BZN Bozeman Yellowstone International Airport

2020 MASTER PLAN UPDATE

CHAPTER THREE

FACILITY REQUIREMENTS

Morrison Maierle

engineers • surveyors • planners • scientists

CHAPTER THREE: FACILITY REQUIREMENTS

3.1 Introduction

The previous chapter forecasted the levels of aviation demand that could reasonably be expected to occur at Bozeman Yellowstone International Airport (BZN) through the planning period (2039). This chapter will assess whether or not existing facilities are adequate to meet that demand. This chapter will also identify what types and quantities of new facilities may be required as well as establish a time frame for when these facilities may be needed to accommodate the future demand. Further, an extensive analysis will be conducted to ensure that all airside facilities meet current FAA design standards and, if necessary, a list of all deviations from the current standards will be provided.

The FAA outlines the essential facilities into the following categories:

- Runways
- Taxiways
- Navigational Aids
- Aprons
- Terminal Building and Associated Facilities
- Airport Access and Automobile Parking
- Airport Support Facilities

This chapter will provide a complete assessment of these facilities at BZN.

In this chapter, requirements for new facilities will be expressed in Planning Horizon Activity Levels rather than in years. This is because the need to develop facilities is determined by demand, rather than a point in time. Activity levels for short, intermediate and long-term planning horizons roughly correlate to five-year, ten-year, and twenty-year time frames in the forecasts. Future facility needs will be tied to these activity levels rather than a specific year to retain flexibility in the plan. **Table 3-1** summarizes the activity levels that define the planning horizons used in the remainder of this master plan.

Table 3-1: Planning Horizon Activity Levels

	Short Term Planning Horizon (2024)	Intermediate Term Planning Horizon (2029)	Long Term Planning Horizon (2039)
Enplanements	1,033,679	1,295,763	1,836,063
Based Aircraft	386	434	533
Annual Operations	105,507	116,475	139,980

3.2 Demand / Capacity Analysis

Based on the forecasts from Chapter 2, it is expected that within 20 years, the airport is likely to provide service for over 130,000 operations per year. Future development at the airport within this time frame will be necessary to accommodate this future demand. The next step in the Demand / Capacity Analysis is to determine the current capacity of the airfield.

The principal guidance for the analysis of airfield capacity is FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*. There are two key measurements of airfield capacity that assist planners in evaluating the adequacy of airfield facilities- hourly capacity and Annual Service Volume (ASV).

Hourly capacity considers the throughput during a typical busy hour. Factors such as percentage of arrivals, runway crossings, and taxiway exit locations are considered to arrive at an hourly number of aircraft that can use the airfield without undue delays.

Annual Service Volume (ASV) is an estimate of the number of aircraft operations that can be accommodated in one year. This measure is used to program additional runways, and/or modified taxiway exits. Airfield capacity improvements are typically programmed when actual annual operations reach 60 percent of ASV and constructed when operations reach 80 percent of ASV.

This approach utilizes the projections of annual operations by the specified fleet mix as projected in the Aviation Activity Forecasts. It considers a variety of factors including airfield layout, meteorological conditions, runway conditions, runway use, aircraft mix, percent arrivals, percent touch-and-go's, and exit taxiway locations.

Weather also plays a key role in determining hourly capacity. When weather conditions are such that there are low clouds and/or reduced visibility, arriving and departing aircraft operate under different flight rules. The conditions for each set of rules are listed below:

Visual Flight Rules (VFR)

Conditions necessary to operate under VFR are a cloud ceiling that is equal to or greater than 1,000 feet above the ground level (AGL) and the visibility is equal to or greater than 3 statute miles. This does not cover every situation, but these are the most common criteria used at most commercial service airports with instrument approaches.

Instrument Flight Rules (IFR)

Conditions requiring operation under IFR are complicated, but in general are conditions that do not qualify as VFR. Weather that is worse than the minimum requirements for instrument approach procedures at an airport will preclude any operation at the airport and can cause cancellations or diversions to other airports. These conditions vary by operation type, type of aircraft, and aircraft equipment.

When operating in VFR conditions, pilots are responsible for the separation of their aircraft from other aircraft and obstacles. However, when IFR operations are required, Air Traffic Control is responsible for the separation of aircraft and obstacle clearance. This is done with the use of radar, where available, and through the use of Standard Instrument Procedures. Large margins are built into the system, which is what limits the capacity in the airspace surrounding the airport, as well as the hourly capacity of the airfield.

3.2.1 Airfield Capacity

The airport's ASV and hourly capacity are calculated using the methodology documented in FAA AC 150/5060-5 *Airport Capacity and Delay*. Calculation in this method requires the mix index and runway use configuration. The mix index is an equation (C+3D) that determines the percentage of aircraft operations that have a Maximum Takeoff Weight (MTOW) over 12,500 pounds. C represents the percent of aircraft over 12,500 but under 300,000 pounds. D represents the percent of aircraft over 300,000 pounds.

BZN currently does not have regular operations by aircraft with a certified takeoff weight over 300,000 pounds and these aircraft are not expected to regularly utilize the airport over the planning period. The mix index is, then, the percentage of Class C aircraft that use the airport. **Table 3-2** shows the VFR mix index for BZN based on tower operations counts and TFMSC data for 2019.

Table 3-2: VFR Mix Index

2019 Operations (>12,500 lbs)*	26,854
Total BZN Operations 2019**	97,867
C	27%
D	0%
Mix index (C+3D)	27%

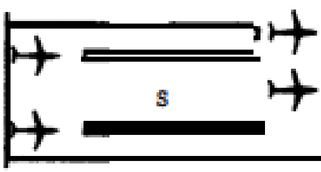
* TFMSC Counts
** Tower Counts

In IFR conditions, the mix index is assumed to be 100% C aircraft with no aircraft weighing less than 12,500 pounds operating in IFR conditions.

Runway Configuration

BZN has a three runway system. Runway 12-30 serves as the primary runway, principally because of its orientation with respect to the prevailing winds, length, strength, and navigational aids. Runway 11-29 serves as a parallel runway for general aviation operations. Runway 11-29 was constructed to serve small aircraft weighing less than 12,500 pounds. A 940-foot separation between Runway 12-30 and Runway 11-29 allows for simultaneous operations on the two runways. Runway 3-21 serves as a crosswind runway for small "utility" aircraft weighing less than 12,500 pounds. Since the airport is controlled, the FAA air traffic control tower can direct operations on two or more runways at any time. The turf runway was not considered in current capacity calculations as it is used interchangeably with Runway 11-29. Crosswind Runway 3-21 also was not included in capacity calculations given its short length and the understanding that any traffic utilizing the crosswind runway would delay traffic on the main runway, thereby reducing the capacity of Runway 12-30.

The runway use configuration for BZN under VFR conditions is Runway Use Diagram 9 from Chapter 4 of AC 150/5060-5 for parallel runway airports with one runway restricted to use by small aircraft, shown in Figure 4-1 of the advisory circular and **Figure 3-1** below. Under IFR conditions, with no radar and no ILS on Runway 11-29, the airport operates as single runway, which is represented by Figure 4-15 in the advisory circular.

Runway-use Diagram	Diag. No.	Runway Spacing (S) in feet	Figure No. for Capacity: Poor Visibility Conditions	Inoperative Navaids	Restricted Runway-use: VFR	IFR
	9	700 to 2499	4-3	4-16	4-17	4-21
	10	2500 to 2999	4-9		4-18	
	11 12	3000 or more	4-11			4-22

Source: Figure 4-1 AC 150/5060-5

Figure 3-1: Runway Configuration – Capacity and Delay AC 150/5060-5

Hourly Capacity

VFR hourly capacity was calculated using Figure 4-17 from the AC and IFR hourly capacity was calculated using Figure 4-15 as indicated in the runway configuration chart. The output was 135 operations per hour (OPH) for VFR conditions and 27 OPH for IFR conditions as depicted in **Figure 3-2** and **Figure 3-3**.

