircraft is the CRJ 200, which comprised 52 percent of commercial aircraft in 2015, based on information obtained from the U.S. Department of Transportation's T100 Database. While the CRJ 200 is capable of slightly faster approach speeds, it generally operates within the range of 121 knots and 141 knots and has a wingspan between 49 and 79 feet. As a result, this aircraft can be described as primarily a C-II aircraft. A sample of Runway 13/31 commercial aircraft activity for year 2015 is shown in **Table 3-10** and is ranked in descending order of annual operations.

The critical aircraft factoring into runway design, particularly at busy airports, is not necessarily a single aircraft, but can be a conglomeration of the most demanding aircraft at an airport. The most demanding aircraft currently operating at BIS is the MD-83. Therefore, the RDC for Runway 13/31 for the duration of the planning period is D-III.

Table 3-10: RDC for Selected Aircraft of Runway 13/31

Aircraft Type	2015 Operations	Seating Capacity	Runway Design Code	Approach Speed (knots)	Wingspan (feet)	Tail Height (feet)
Bombardier CRJ200	5,312	50	C-II	135	69	20
Embraer 145	1,424	50	C-II	135	65	22
Airbus A319	780	128	C-III	138	112	40
MD 83	472	163	D-III	144	108	30
Bombardier CRJ900	436	86	C-III	141	81	24
Airbus A320	310	150	C-III	138	111	39
Bombardier CRJ700	262	70	C-II	137	76	24
Embraer 170	200	78	C-III	124	85	32
MD 90	98	160	C-III	138	108	31
Boeing 717-200	58	134	C-III	125	93	30
Embraer 175	44	86	C-III	124	85	31
Boeing 737-800	32	175	C-III	140	94	37
Boeing 757-200	14	180	C-IV	137	125	45
Embraer 190	12	100	C-III	124	94	35
Boeing 737-700	6	143	C-III	130	113	42

Source: BIS Airport Records, Aircraft Planning Manuals, AC 150/5300-13A *Airport Design*

Runway 3/21 RDC

At BIS, air carriers typically operate from Runway 13/31 in order to immediately access the passenger terminal and conserve fuel. General Aviation (GA) aircraft operate on both runways; however, they typically utilize Runway 3/21. As depicted in **Table 3-11**, Traffic Flow Management System Counts (TFMSC) data was used to determine the number of GA turbine aircraft operations occurring on Runway 3/21 during 2015. However, TFMSC only records activity as filed under instrument flight plans, therefore this does not reflect all operations at BIS. Although the most demanding GA aircraft is the Gulfstream IV, air carriers such as the A319 also use Runway 3/21 when crosswinds or traffic prohibit use of the primary runway. Therefore, based on existing use of the crosswind runway by air carriers and on Airport interviews, the RDC for Runway 3/21 is C-II. In addition, the crosswind runway will be able to serve air carrier traffic during the upcoming Runway 13/31 reconstruction project.

Table 3-11: RDC for Selected Aircraft of Runway 3/21

Aircraft Type	2015 Operations	Runway Design Code	Approach Speed	Wingspan	Tail Height
Existing Aircraft					
Beech 1900/C-12J	2,031	B-II	113	55	15
Cessna Encore	1,099	B-II	107	56	17
Airbus A319	780	C-III	138	112	40
Falcon 50	222	B-II	107	61	22
Cessna Citation CJ4	203	B-II	100	51	15
Embraer 170	200	C-III	124	85	32
Cessna Bravo	163	B-II	108	52	15
Hawker 800	111	C-I	128	51	18
Gulf Stream 280	50	B-II	108	63	21
Bombardier Learjet 60	40	C-I	132	43	14
Gulfstream IV/G400	25	C-II	128	77	24

Source: Aircraft Planning Manuals, AC 150/5300-13A *Airport Design*

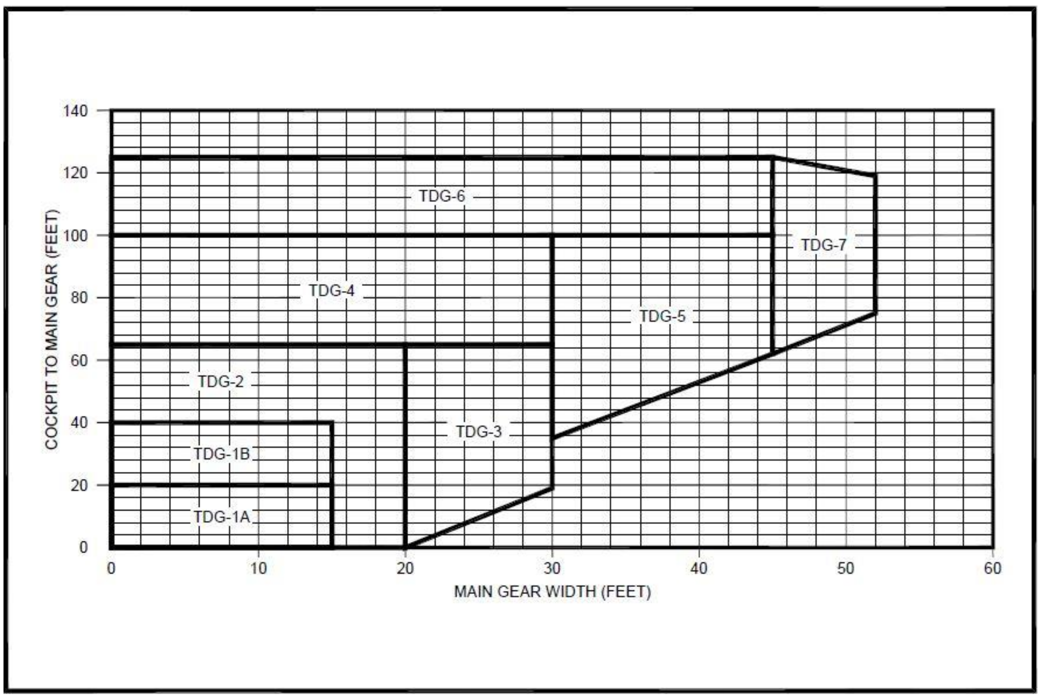
Note: As runway specific information is not available total operations are shown

3.3.2 Taxiway Design Group

In September 2012, Advisory Circular 150/5300-13A, *Airport Design*, was published, which includes updated guidance for taxiway design. Similar in determination to RDC, taxiway design is based on the combination of the taxiway design group (TDG) and ADG classification of the critical design aircraft intended to operate on the taxiway in question. The TDG classification determines the physical pavement dimensions of a taxiway, while the ADG classification determines required taxiway separations and the width of the taxiway safety area and taxiway object free area (TOFA).

Historically, taxiway pavement dimensions were designed based on the ADG of the critical aircraft. The updated guidance instead uses a TDG based upon the overall Main Gear Width (MGW) and the Cockpit to Main Gear Distance (CMG) of the critical design aircraft landing gear (see **Exhibit 3-3** for limitations). Based on the dimensions of the CRJ200, the TDG for this aircraft is TDG-1B while the MD-83 is TDG-4. Additional aircraft within the fleet (**Table 3-12**) are discussed in greater detail in a following section.

Exhibit 3-3 Taxiway Design Groups



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

Table 3-12 TDG for Selected Aircraft					
Aircraft Type	**2015 Operations**	**Seating Capacity**	**Taxiway Design Code**	**Cockpit to Main Gear**	**Main Gear Width**
Bombardier CRJ200	5,312	50	TDG-1B	37 feet	13 feet
Embraer 145	1,424	50	TDG-2	47 feet	14 feet
Airbus A319	780	128	TDG-3	45 feet	29 feet
MD 83	472	163	TDG-4	71 feet	20 feet
Bombardier CRJ900	436	86	TDG-3	56 feet	17 feet
Airbus A320	310	150	TDG-3	50 feet	29 feet
Bombardier CRJ700	262	70	TDG-3	48 feet	17 feet
Embraer 170	200	78	TDG-3	38 feet	17 feet
MD 90	98	160	TDG-4	77 feet	18 feet
Boeing 717-200	58	134	TDG-3	56 feet	20 feet
Embraer 175	44	86	TDG-3	40 feet	19 feet
Boeing 737-800	32	175	TDG-3	56 feet	23 feet
Boeing 757-200	14	180	TDG-4	72 feet	28 feet
Embraer 190	12	100	TDG-3	47 feet	21 feet
Boeing 737-700	6	143	TDG-3	47 feet	23 feet

Source: Aircraft Planning Manuals, AC 150/5300-13A *Airport Design*

3.4 RUNWAY SYSTEM

There are two intersecting runways at BIS. The primary runway, Runway 13/31, is 8,794 feet long and 150 feet wide. The crosswind runway, Runway 3/21, is 6,600 feet long and 100 feet wide. This section will discuss the various aspects of the runways and their ability to meet the current and anticipated design aircraft.

3.4.1 Runway Length

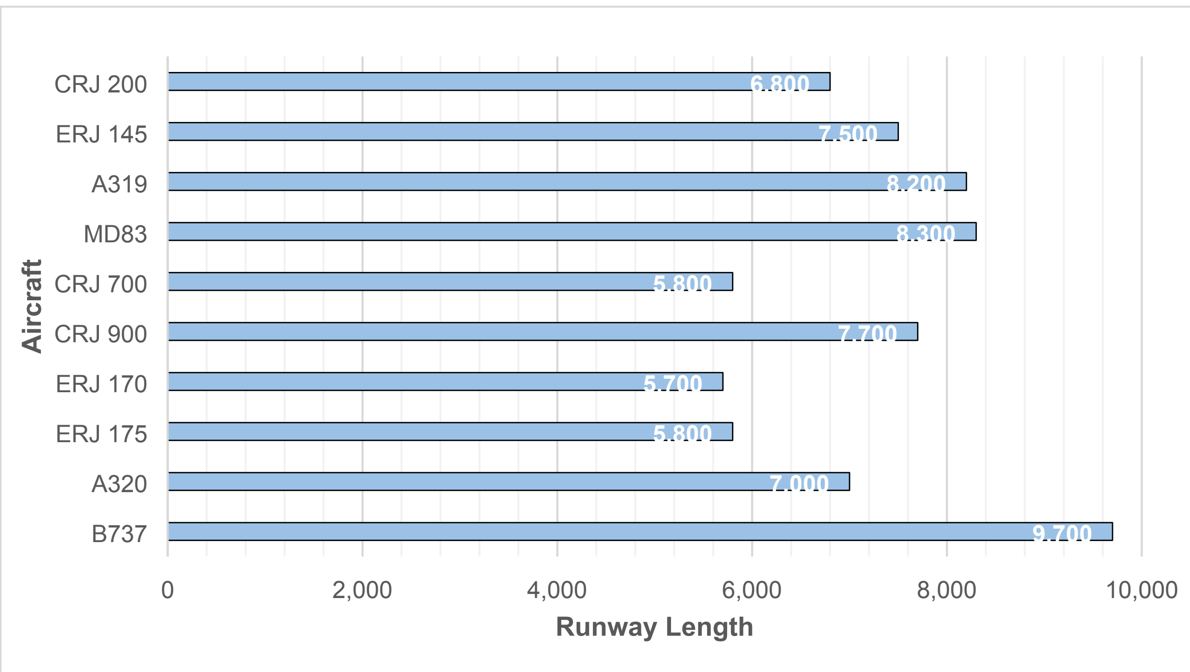
Runway lengths are determined based on the specific performance characteristics of aircraft intended to use the airport. Determining variables for runway length include the mean daily maximum temperature of the hottest month of the year, and the airport elevation. Both parameters influence air density. Air density directly impacts aircraft performance through two principles. First, the thrust generated by propeller or jet engines will be less effective at higher temperatures and elevations, as the thinner air will not produce as much forward momentum in the aircraft. Second, the air moving over the wing will not generate as much lift and greater speeds are required to generate the same amount of lift as at lower temperatures and elevations. These two principles compound to exponentially increase an aircraft's takeoff distances as temperature and elevation increase.

The length of a runway can accommodate the landing and takeoff distance requirements of the most demanding types of aircraft conducting regular operations. The length necessary is therefore dependent on aircraft performance and FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*, provides guidance on how the necessary length of the runway is to be derived based on aircraft performance. Based on this guidance the airport temperature parameter should be set equal to the mean daily maximum temperature of the hottest month at the airport. According to the National Oceanic and Atmospheric Administration (NOAA), the mean daily maximum temperature of the hottest month from 2011 to 2015 at BIS was 85.2°F, which occurred in July. The Airport elevation is 1,661 feet above sea level according to the latest FAA Airport/Facility Directory. This data was used to determine the runway length required for the critical aircraft at BIS.

Runway 13/31

The aircraft currently operating on the airport, or which may be prevalent in the future, have been discussed in Section 3.3. Required runway lengths for each air carrier aircraft at maximum takeoff weight in the conditions specific to BIS, described above, are shown below in **Exhibit 3-4**. As the upcoming runway reconstruction project will correct the existing runway grades, the existing grading was not considered when determining runway length. As Runway 13/31 is the primary runway and intended to serve air carriers, it is important to consider how many aircraft are able to operate on these runways. Runway 13/31 is 8,794 feet long and able to serve the majority of aircraft at their maximum takeoff weight either currently operating or expected to operate at BIS. The Boeing 737-800 is not able to takeoff at its maximum takeoff weight at the current runway length. This means that this aircraft must either reduce fuel on board, which would also reduce potential service range and markets, or the number of passengers and/or cargo that they carry.

Exhibit 3-4: Runway Length Requirements

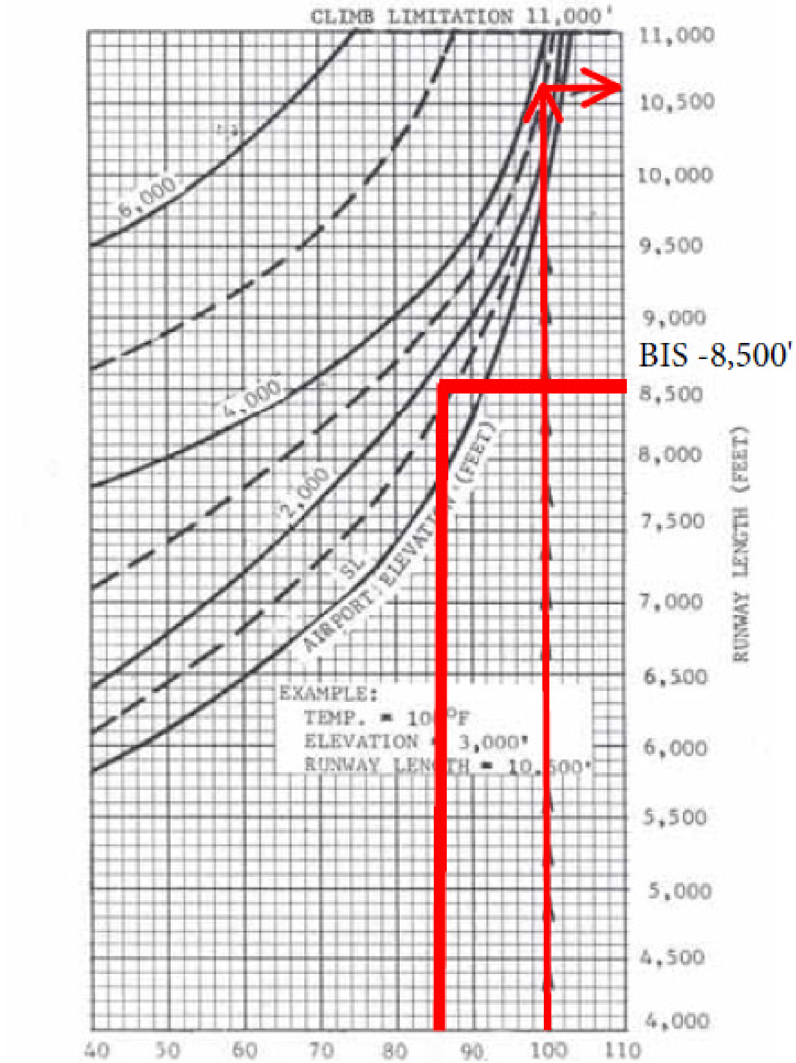


The Runway 13/31 length analysis conducted as part of the 2016 Engineering Design Report (EDR) stated that the most demanding aircraft currently operating at the Airport is the MD83 flying to various Allegiant markets, such as Las Vegas, Phoenix, and Orlando. Of these destinations, Orlando would be the most demanding, requiring a runway length of 8,100 feet. That flight is currently served by an A319 although Allegiant has a substantial fleet of MD83s and, in 2014, used the MD83s to service Orlando from BIS 11 times. When determining runway requirements for corporate aircraft, a calculation for 100 percent of the fleet at a 90 percent useful load supported the need for a length of at least 8,500 feet, as shown in **Exhibit 3-5**. When grade changes in the runway are considered as well, this brings the total required runway length to 8,600 feet. Shortening the runway to this length was estimated approximately $1 million more expensive that reconstruction at its current length due to shifting the associated NAVAIDS (i.e. PAPI, MALS), ILS approach equipment and any additional FAA costs and time for development of new approaches. Therefore, the current length of 8,794 feet is the recommended length for the duration of the 20-year planning period.

Runway 3/21

Runway 3/21 is the crosswind runway at BIS. Therefore, it tends to serve GA aircraft and air carrier traffic when crosswind conditions are not favorable or when Runway 13/31 is occupied. Since the growth of oil development in the western half of North Dakota in 2010, GA activity of aircraft weighing between 12,500 – 60,000 pounds has increased considerably. The 2015 Engineering Design Report (EDR) stated that in 2013, 1,800 operations occurred in this category while in 2014, activity increased to 2,100 operations. A 90 percent useful load is used in the analysis for runway length due to the range and onboard fuel of the jets. A summary of these jets based at BIS are shown below in **Table 3-13**.

Exhibit 3-5: EDR Runway Length Requirement



Source: 2016 EDR, AC 150/5325-4B, *Runway Length*

Table 3-13: Based Jet Operations				
Company	Aircraft	Typical Stage Length	Flights at or above 90% Useful Load	RDC
Basin Electric	2 Cessna Encores	500 – 600 miles	40%	B-II
MDU	Cessna Encore	500 – 600 miles	75%	B-II
	Cessna Bravo	600 – 700 miles		B-II
Rocket Man	Falcon 50	600 – 700 miles	60%	B-II
	Beech Jet	600 – 700 miles		C-I
MBI Leasing	Gulf Stream 280	+ 1,000 miles	60% – 70%	B-II
	Cessna Citation CJ4	+ 1,000 miles		B-II

Source: Bismarck Airport Records, Mead & Hunt, 2016

The current length of Runway 3/21 is able to serve most aircraft. The Beechjet 1900 and Gulfstream IV are not able to depart at maximum takeoff weight (MTOW). While the Beechjet is a common aircraft at BIS (in 2015 it conducted at least 2,031 operations) its limitation is not thought to affect normal operations. The Gulfstream IV does not operate with enough frequency to justify a longer runway length at this time. Therefore, Runway 3/21 is of sufficient length for the duration of the planning period.