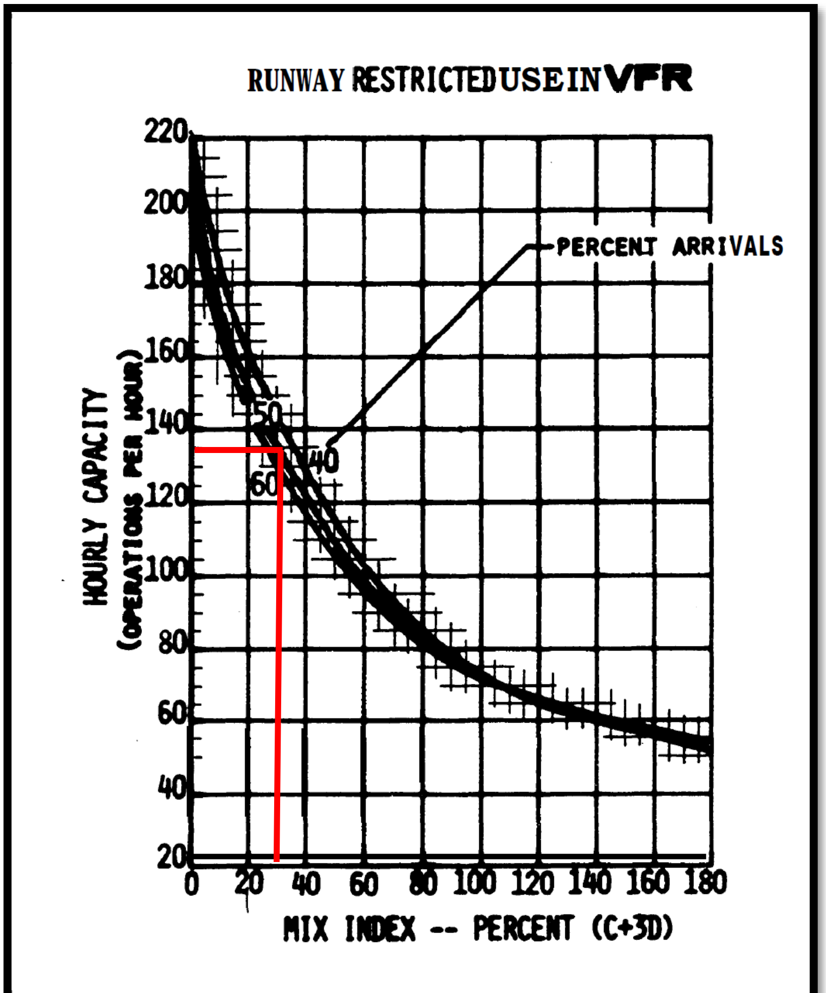


FIGURE 4-17, HOURLY CAPACITY OF RUNWAY-USE DIAGRAM NO. 9.

Figure 3-2: Hourly Capacity of Runway Use Parallel Runway Airports with one Runway Restricted to Use by Small Aircraft in VFR Conditions

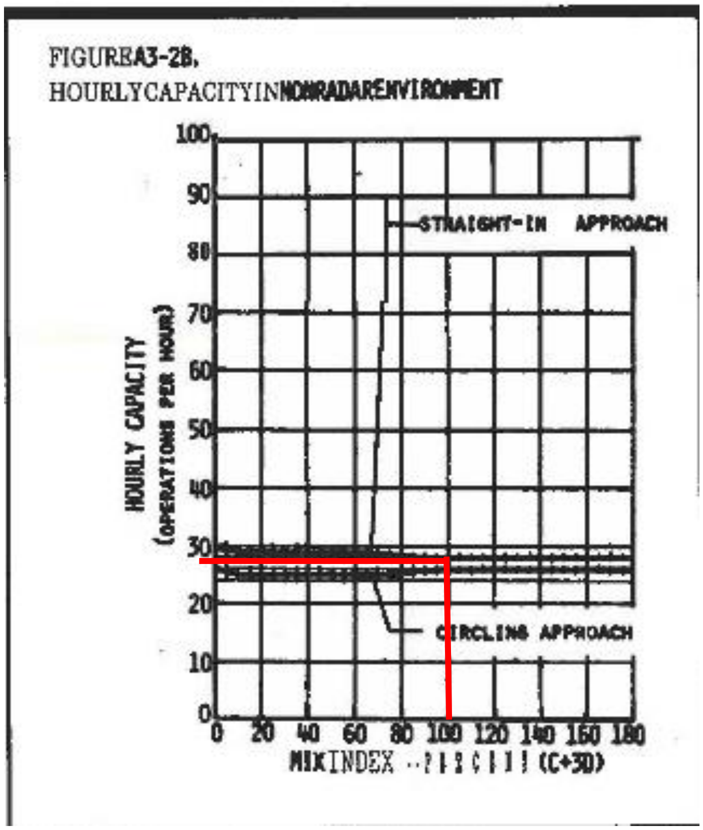


Figure 3-3: Hourly Capacity of Runway Use Single Runway in IFR Conditions (figure 4-15)

The weighted hourly service volume (Cw) models hourly capacity, taking into account the percent of time each meteorological condition occurs and is modeled by the equation:

$$Cw = \frac{(P1 * C1 * W1) + (P2 * C2 * W2)}{(P1 * W1) + (P2 * W2)}$$

Where:

P1 = the percent of time the airport is under VFR conditions
C1 = hourly capacity under VFR conditions
W1= weighting factor for VFR conditions
P2 = the percent of time the airport is under IFR conditions
C2= hourly capacity under IFR conditions
W2= weighting factor for IFR conditions

VFR conditions exist 92% (P1) of the time according to NOAA data, with 135 operations per hour (C1). IFR conditions exist 8% of the time (P2) with 27 operations per hour (C2). According to Table 3-1 of the advisory circular, weighting factors are 1 for VFR and 25 for IFR.

The hourly combined capacity is calculated as:

$$Cw = \frac{(0.92 * 135 * 1) + (0.08 * 27 * 25)}{(0.92 * 1) + (0.08 * 25)} = 61 \text{ OPH}$$

Annual Service Volume

Annual Service Volume (ASV) is calculated as:

ASV=Cw X D X H

Where:

D = the ratio of annual demand to the average daily demand in the peak month
H = the ratio of the average daily demand in the peak month to the average peak hour in the peak month.

The current and future ASV for BZN was determined to be approximately 113,000 operations. With operations in 2019 at 97,867, the airport is currently at 86% of its annual service volume. **Table 3-3** summarizes the airport's ASV over the long range planning horizon under the current runway configuration.

Table 3-3: Annual Service Volume Comparison – Current Runway Configuration

		Forecasts			
	2019	**2024**	**2029**	**2034**	**2039**
Total Annual Operations	97,867	105,507	116,475	128,030	139,980
Peak Month	11,117	12,037	13,327	14,691	16,106
Average Day	353	382	422	465	509
Peak Hour	53	57	63	69	76
D = Total Annual Ops / Average Day	277	277	276	276	276
H= Average Day / Peak Hour	6.7	6.7	6.7	6.7	6.7
ASV	113,216	112,945	112,762	112,583	112,412
Ops % ASV	86%	93%	103%	114%	125%
Hourly Capacity	61	61	61	61	61
Ops % Hourly Capacity	86%	93%	103%	114%	125%

Airfield Capacity Conclusions and Recommendations

FAA Order 5090.5, Field Formulation of the National Plan of Integrated Airport Systems (NPIAS), identifies the 60% of capacity level as the point that planning for additional runways or changes in runway configurations to improve capacity should begin, with development to occur at 80%. According to ASV analysis, the airport is currently operating over 80% of its ASV.

The most straightforward capacity enhancing improvement to the airfield would be to improve Runway 11-29 to accommodate traffic by aircraft weighing over 12,500 lbs.

Without addition of radar and ILS, the airfield configuration would be represented by Figure 3-9 from the AC for VFR conditions and Figure 4-16 from the AC for IFR conditions as indicated in the runway configuration chart. The output was 140 for VFR conditions and 39 for IFR conditions as depicted in **Figure 3-4** and **Figure 3-5** below. **Table 3-4** summarizes the airport's ASV over the long-range planning horizon assuming two parallel runways capable of handling large aircraft, but without the addition of radar and ILS.