3.4.2 Runway Width

Although the length of a runway is based on the specific operating needs of the critical aircraft, the width of a runway is based directly on its RDC. However, in addition to the width of the runway itself, the width of the shoulders of the runways and the attached blast pads should also be considered. The shoulder and blast pads of a runway protect the surrounding earth from erosion due to jet and prop wash while also supporting maintenance and emergency vehicles. Although neither runway at BIS has paved shoulders, they are required for runways accommodating ADG IV and higher and are recommended for runways accommodating ADG III aircraft. The required width for each of these aspects of the runway are shown in **Table 3-14**. In summary, Runway 13/31 lacking paved shoulders and the width of the blast pads are 150 feet and do not meet existing standards. While Runway 3/21 does not have paved shoulders, it does not require them as it is not intended to serve ADG IV aircraft. Additionally, the width of blast pads for Runway 13/31 will be increased to achieve compliance with current FAA requirements as part of the Runway 13/31 reconstruction project.

Table 3-14: Runway Width Requirements

Runway	RDC	Runway Width	Shoulder Width	Blast Pad Width
Runway 13/31	D-III	150 feet	***25 feet***	***200 feet***
Runway 3/21	C-II	100 feet	20 feet	140 feet

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

Note: Bold italicized text may note a discrepancy between FAA Standards and actual runway measurements

3.4.3 Runway Grade

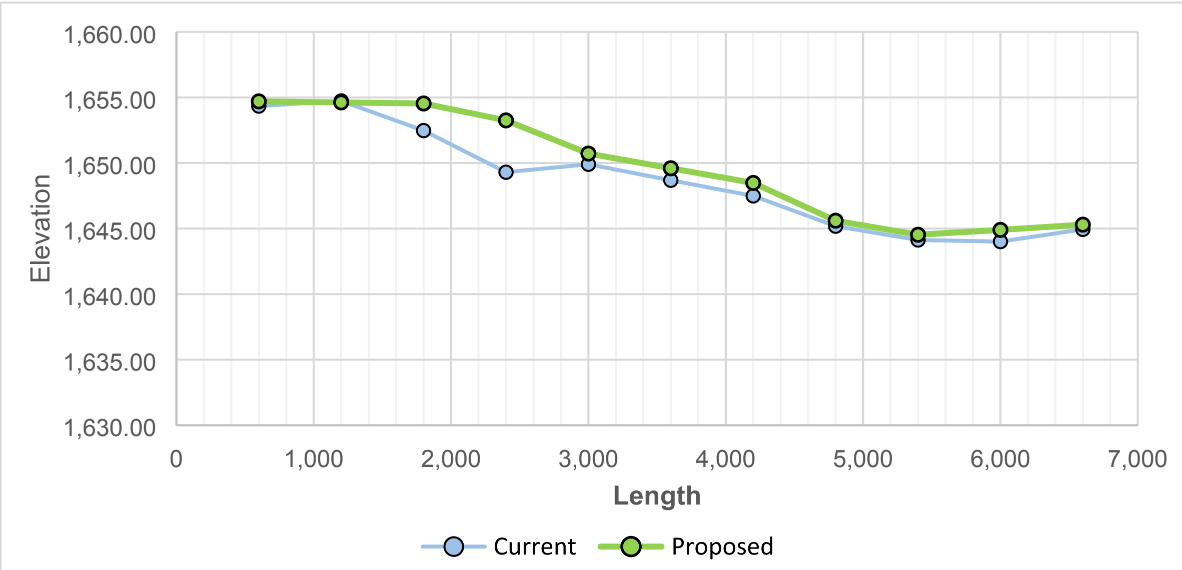
Runway gradient design standards are outlined in FAA AC 150/5300-13A, *Airport Design*, so that pilots and air traffic controllers can view that any one point on a runway is clear of aircraft, vehicles, wildlife, and other objects. Design standards for longitudinal and transverse runway grades are based on the AAC of the critical design aircraft. Gradient standards are the same for AAC category C, D, and E aircraft with the maximum allowable longitudinal grade change between runway ends being ±1.50 percent; it should be noted that the longitudinal grade may not exceed ±0.80 percent in the first and last quarter of a runway. Although there are grading concerns, the current line of sight for the runways are sufficient and will be maintained during the implementation of the Runway 13/31 rehabilitation project.

Excerpts from the 2016 EDR summarize the findings associated with the runway grading. The current Runway 13/31 profile does not meet FAA design standards as the runway has grade changes in the first and last quarter of the runway, as shown in **Exhibit 3-6**. The proposed grading in the EDR has also been designed to meet current FAA runway grading standards; however, it should be noted that these grades are approximations and subject to change during final design. Additionally, the Runway Safety Area (RSA) of Runway 13/31 1,000 feet off the longitudinal grade changes over 2.0 percent in 100 feet. At various points along the runway, the graded shoulder does not meet grading requirements of 1.5 to 5 percent per FAA design standards. The Runway 13 end profile and Runway 31 end profile do not meet the FAA design standards, which does not allow grade changes in the first and last quarter, or first and last 2,500 feet of the runway, whichever is less. The Object Free Area (OFA) by Taxiway B does not meet FAA design standards because the existing ground is higher than the existing runway centerline elevation. The connecting Taxiway C5 profile elevation is higher than the runway centerline profile, which does not meet FAA design standards. The Airport has recently received a FAA Airport Improvement Plan (AIP) Grant which will fund the reconstruction of Runway 13/31. This AIP project is anticipated to begin in mid-2017 and will correct existing runway grade deficiencies.

3.4.4 Airfield Pavement Strength & Condition

As part of the September 2015 Pavement Condition Index (PCI), the BIS airfield was examined by Applied Pavement Technology, Inc. (APTech) under a FAA AIP planning grant to the ND Aeronautics commission to determine the condition of pavement surfaces and develop recommendations for future rehabilitation and repair. The PCI is a rating system that gives a numerical value to the existing condition of pavement based on distresses observed on the surface. To conduct this evaluation, past pavement management records were reviewed from the State of North Dakota airport pavement management system, construction history information, and traffic data. Visual pavement condition inspections were used to determine the PCI.

Exhibit 3-6: Runway 13/31 Grade



Source: Mead & Hunt, 2016

Note: Elevations are approximate and for planning purposes only.

As discussed in Chapter 1, the PCI scale ranges from a value of 0 for pavements in a completely failed condition to a value of 100 for pavement in perfect structural condition. As shown in **Table 3-15**, each PCI value corresponds to a required level of treatment in order to restore or maintain pavement to an operable condition.

The overall PCI value of BIS airfield pavements is 69 with conditions ranging from 2 to 100. The highest PCI values were found around newly constructed pavement, such as some of the apron terminal area and the recently reconstructed sections of Taxiway B. The lowest PCI values are found on various areas of Runway 13/31 (PCI 32) and near the passenger terminal (PCI 29). A summary of the PCI values for Airport surfaces can be seen in **Table 3-16** and **Exhibit 3-7** and a comprehensive list of pavement condition by branch (as labeled by Exhibit 3-7) can be seen in **Table 3-17**.

Table 3-15: Pavement Conditions	
PCI	**Condition**
100 – 71	Preventive Maintenance
70 – 41	Major Rehabilitation
40 – 0	Reconstruction

Source: 2015 Pavement Condition Index Report

Table 3-16: PCI Change over Time			
Pavement Surface Branch	**2015 PCI (Existing)**	**2020 PCI**	**2025 PCI**
Runways			
Runway 3/21	84-54	72-46	59-35
Runway 13/31	94-32	83-19	74-07
Taxiways			
Taxiway B	94	85-83	73-71
Taxiway C	79-37	66-24	58-14
Taxiway D	87-30	75-17	63-05
Taxiway E	97-2	93-0	89-0
Aprons			
Air Carrier Apron	98-29	91-10	84-0
GA Apron	100-31	94-13	87-0

Source: ND Aeronautics Commission Pavement Management System Update

Notes: Table assumes no maintenance during the periods shown.

More information on PCIs is provided in Chapter 1 Section 1.6.1

As Runway 13/31 is the primary runway at BIS and is intended to support the most demanding aircraft utilizing the Airport, any deterioration for this runway will affect usefulness of the Airport as a whole. In its present condition, the North Dakota Aeronautics Commission Pavement Management System's PCN results states that "Runway 13/31 is not structurally adequate to handle regular operations of a fully-loaded B787-8, B737-800, or MD83 aircraft." Of the airframes listed, the B737-800 and MD83 are currently operating at the Airport. As stated previously, the Airport is currently completing the engineering design for the full reconstruction of Runway 13/31 and will be begin construction in mid-2017. The preliminary costs for maintenance and repairs based on an unlimited budget are shown in **Table 3-18**.

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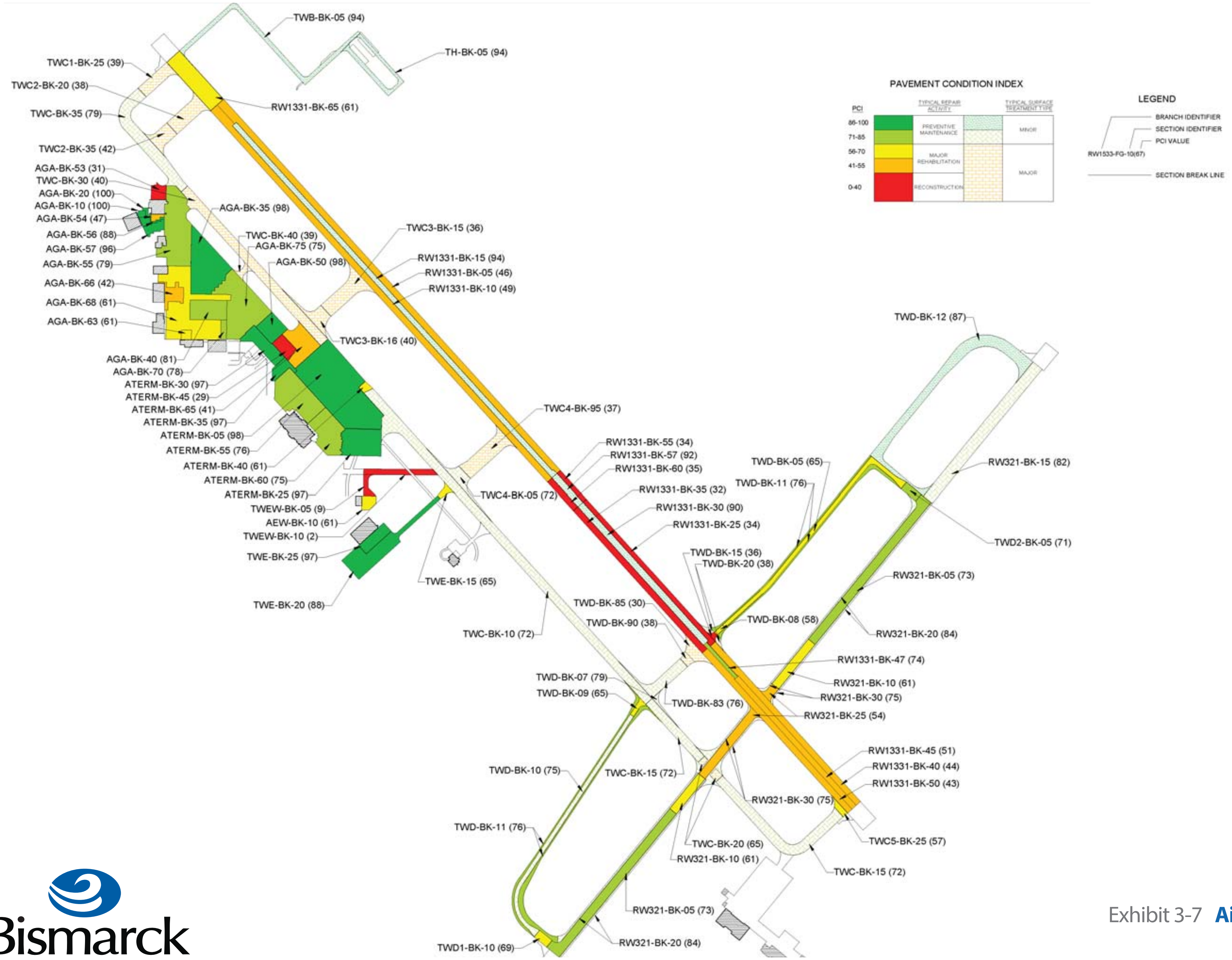

Exhibit 3-7 **Airport PCI Map**

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Table 3-17: Pavement Condition by Section				
Branch	Section	Section Area (square feet)	Projected PCI Before Work	Projected PCI After Work
AEW-BK	10	13,036	61	100
AGA-BK	35	128,898	98	99
AGA-BK	40	54,440	81	81
AGA-BK	53	16,760	30	100
AGA-BK	54	5,264	47	100
AGA-BK	*55*	146,784	79	82
AGA-BK	57	14,705	96	99
AGA-BK	63	7,177	61	100
AGA-BK	66	25,970	42	100
AGA-BK	68	172,613	61	100
AGA-BK	75	150,248	75	80
ATERM-BK	40	6,270	60	100
ATERM-BK	45	23,066	28	100
ATERM-BK	*55*	110,916	76	80
ATERM-BK	60	78,557	75	80
ATERM-BK	*65*	61,804	40	100
RW1331-BK	5	233,539	45	100
RW1331-BK	10	235,459	49	100
RW1331-BK	15	184,633	94	99
RW1331-BK	25	67,549	33	100
RW1331-BK	30	93,729	90	96
RW1331-BK	35	88,374	31	100
RW1331-BK	40	97,045	43	100
RW1331-BK	45	74,381	51	100
RW1331-BK	47	12,681	74	100
RW1331-BK	50	98,495	42	100
RW1331-BK	55	13,300	33	100

Table 3-17: Pavement Condition by Section (continued)				
Branch	**Section**	**Section Area (square feet)**	**Projected PCI Before Work**	**Projected PCI After Work**
RWI331-BK	57	19,394	92	98
RW1331-BK	60	17,688	34	100
RW1331-BK	65	85,200	60	100
RW321-BK	5	248,650	73	100
RW321-BK	10	67,010	61	100
RW321-BK	15	150,300	82	90
RW321-BK	20	104,700	84	94
RW321-BK	25	66,430	54	100
RW321-BK	30	44,486	75	93
TH-BK	5	38,825	94	100
TWB-BK	5	75,827	94	100
TWC1-BK	25	35,310	39	91
TWC2-BK	20	47,965	38	94
TWC2-BK	35	30,287	42	97
TWC3-BK	15	65,008	36	91
TWC3-BK	16	30,686	40	96
TWC4-BK	5	27,213	72	92
TWC4-BK	95	65,520	37	80
TWC5-BK	25	7,390	57	100
TWC-BK	10	295,514	72	88
TWC-BK	15	174,205	72	90
TWC-BK	20	9,800	65	81
TWC-BK	30	145,819	40	92
TWC-BK	35	108,925	79	99
TWC-BK	40	8,150	39	95
TWD1-BK	10	10,460	69	78
TWD2-BK	5	12,390	71	78
TWD-BK	5	82,960	65	100

Table 3-17: Pavement Condition by Section (continued)				
Branch	Section	Section Area (square feet)	Projected PCI Before Work	Projected PCI After Work
TWD-BK	7	5,703	79	93
TWD-BK	8	3,330	58	100
TWD-BK	9	7,090	65	100
TWD-BK	10	80,760	75	80
TWD-BK	11	157,430	75	100
TWD-BK	12	169,760	87	90
TWD-BK	15	2,990	35	100
TWD-BK	20	7,260	38	87
TWD-BK	83	43,250	76	91
TWD-BK	85	21,000	30	82
TWD-BK	90	7,780	38	85
TWE-BK	15	7,380	65	97
TWE-BK	20	96,280	88	94
TWEW-BK	5	10,449	9	100
TWEW-BK	10	29,125	2	100

Source: 2015 PCI Study

Table 3-18: BIS Five Year Repair Cost				
Area	Preventative maintenance	Surface Treatment	Major Maintenance and Rehabilitation	Total
GA Apron Total	$18,219	$0	$2,691,574	$2,709,793
Air Carrier Apron Total	$171,416	$0	$1,044,271	$1,215,687
Runway 13/31 Total*	$0	$232,250	$9,900,173	$10,132,423*
Runway 3/21 Total	$3,397	$291,431	$2,134,644	$2,429,472
Taxiway B Total	$0	$89,429	$0	$89,429
Taxiway C Total	$20,323	$1,149,055	$59,490	$1,228,868
Taxiway D Total	$7,136	$289,812	$1,313,690	$1,610,638
Taxiway E Total	$83,636	$11,513	$464,203	$559,352
Grand Total	***$304,127***	***$2,063,490***	***$17,608,045***	***$19,975,662***

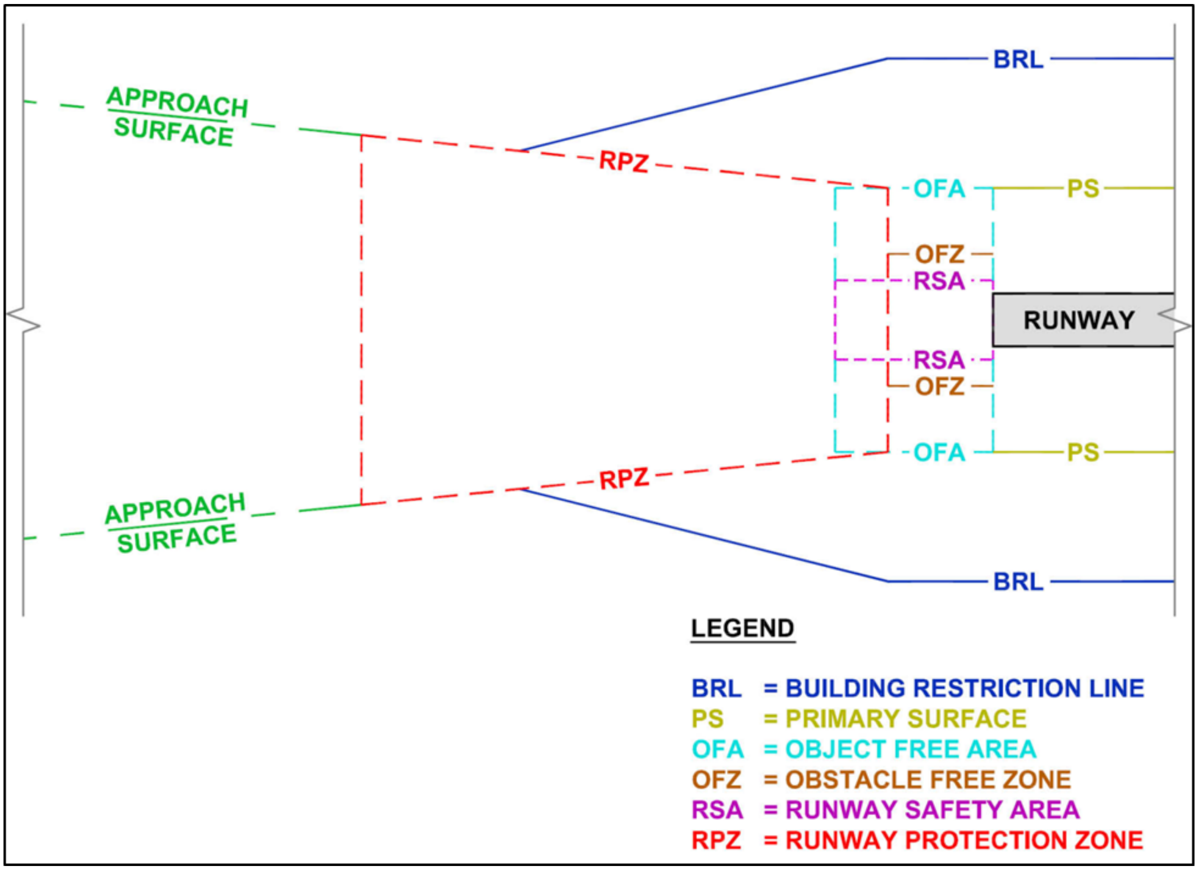
Source: 2015 PCI Study Executive Summary

*Runway 13/31 has since been slated for a full reconstruction at a cost of $69,000,000

3.4.5 Runway Design Surfaces

In addition to the length, width, and strength of the pavement surface, there are also a number of other design components associated with runways that protect aircraft from obstructions and provide a margin of safety in the event of an unintentional deviation from the runway. As illustrated in **Exhibit 3-8** below and in Exhibit 3-2, in the beginning of this chapter, these surfaces include safety areas, object free areas, and protection zones. The following section reviews each of these design surfaces as they are associated with BIS runways, and evaluates if dimensional changes will be needed to accommodate aircraft that are project to operate there during the planning period.

Exhibit 3-8: Runway Design Surfaces



Source: Mead & Hunt, Inc. (2016)

Runway Safety Area – The Runway Safety Area (RSA) is a two-dimensional surface at the elevation of the runway that is centered on the extended centerline which provides an area to support an aircraft in the event of an unintended excursion from the runway surface. According to FAA AC 150/5300-13A, *Airport Design*, runway safety areas must be:

- Cleared, graded, free of hazardous surface variations, and properly drained.
- Capable of supporting an aircraft without causing structural damage as well as airfield maintenance and emergency response vehicles.

- Free of objects except those which are necessary such as navigational signs and lighting upon which must be mounted on low-impact resistant supports.

The dimensions of the RSA for each runway are shown below in **Table 3-19**.

Table 3-19: RSA Dimensions				
Runway	**RDC**	**Length Beyond Departure End**	**Width**	**Length Prior to Threshold**
Runway 13/31	D-III	1000	500	600
Runway 3/21	C-II	1000	500	600

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

As noted, the RSA must be kept free of objects except those necessary by function. The Runway 31 RSA extends 1,000 feet beyond the approach end of the runway, and the localizer antenna for Runway 31 is located 1,000 feet from the approach end of the runway, outside of the RSA. It should be noted that the FAA has recently placed an emphasis on maintaining safety areas that meet design standards and are free of all objects, except those necessary by function which must be mounted on low-impact resistant supports. Most of the objects within the RSA, such as potions of the approach lighting system, are fixed by function with the RSA. However, it is possible to reduce the presence of the radar and MALSR access roads within the RSA. The upcoming runway rehabilitation project will consider rerouting these access roads to minimize conflicts with the RSA.

Grading of the RSA is also important to allow for emergency and maintenance vehicles to access aircraft deviating from the runway. The grading along the extended centerline is not within current FAA standards. According to AC 150/5300-13A, *Airport Design*, the first 200 feet of the RSA beyond the runway ends, the longitudinal grade should be between 0 and 3.0 percent. The remainder of the grade may not allow penetration of the

RSA with any applicable approach surface or clearway plane. Although neither end of Runway 13/31 meets this standard, the upcoming Runway 13/31 rehabilitation project will bring the grading back into current FAA RSA grading standards.

Runway Object Free Area – The Runway Object Free Area (ROFA) is also a two-dimensional ground area at the elevation of the runway and centered on its extended centerline; however, the function of the ROFA varies from the RSA in that it is intended to protect aircraft operating on the runway and within the RSA from colliding with objects. It should be noted that the FAA prohibits aircraft from parking within the OFA, except for ground maneuvering purposes, and all above-ground objects protruding from the edge of the RSA elevation, except those fixed by function for navigational purposes. Dimensions of an ROFA are based on the critical design aircraft intended to use a runway and its approach visibility minimums. The ROFA for Runway 13/31 and Runway 3/21 is 800 feet wide and extends 1,000 feet beyond each runway end meeting design standards for RDC category D-III and C-II aircraft, respectively.

The glide slope antenna for Runway 31 lies within the ROFA for Runway 3/21. In addition, the Runway 13 glideslope is less than 400 feet from the centerline of Runway 13/31 and lies within the ROFA. Both glideslopes are owned and maintained by FAA. While above-ground objects that are fixed by function for navigational purposes can protrude from the edge of the RSA elevation within the OFA, the FAA recommends that glide slope antennas be located a minimum of 400 feet from the centerline of a runway. The Runway 13/31 EDR report considered the relocation of the glide slope antenna for Runway 31; however, it was recommended to keep this glide slope in its current location based on the decision to maintain Runway 13/31 at its current length. Neither BIS nor the FAA plan to relocate the Runway 31 glideslope antenna as part of the Runway 13/31 reconstruction project. The potential relocation of the Runway 13 glideslope antenna will be examined during the airport alternatives chapter. Finally, a small segment of the airport perimeter roadway extends into the ROFA located north of Runway 13. Current FAA standards prohibit roads within critical safety areas such as the ROFA; however, because the road is used solely by the Airport for perimeter access and is located in the far northern corner of the ROFA, FAA has allowed the road to remain in its current location. Options for achieving FAA ROFA compliance will be addressed during the airport alternatives chapter. Finally, the ROFA also overlaps the airport perimeter road north of Runway 13.

Obstacle Free Zone – The Obstacle Free Zone (OFZ) is a three-dimensional volume of airspace located along the runway and beyond its end. Clearing standards prohibit taxiing aircraft, parked aircraft, vehicles, and other objects, except those fixed by function, from being located within the OFZ when aircraft are departing from or arriving to a runway surface. The OFZ is comprised of three design elements, each of which are described in the following summaries:

- **Runway Obstacle Free Zone –** The Runway Obstacle Free Zone (ROFZ) extends 200 feet beyond the end of a runway at a width determined by the type of aircraft conducting operations on the runway surface. Since all the runways are designated for use by aircraft over 12,500 pounds, the ROFZ width is 400 feet for all runways. As there are no known noncompliant objects within the ROFZ's, no improvements are anticipated to be needed to the ROFZs associated with these runways.
- **Inner-approach OFZ –** The inner-approach OFZ is a volume of airspace centered on the runway centerline and only applies to runways with an approach lighting system (ALS). The inner approach OFZ begins 200 feet beyond the runway threshold and extends 200 feet beyond the last light unit in the ALS. The width is the same as the ROFZ and rises at a slope of 50:1 outward and upward from the beginning of the surface located 200 feet beyond the end of the runway. Since only Runways 13 and 31 are equipped with an ALS, an inner approach OFZ is located 200 feet beyond the end of the runway at a width of 400 feet and extends outward and upward at a slope of 50:1 to a horizontal distance of 2,980 feet on the 13 end and 2,660 feet off the 31 end, which extends 200 feet beyond the last light units of

the ALS. The inner-approach OFZ at the approach ends of Runways 13 and 31 meet FAA design standards; as such, improvements are not anticipated during the planning period.

Runway Protection Zone – The Runway Protection Zone (RPZ) is designed to enhance the protection of people and property on the ground. RPZs are to be controlled by an airport and be clear of any incompatible land uses such as occupied buildings, concentrations of people, wildlife attractants, and objects of height. The RPZ is trapezoidal in shape and centered on the extended centerline of the runway located 200 feet beyond the end of a paved runway surface with an inner and outer width that is based on the AAC of the critical design aircraft and type of approach to the runway. **Table 3-20** presents the dimensions of the approach RPZ located at either end of each runway.

Table 3-20: Runway Protection Zone Dimensions

Dimensions	Runway			
	31	13	03	21
Runway Design Code (RDC)	D-III	D-III	C-II	C-II
Visibility Minimums (miles)	1/2	3/4	3/4	1
Length	2,500 feet	1,700 feet	1,700 feet	1,700 feet
Inner Width	1,000 feet	1,000 feet	1,000 feet	1,000 feet
Outer Width	1,750 feet	1,510 feet	1,510 feet	1,510 feet

Source: FAA Advisory Circular 150/5300-13A, *Airport Design*

It should be noted that the dimensions of the RPZs found at each end of all runways meet FAA design standards as identified in FAA AC 150/5300-13A, *Airport Design*, for their respective RDC categories if the approach visibility minimums to either end of the runways remain unchanged. Changes to the dimensions and/or locations to the RPZs are only anticipated if a runway is extended and/or an instrument approach with lower visibility is developed for the runway. The FAA recommends that land within an RPZ be controlled by an airport to prevent and eliminate incompatible objects and activities for the protection of people and property on the ground. Should any runway be extended, or an approach with increased visibility minimums be developed, the acquisition of land or an easement may be needed should any portion of a relocated or increased RPZ fall outside existing Airport property to control incompatible land uses. Existing easements for the RPZs include the northern portion of the Runway 13 RPZ and the eastern section of the Runway 31 RPZ. Both easements are outside of the perimeter fence. RPZs for Runway 3/21 are owned entirely by the Airport.

There are some public roadways within the RPZs, such as Airport Road near the approach end of Runway 13 and Yegan Road near the approach end of Runway 31. The elevation of Yegan Road exceeds the elevation of Runway 31 end by approximately 10 feet. Based on current FAA RPZ guidance, public roadways within the RPZ are highly discouraged and may have to be relocated if Runway 13/31 is ever extended. In contrast, the elevation of Airport Road is approximately 10 feet less than the elevation of Runway and does not have an adverse effect on the Airport. Additionally, none of the RPZs include any land uses that are residential or places of assembly. Therefore, the RPZs comply with the interim FAA design standards guidance. Based upon the interim guidance, regional and ADO staff must consult with FAA Headquarters if any of the conditions in **Table 3-21** are met.

Table 3-21: New or Modified Land Uses in the RPZ Requiring Coordination
1. An airfield project (e.g., runway extensions, runway shift)
2. A Change in the critical design aircraft that increases the RPZ dimensions
3. A new of revised instrument approach procedure that increases the RPZ dimensions
4. A local development proposal in the RPZ (either new or reconfigured)

Source: FAA *Interim RPZ Guidance*, 2012.

In addition to the physical dimensions of the runways, there are also a few design components associated with the runway to ensure safety by protecting aircraft from obstruction and provide a buffer area in the event on an unintentional deviation from the runway. This section will provide a review of the purpose and dimensions of each of these design surfaces as they are associated with BIS and evaluate any necessary changes during the planning period.

Threshold Sitting Requirements

The threshold of the runway is generally where the takeoff roll begins and the landing roll ends. The approach and departure surfaces associated with the threshold are intended to protect the use of the runway for arriving and departing aircraft. The specific dimensions of these surfaces are determined based off the type of aircraft that the runway is intended to serve, and the approach types associated with the runway. The dimensions of each surface are shown below based on runway type in **Exhibit 3-9** and **Exhibit 3-10**.

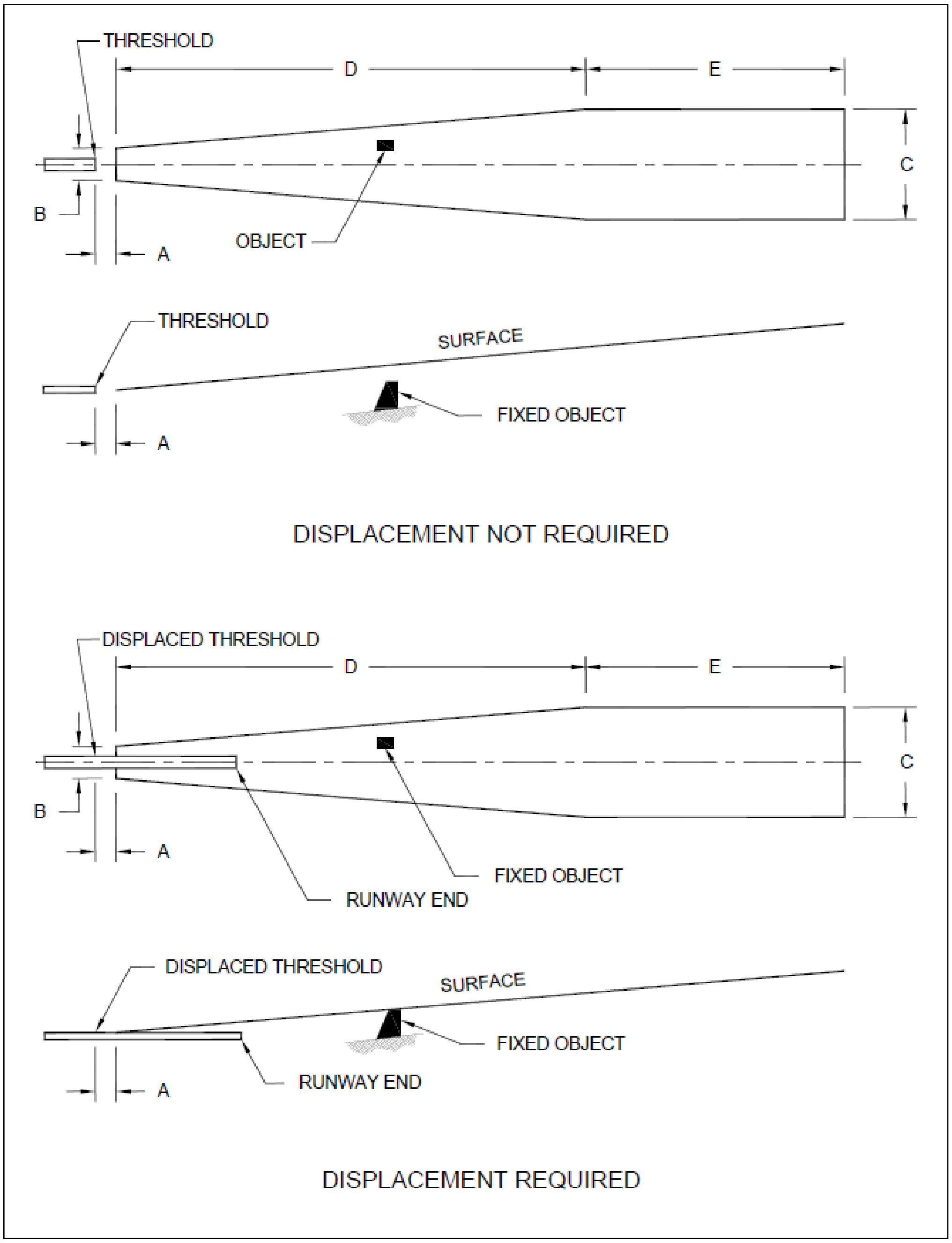
As Runway 13/31 offers vertical guidance due to its ILS approaches, it is categorized as a Type 8 runway. Runway 3/21, due to its lack of instrument approaches with visibility minimums less than 3/4 mile is classified as a Type 6 Runway. The dimensions of the approach surfaces for each of these runways are depicted in Exhibit 3-10.