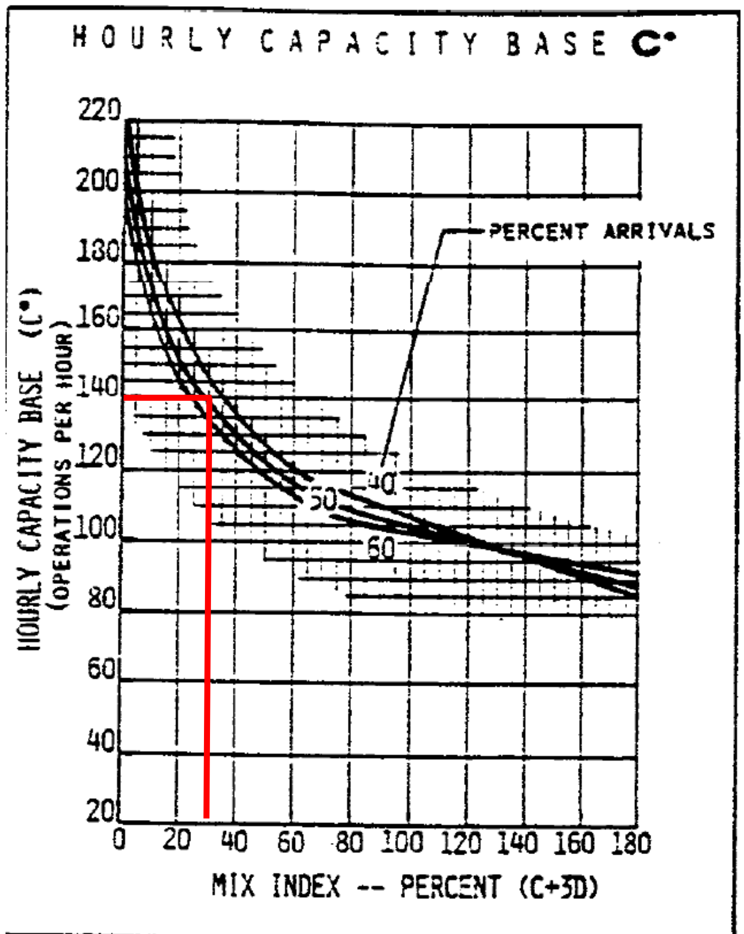


Figure 3-4: Hourly Capacity of Runway Use Parallel Runways in VFR Conditions (AC Figure 3-9)

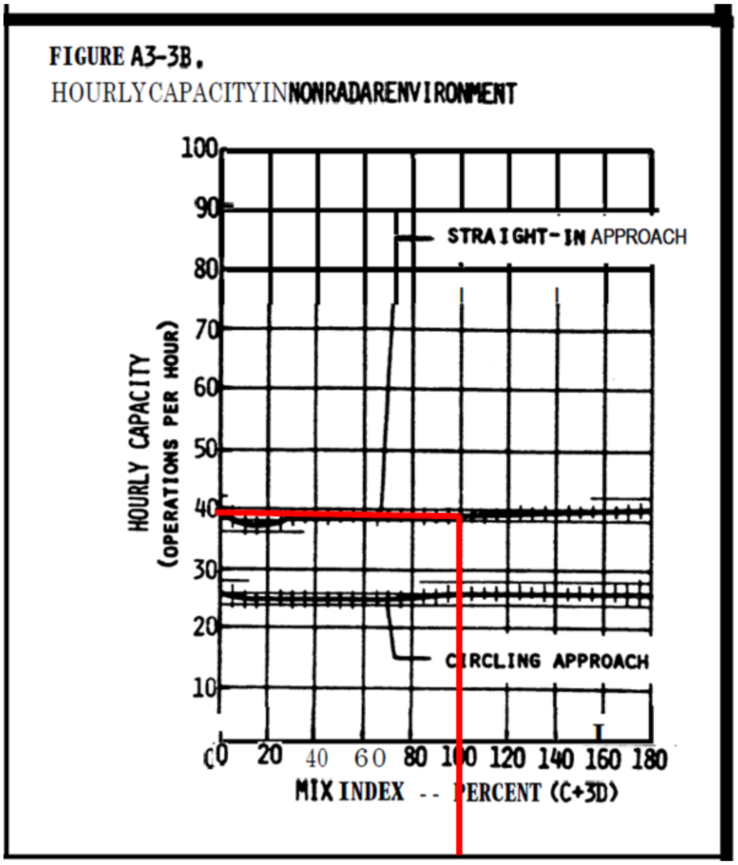


Figure 3-5: Hourly Capacity of Runway Use Parallel Runways with Inoperative Navaids in IFR Conditions (Figure 4-16)

Table 3-4: Annual Service Volume Parallel Runways Serving Large Aircraft no Radar / ILS

		Forecasts			
	2019	2024	2029	2034	2039
Total Annual Operations	97,867	105,507	116,475	128,030	139,980
Peak Month	11,117	12,037	13,327	14,691	16,106
Average Day	353	382	422	465	509
Peak Hour	53	57	63	69	76
D = Total Annual Ops / Average Day	277	277	276	276	276
H= Average Day / Peak Hour	6.7	6.7	6.7	6.7	6.7
ASV	131,386	131,072	130,859	130,652	130,453
Ops % ASV	74%	80%	89%	98%	107%
Weighted Hourly Capacity (Cw)	71	71	71	71	71
Ops % Hourly Capacity	74%	80%	89%	98%	107%

With the addition of ILS on both runways and radar coverage to the airport, the runway configuration would be represented by Figure 3-9 from the AC under VFR conditions and Figure 3-44 from the AC under IFR conditions. The output was 140 for VFR conditions and 59 for IFR conditions as depicted in **Figure 3-6** and **Figure 3-7** below. Under this configuration, BZN accommodates its ASV over the long term planning horizon as shown in **Table 3-5**.

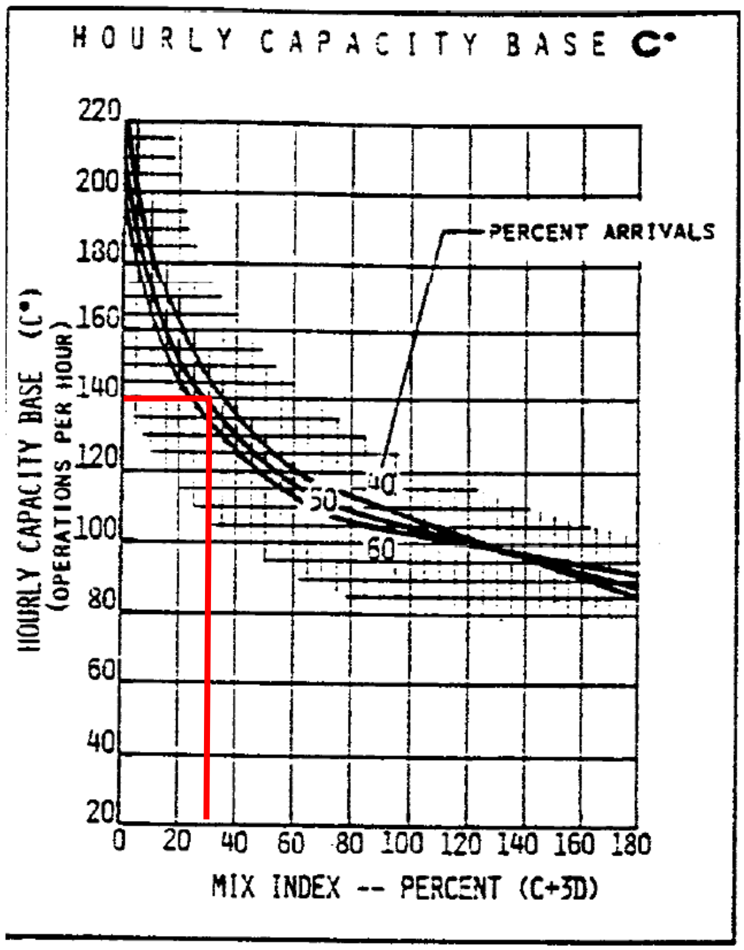


Figure 3-6: Hourly Capacity of Runway Use Parallel Runways in VFR Conditions (AC Figure 3-9)

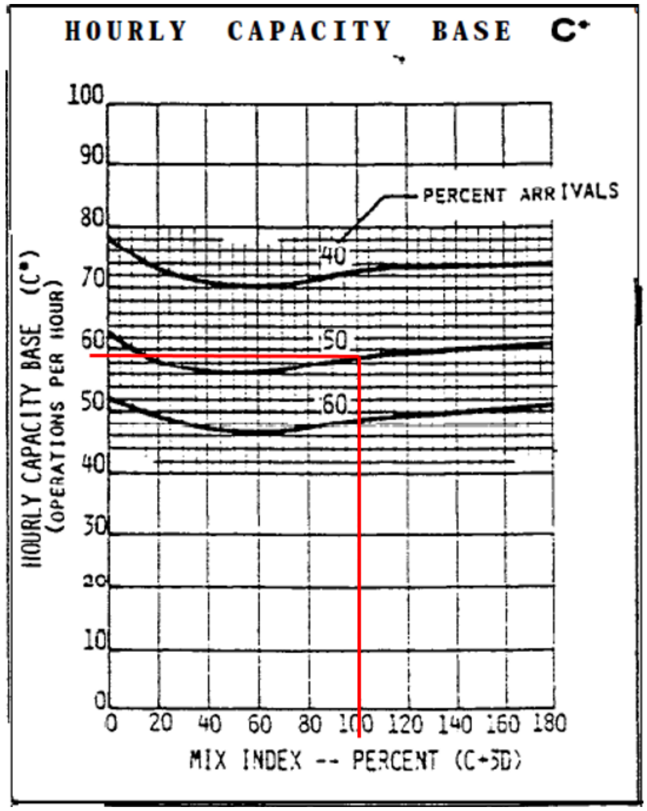


Figure 3-7: Parallel Runways in IFR Conditions (Figure 3-44)