Exhibit 3-9: Approach/Departure Standards Table

Runway Type		DIMENSIONAL STANDARDS* Feet (Meters)					Slope/ OCS
		A	B	C	D	E	
1	Approach end of runways expected to serve small airplanes with approach speeds less than 50 knots. (Visual runways only, day/night)	0 (0)	120 (37)	300 (91)	500 (152)	2,500 (762)	15:1
2	Approach end of runways expected to serve small airplanes with approach speeds of 50 knots or more. (Visual runways only, day/night)	0 (0)	250 (76)	700 (213)	2,250 (686)	2,750 (838)	20:1
3	Approach end of runways expected to serve large airplanes (Visual day/night); or instrument minimums ≥ 1 statute mile (1.6 km) (day only).	0 (0)	400 (122)	1000 (305)	1,500 (457)	8,500 (2591)	20:1
4	Approach end of runways expected to support instrument night operations, serving approach Category A and B aircraft only. [1]	200 (61)	400 (122)	3,800 (1158)	10,000 [2] (3048)	0 (0)	20:1
5	Approach end of runways expected to support instrument night operations serving greater than approach Category B aircraft. [1]	200 (61)	800 (244)	3,800 (1158)	10,000 [2] (3048)	0 (0)	20:1
6	Approach end of runways expected to accommodate instrument approaches having visibility minimums ≥ 3/4 but <1 statute mile (≥ 1.2 km but < 1.6 km), day or night.	200 (61)	800 (244)	3,800 (1158)	10,000 [2] (3048)	0 (0)	20:1
7	Approach end of runways expected to accommodate instrument approaches having visibility minimums < 3/4 statute mile (1.2 km).	200 (61)	800 (244)	3,800 (1158)	10,000 [2] (3048)	0 (0)	34:1
8[3,5,6,7]	Approach end of runways expected to accommodate approaches with vertical guidance (Glide Path Qualification Surface [GQS]).	0 (0)	Runway width + 200 (61)	1520 (463)	10,000 [2] (3048)	0 (0)	30:1
9	Departure runway ends for all instrument operations.	0 [4] (0)	See Figure 3-4.				40:1

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

Exhibit 3-10: Threshold Siting Based on Approach Slope



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

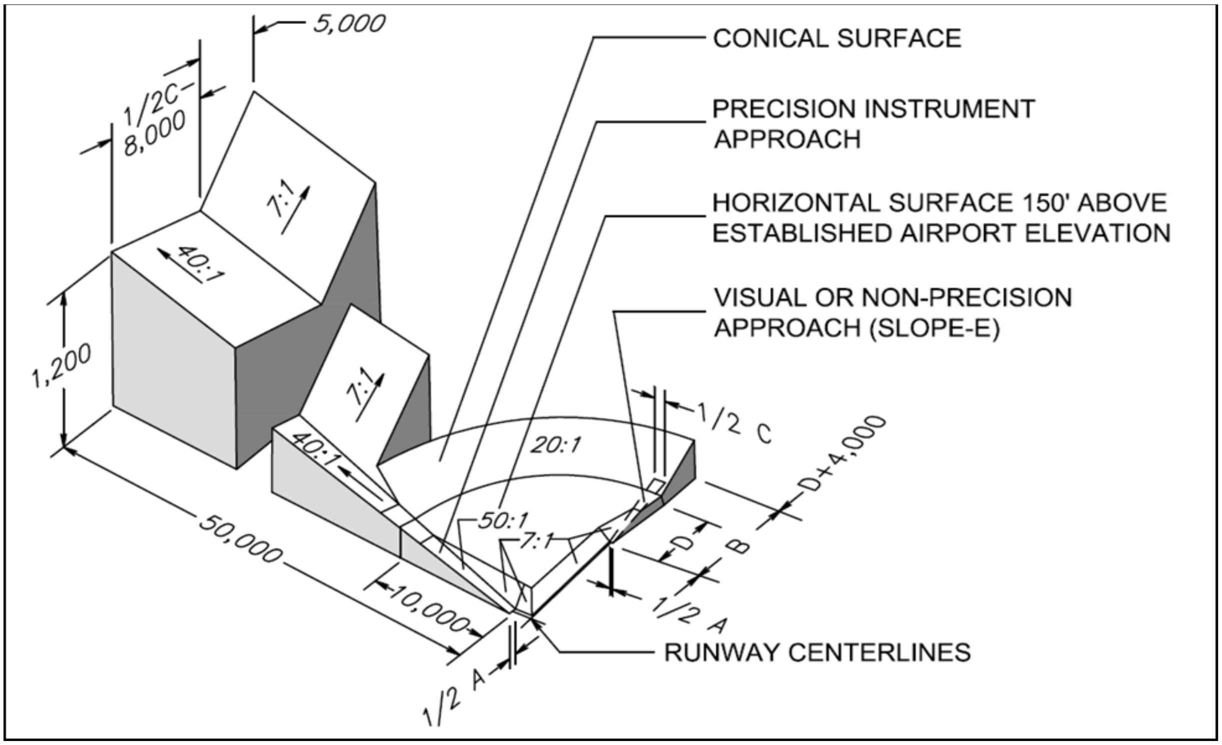
Federal Aviation Regulation Part 77 Surfaces

Airspaces surrounding the Airport allow the transition from the National Airspace System to the airport and other destinations. To provide a safe environment during takeoff, landing, and transition in and out of the airspace, Federal Aviation Regulation (FAR) Part 77, Safe Efficient Use and Preservation of the Navigable Airspace, enacts five "imaginary surfaces" that surround physical Airport surfaces. The dimensions of each of these surfaces are based on the category of runway as defined by FAR Part 77 and the most precise approach (existing or planned) for a runway end. A description of the five FAR Part 77 imaginary surfaces and discussion of their dimensions as they relate to the BIS runways are presented in the following sections and are illustrated in **Exhibit 3-11**.

Primary Surface – The primary surface is a two-dimensional surface centered longitudinally on a runway and extends 200 feet beyond the end of a prepared hard surface (or at the end of a runway if there is no prepared hard surface). The elevation of the primary surface is the same elevation as the nearest point on the runway centerline and has a width based upon the designation of the runway and type of the approach. For paved runways, such as the runways at BIS, the primary surface extends 200 feet beyond the end of that runway, while the width is determined by the approach to the runway. Runway 13/31 is equipped with a precision Instrument Landing System (ILS) approach to each end; therefore, the width of the primary surface is 1,000 feet. Runway 3/21 is equipped with a GPS RNAV approach and has visibility limits of 3/4 miles; therefore, the primary surface also has a width of 1,000 feet.

Approach Surface – The approach surface is centered longitudinally on the extended runway centerline and extends outward and upward from each end of the primary surface. The dimensions of the approach surface at each end of a runway is based upon the type of approach available or planned for that runway end. The inner width of the approach surface is the same width as the primary surface and expands uniformly. Dimensions for each aspect of the approach surface are shown for each runway in **Table 3-22**.

Exhibit 3-11: Federal Aviation Regulation Part 77 Surfaces



Source: FAA AC 150/5070-6B *Airport Master Plans*, 2007

Transitional Surface – The transitional surface extends outward and upward at right angles to the extended runway centerline at a slope of 7:1 from the sides of the primary approach surface. Those portions of the transitional surface adjacent to precision approach surfaces, which project through and beyond the limits of the conical surface, extend to a distance of 5,000 feet measured horizontally from the edge of the approach surface and at right angles to the runway centerline.

Table 3-22: Runway Approach Surfaces Dimensions		
Dimensions	**Runway 13/31**	**Runway 3/21**
Inner Width	1,000 feet	1,000 feet
Outer Width	16,000 feet	3,500 feet
Horizontal Distance	10,000 feet / 40,000 feet*	10,000
Slope	50:1 / 40:1*	34:1

Note: *Runway 13/31 has a two stage horizontal distances. The slope and distance for each state

Source: FAA AC 150/5300-13A *Airport Design*

Horizontal Surface – The horizontal surface is a plane 150 feet above the elevation of an airport whose perimeter is constructed by swinging arcs of specified radii from the center of each end of the primary surface for each runway at an airport and connecting the adjacent arcs by lines of tangent. The radius of each arch is 10,000 feet for any runway that is intended to be used by aircraft above 12,500 pounds or has an instrument approach. Therefore, the radii of the arc found at the Runway 13/31 and Runway 3/21 end is 10,000 feet.

Conical Surface – The conical surface extends outward and upward from the periphery of the horizontal surface at a slope of 20:1 for a horizontal distance of 4,000 feet. Objects that penetrate the FAR Part 77 surfaces are hazards to air navigation unless determined otherwise by an aeronautical study conducted by the FAA. It should be noted that aeronautical studies only determine if an object is a hazard to air navigation and do not give the FAA specific authorization to limit the height of objects that may be identified as hazards to air navigation. As such, it is the responsibility of an airport to work with state or local governmental jurisdictions to control objects that may penetrate FAR Part 77 surfaces. Objects that are identified as hazards to air navigation should be removed (or pruned in the case of vegetation) or illuminated with an obstruction light if the objects cannot be removed or are fixed by function.

3.5 TAXIWAY SYSTEM

The design standards of a taxiway are based on the combination of the TDG and ADG classification of the critical aircraft intended to operate on the surface. Based on the classification of the aircraft utilizing the taxiways, the dimensions of the taxiway and its associated surfaces are determined. Like runways, taxiways are designed to protect aircraft and the surrounding people and property in the event of an unintended excursion from the taxiway surface.

There are two primary full parallel taxiways at BIS: Taxiway C, serving Runway 13/31; and Taxiway D, serving Runway 3/21. As Runway 13/31 is the primary runway for BIS, it generally is utilized by the commercial air carriers. This means that the most demanding aircraft use the associated taxiway system as it leads to the passenger terminal area. Runway 3/21 is the crosswind runway and offers another option for small aircraft to land during stronger crosswind conditions and connects to the army aviation support facility. However, Runway 3/21 alignment does offer noise abatement advantages compared to the primary runway as the extended centerline of Runway 3/21 is less densely populated. Therefore, the aircraft that use Runway 3/21's associated taxiway, Taxiway D, are generally smaller aircraft, such as corporate and other general aviation aircraft and some air carrier traffic, such as the Airbus 319. The TDG for each taxiway system and dimensions of the design surfaces associated with the TDG are shown in **Table 3-23**. Per an agreement between the Airport and the FAA, Taxiways C, C1, C3 and a small segment of Taxiway D (between RW 13/31 and TW C) will be designed at TDG 5 to accommodate larger aircraft taxiing to and from Runway 3/21. The remaining segments of TW D are designated as TDG 3. The remainder of this section will analyze the dimensions of the taxiways in comparison to the standards and general layout of the taxiway system.

Table 3-23: Taxiway Dimensions and Standards					
ADG	**I**	**II**	**III**	**IV**	**V**
Taxiway Safety Area	49 feet	79 feet	118 feet	171 feet	214 feet
Taxiway Object Free Area	89 feet	131 feet	186 feet	259 feet	320 feet
Taxilane Object Free Area	79 feet	115 feet	162 feet	225 feet	276 feet
TDG	**1B**	**2**	**3**	**4**	**5**
Taxiway Width	25 feet	35 feet	50 feet	50 feet	75 feet
Taxiway Edge Safety Margin	5 feet	7.5 feet	10 feet	10 feet	15 feet
Taxiway Shoulder Width	10 feet	15 feet	20 feet	***20 feet***	***30 feet***

Note: Bold italicized text indicates that standards are not met.

Terminal facilities are located outside the TOFA and TSAs; however, Taxiways C, its connectors, and Taxiway D (between Taxiway C and Runway 13/31) are lacking paved shoulders. Similar to paved shoulder for runways, paved taxiway shoulders help to protect against erosion from jet blast and support maintenance and emergency operations. Although the width of these taxiways tends to exceed current FAA standards, any future reconstruction of the taxiways should consider incorporating paved shoulders.

In addition to taxiway layout, other aspects of the taxiway dimensions including taxiway width, turn radii, and other dimensions of the paved area are centered on the design concept of the Taxiway Edge Safety Margin (TESM). The TESM is a design feature intended to ensure that there is extra pavement beyond the wheel of a taxiing aircraft. Taxiway width and dimensions are designed with the intention of maintaining a certain TESM per design group to provide an additional margin of safety. TESM is used in conjunction with other mandatory dimensions to help provide a buffer of protection around taxing aircraft. As most of the taxiways at BIS are of sufficient or greater width for their TDG, the required TESM is provided except for around turns due to the fillets.

One important consideration when considering taxiway standards is the width of fillets around turns. Fillets are the extra portion of pavement that temporarily increases the width of the taxiway during turns. This extension compensates for the fact that while the nose gear of an aircraft may be able to closely trace the centerline of a taxiway, the main gear follows an asymmetrical turn and does not remain centered. Fillets allow for the wheels of an aircraft to maintain the designed TESM. However, the taxiways at BIS are either lacking fillets or have non-standard fillets. By adding fillets to the turns, the taxiway system would be able to meet higher TDG standards. The FAA approved TDG classifications for each area of the taxiway systems are shown in **Exhibit 3-12**. The non-standard fillets are a preexisting condition from before the AC 150/5300-13A was published in 2012. Therefore, as taxiways are reconstructed, it is recommended to incorporate these fillets into future design to meet standards and allow for the asymmetrical turning nature of air carrier aircraft. More information on taxiway dimensions is depicted on the ALP and in **Table 3-23**.

Finally, the layout of the taxiway system should be considered. FAA AC 150/5300-13A, *Airport Design*, recommends that taxiways that connect from aprons not have direct access to a runway. Pilots generally anticipate that aprons will connect to parallel taxiways and so a taxiway connecting directly from the apron to the runway, without a necessary turn first, may disorient pilots and create a situation in which a runway incursion is could occur. Taxiways C3, C4, and C5 all allow for direct access onto nearby aprons. Reconfiguration of the taxiways or apron will be evaluated during the alternatives evaluation process to comply with current FAA guidance.

In conclusion, the current taxiway system at BIS is expected to be able to serve the anticipated aircraft throughout the planning period. However, correcting the taxiways that lead directly onto the runway from the apron would increase safety and correct existing discrepancies. Additionally, adding fillets to the taxiways at BIS would serve to increase the TDG of the taxiways while adding only a minimal amount of pavement.

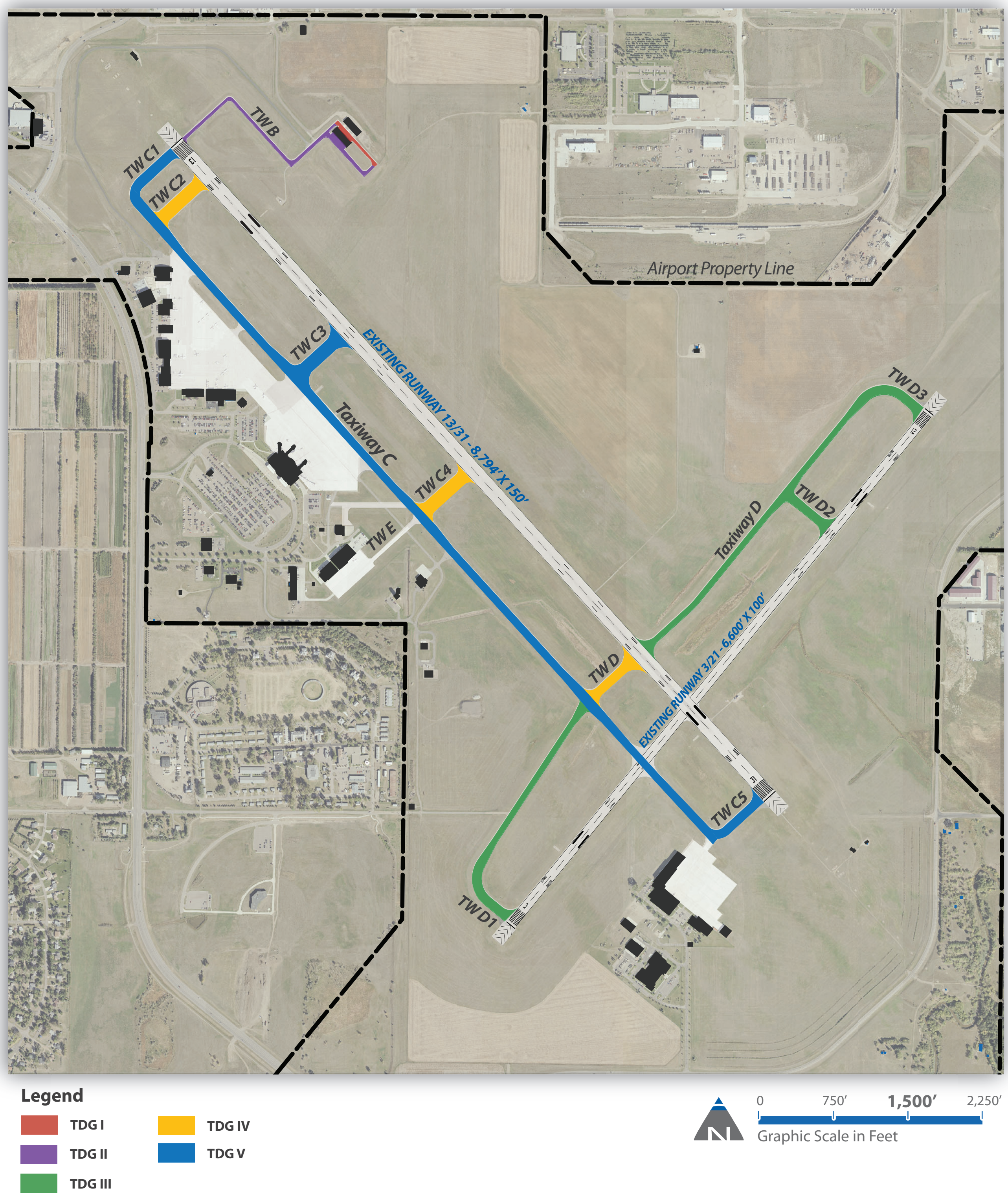


Exhibit 3-12 **Taxiway System Designations**

3.6 GA APRONS

The function of an apron is to provide an area for aircraft to maneuver, load and unload passengers, and to support fueling, maintenance, and parking. The size of the apron comprises several factors including purpose of the apron, number of parking positions, and the type of aircraft intended to use 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 amount of apron space that will be needed to accommodate demand throughout the planning period. **Table 3-24** shows the required apron space for the planning period.

Table 3-24: Apron Demand

Criteria	2015	2020	2025	2030	2035
Annual GA Itinerant Operations	25,131	26,770	27,795	28,622	29,643
Percentage of Total Ops in Peak Month	10.20%	10.20%	10.20%	10.20%	10.20%
Peak Month Operations	2,563	2,731	2,835	2,919	3,024
Peak Month Average Day Operations	85	91	95	97	101
Existing apron area (sq ft)	750,000	750,000	750,000	750,000	750,000
Itinerant Apron Demand per Aircraft (sq ft)	5,625	5,625	5,625	5,625	5,625
Total Itinerant Apron Demand (sq ft)	480,630	511,976	531,579	547,396	566,922
Apron Surplus (+) / Deficiency (-)	269,370	238,024	218,421	202,604	183,078

Source: Mead & Hunt, 2016.

Itinerant GA aircraft operations have made a strong recovery since the 2008 recession. However, existing apron is expected to meet the needs of itinerant aircraft for the duration of the planning period with a surplus of 183,078 square feet. Like runways and taxiways, aprons have surface gradient design standards as identified in FAA AC 150/5300-13A, *Airport Design*, to ease aircraft towing and taxiing while promoting positive drainage. Gradient design standards are based upon the AAC of the most demanding type of aircraft intended to operate on the surface. For AACs A and B, the maximum allowable grade in any direction is two percent while the maximum allowable grade for AACs C, D, and E is one percent. The existing aircraft aprons at BIS comply with current FAA gradient design standards. While these aprons meet FAA standards, previous flooding has occurred during periods of extensive rainfall which surpassed 100-year flood levels.

There are existing plans to expand the GA apron approximately 650 feet to the northwest parallel to the primary runway. This would allow the FBO to expand their facilities, remove some of the outdated hangers, and build new additional hangars to better serve corporate aircraft. The apron expansion, proposed in the 2015 Environmental Assessment, would allow for additional hangars to be constructed near Taxiway C, an accessible area and prime real estate for future development. Hangar demand is covered in more detail in section 3.9.3.

3.7 NAVIGATIONAL AIDS AND WEATHER EQUIPMENT

Visual and electronic guidance for pilots on approach to land and during takeoff are provided by Navigational Aids (NAVAIDs) that are either physically on an airfield, are other nearby ground-based electronic equipment, or guidance from orbiting satellites. The Airport's existing NAVAIDS are shown on **Exhibit 3-13**. Several factors such as the type and volume of aviation activity, local meteorological conditions, and established instrument approach procedures dictate the types of NAVAIDs that should be installed at an airport. Several FAA documents such as AC 150/5300-13A, *Airport Design*; FAA Order 7031.2C, *Airway Planning Standard Number One – Terminal Air Navigation Facilities and Air Traffic Control Services*; FAR Part 139, *Certification of Airports*, and the *Aeronautical Information Manual (AIM)* offer guidance on the type of visual and electronic NAVAID equipment needed to meet the projected demand. NAVAIDs are discussed in this section by two categorizations: Visual NAVAIDs and electronic NAVAIDs.

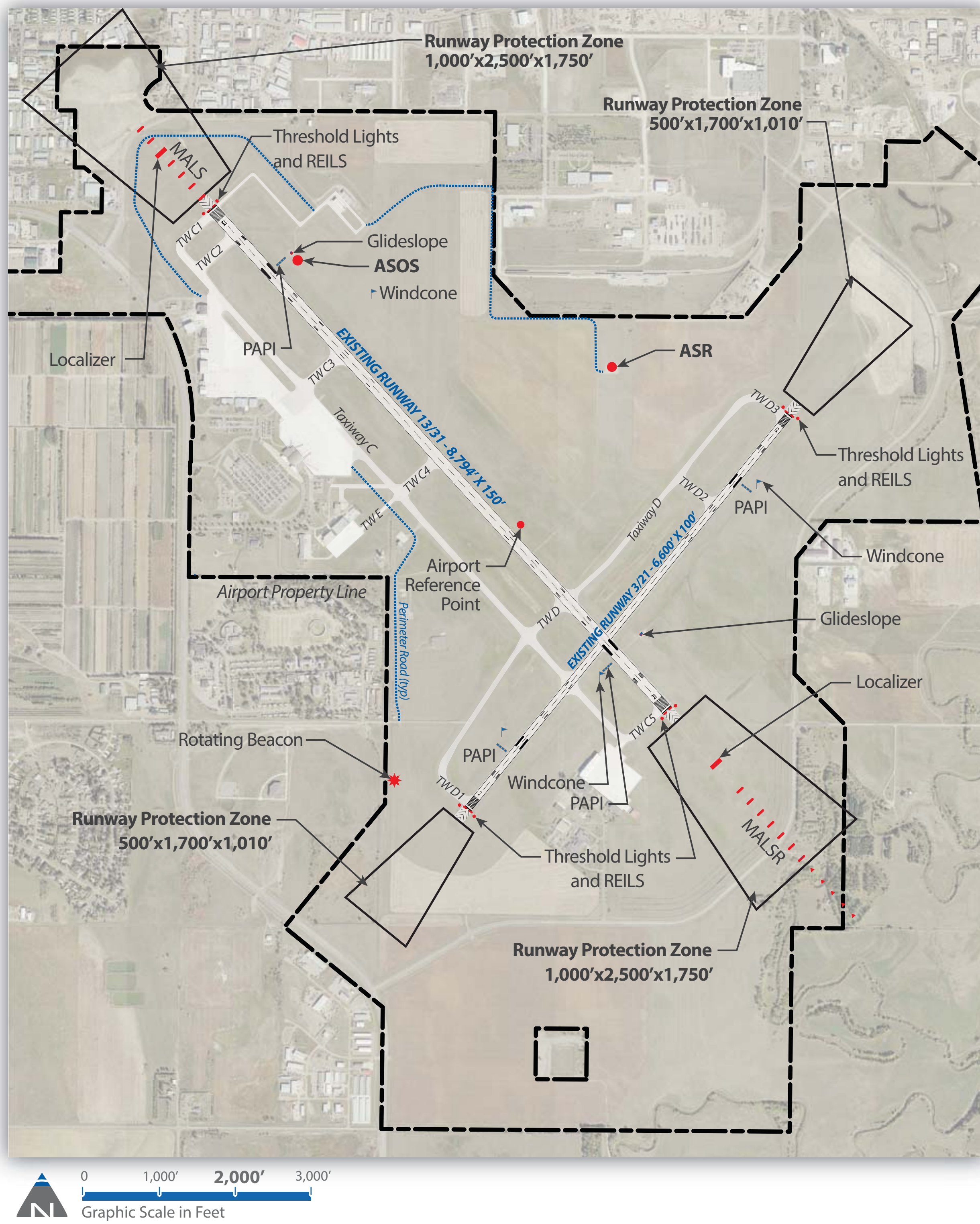


Exhibit 3-13 **Airport Navaids**

This section will also review the weather equipment currently installed at BIS. This equipment provides important information to pilots that impact navigation procedures, such as wind direction, wind speed, visibility, cloud ceiling height, and local atmospheric conditions such as rain and snow. This review, which is presented at the end of the section, will focus on whether any upgrades or relocation of the equipment is necessary to improve the accuracy of weather condition reporting at BIS.

3.7.1 Visual Navigational Aids

Navigational devices that require optic recognition by a pilot are visual NAVAIDs and include devices such as approach lighting, windsocks, and signage. Visual NAVAIDs are most beneficial in assisting a pilot to visually locate a runway and complete the transition from flight to touchdown. It should be noted that visual NAVAIDs often compliment electronic NAVAIDs and may be required in certain circumstances to fulfill the installment of the electronic NAVAID for purposes of safety and accuracy. The following summarizes the review that was conducted of each visual NAVAID and discusses any improvements that may be necessary for the device to continue to provide accurate navigational information to pilots.

Rotating Beacon – A rotating beacon is a high intensity light that rotates 360 degrees and is operated during low visibility situations, such as at night and in inclement weather, to assist pilots in identifying the location of an airport from the air. Rotating beacons are equipped with a green and white lens separated 180 degrees from each other so that alternating green and white flashes can be viewed from the air signaling to pilots that an airport is available for public use. The airport-owned rotating beacon at BIS is located on a freestanding tower just west of the Runway 3 end. There are no obstructions or surrounding terrain that obstruct viewing of the light beam; as such, no improvements, such as relocation of the rotating beacon or mitigation of possible obstructions, are necessary.

Wind Indicators – Wind indicators (also known as wind socks or wind cones) are orange cone-shaped fabric devices that visually indicate wind strength and direction. Wind indicators are most beneficial to pilots just prior to landing and during takeoff, when aircraft are most impacted by surface winds. Four wind indicators are located at the Airport, all of them being illuminated and located near each end runway end. No additional wind indicators are necessary to retain the safe conditions of the airfield. Other than routine maintenance, no changes to wind indicators are expected during the planning period.

Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) – The MALSR is a series of light bars located at the threshold of a runway used in assisting pilots to confirm the centerline of a runway during landing. At BIS, a FAA-owned MALSR is located at the approach end of Runway 31, while the 13 end has only a MALS. On Runway 31, the approach lighting segment intensity can be controlled by the pilot. An approach lighting system such as a MALSR is required for approach visibility minimums below 3/4 mile. As part of the upcoming Runway 13/31 rehabilitation project, the Airport is currently evaluating the feasibility of upgrading the ILS to eliminate signal reflection issues affecting some aircraft types. In consultation with FAA, the Airport elected not to replace the existing ILS. Instead, the Airport made the decision to relocate the MALSR electrical control building further west and make improvements to the existing grade for a new FAA-owned lighting system to be installed during the spring of 2017. The combination of grading, relocation of the MALSR building, and the installation of a new approach lighting system will eliminate the present-day ILS signal issues for Runway end 13 and help achieve improved aircraft approach minimums

Precision Approach Path Indicators – Precision Approach Path Indicators (PAPIs) provide the correct glide slope path for an aircraft approaching a runway through a series of red and white lights arranged in a single row consisting of either two- or four-light units. A combination of red and white, all red, or all white lights identifies if a pilot is on the glide slope, below the glide slope, or above the glide slope, respectively. A four-light PAPI unit is located at each end of Runways 13/31 and 3/21. The PAPIs serving the Runway 13 end are FAA-owned, while the remaining units are owned by the Airport. Upgrades to the PAPI systems on Runway 13/31 will be completed during the runway rehabilitation project. No changes to the Runway 3/21 PAPIs are foreseen at this time. Continued scheduled maintenance and inspection is recommended through the 20-year period.

Runway Edge Lighting – Runway edge lights are a vital tool for visual navigation for pilots. The edge lighting lenses are white except for the final 2,000 feet of an instrument runway where lighting changes to amber to help identify the end of the surface. Runways 13/31 and 03/21 are each equipped with a high intensity runway lighting (HIRL) system which offers five illumination intensity settings and the ability for pilots to request changes to the intensity of the lights through communications with the air traffic control tower. Since this is the highest intensity light system in use today, it is recommended that the Airport is to convert to light emitting diode (LED) lighting as lights are replaced in the future.

Airfield Pavement Markings – Airfield pavement markings applied to runways, taxiways, and apron surfaces provide visual and perceptual navigational cues to pilots and ground vehicle operators when navigating an airfield surface. Examples of pavement markings include runway markings, the boundary of a runway and its associated safety area, and the boundary of the movement area where communication with air traffic control is necessary. Runways that support precision instrument approaches are required to include a landing designator marking, centerline, threshold markings, aiming point marking, touchdown zone markings, and side stripes. Each end of Runways 13/31 and 03/21 are painted with these precision pavement markings. Only routine maintenance is anticipated throughout the planning period to maintain the reflectivity and visibility standards so that they can be easily identified in reduced visibility and nighttime conditions.

Airfield Signage – Airfield signage is an important visual navigational aid that helps identify the locations of runways, taxiways, and aprons, as well as provide noise abatement instructions and other airfield information to pilots. Airfield signage at the Airport includes runway hold position signs, runway distance remaining signs, taxiway locations, taxiway directional signs, and destination location signs. Currently, several of the airfield signs do not meet existing airfield signage standards set forth in FAA AC 150/5340-18F, *Standards for Airport Sign Systems*. The Airport is aware of these nonstandard signs and will install new FAA compliant signs during the Runway 13/31 rehabilitation project. Once the new signs have been installed, the Airport will continue to conduct routine inspections, maintenance, and periodic replacement to ensure signs continue meet reflectivity and visibility standards throughout the planning period.

Taxiway Edge Lighting – Taxiway edge lighting is similar to runway edge lighting in that it is an important navigational tool for pilots and ground vehicle operators. It helps to identify the edge of a taxiway surface when visibility conditions are limited, such as during the night and in inclement weather. The taxiway edge lighting installed are a medium intensity taxiway lighting (MITL) systems, offering three illumination intensities. The entire airfield is equipped with a MITL system, and no improvements are necessary; however, during routine maintenance and projects, the Airport should convert the lighting to LED as funding allows.

3.7.2 Electronic Navigational Aids

Electronic NAVAIDs are important navigational tools in that they allow properly equipped aircraft to conduct landings when conditions impact the ability of a pilot to visually navigate a landing into an airport with low cloud ceilings, night conditions, or inclement weather. Electronic NAVAIDs range from signal transmitting devices installed at an Airport to off-airport electronic equipment and satellites orbiting in space. The following section explains electronic NAVAIDs that are utilized for aircraft landings at the Airport.

Instrument Landing System – An ILS comprises two components: a localizer and a glide slope antenna. The localizer is an antenna placed at the departure end of a runway that transmits a signal to align aircraft with the centerline of a runway when on approach to land. The glide slope antenna is positioned near the aiming point marking at the approach end of a runway and provides vertical guidance to aircraft to align them with the correct landing decent path. ILSs permit properly equipped aircraft with certified pilots to conduct precision instrument approaches during periods of limited visibility.

The type of precision instrument approach offered by an ILS is categorized based on the minimum cloud ceiling height and visibility requirement that is necessary for a pilot to fly the approach, with Category III approaches offering lower decision heights and visibility requirements than Category I approaches. The Airport is equipped with a FAA-owned Category I ILS approach to Runways 13 and 31. As part of the Runway 13/31 rehabilitation project, the Airport is evaluating the feasibility of upgrading the existing ILS system with a newer, more technologically advanced, system which will eliminate current signal reflection issues affecting some aircraft types upon approach. The existing ILS can serve the Airport throughout the 20-year planning period should the Airport decide not to upgrade the ILS as part of the runway rehabilitation project.

The Airport's crosswind, Runway 3/21, is not equipped with a precision approach at this time. This is potentially significant since during Instrument Flight Rules (IFR) conditions, Runway 3 provides the greatest wind coverage at all crosswind components. This would provide a reasonable amount of justification for increasing the instrument capabilities of the Runway 3 end. Currently, Runway 3 has a localizer performance with vertical guidance (LPV) approach with minimums as low as ¾ statute mile. Since the FAA is moving away from ground-based instrumentation to provide precision instrument approaches, in support of satellite based "NextGen" navigation initiatives, legacy systems such as ILSs are not being installed. However, for an airport to receive a satellite-based precision instrument approach minimum, other infrastructure components such as an approach lighting system will still be required. Therefore, it is recommended that the Airport consider installation of an approach lighting system such a MALSF to Runway 3. With this system, the runway would be properly equipped to receive approach minimums as low as a Category I ILS.

Global Positioning System – Global Positioning System (GPS) is a satellite-based navigational system that transmits signals to properly equipped aircraft so that location altitude, direction, and speed can be determined. Currently, BIS has four published satellite-based instrument approach procedures. All four of these approaches offer LPV, which allows high-accuracy approaches with minimums as low as one half mile. These approaches each offer properly trained pilots the ability to conduct a GPS-based approach when the visibility is at its lowest and receive vertical and horizontal guidance. The GPS approaches to BIS's runways appear adequate to meet the demands of users throughout the planning period. If more advanced approach lighting were installed on another runway end, there might be an opportunity to reduce minimums in the future.

Very High Frequency Omni-Directional Radio Range Antenna – The Very High Frequency Omni-Directional Radio Range antenna, also known as a VOR, is a ground based NAVAID that emits radio signals so that a pilot can determine his or her course and position in relation to the distance from the VOR. While no VOR is located on Airport property, a FAA-owned VOR is installed approximately 2.9 miles from Runway 31 and has published non-precision circling approaches to all runways. VORs do not offer the accuracy of GPS, and the FAA is currently evaluating the necessity, benefits, and costs of these NAVAIDs throughout the National Airspace System (NAS). No changes are anticipated to the VOR during the planning period.

Airport Weather Observation System – Weather observation equipment is installed on airfields to disseminate accurate and timely weather conditions to pilots on the ground and en route aircraft. At the Airport, an ASOS unit, owned by the National Weather Service, is located adjacent to the Runway 13 PAPI, approximately 1,100 feet from the approach end of the runway. The existing ASOS unit installed at the Airport meets the accuracy of weather reporting required for aircraft to conduct Category I precision instrument approaches and does not need to be replaced with a system offering more weather reporting accuracy to meet the demands of users within the planning period. An existing FAA-owned RVR station is located at the North end of the airport and is aligned with Runway 31. The presence of RVR equipment increases the accuracy of visibility measurements during low visibility conditions, and aids pilots in making more informed decisions. The existing RVR equipment located at BIS is anticipated to meet the future needs of the Airport throughout the 20-year planning period. If the Airport upgrades the ILS system to achieve Category II approach capabilities, the existing weather observation equipment will also need to be upgraded to support Category II requirements.

3.8 TERMINAL AREA

In addition to airside elements, a review of the facility needs in the terminal area was also conducted as a part of this master plan study. The terminal area is shown in **Exhibit 3-14**. Terminal area elements assessed include the terminal gates and apron, terminal building, landside vehicular access, and vehicle parking, and that is how they are organized in the following sections:

- Terminal Apron and Gate Requirements
- Terminal Building Requirements
- Landside Access Requirements
- Terminal Area Vehicle Parking Requirements

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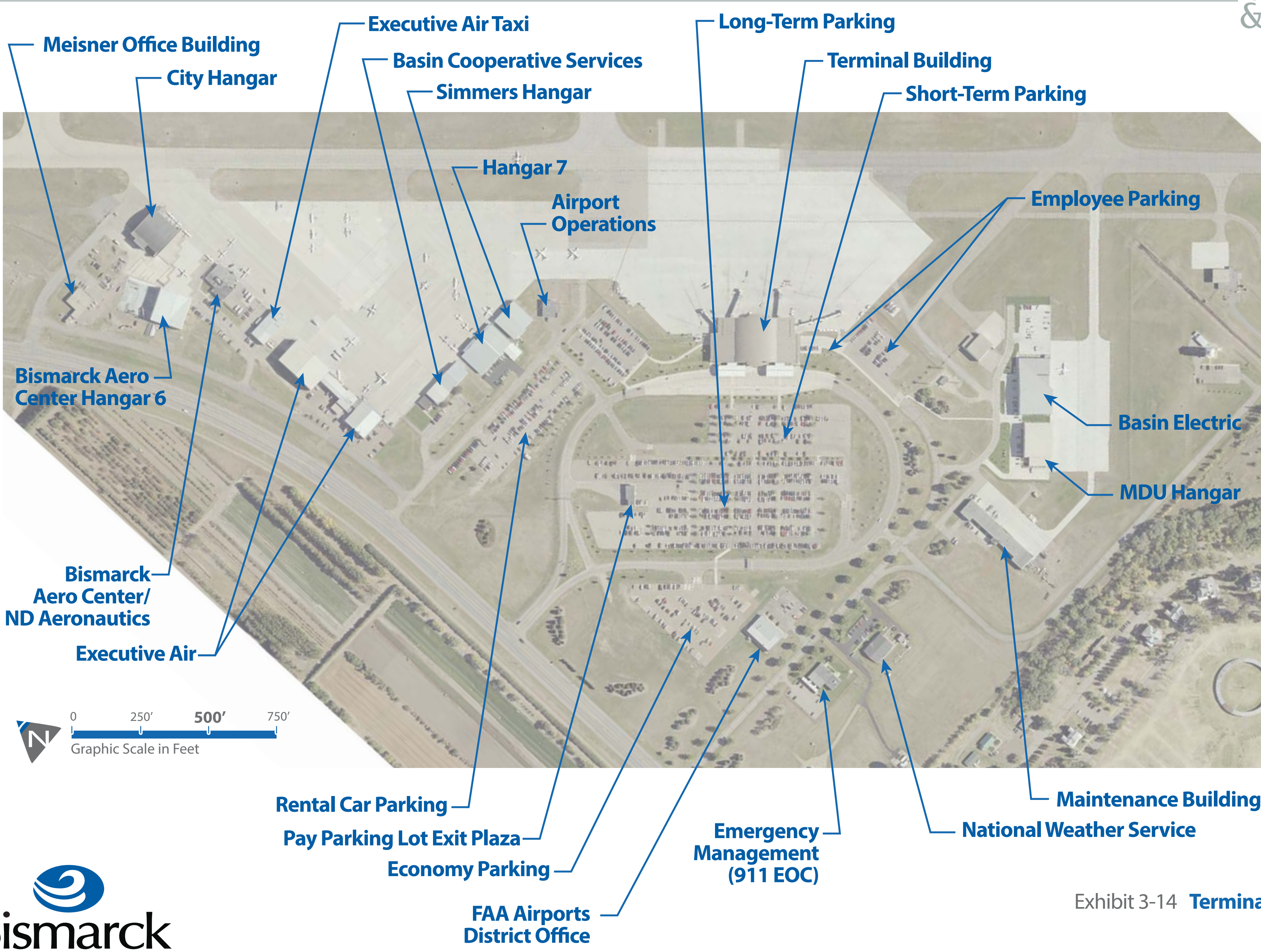