Table 3-5: Annual Service Volume Parallel Runways Serving Large Aircraft with Radar / ILS

		Forecasts			
	2019	**2024**	**2029**	**2034**	**2039**
Total Annual Operations	97,867	105,507	116,475	128,030	139,980
Peak Month	11,117	12,037	13,327	14,691	16,106
Average Day	353	382	422	465	509
Peak Hour	53	57	63	69	76
D = Total Annual Ops / Average Day	277	277	276	276	276
H= Average Day / Peak Hour	6.7	6.7	6.7	6.7	6.7
ASV	156,799	156,425	156,170	155,923	155,686
Ops % ASV	62%	67%	75%	82%	90%
Weighted Hourly Capacity (Cw)	85	85	85	85	85
Ops % Hourly Capacity	62%	67%	75%	82%	90%

3.3 Airfield Requirements

3.3.1 Design Standards Concepts and Terminology

The planning and design of airfield facilities is based primarily on the types of aircraft using the airport. The FAA has established the **Airport Reference Code (ARC)** for planning and design purposes that signifies the airport's highest **Runway Design Code (RDC)** minus the third (visibility) component of the RDC. The RDC is a code based on planned development and signifies the design standards to which the runway is to be built.

The Runway Design Code has three components. The first component, depicted by a letter, is the **Aircraft Approach Category (AAC)** and relates to aircraft approach speed. The second component, depicted by a Roman numeral, is the **Airplane Design Group (ADG)**. ADG is a function of the design aircraft's wingspan and tail height. The third component of the RDC is the Visibility Minimums and is used to establish runway to taxiway separation distances. The FAA has also introduced the Runway Reference Code (RRC) which is comprised of the same three components as the RDC, however, describes the current operation capabilities of a runway where no special operating procedures are necessary. For layout of airport facilities, the design aircraft is the most demanding aircraft or group of aircraft having, or forecast to have, more than 500 annual operations at the airport.

AAC is a grouping of aircraft based on 1.3 times their stall speed in their landing configuration at their maximum certificated landing weight. FAA design standards recognize the following Aircraft Approach Categories:

Table 3-6: Aircraft Approach Categories

Aircraft Approach Category (AAC)	
AAC	**Approach Speed (1.3 X Stall Speed)**
A	Less than 91 knots.
B	91 knots or more but less than 121 knots.
C	121 knots or more but less than 141 knots.
D	141 knots or more but less than 166 knots.
E	166 knots or more.

*A knot = 1.15078 miles per hour, therefore 91 knots is the equivalent of 104.72 miles per hour.

The ADG is a grouping of aircraft based on wingspan and tail height. FAA design standards recognize the following ADGs:

Table 3-7: Airplane Design Groups

Airplane Design Group (ADG)		
ADG	**Tail Height (ft.)**	**Wingspan (ft.)**
I	<20'	< 49'
II	20' - < 30'	49' - < 79'
III	30' - < 45'	79' - < 118'
IV	45' - < 60'	118' - < 171'
V	60' - < 66'	171' - < 214'
VI	66' - < 80'	214' - < 262'

It is important to note that it is not necessary to design all airfield systems to the standards of the most demanding aircraft using the airfield. **Figure 3-8** provides a visual representation of various aircraft and their associated ARC's.

Figure 3-8: Airport Reference Codes

Visibility Minimums are expressed as **Runway Visual Range (RVR)** values in feet corresponding to the following Flight Visibility categories:

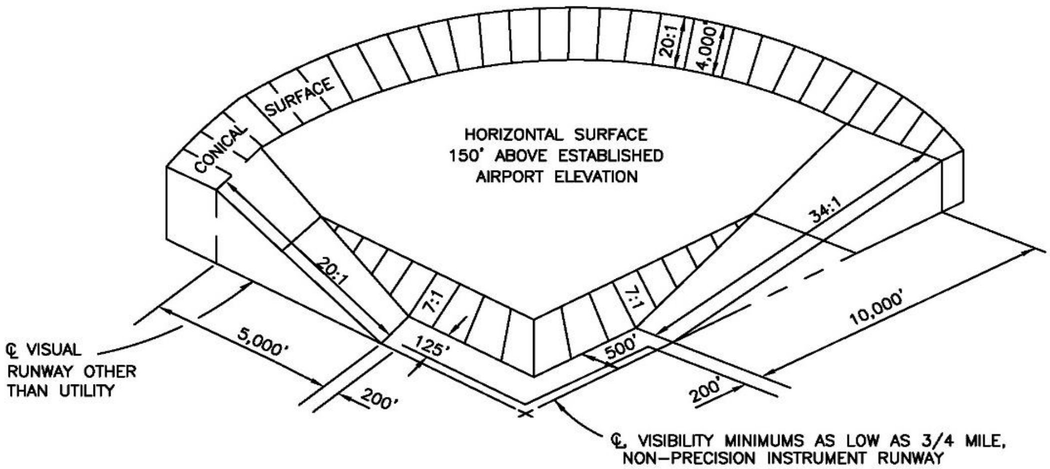
Table 3-8: Runway Visual Range

Runway Visual Range (RVR)	
4000 ft:	Lower than 1 mile but not lower than ¾ mile
2400 ft:	Lower than ¾ mile but not lower than ½ mile
1600 ft:	Lower than ½ mile but not lower than ¼ mile
1200 ft:	Lower than ¼ mile

Therefore, for example, RDC B-I/2400 is an aircraft meeting the requirements for Aircraft Approach Category B (91 knots or more but less than 121 knots) and Airplane Design Group I (wingspan up to but not including 49 feet, tail height less than 20 feet) with visibilities lower ¾ mile. Typically, increasing the Aircraft Approach Category or Airplane Design Group, and providing for lower approach visibility minimums will increase required airport geometric design standards.

Additional design criteria are determined based on aircraft weight and type of approach. A small aircraft is defined in Advisory Circular 150/5300-13A, Airport Design, as "an airplane of 12,500 pounds or less maximum certificated takeoff weight". An aircraft weighing more than 12,500 pounds is considered a large aircraft.

Aircraft weight affects the required Part 77 surfaces, runway length requirements and pavement design strength. Part 77 of the Federal Aviation Regulations defines "Objects Affecting Navigable Airspace" and establishes imaginary surfaces around airfields and approach/departure slopes to and from runways. **Figure 3-9** illustrates the Part 77 airspace surface structure for different runway categories.



TYPICAL CIVIL AIRPORT
IMAGINARY SURFACES DETAIL

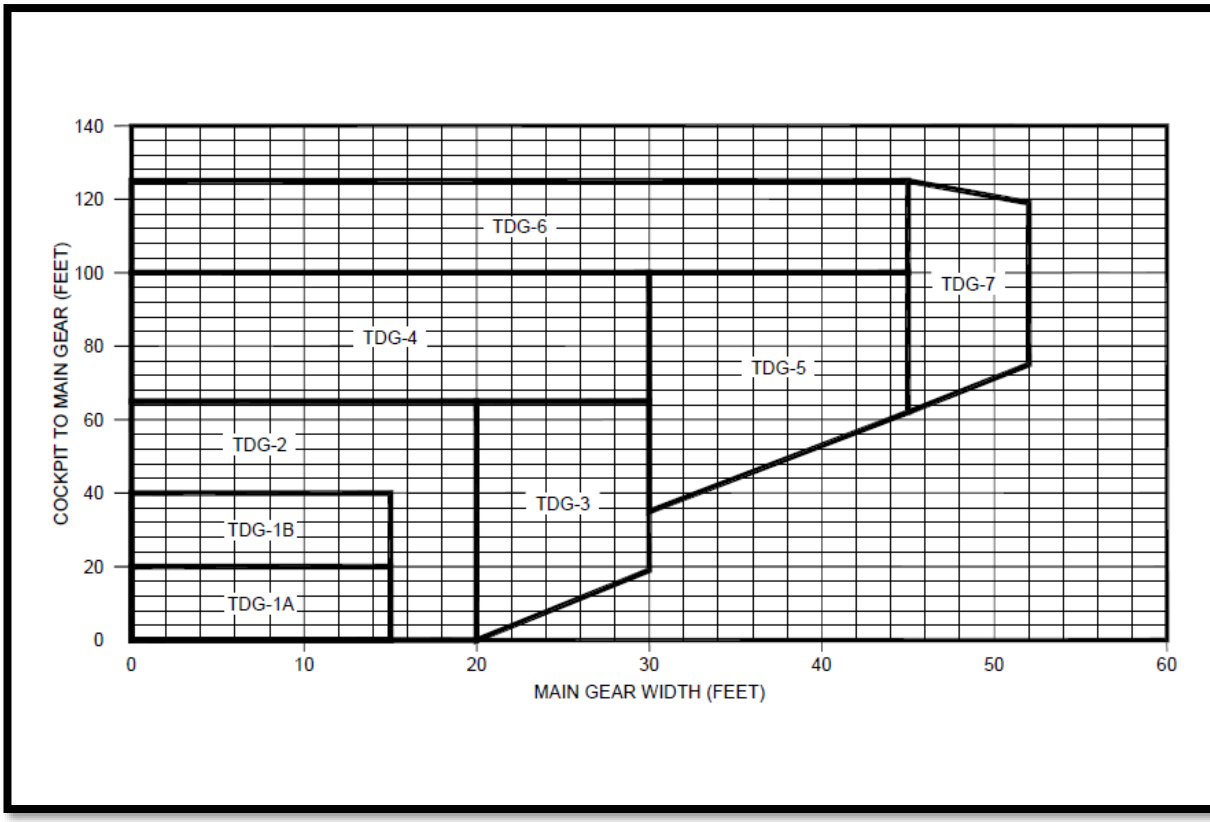
AIRPORT SURFACE DATA

ITEM	DIMENSIONAL STANDARDS (FEET)					
	VISUAL RUNWAY		NON-PRECISION INSTUMENT RUNWAY			PRECISION INSTRUMENT RUNWAY
	A	B	A	B		
				C	D	
WIDTH OF PRIMARY SURFACE AND APPROACH SURFACE WIDTH AT INNER END	250	500	500	500	1,000	1,000
RADIUS OF HORIZONTAL SURFACE	5,000	5,000	5,000	10,000	10,000	10,000
	VISUAL APPROACH		NON-PRECISION INSTRUMENT APPROACH			PRECISION INSTRUMENT APPROACH
			A	B		
	A	B		C	D	
APPROACH SURFACE WIDTH AT END	1,250	1,500	2,000	3,500	4,000	16,000
APPROACH SURFACE LENGTH	5,000	5,000	5,000	10,000	10,000	a
APPROACH SLOPE	20:1	20:1	20:1	34:1	34:1	a

A - UTILITY RUNWAYS
B - RUNWAYS LARGER THAN UTILITY (EXISTING VISUAL)
C - VISIBILITY MINIMUMS GREATER THAN 3/4 MILE
D - VISIBILITY MINIMUMS AS LOW AS 3/4 MILE (ULTIMATE)
a - PRECISION INSTRUMENT APPROACH SLOPE IS 50:1 FOR INNER 10,000 FEET AND 40:1 FOR AN ADDITIONAL 40,000 FEET

Figure 3-9: Typical Civil Aircraft Imaginary Surfaces Detail

Under former guidance, taxiway design was based on Airplane Design Groups (ADG). In the updated Advisory Circular AC 150/5300-13A, taxiway design is based on newly established **Taxiway Design Groups (TDG)**, which are based on the overall Main Gear Width (MGW) and the Cockpit to Main Gear (CMG) distance. TDG classifications are presented in **Figure 3-10**.



Source: Figure 1-1 from AC 5300-13a, Change1

Figure 3-10: Taxiway Design Groups

Critical Aircraft

Federal Aviation Administration (FAA) Advisory Circular AC150-5325-4B, *Runway Length Requirements for Airport Design*, indicates that critical aircraft, upon which runway design is based, are required for federally funded projects to "have at least 500 or more annual itinerant operations at the airport (landings and takeoffs are considered as separate operations) for an individual airplane or a family grouping of airplanes." The AC also states that adjustments may be made to the 500 total annual itinerant operations threshold after considering the circumstances of a particular airport.

Based on the analysis in Chapter 2 - *Forecasts of Aviation Demand*, the current critical aircraft at the BZN is a family of airplanes with AAC – D and ADG- III, weighing more than

12,500 pounds. In the future, D-IV aircraft are projected to be the most demanding type of aircraft with more than 500 operations at the BZN.

It is important to note that it is not necessary to design all airfield systems to the standards of the most demanding aircraft using the airfield. For airports with two or more runways it is generally most practical to design some components for a less demanding RDC. For example, at BZN, Runway 12-30 has a more demanding AAC and ADG than Runways 11-29, 3-21 and the turf runway.

Runway 11-29 is a general aviation runway designed for use by based and transient GA aircraft including small single- and multi-engines (RDC A-I and B-I) and corporate turboprops and jets (RDC B-II).

Runway 11-29 was originally designed with the intent of separating small general aviation from larger and faster commercial airplane classes on the airfield.

The analysis of airfield capacity indicates that future planning for the runway should include improvements to enhance the capacity of the airfield and accommodate traffic by aircraft weighing over 12,500 lbs.

According to AC150/5325-4B *Runway Length Requirements*, paragraph 103, "additional primary runways for capacity justification are parallel to and equal in length to the existing primary runway unless they are intended for smaller airplanes." To provide maximum capacity enhancement benefits, Runway 11-29 should ultimately, to the extent practicable, be constructed to comparable standards as Runway 12-30. In addition to maximizing airfield capacity, this would provide redundancy in cases of runway closure, allowing the airport to remain operational while one of the primary runways is closed for maintenance or for operational reasons.

Crosswind Runway 3-21 currently meets the dimensional standards of a B-II runway for small aircraft exclusively (under 12,500 pounds gross weight). As a crosswind runway, requirements for Runway 3-21 are based on wind analysis. Analysis of crosswind components at BZN, provided later in this chapter, determined a requirement for a crosswind runway to serve small aircraft at BZN.

The turf runway is designed according to B-I small aircraft standards. This classification is appropriate for future planning for the turf runway.

In terms of taxiway design, as noted in Chapter 2, *Forecasts*, the most demanding aircraft regularly operating at BZN is the Bombardier Dash 8 Q-400, which is in TDG 5. Taxiways serving portions of the airfield meant to accommodate the most demanding critical aircraft should be designed to TDG 5 standards. Other taxiways should be designed according to the associated runway and landside facilities served.

In summary, the Runway Reference Code and Taxiway Design Groups of the associated airside facilities are shown in **Table 3-9.**

Table 3-9: Facility Classifications

	Existing Classification	Ultimate Classification
Runway 12-30	D-III	D-IV
Runway 11-29	B-II (Small)	D-IV
Runway 3-21	B-I (Small)	B-II (Small)
NW/SE Turf Runway	B-I (Small)	B-I (Small)
Taxiways*	TDG 5	TDG 5

* Taxiways designed according to applicable runway and landside facility

Runway Length

Adequate planning for runway configuration requirements is very important as runway projects can affect the community beyond the property line. Runway projects are large in magnitude and can require many resources and long lead times for planning, environmental review and funding allocation.

The design approach identified in *FAA AC 150/5325-4B, "Runway Length Requirements for Airport Design"* was used to determine runway length calculations for the BZN.

Aircraft Less than 60,000 Pounds

Chapter 2 of *FAA AC 150/5325-4B "Runway Length Requirements for Airport Design"* provides the guidance to determine recommended runway lengths for aircraft of 12,500 pounds or less, while Chapter 3 provides the guidance to determine recommended runway lengths for aircraft weighing more than 12,500 pounds and less than 60,000 pounds (large aircraft). These recommendations are based on the assumption of no obstructions, zero wind, dry runway surfaces, and zero effective gradient.

Utilizing this information results in the recommended runway lengths summarized in **Table 3-10**. The runway lengths for large aircraft should be increased from the values shown at a rate of 10 feet for each foot of elevation difference between the high and low points of the runway centerline.