Exhibit 3-14 **Terminal Area**

Bismarck AIRPORT Master Plan Update

Mead & Hunt

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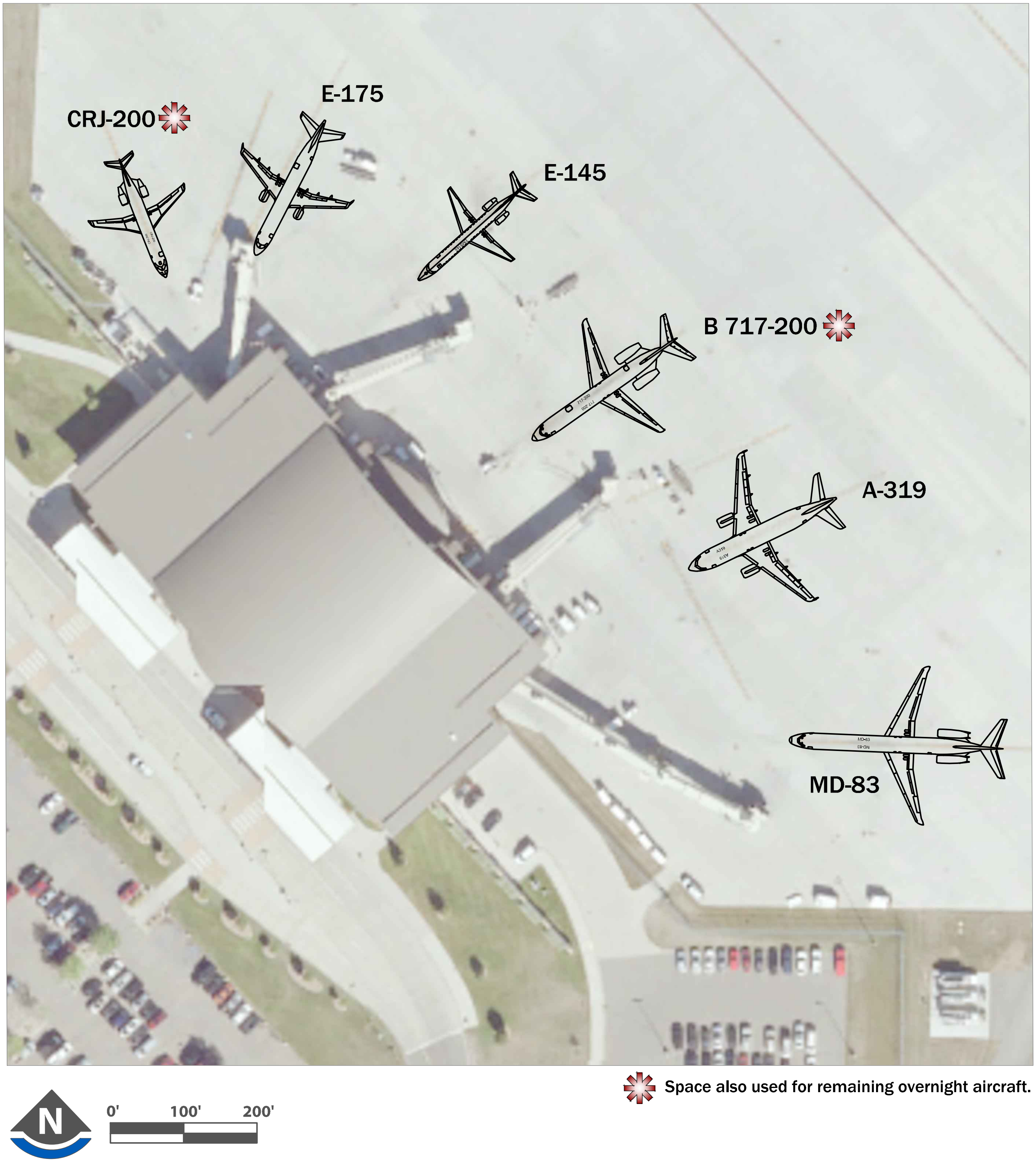


Exhibit 3-15 **Terminal Apron**

3.8.1 Terminal Apron and Gate Requirements

The number of gates needed to support forecasted activity is a critical element in determining the overall size and configuration of the terminal complex. A gate is defined as an aircraft parking position near the terminal that is used daily for the loading and unloading of passengers. The Airport currently has four gate positions, each served with a passenger boarding bridge. There are also additional aircraft parking positions around the perimeter of the apron to accommodate deicing operations and parking of aircraft near the terminal building. **Exhibit 3-15** depicts the passenger terminal building and aircraft parking apron.

3.8.2 Passenger Terminal Building

The 78,000 square foot terminal building space at the Airport consists of four boarding gates, four passenger boarding bridges, two baggage claim devices, a single security checkpoint equipped with three X-ray screening lanes, airline and rental car spaces, Transportation Security Administration (TSA) offices, concessions spaces, and other ancillary spaces. While this master plan study does not include a detailed space programming study of the individual components within the terminal building facility, but it does include an assessment and planning for overall gross terminal building space needs.

This BIS passenger terminal building was constructed in 2005 and was designed to meet the anticipated level of future demand estimated in the previous 2003 airport master plan. Since that time, a number of changes have occurred in the aviation industry including the initial phase out of the 50-seat regional jet, the increased use of larger narrow body aircraft, and the growth of low and ultra-low-cost airlines operating from BIS. Additionally, the continued evolution of TSA requirements within the terminal and the continued increase in passengers have resulted in a need for increased space throughout the terminal building. The existing Security Check Point often becomes highly congested during peak activity periods causing a backup of passengers extending down the stairs to the ticket lobby. As a result, the Airport implemented a third screening lane in November 2016 to help alleviate some of the congestion during the busiest times of the day. In 2017, the Airport plans to install additional floor space in the upper terminal level in front of the TSA Security Check Point and begin design on a project which will further widen the exit lane out to the stairwell/escalators. This project will provide additional floor space room for queuing lines leading into the future TSA Security Check Point. The addition will reduce expansion and enable passengers to exit the departure gates more quickly thereby reducing congestion during peak periods.

As noted in Chapter One, the BIS passenger terminal is a two-level structure oriented in a simple linear configuration. The total size of the terminal building consists of approximately 78,000SF. In order to accommodate the estimated level of future aviation activity, the passenger terminal building will need to expand in size. For the purposes of determining future terminal capacity, Airport Cooperative Research Program (ACRP) Report 25: Airport Passenger Terminal Planning Volume 1 was used for gross terminal planning calculations. Report 25 recommends that gross planning area standards for small domestic airports be identified using a ratio of square footage per narrow body gate, otherwise known as Narrow Body Gate Equivalent (NBGE). This methodology is top down approach for determining a general range of square feet per future passenger enplanements (Ep). Based on the 2035 forecast of future passenger enplanements (431,961), the following calculation was applied for two ranges, low and high.

Small Domestic Airports

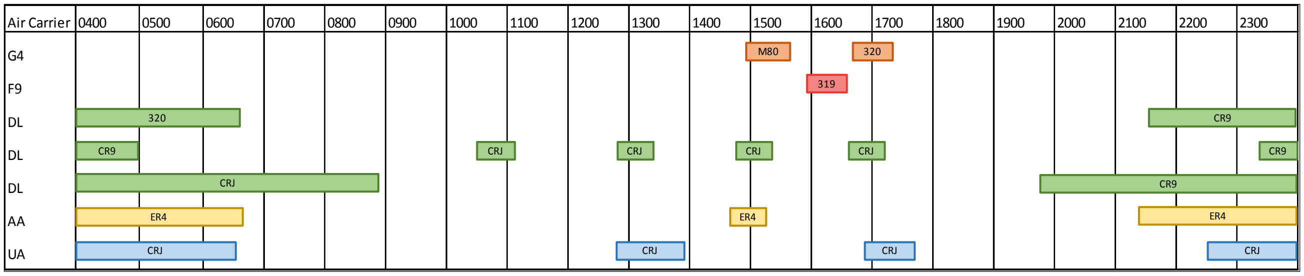
Low Range -15,000SF per NBEG X 120,000SF/431,961 Eps (2035) = 0.28SF per Ep

High Range -15,000SF per NBEG X 144,000SF/431,961 Eps (2035) = 0.33SF per Ep

Based on the assumptions identified in Chapter Two, it is assumed that narrow body aircraft will continue to be the primary airframe to serve BIS throughout the 20-year planning period. As a result, a planning ratio of 0.30SF per Ep was used to determine future gross terminal area square footage needed to adequately serve future passengers. The selection of 0.30SF per Ep fell within the low and high range noted above. Applying the calculation, an estimate of 128,000SF of total terminal area is recommended by 2035. From its current size of approximately 78,000SF, the terminal would need to expand by an additional 50,000SF by 2035. This estimate includes space for both terminal levels one and two and includes additional administrative and support space over the 20-year planning period. The exact size of the terminal expansion may vary based on the individual needs of the Airport and available funding. The purpose of this recommendation is to identify a general estimate based on future space recommendations.

Terminal Apron - The size of the terminal apron should be able to accommodate the fleet mix of commercial aircraft types present during periods where the demand for space is at its greatest. **Exhibit 3-16** depicts the airline schedule of the peak month (December 2015) as a ramp chart by carrier. This ramp chart shows a bar for the arrival and departure time of each passenger aircraft at the Airport indicating when a gate or parking position at the terminal is occupied.

Exhibit 3-16: Air Carrier Ramp Chart



Source: Mead & Hunt, 2016.

The greatest demand for terminal gate and apron space occurs during the overnight period when aircraft from the final arriving flights of the day are parked and staged for departure the following morning, also known as remain overnight aircraft (RON). RON aircraft parking during the peak month of December is presented in the air carrier ramp chart (Exhibit 3-10). As shown, airlines schedules include five overnight aircraft with an additional aircraft parking space located near Gate 1. It should also be noted that the above exhibit is an example of a single day and peak hours may fluctuate the gate demand remains the same. The Airport experiences variations in airline flight schedules that alter the air carrier ramp chart and overnight parking demands shown in **Table 3-25**. The Airport also experiences occasional RON charter flights that are not included in the ramp chart of scheduled passenger activity.

The forecasted demand for RON aircraft parking on the terminal apron through 2035 is presented in Table 3-25. It is assumed that the total number of typical daily departures is directly proportional to the total number of annual scheduled passenger aircraft departures. Using the demand for RON aircraft parking on a typical Sunday in the peak month of December 2015 as a benchmark, the projected demand for RON aircraft parking by aircraft type was extrapolated from the projected typical daily departures.

Table 3-25: Projected Overnight Aircraft Parking Demand					
Year	Current	Projected			
	2015	2020	2025	2030	2035
Annual Enplanements:	259,734	296,308	341,525	386,743	431,961
Total Annual Scheduled Passenger Aircraft Departures:	4,639	4,944	5,476	5,959	6,396
Peak Month Typical Day (PMTD) Departures:	13	14	15	17	18
Overnight Aircraft Parking Demand:	5	5.3	5.9	6.4	6.9
Percent of Total Average Daily Departures:	38.5%	38.5%	38.5%	38.5%	38.5%

Source: Diio Mi Airline Schedules, Mead & Hunt, Inc. (2016)

As illustrated in the Table 3-25, the total number of daily flights is anticipated to increase through the planning period. Likewise, the table also indicates that the number of overnight aircraft are also anticipated to increase through the planning period. Therefore, it is anticipated that daily RON aircraft in 2035 will increase to 6.9 or approximately 7 aircraft. Furthermore, it is desirable for the terminal apron to be sized to accommodate at least one or two additional aircraft beyond those projected to accommodate late arriving or departing flights, changes in airline flight schedules, charter activity, a new entrant service carrier, or aircraft diversions from other airports due to weather. Therefore, through the planning period, the Airport should plan to accommodate at least 8 to 9 aircraft parking positions for RON aircraft.

Terminal Gates – In addition to RON aircraft parking, terminal gate demand during peak activity hours was also evaluated. As noted previously, there are currently four fully functioning gates within the passenger terminal building. As was shown on the airline ramp chart, the peak gate demand outside of RON aircraft parking occurs around 16:50 (4:50 p.m.) when there are three gates used simultaneously. Also, unscheduled charter flights occasionally occur requiring gate facilities. The use of ground boarding is not desirable during winter months, therefore, each of the existing four gates are used yearround. Currently, these four gates can accommodate the existing passenger demand; however, the anticipated increase in passenger enplanements identified in Chapter Two indicate that additional gates will be required.

Table 3-26 illustrates the calculations used to determine the number of new aircraft gates needed by 2035. Each of these calculations are based on the peak hour (PH) forecasts identified in Chapter Two. The first calculation utilizes the percentage of peak month typical day (PMTD) activity occurring within the peak hour. The results of this calculation indicate that the approximately 27.5 percent of 2015 total average daily departures occur during the peak hour. If held constant throughout the 20-year planning period, a total of 4.9 (rounded up to 5) gates are needed to accommodate the 2035 forecast of passenger enplanements (431,961Eps). The second calculation shown in Table 3-26 examines the number of total annual enplanements occurring per gate. In 2016, it is estimated that the Airport will accommodate 64,934 enplanements per gate. Assuming a similar level of passenger activity per gate over the same 20-year period, 6.7 (rounded up to 7 gates) will be needed to accommodate the estimated 431,961 enplanements anticipated through the planning period.

Table 3-26: Projected Aircraft Gate Demand					
Year	**Current**	**Projected**			
	2015	**2020**	**2025**	**2030**	**2035**
Annual Enplanements:	259,734	296,308	341,525	386,743	431,961
Total Annual Scheduled Passenger Aircraft Departures:	4,639	4,944	5,476	5,959	6,396
Peak Month Typical Day (PMTD) Departures	13	14	15	17	18
Peak Hour Percentage					
Peak Hour Gate Demand	3.6	3.8	4.2	4.6	4.9
Percent of Total Average Daily Departures in PH:	27.5%	27.5%	27.5%	27.5%	27.5%
Annual Enplanements per Gate:	64,934	74,077	85,381	96,686	107,990
Enplanements per Gate					
Peak Hour Gate Demand	4.0	4.6	5.3	6.0	6.7
Percent of Total Average Daily Departures in PH:	27.5%	32.9%	34.3%	35.7%	37.1%
Annual Enplanements per Gate:	64,934	64,934	64,934	64,934	64,934

Source: Diio Mi Airline Schedules, Mead & Hunt, Inc. (2016)

As shown in Table 3-26, the peak gate demand is anticipated to increase through the planning period. Since airline schedules are constantly changing, it is recommended that planning be included for at least one or two additional gates beyond the projected demand to accommodate changes in airline flight schedules, late arriving or departing flights, charter activity, a new entrant service carrier, and aircraft diversions from other airports for weather or other reasons. Having a plan for additional gates and protecting additional space within the terminal area for additional gates is recommended to accommodate future growth beyond the planning period or in case passenger enplanements exceed the selected calculation.

Therefore, for terminal and space planning purposes, it is projected that the airport will have a need for a total of five or six gates through the planning period and should protect space for future gates totaling seven or eight gates. The existing terminal has four gate parking positions and hold rooms, indicating that planning should occur for at least two additional gates and hold rooms, and space should be protected for four additional gates.

3.8.3 Landside Access

Landside vehicular access to the Airport was also reviewed. In addition to on-Airport roadways and traffic circulation, access to the Airport from major regional traffic arteries was also evaluated to determine if roadway infrastructure appear adequate. Nearby roadways are shown on **Exhibit 3-17**.

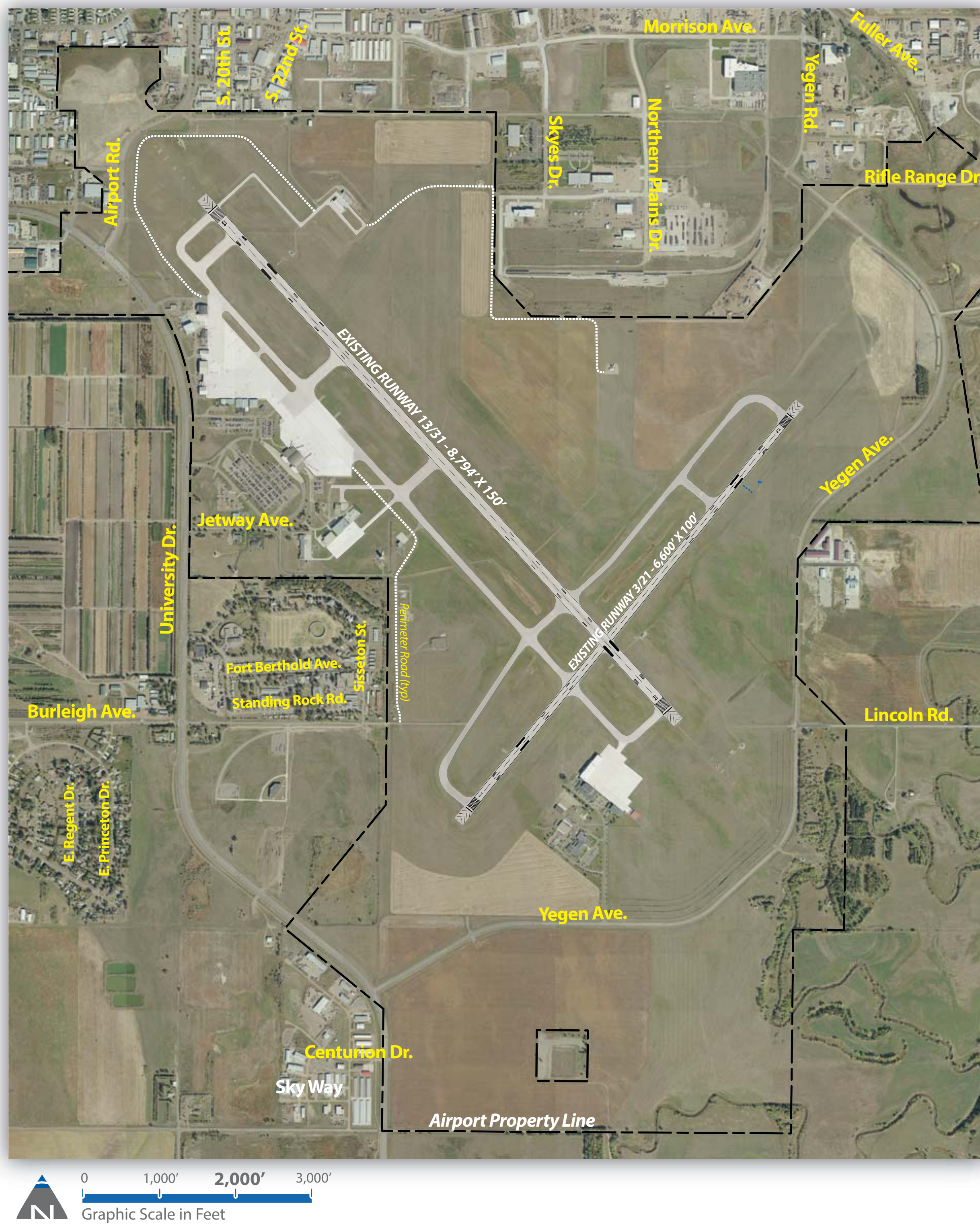
Off-Airport Access - Overall, the Airport is well situated south of Interstate 94. The Airport terminal road provides circulation through the terminal area and access to parking and other Airport facilities. The terminal road intersects with University Drive, which connects to the city center. No highway infrastructure improvements were identified within the region to further improve connectivity to the Airport.