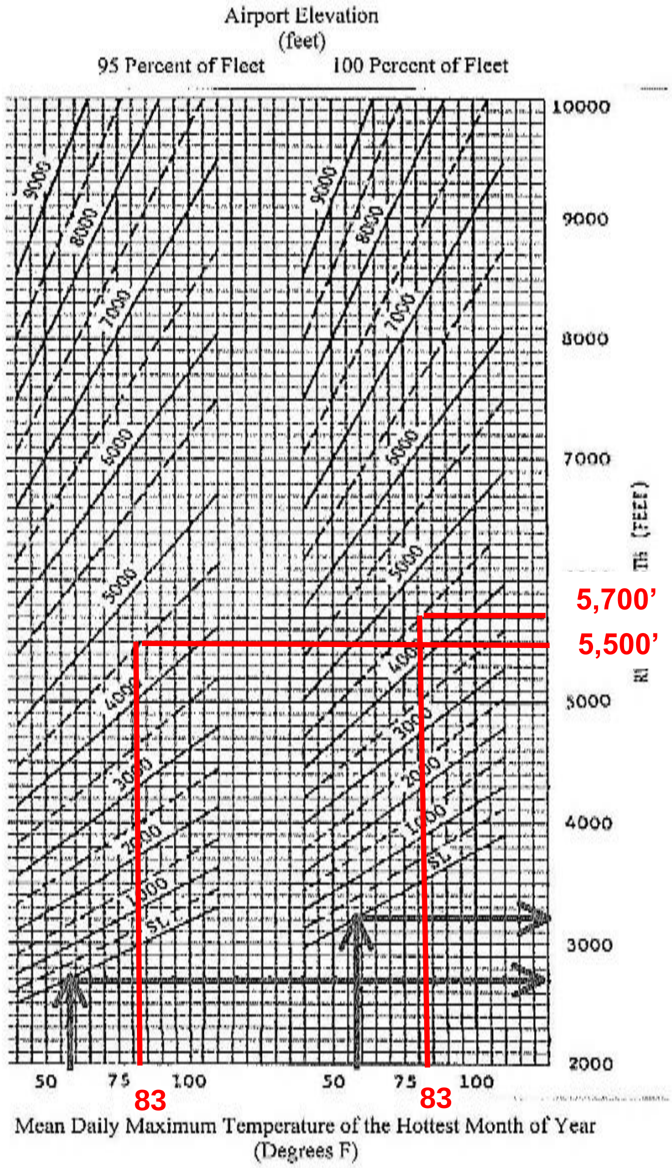
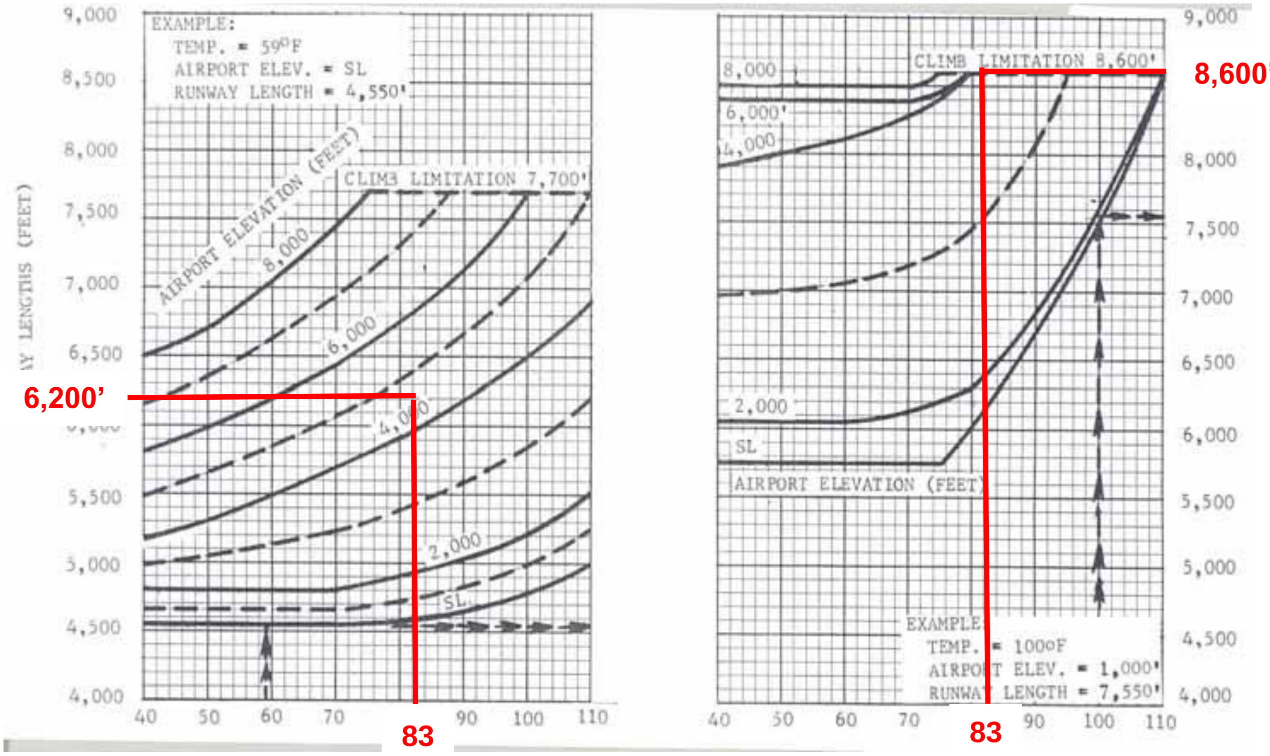


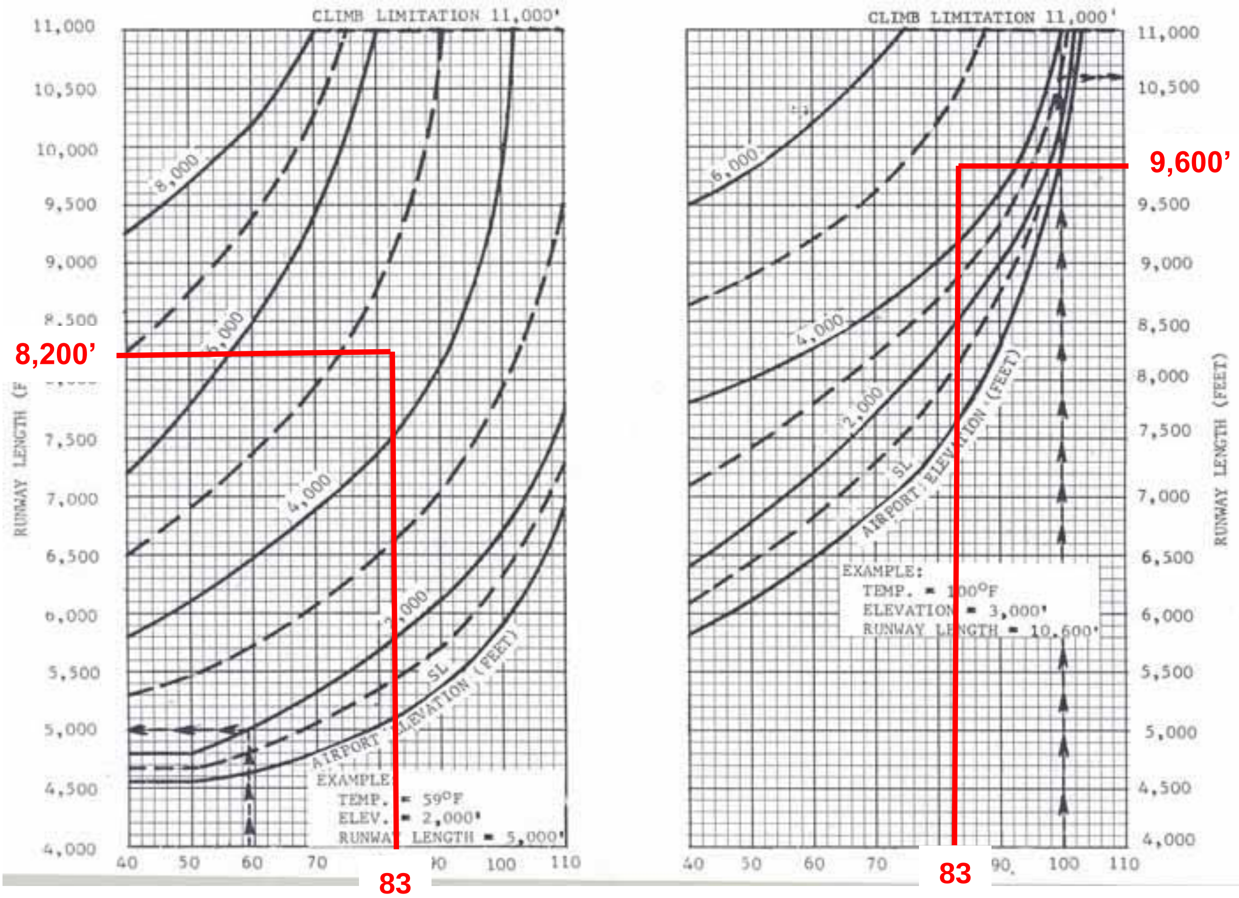
Figure 3-11: AC 150/5325-4B: Small Airplanes with Fewer than 10 Passenger Seats 95 or 100 percent Useful Load



Mean Daily Maximum Temperature of Hottest Month of the Year in Degrees Fahrenheit

75 percent of feet at 60 percent useful load **75 percent of feet at 90 percent useful load**

Figure 3-12: AC 150/5325-4B: Large Airplanes Over 12,500 Pounds
75 Percent of Fleet at 60 or 90 percent Useful Load



Mean Daily Maximum Temperature of Hottest Month of the Year in Degrees Fahrenheit

100 percent of feet at 60 percent useful load **100 percent of feet at 90 percent useful load**

Figure 3-13: AC 150/5325-4B: Large Airplanes Over 12,500 Pounds
100 Percent of Fleet at 60 or 90 percent Useful Load

Table 3-10: FAA Runway Lengths

AIRPORT AND RUNWAY DATA	
Airport elevation	4473.60 feet
Mean daily maximum temperature of the hottest month	83.2 F
RUNWAY LENGTHS RECOMMENDED FOR AIRPORT DESIGN	
Small airplanes with approach speeds of less than 30 knots	435 feet
Small airplanes with approach speeds of less than 50 knots	1,158 feet
Small airplanes with less than 10 passenger seats	
95 percent of these small airplanes	5,500 feet
100 percent of these small airplanes	5,700 feet
Small airplanes with 10 or more passenger seats	5,700 feet
Large airplanes of 60,000 pounds or less	
75 percent of these large airplanes at 60 percent useful load	6,200 feet
75 percent of these large airplanes at 90 percent useful load	8,600 feet
100 percent of these large airplanes at 60 percent useful load	8,200 feet
100 percent of these large airplanes at 90 percent useful load	9,600 feet

Note: For large airplanes, the runway lengths should be increased from the values shown at a rate of 10 feet for each foot of elevation difference between the high and low points of the runway centerline

REFERENCE:
Chapter 2 of *AC 150/5325-4B, "Runway Length Requirements for Airport Design",* no Changes included.

At 8,994 feet in length, Runway 12-30 can accommodate 100 percent of small aircraft under 12,500 pounds, 75 percent of large aircraft under 60,000 pounds at 90 percent useful load and 100 percent of large aircraft under 60,000 pounds at 60 percent useful load.

Aircraft More than 60,000 Pounds

Runway Length calculations for regional jets and aircraft over 60,000 pounds are based on the requirements of the most demanding aircraft that regularly uses the runway. Chapter 3 of Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5325-4B "Runway Length Requirements for Airport Design" sets forth the procedure used to determine recommended runway lengths for runways serving regional jets and aircraft over 60,000 pounds. Runway 12-30 is the designated runway for use by regional jets aircraft over 60,000 pounds at BZN, therefore, length analysis for Runway 12-30 follows this procedure.

The steps outlined in the advisory circular are as follows:

- **Step 1:** Identify the list of critical airplanes.
- **Step 2:** Identify the aircraft that require the longest length at Maximum Takeoff Weight (MTOW).
- **Step 3:** Determine the method to be used in determining runway length.
- **Step 4:** Select the runway length requirement for the critical aircraft.
- **Step 5:** Make adjustments to the length calculations.

The key factors influencing runway length calculation and specific data used for BZN include:

- Airport Elevation: 4473.6 feet
- Mean Maximum Temperature: 83.2 degrees F
- Runway Gradient: 0.41%
- Airplane Operating Weights: Due to the airport elevation of 4,473.6 MSL and the maximum mean temp of the hottest month of 83.2º F, most of the airplanes maximum takeoff weight (MTOW) is restricted. Operating weights are evaluated relative to fuel load requirements for anticipated stage lengths.

International Standard Atmosphere (ISA) is a mathematical model that describes how the earth's atmosphere, or air pressure and density, change depending on altitude. The atmosphere is less dense at higher elevations. ISA is frequently used in aircraft performance calculations because deviation from ISA will change how an aircraft performs. ISA at sea level occurs when the temperature is 59°F. ISA at BZN's 4,473 feet AMSL occurs when the temperature is 43°F.

Density Altitude (DA) is a measurement comparing air density at a point in time and specific location to ISA, and is a critical component of aircraft performance calculations. DA is used to understand how aircraft performance differs from the performance that would be expected under ISA. DA is primarily influenced by elevation and air temperature. To examine the effect of changes to either variable, this calculation holds the other variable constant.

- When elevation is constant: When air temperature increases, DA increases. When air temperature decreases, DA decreases. This comparison is often used when analyzing aircraft performance at an airport during different times of the day and different days of the year.

- When temperature is constant: When elevation increases, DA increases. When elevation decreases, DA decreases. This comparison, which is not often used, can be employed to compare aircraft performance at different airports under identical climate conditions.

Figure 3-14 illustrates how DA is impacted when factoring in the average maximum temperature (83.2°F) for BZN. The result is a density altitude increased to approximately 7,000 feet MSL.

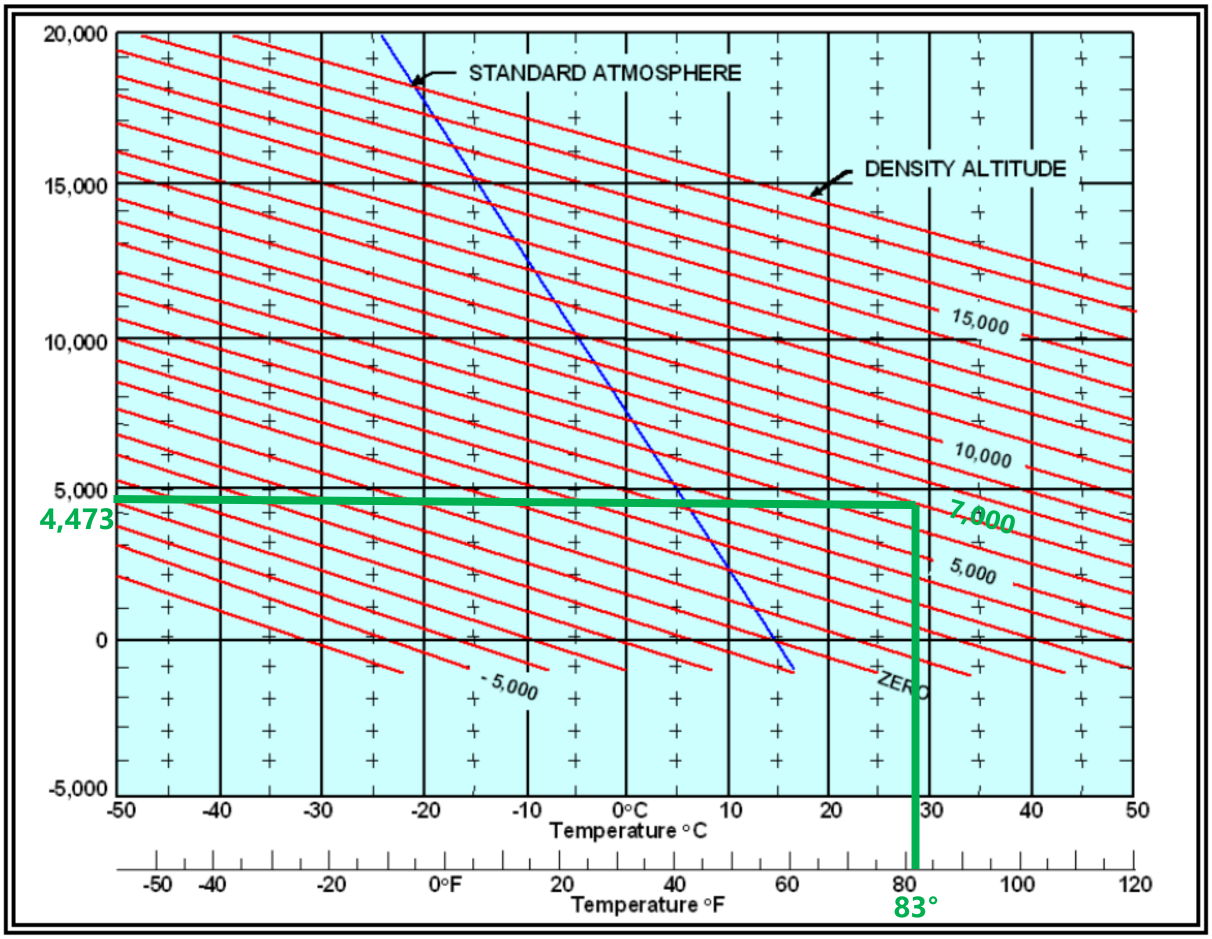


Figure 3-14: Density Altitude for BZN Average Maximum Temperature

The overall goal of AC 150/5325-4B is to assure that sufficient runway length is available to serve the needs of the aircraft and users of the airport. The process used for BZN is as follows:

Step 1: Identify the list of critical design aircraft: The projected aircraft fleet for BZN has been presented in the forecast of aviation demand. The most critical aircraft were identified as the commercial aircraft used by the Part 121 carriers. These aircraft are shown in **Table 3-11** together with the haul lengths of the destinations they currently serve. Haul lengths of potential future destinations are also shown.