On-Airport Access – Although the primary means of accessing the Airport is University Drive, Yegen Road connects to University Drive approximately 1.5 miles to the south and provides access to the Army Aviation Support Facility based at BIS. Yegen Road continues to circumnavigate the north, south and east sides of the Airport. Several secure gates provides access to the airfield, such as off of Lincoln Road and Sykes Drive. Secure gates provide multiple access points to the Airport for emergency personnel and tenants to access hangars and other Airport facilities. Eclipse Way provides landside access to many Airport tenants, such as the FBO, ND Aeronautics Commission, and cargo facilities. These secure access gates also provide access to the airside. Jetway Avenue and Corporate Circle, located on the south side of the terminal area, provide access to corporate hangars, the FAA ADO, and the National Weather Service. Finally, an additional access road located on the south side of the terminal provides access to the

ATCT and is equipped with gate connecting the ARFF facility to the airfield. Each of these access roads are in working order and will continued to be maintained as part of normal operations. Therefore, access to the Airport is considered both adequate and efficient; therefore, no improvements are recommended at this time.

3.8.4 Terminal Area Vehicle Parking Requirements

An evaluation of vehicle parking at the Airport was carried out to assess the needs for adequate, convenient parking throughout the planning period as passenger enplanements and facilities expand to meet demand. In addition, an evaluation of employee parking and rental car ready/return parking needs was conducted to determine if future expansion of existing vehicular parking areas will be necessary. The basis of these analyses involved benchmarking past and current relationships between parking demand and originating passenger enplanements. Therefore, future parking demand is projected by determining the current ratio of parking spaces to enplanements and maintaining that ratio as enplanements increase over time. This method allows parking projections and enplanements to grow at a similar rate to determine annual demand. Current vehicles parking areas are shown in **Exhibit 3-18**.



Bismarck AIRPORT Master Plan Update

Exhibit 3-17 **Landside Roadways in Proximity to the Airport**

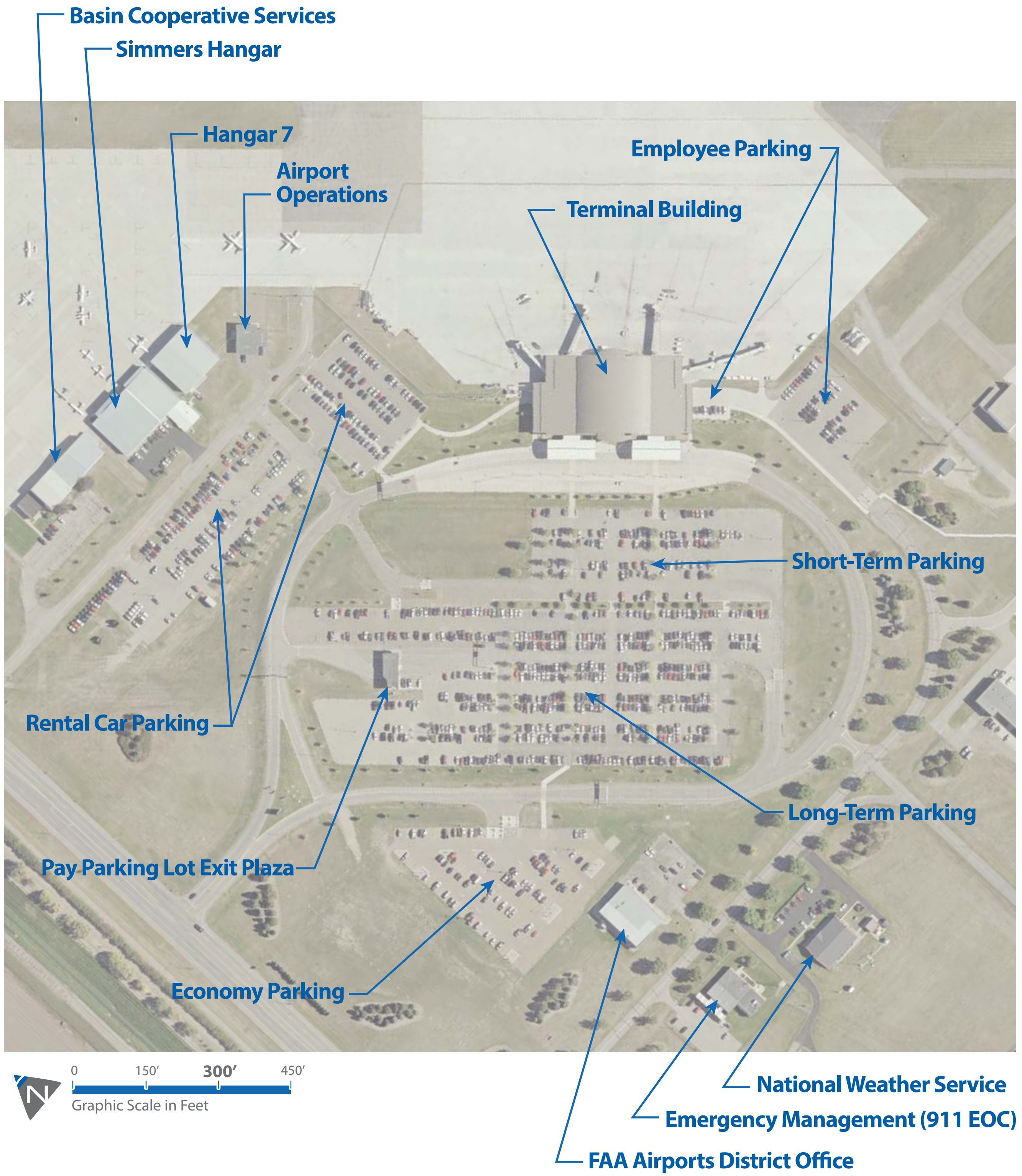


Exhibit 3-18 **Vehicle Parking**

Parking Capacity – There are currently 1,119 spaces available for public parking at BIS. These parking spaces are located west of the commercial airline terminal building and used for long term (660 spaces), economy (177 spaces), and short-term (282 spaces) parking. Other parking areas supporting terminal activities include the employee parking area (87 spaces) to the south of the terminal and the rental car parking area (435 spaces) located on the north side of the terminal building. **Table 3-27** summarizes the current parking capacity at the Airport.

Table 3-27: Terminal Area Parking Supply	
Public	
Long Term	660
Hourly	282
Economy	177
Subtotal	*1,119*
Rental	
Ready	76
Return	39
Storage	320
Subtotal	*435*
Miscellaneous	
Employee	87
FBOs	208
Other	48
Subtotal	*343*
Grand Total	**1,897**

Source: Bismarck Airport records (2015)

Public Parking Demand – Parking demand at an airport is normally expressed as a ratio of spaces required per 1,000 annual originating enplanements. Like most systems, a parking system runs most efficiently when it is at 85 percent to 95 percent capacity. The allowance of five percent to 15 percent of excess spaces allows for the dynamics of cars moving in and out, reduces search time for a space, and allows for a temporary loss of spaces due to parking lot maintenance activities, snow cover, or other unforeseen circumstances. Ideally, this cushion can also accommodate parking on days that are busier than the average or typical day. On extremely busy days, the capacity of the parking lot should be capable of meeting demand, but the cushion will be limited, and parking space search times could be greater. During the Airport's busiest travel periods including the Thanksgiving and Christmas holiday season, parking is insufficient as cars often must park in grass overflow areas adjacent to the short-term and economy parking lots. area Therefore, this parking assessment analyzes the peak parking days, so that the system can accommodate the peak parking needs, which includes an allowance of 5 to 15 percent excess capacity for average days. **Table 3-28** identifies the recommended public parking projections for the 5-, 10-, and 20-year planning periods.

Table 3-28: Public Parking Demand Projections					
Parking Demand	**Scheduled Annual Enplanements**	**Demand Ration per 1,000 Enplanements**	**Parking Demand**	**Parking Capacity**	**Surplus/ Deficiency**
Short-Term					
2015	259,734	1.09	282	282	0
Projected					
2020	296,308	1.09	323	282	-41
2025	341,525	1.09	372	282	-90
2030	386,743	1.09	422	282	-140
2035	431,961	1.09	471	282	-189
Economy					
2015	259,734	0.68	177	177	0
Projected					
2020	296,308	0.68	201	177	-24
2025	341,525	0.68	232	177	-55
2030	386,743	0.68	263	177	-86
2035	431,961	0.68	294	177	-117
Long-Term					
2015	259,734	2.54	660	660	0
Projected					
2020	296,308	2.54	753	660	-93
2025	341,525	2.54	867	660	-207
2030	386,743	2.54	982	660	-322
2035	431,961	2.54	1,097	660	-437

Source: Mead & Hunt, 2016.

It should be noted that the parking demand ratio can be measured with some precision for any year as long as the proper data is collected. However, it is not a static number, although it has been treated as such in the projections because the nature of airline passengers can change frequently over time due to several factors. For example, if enplanements on low-cost carriers comprised a larger portion of the increase in enplanements at the Airport, the parking demand may increase more quickly than enplanements due to the nature of these passengers and longer trip durations. As a result, it is recommended this calculation be checked each year to track trends and adjusted accordingly to changing parking activity.

It should also be noted that the above parking demand calculation is quantitative, not qualitative; in other words, there may be enough parking, but it may not provide the level of customer service desired by the Airport. In the future, consideration should be given to adjust parking rates, or create VIP parking areas, particularly on the most convenient parking close to the terminal.

Employee Parking Demand – Employees parking at the Airport include those from the Airport staff, TSA, car rental agencies, tenants, and airlines. Seven parking spaces are situated along the south side of the terminal building and used by Airport administration staff. A larger lot to the south with 80 spaces is used by other employees. Airport management estimates that, on peak days, these lots are basically at capacity and are full at times of high demand, such as during a shift change. This utilization was used to estimate future employee parking demand, as summarized in **Table 3-29**. A deficit of 56 spaces is anticipated by the year 2035.

Table 3-29: Employee Parking Demand Projections					
Parking Demand	**Scheduled Annual Enplanements**	**Demand Ration per 1,000 Enplanements**	**Parking Demand**	**Parking Capacity**	**Surplus/ Deficiency**
Historical					
2015	259,734	0.33	87	87	0
Projected					
2020	296,308	0.33	98	87	-11
2025	341,525	0.33	113	87	-26
2030	386,743	0.33	128	87	-41
2035	431,961	0.33	143	87	-56

Source: Mead & Hunt, 2016.

Rental Car Ready/Return and Storage Spaces – The rental car ready/return lot north of the terminal contains 435 spaces. Of these, 76 spaces are used for rental cars ready to be used for passengers, 39 spaces are for returns, and the remaining 320 spaces are for storage. Demand for ready and return spaces were projected together at a ratio of 0.44 per 1,000 enplanements. Based on this ratio, an additional 75 spaces will be needed by 2035. Storage for rental cars was determined to have a deficiency of 211 spaces by 2035, as shown in **Table 3-30**. It should be noted that a wash facility was recently added to this area for rental cars; however, the additional parking spaces built in this area have no impact on the calculation of future rental car parking demand.

Table 3-30: Rental Car Parking Demand Projections					
Parking Demand	**Scheduled Annual Enplanements**	**Demand Ration per 1,000 Enplanements**	**Parking Demand**	**Parking Capacity**	**Surplus/ Deficiency**
Ready/Return					
2015	259,734	0.44	115	115	0
Projected					
2020	296,308	0.44	130	115	-15
2025	341,525	0.44	150	115	-35
2030	386,743	0.44	170	115	-55
2035	431,961	0.44	190	115	-75
Storage					
2015	259,734	1.23	320	320	0
Projected					
2020	296,308	1.23	364	320	-44
2025	341,525	1.23	420	320	-100
2030	386,743	1.23	476	320	-156
2035	431,961	1.23	531	320	-211

Note: *Long term parking includes both long term and economy parking

Source: Mead & Hunt, 2016.

Parking Needs Summary – A summary of existing and projected parking capacity and demand throughout the planning period is presented in **Table 3-31**. Review of the table indicates that additional parking deficits will increase through 2035 for public parking, rental car ready/return parking, rental car storage, and employee parking as passenger activity levels increase. As shown in Table 3-31, without the development of additional parking capacity, parking deficits will continue to increase in all areas as passenger enplanements increase. The desired level of customer service should be considered along with the number of spaces provided as plans are developed for future parking facility needs.

Table 3-31: Parking Capacity/Demand Summary					
Airport Parking	**2015**	**2020**	**2025**	**2030**	**2035**
Public Parking					
Demand	1,119	1,277	1,472	1,667	1,862
Capacity	1,119	1,119	1,119	1,119	1,119
Difference	0	-158	-353	-548	-743
Employee Parking					
Demand	87	98	113	128	143
Capacity	87	87	87	87	87
Difference	0	-11	-26	-41	-56
Rental Ready/Return					
Demand	115	130	150	170	190
Capacity	115	115	115	115	115
Difference	0	-15	-35	-55	-75
Rental Storage					
Demand	320	364	420	476	531
Capacity	320	320	320	320	320
Difference	0	-44	-100	-156	-211
Total					
Demand	1,641	1,870	2,155	2,440	2,726
Capacity	1,641	1,641	1,641	1,641	1,641
Difference	0	-229	-514	-799	-1,085

Source: Airport Records, Mead & Hunt, 2016.

3.9 GENERAL AVIATION FACILITIES

Local and itinerant general aviation (GA) aircraft accounted for roughly 72 percent of all operations in 2015. This fact will be evaluated along with the GA facilities at the Airport, including the suitability of existing groundwork. The type and size of facilities required to accommodate GA activity has a direct relation to the size and type of GA aircraft that operate at an airport. Environmental and geographic factors such as climate, available undeveloped land, and anticipated demand also guide facility planning when reviewing GA infrastructure at an airport. This facilities review focused on major components that are presented in this section: the GA terminal buildings, services provided to GA users, and hangar space available at the Airport. This review of GA facilities also focused on the adequacy of the fuel farm to meet fuel storage requirements of the airlines as well as the air cargo facilities at the Airport.

3.9.1 General Aviation Terminal Buildings

Two GA terminal buildings serve as the focal point for all GA activity at the Airport. These two public-access terminals include the Bismarck Aero Center and Executive Air. Both serve as the transfer point for pilots and passengers of GA flights, provide administrative offices for staff, and provide space for pilots to plan flights and access weather information. These facilities are equipped with conference rooms, passenger waiting areas, crew rest areas, and reception desks that also serve as the communication centers for GA line services. Combined, both terminal buildings provide approximately 17,200 square feet of area. The GA terminals were designed to provide adequate space to meet the long-term demands of public circulation, waiting area space, administrative areas, flight planning/conference room space, and utility/storage areas. It is recommended that future airport planning keep in mind expansion needs of the GA terminal buildings and associated facilities so that these areas continue to meet the demands of the users.

3.9.2 Fixed Base Operator Services

Fixed base operator (FBO) services are those that support GA activity, such as fueling, aircraft maintenance and repair, and coordination of ground transportation for itinerant users. FBO services currently being provided at the Airport include 100 low lead (LL) and Jet-A aviation fuels, flight training, charter services, airframe and avionics maintenance and repair services for single- and multi- engine aircraft, power plant maintenance and repair, and line service personnel available to marshal taxiing aircraft and assist in other ground service aircraft needs. It should be noted that the Airport places an emphasis on providing a high level of customer service when providing FBO services to GA users at the Airport; as such, compliments are often received by both based and itinerant users for the friendliness of Airport staff and the efficiency in which FBO requests are handled. While it appears that the FBO services currently being provided at the Airport will meet the needs of based and itinerant users throughout the planning period, it is recommended that the Airport continue to place a focus on efficiency, quality, and courteousness when providing its FBO services to customers.

3.9.3 Hangars

Due to the local weather extremes throughout the year, it is assumed that all based aircraft will desire hangar storage when evaluating the capacity of existing hangars to meet future demand. Forecasts presented in Chapter Two project the number of based aircraft by fleet mix that can be anticipated at the Airport during the planning period. As summarized in **Table 3-32**, based aircraft are anticipated to grow from a total of 117 aircraft in 2015 to 133 aircraft by 2035. This equates to five additional single-engine aircraft, two additional multi-engine aircraft, six turbine aircraft, one large jet, and one additional helicopter.

Table 3-32: Projections of Based Aircraft by Fleet Mix

Year	Single Engine	Multi Engine	Turbine	Jet Aircraft	Other	Helicopters
2015	65	20	10	2	17	3
2020	66	20	11	2	17	3
2025	67	21	13	2	17	4
2030	68	21	15	3	17	4
2035	70	22	16	3	17	4

Source: Mead & Hunt, Inc. (2016)

Given the projected number of based aircraft by fleet mix that can be anticipated throughout the planning period, the demand for box-style and T-style hangars by square feet can be estimated. **Table 3-33** summarizes the approximate parking area in square feet needed to park each type of aircraft fleet mix classification. It should be noted that the amount of area required to park an aircraft varies based on the size and type of aircraft; as a result, planning ratios were used for each fleet mix classification as identified in the Table 3-33. The size approximations for each aircraft classification included a safety margin for wingtip, nose, and tail clearances.

Table 3-33: Parking Area Sizes for Aircraft Fleet Mix Classifications		
Aircraft Type	**Examples**	**Approximate Square Feet**
Single-Engine	Cessna 172, Cirrus SR-22	1,400 square feet
Multi-Engine	Piper Seneca, Beechcraft King Air	2,500 square feet
Small & Mid-Sized Jets	Cessna Citation, Learjet	3,600 square feet
Large Business Jets	Gulfstream G550, Global Express	10,000 square feet
Helicopter	Sikorsky S-76, Bell 206	1,400 square feet
Other	Experimental, UAV, etc.	1,000 square feet

Source: Mead & Hunt, Inc. (2016)

Table 3-34 illustrates the total demand in square feet for hangar space by aircraft fleet mix classification that can be anticipated at the Airport through 2035. As the table shows, the total demand for hangar space will grow by approximately 22 percent throughout the planning period with turbine aircraft requiring an additional 34,000 square feet of hangar space followed by single-engine aircraft (6,000 square feet) and multi-engine aircraft (5,000 square feet). It should be noted that the hangar space demand for single- and multi-engine aircraft should be considered by square feet and the number of T-hangar units needed to house each aircraft.

Table 3-34: Projected Hangar Area Demand by Aircraft Fleet Mix Classification					
	2015	**2020**	**2025**	**2030**	**2035**
Single-Engine					
Projected Based Aircraft	65	66	67	68	70
Approximate Area per Aircraft	1,400	1,400	1,400	1,400	1,400
Total Demand	**91,000**	**92,302**	**93,956**	**95,639**	**97,353**
Multi-Engine					
Projected Based Aircraft	20	20	21	21	22
Approximate Area per Aircraft	2,500	2,500	2,500	2,500	2,500
Total Demand	**50,000**	**51,200**	**51,903**	**52,993**	**55,243**
Small and Medium Turbine Aircraft					
Projected Based Aircraft	10	11	13	15	16
Approximate Area per Aircraft	3,600	3,600	3,600	3,600	3,600
Total Demand	**36,000**	**40,757**	**46,171**	**52,332**	**59,348**
Large Turbine Aircraft					
Projected Based Aircraft	2	2	2	3	3
Approximate Area per Aircraft	10,000	10,000	10,000	10,000	10,000
Total Demand	**20,000**	**22,338**	**24,950**	**27,866**	**31,124**
Helicopters					
Projected Based Aircraft	3	3	4	4	4
Approximate Area per Aircraft	1,400	1,400	1,400	1,400	1,400
Total Demand	**4,200**	**4,763**	**5,402**	**5,996**	**6,103**
Military					
Projected Based Aircraft	17	17	17	17	17
Approximate Area per Aircraft	1,000	1,000	1,000	1,000	1,000
Total Demand	**17,000**	**17,000**	**17,000**	**17,000**	**17,000**
Total Demand	**218,200**	**228,361**	**239,382**	**251,827**	**266,172**

Source: Mead & Hunt, Inc. (2015)

A summary of the existing hangar capacity at the Airport is presented in **Table 3-35**. As illustrated in the table, a total of 139,200 square feet of hangar space is available to park based aircraft by means of 12 hangar structures with varying numbers of units that offer 17 hangar units for single- and multi-engine aircraft.

Table 3-35: Existing Hangar Capacity for Based Aircraft			
Hangar	**Number of Structures**	**Number of Units for Aircraft Parking**	**Total Approximate Sq. Ft. Available**
Box	12	17	139,200
Total	**12**	**17**	**139,200**

Notes: The number of available aircraft parking positions within each unit varies based on size of aircraft
Source: Mead & Hunt, Inc. (2016)

Table 3-36 illustrates the demand for projected hangar capacity at the Airport for the planning period. As illustrated in the table, an additional 109,300 square feet of box-style hangar area and 63,000 square feet of additional T-hangar units are recommended by 2033. It should be noted that the future demand for box-style hangar space includes what would be needed to house multi-engine, jets, and helicopter aircraft while the demand for T-style hangar space only includes single-engine aircraft. The size and type of projected hangar needs are generalized, and it is recommended that the Airport plan for a variety of sizes and types to accommodate various types of users as demand materializes.

It is recommended that construction of any new T-style hangar units should be to a width greater than 41 feet, 6 inches and a height greater than 12 feet. This will allow dedicated parking for larger single-engine and smaller twin-engine aircraft, better utilizing existing and future box-style hangars for larger twin-engine and jet aircraft.

Table 3-36: Projected Hangar Capacity				
Hangar Style	**2018**	**2023**	**2028**	**2033**
Box-Style				
Projected Demand	235,865 sq. ft.	259,165 sq. ft.	283,865 sq. ft.	311,065 sq. ft.
Available Capacity	201,765 sq. ft.	201,765 sq. ft.	201,765 sq. ft.	201,765 sq. ft.
Surplus/Deficit	- 34,100 sq. ft.	- 57,400 sq. ft.	- 82,100 sq. ft.	- 109,300 sq. ft.
T-Style				
Projected Demand	77,984 sq. ft. (59)	94,784 sq. ft. (67)	114,384 sq. ft. (77)	133,984 sq. ft. (87)
Available Capacity	70,984 sq. ft. (55)	70,984 sq. ft. (55)	70,984 sq. ft. (55)	70,984 sq. ft. (55)
Surplus/Deficit	- 7,000 sq. ft. (4)	- 23,800 sq. ft. (12)	- 43,400 sq. ft. (22)	- 63,000 sq. ft. (32)

Projections: Mead & Hunt, Inc. (2016)

3.9.4 Aircraft Fuel Storage Facilities

There is one fuel storage area at Bismarck, 2,500 feet west of the runway intersection, which is separated into two main storage sites, each of which are owned by their respective FBOs. The north portion consists of one 500-gallon diesel fuel tank, two 15,000-gallon Jet-A fuel tanks, and one 15,000-gallon 100 low lead (100LL) tank, owned by EATC. The south portion consists of three Jet-A fuel tanks totaling 52,000 gallons, one 17,000-gallon 100LL tank, and one 500-gallon diesel tank, owned by BAC. Combined, these facilities offer the Airport the capability to store 82,000 gallons of Jet-A fuel, 32,000 gallons of 100LL aviation fuel, and 1,000 gallons of diesel.

To evaluate the aircraft fuel storage requirements of the Airport throughout the planning period, it is first important to review the historical sale of fuel to establish a baseline of demand. **Table 3-37** illustrates the annual fuel sales at the Airport from 2011 to 2015. As illustrated in the table, an average of approximately 3,992,900 gallons of Jet-A fuel and 132,060 gallons of 100LL fuel have be sold annually between 2011 and 2015.

Table 3-37: Fuel Sales by Year (2011-2015, in gallons)				
Year	**Airline Jet-A Sales**	**General Aviation Jet-A Sales**	**100LL Sales**	**TOTAL SALES**
2011	2,718,488	896,815	121,028.9	**3,772,974.4**
2012	2,890,202	1,020,033	139,520.1	**4,084,352.2**
2013	2,890,536	1,030,413	147,836.4	**4,110,506.5**
2014	3,018,029	1,249,075	128,078.2	**4,550,312.6**
2015	2,994,848	1,256,081	123,850.3	**4,895,740.4**
'11-'15 Average	***2,902,420.6***	***1,090,483.4***	***132,062.78***	***4,282,777.22***

Source: Bismarck Airport records (2015)

Next, the fuel storage turnover rate, or the rate at which the fuel tanks at the Airport need to be refilled to meet demand, must be calculated. This rate can be calculated by dividing the annual sale of fuel by the number of days in a year to find the average daily fuel sales. The total fuel storage capacity at the Airport is then divided by the average daily fuel sales to determine the average fuel storage turnover rate. **Table 3-38** presents the findings of the historical fuel storage turnover rate for Jet-A fuel while **Table 3-39** presents the historical fuel storage turnover rate for 100LL fuel.

Table 3-38: Historical Jet-A Fuel Storage Turnover Rate (in gallons)				
Year	**Total Jet-A Sales**	**Average Daily Fuel Sales**	**Total Jet-A Fuel Storage Capacity**	**Average Fuel Storage Turnover Rate**
2011	3,615,303	9,905	82,000	**8.2 days**
2012	3,910,235	10,713	82,000	**7.6 days**
2013	3,920,949	10,742	82,000	**7.6 days**
2014	4,267,104	11,690	82,000	**7.0 days**
2015	4,250,929	11,646	82,000	**7.0 days**
'11-'15 Average	***3,992,904***	***10,939***	***82,000***	***7.5 days***

Source: Mead & Hunt, Inc. (2016)

Table 3-39: Historical 100LL Fuel Storage Turnover Rate (in gallons)				
Year	**Total 100LL Sales**	**Average Daily Fuel Sales**	**Total 100LL Fuel Storage Capacity**	**Average Fuel Storage Turnover Rate**
2011	121,028.9	331.5	32,000	**96.5 days**
2012	139,520.1	382.2	32,000	**83.7 days**
2013	147,836.4	405.0	32,000	**79.0 days**
2014	128,078.2	350.9	32,000	**91.2 days**
2015	123,850.3	339.3	32,000	**94.3 days**
'11-'15 Average	***132,062.78***	***361.8***	***32,000***	***88.4 days***

Source: Mead & Hunt, Inc. (2016)

As illustrated, the storage capacity of existing fuel tanks at the Airport can store, on average, a seven-day supply of Jet-A fuel and an 88-day supply of 100LL fuel. Airport fuel sales could increase if more long-range, non-stop routes, such as those to destinations in the Southeast and Southwest, are implemented from the Airport. Increases in operations by larger aircraft and longer-range non-stop routes, as projected to occur during the planning period, will increase the fuel storage turnover rate and thus may require an expansion of fuel storage facilities. Overall, the Airport's trend in fuel sales closely follows operational trends in the general aviation industry. It is recommended that initial planning be scheduled to prepare for an expansion of fuel storage facilities at the Airport.

3.9.5 Air Cargo

As discussed in Chapter Two, the recent decline in the oil boom and has directly affected all aspects of cargo activity. Therefore, two forecasts were prepared, one with the resumption of the oil boom and a baseline forecast that does not forecast oil boom activity resuming.

The baseline forecast was selected as the preferred forecast and is shown below:

- 7.9 million pounds in 2015
- 8.1 million pounds in 2020
- 8.3 million pounds in 2025
- 8.5 million pounds in 2030
- 8.7 million pounds in 2035

The dynamic of local BIS industries means that there is not the demand to ship small high value items that would foster the departure of air cargo. During normal cargo operations, non-oil boom, approximately 70 percent of cargo at BIS was arriving. During the oil boom this increased to approximately 75 percent. This disparity, combined with the modest forecast in cargo operations for the planning period, means that only minimal addition to cargo facilities should be required. The preservation of adequate space for air cargo operations, ground service equipment storage and maintenance, sortation facilities, and truck and auto parking should be maintained.

3.10 SUPPORT FACILITIES

Infrastructure components that are necessary to support the operation and maintenance of the Airport are support facilities. A review of these facilities including the fire station, snow removal equipment building, and operations building containing the airfield electrical vault and generator was conducted as a part of evaluating the adequacy of existing infrastructure to meet future demand. This section reviews each support facility element and discusses improvements that will be needed, if any, to meet the forecasted level of demand.

3.10.1 Aircraft Rescue and Fire Fighting Facility

The existing 6,500 square feet Aircraft Rescue and Fire Fighting (ARFF) facility at Bismarck Airport is located southeast of the terminal building, adjacent to Taxiway C. The current configuration is satisfactory in scope to meet the current vehicle and firefighting equipment storage needs of the Airport. The current ARFF Index (Index B) meets all the facilities and storage requirements the Airport is likely to require well into the future. However, due to increasing vehicle sizes, the building may not support all desired equipment in the future. A new 3,000-gallon truck will not fit within the current configuration due to width and length restrictions, so consideration for this should be made when planning for future expansion. Many airports around the country have consolidated ARFF capabilities into less vehicles, such as the Oshkosh Strikers. This combined approach allows increased capability with minimal crew requirements. As such, it is anticipated that additional ARFF facilities may be required during the planning period, even without a significant change to the ARFF index levels. The facility is currently capable of Index C requirements if necessary.

Upon evaluation of the existing ARFF facility, the following requisites were identified to support the firefighting operations at the Airport.

- **ARFF Index –** It is anticipated that the ARFF Index at the Airport will remain at Class I Index B throughout the planning period based on the fleet mix of commercial aircraft types that are projected to operate at the Airport; however, they are capable of Index C if needed. It is recommended that the ARFF facility remain capable of supporting these Index C requirements, unless the aircraft operating from the Airport prompt a permanent change earlier.
- **ARFF Vehicles –** Bismarck Airport's three trucks, command vehicle, and foam trailer are all in good condition. One of the trucks, a 3,000-gallon Oshkosh, is slated for replacement around year 2020.
- **Personnel Areas –** The firefighting staff at the ARFF facility has access to support areas such as restroom and shower facilities, a training room, fitness area, kitchen/break area, and office space. These spaces allow the facility to

be able to accommodate firefighters for the duration of their shifts, which can be multiple days in length. No immediate needs in the personnel areas have been identified for the planning period.

- **Equipment and Raw Material Storage –** In addition to the three vehicle bays and personnel areas, additional storage areas comprise the rest of the ARFF facility. As identified in FAA AC 150/5210-15A, *Aircraft Rescue and Firefighting Station Building Design*, these storage areas accommodate firefighting turnout gear, first aid medical equipment, surplus equipment, supplies, rescue tools, self-contained breathing apparatuses (SCBA), and raw material firefighting agents such as chemicals and powders. These areas are sufficiently sized to store and move the equipment and materials in an effectual manner.

3.10.2 Snow Removal Equipment Facility

The Airport's existing snow removal equipment (SRE) facility does not currently provide adequate areas for Airport maintenance personnel and storage of equipment. The Airport is tasked with swapping equipment in and out of heated storage to make room for the implements needed to combat the current conditions. This creates an inefficient workflow, as well as increased safety concerns of trying to put more equipment into an area designed for a much lower capacity. The current SRE buildings are currently over capacity. Therefore, it is recommended that the Airport plan for an expansion of the SRE building/s to relieve overcrowding of the current facility, as well as room for additional equipment. The actual size of a future SRE expansion at BIS should be based on the size, type and function of the equipment needed for snow removal over the next 20-year period. It is recommended that the Airport consultant with maintenance personnel to identify specific equipment and spacing needs prior to beginning preliminary design.

3.10.3 Operations Building/Airfield Electrical Vault and Generator

There are two airfield electrical vaults located at BIS, one located south near the intersection of Runway 13/31 and Runway 3/21 and the other located to the north adjacent to the rental car parking area. Airfield electrical vaults are structures designed to house transformers, lighting panels, CCRs, relays, and other electrical components. Since many of the electrical components inside the vault have been upgraded and installed as airfield lights have been upgraded, it is not anticipated that improvements to the vault or generator will be needed to meet the electrical demands of airfield components during the planning period. It is recommended that any future airfield lighting projects at the Airport consider the components of the vault so major upgrade costs can be avoided if possible. The electrical vault structure located to the north also houses a centralized location for operations staff. Both electrical vaults are relatively new, and are adequate in size to sustain these duties throughout the 20-year planning period. If staff numbers increase, the accommodations within the northern vault/operations building should be reevaluated for size at that time.

3.10.4 Collection, Treatment, and Disposal of Deicing Fluids

The application of deicing fluids on aircraft is a necessary and important flight preparation procedure during the winter season to remove and prevent snow, ice, and frost from interfering with the aerodynamic surfaces of an aircraft. However, deicing fluids biodegrade rapidly, which can cause depletion of dissolved oxygen in streams that receive deicing runoff. As a result, measures need to be taken to properly collect and dispose of spent deicing fluids in order to not adversely impact the water quality of streams, rivers, lakes, and other bodies of water.

Aircraft Deicing Operations

Aircraft are currently deiced at two locations on the airport, the Terminal Apron and GA aprons. The majority of deicing is conducted at the Terminal Apron. Very infrequent aircraft deicing is conducted at the two other GA apron locations. Seasonal aircraft deicing fluid (ADF) usage in gallons of undiluted product is reported by the contractors and the FBOs that conduct deicing. Both Type I and IV propylene glycol based ADF are employed.

Regulatory Requirements

The Airport is authorized under the State of North Dakota's general industrial stormwater permit to discharge stormwater impacted by industrial activities, including deicing. Compliance with the permit requires that the Airport prepare and implement a Stormwater Pollution Prevention Plan for the following checks and balances to occur: to see that "practices are implemented to minimize the contribution of pollutants;" to conduct monitoring of deicing season stormwater discharges to assess stormwater quality against benchmark values; and to submit an annual report with the results of the monitoring and the amounts of ADF used during the year.

Development at the airport must adhere to the stormwater management requirements of both the City of Bismarck and the North Dakota Department of Health. Furthermore, FAA Advisory Circular 150/5200-33B, Hazardous Wildlife Attractants on or near Airports, states the maximum time stormwater can be detained is 48 hours. To meet these requirements, airfield drainage will be analyzed in the environmental chapter of this document. Any deficiencies will be addressed in the alternatives section. Stormwater treatment will be looked at on a regional basis to provide an efficient and cost-effective approach that does not adversely affect development and operation of the Airport.

3.11 AIRPORT TRAFFIC CONTROL TOWER

The Airport has an FAA-controlled tower that operates from 6:00am to 12:00am each day. The control tower, constructed in 1986, is maintained jointly by the FAA and the Airport Authority. Due to the age of the control tower, many of the technologies in use are outdated and some of the equipment is near the end of its useful lifespan. It would be prudent for the Airport to continue to routinely communicate with FAA tower employees on technology shortfalls such as equipment outages, access to qualified repairmen and the ability to get replacement parts for aging equipment. It is not recommended to investigate new sites for the control tower, as there are not sufficient location-related issues with the current tower. The only line of site issue identified was an apron blind spot that is in an uncontrolled portion of the airfield. This is not considered a significant problem to the FAA and will not be addressed further by this Master Plan. All supplementary development, including vehicle parking, has been determined to be sufficient for the 20-year period.

3.12 SUMMARY OF RECOMMENDATIONS

Planning and investment made to improve infrastructure facilities at the Airport will allow it to meet the air transportation demands of the region for the next 20 years. This chapter has a review of existing infrastructure at the Airport and its ability to accommodate anticipated demand has identified a few areas that should be the focus of future facility planning and development. The following chapter will evaluate development alternatives for meeting the facility identified in this chapter. **Table 3-40** summarizes the recommended improvements from this chapter to the various infrastructure and facilities at Bismarck Airport.

Table 3-40. Future Airport Development	
Airport Facility	**Recommended Improvement**
Runway System	Change Runway 13/31 Design Code from D-IV to D-III
	Change Runway 3/21 Design Code from C-II to C-II
Taxiway System	Add fillets to all taxiways as per latest AC
Approach Lighting	Update Runway 13 to MALS-R or MALS-F
	Add MALS-F to Runway 3
Pavement Lighting	Upgrade to LED lights as projects allow
ILS	Upgrade Runway 31 ILS to address signal reflectivity
Terminal Building	128,000 sf expansion by 2035
Terminal Apron	Expansion to accommodate two additional aircraft
Terminal Gates	Add another 3 gates by 2035
Terminal Parking	Expanded long-term, short-term, and economy areas
Other Parking	Additional employee, rental ready/return, and rental storage needed
Box Hangars	109,300 sf deficit by the end of the planning period
T-Hangars	32-aircraft deficit by the end of the planning period
SRE Facility	Immediate need for additional storage space