Table 3-11: Aircraft by Destination Served and Haul Length

Current Destinations	Haul Length (NM)	*2021 Departures	Aircraft
Salt Lake City	300	1,794	A319, A320, CRJ 200, ERJ 175
Denver	460	2,643	A319, A320, 737-800, CRJ 200, ERJ-175
Seattle	470	1,515	ERJ 175
Portland	480	256	Q400, ERJ 175
Las Vegas	610	631	A319
San Francisco	700	492	A319, A320, 737-800, 737-900, ERJ 175
Phoenix / Mesa	750	285	A320
Minneapolis	760	986	A320, A321
Los Angeles / Long Beach	790	1,061	A319, A320, CRJ 700
Dallas / Ft. Worth	1010	673	737-800
Chicago	1030	915	A319, A320, 737-800
Detroit	1200	20	A319
Houston	1230	230	ERJ 175
Atlanta	1430	316	757-200
Philadelphia	1610	113	ERJ 175, 737-800
Newark	1640	162	A319, 737-700
New York / LaGuardia	1650	162	A320
Future Destinations			
Boston	1730		
Orlando	1760		
Miami	1910		
Honolulu	2700		

*Source FAA ASPM Data

Step 2: Identify the aircraft that require the longest runway lengths. The runway length requirements at BZN are driven by the commercial carriers as listed in the previous exhibit.

Step 3: Determine the method to be used in defining runway length: The AC directs that for commercial aircraft runway length requirements should be determined using the airplane manufacturers Airport Planning Manuals (APMs).

Step 4: Select the recommended runway length for the critical aircraft: In calculating runway length, APM data was used to determine takeoff and landing length requirements. These are presented in **Table 3–12** which shows the maximum landing and takeoff weights and the runway length requirements at stage lengths of 1500 Nautical Miles (NM) and 2000 NM. The range for each aircraft based on a 9,000 and 10,500 foot runway are also shown.

Table 3-12: Recommended Runway Lengths

	Airbus A 319	Airbus A 320	Airbus A 321	Boeing 737-800	Boeing 737-900	Boeing 757-200
Maximum Landing Design Weight (MLW)	134,482	142,198	164,244	146,300	146,300	19,800
Landing Length						
- Wet Conditions	6,210	6,300	7,475	7,700	8,000	6,300
- Dry conditions	5,400	5,900	6,500	6,800	7,000	5,500
Maximum Takeoff Design Weight (MTOW)	166,449	169,756	182,984	174,200	174,200	240,000
Takeoff Weight for length of haul @ 1500 NM	142,000	153,000	165,000	147,000	160,000	211,000
Takeoff Length for length of haul @ 1500 NM	6,500	6,700	7,500	8,500	9,700	8,200
Takeoff Length Adjusted for length of haul @ 1500 NM	6,900	7,100	7,900	8,900	10,100	8,600
Takeoff Weight for length of haul @ 2000 NM	154,000	164,000	177,000	154,000	166,000	221,000
Takeoff Length for length of haul @ 2000 NM	9,000	8,200	10,000	9,900	11,500	9,500
Takeoff Length Adjusted for length of haul @ 2000 NM	9,400	8,600	10,400	10,300	11,900	9,900
Haul Length w. 9,000 ft Runway	1,900	2,500		1,600	800	1,700
Haul Length w. 10,500 ft Runway	2,700	2,700		2,100	1,700	2,200

Notes:
Assumes maximum passengers & baggage @200 lb. ea.
Assumes temperature of 83° F.
A319 Wet Conditions calculated by adding 15% to dry conditions.
Manufacturers' data is for planning purposes and recommends consultation with local commercial air carriers to determine actual aircraft operating weights and conditions prior to construction of a runway extension.

Step 5: Make adjustments to the length calculations: An adjustment to the calculated runway length table is made to account for variations in the runway gradient. In this case, a distance of 10 feet of runway length for every foot of difference between the runway high and low points needs to be added. With a high point of 4462.4 feet and a low point of 4425.1 feet, this equals an additional 373 feet of length for takeoffs. The calculations are reflected in **Table 3–12**.

Required Runway Length

Results of the runway length analysis show that 9,000 feet of runway is acceptable for the aircraft currently operating at BZN with the maximum number of passengers on board. An extension of Runway 12-30 up to 11,900 feet would increase payload capacity and the range of aircraft departing from BZN.

The BZN Airport Layout Plan currently shows a future 1,500-foot extension of Runway 12- to the northwest to 10,500 feet. This layout has historically served as the basis for land use planning for BZN and surrounding jurisdictions. It is recommended that this ultimate threshold location continue to be shown on the Airport Layout Plan.

Preliminary analysis indicates that there is an opportunity to shift the threshold of Runway 30 328 feet to the southwest to align with the current threshold of Runway 11-29. This shift establishes a more direct route to the Runway 29 threshold and, with the retention of the existing access taxiways, creates a bypass taxiway at the Runway 30 threshold.

It is recommended that the ability to ultimately extend the runway to a maximum length of 10,828 should be preserved for the long term. This length incorporates the historically planned runway footprint, together with a 328-foot southeast extension. This length accommodates most aircraft types, payloads and haul lengths anticipated to regularly utilize BZN in the future and would provide the airlines with the flexibility to introduce additional flights to longer haul destinations.

As noted in the analysis of airfield capacity, future planning should include an upgrade in the designation of Runway 11-29 from a general aviation secondary runway to an additional primary runway. Runway 11-29 should ultimately, to the extent practicable, be constructed to comparable standards as Runway 12-30. Ideally, Runway 11-29 would ultimately be extended to a length of 10,500 feet, matching Runway 12-30. This is impractical, however given the location of municipal sewage lagoons to the northwest. The VOR is also located in the footprint of the extension of Runway 11-29. Relocation of the VOR is feasible and not a barrier to extension of the runway. Preliminary analysis indicates that a maximum extension of Runway 11-29 to 8,500 feet is possible while maintaining the runway protection zones clear of incompatible uses. As shown on **Table 3-12**, this length would be adequate for landings by the critical aircraft at BZN. This offers a viable opportunity to utilize Runway 11-29 as an arrival runway with Runway 12-30 utilized as a departure runway.

Runway 3-21 is designed to serve small aircraft under 12,500 lbs exclusively. As indicated in **Table 3-10**, a length of 5,500 feet would serve 95% of small aircraft and a length of 5,700 feet would serve 100% of small aircraft. Chapter 4 *Alternatives* will examine the practically achievable length for Runway 3-21 given geographical constraints.

Runway Orientation, Additional Runways

FAA design standards recommend additional runway orientations when the primary runway orientation provides less than 95 percent wind coverage.

Crosswind limitations are a function of an aircraft's stall speed, pilot proficiency and other factors. For general planning purposes, the FAA has established crosswind limits of 10.5 knots for general aviation A-I and B-I aircraft, 13 knots for A-II and B-II general aviation aircraft and 16 knots for transport aircraft A-III, B-III and C-I through D-III. Aircraft in approach category IV (A-IV through D-VI) have a crosswind limit of 20 knots.

Prevailing winds are generally the primary factor in determining runway orientation. The most desirable orientation based on wind is one which has the largest wind coverage and minimum crosswind components.

Wind data was obtained from the National Climatic Data Center (NCDC) utilizing the Wind Rose File Generator and Wind Analysis Tool on the FAA Airports GIS Program website. The data is from the ASOS (KBZN) at BZN, for years 2008 through 2018, excepting the year 2014, which was not available. Three separate sets of data were analyzed, All Weather Wind Data, IFR Wind Data, and VFR Wind Data. The All Weather Data set includes all wind observations in the data set, the IFR Wind Data includes only observations when instrument flight rules apply, and the VFR Wind Data Set incudes observation under visual flight rules.

The three sets of wind data were analyzed for each runway and each runway combination. Because aircraft operations decline significantly after dark at BZN, daytime observations between 6am and 6pm were analyzed. There were 46,052 observations available for analysis during the ten-year period. For each runway an allowable crosswind component is used depending on the runway design group. The allowable crosswind components are shown below:

Runway	Runway Design Group	Allowable Crosswind Component
RW 12-30	D-III	16 knots
RW 11-29	B-II	13 knots
RW 3-21	B-I	10.5 knots

The results of the analysis are shown in **Table 3-13**.

Table 3-13: Wind Coverage Summary

Runway Combination	True Bearing (deg. From true north)	Crosswind Component	All Weather	IFR	VFR
Runway 12-30	136	16	98.24%	99.65%	98.11%
Runway 12-30	136	13	96.33%	98.90%	96.10%
Runway 12-30	136	10.5	94.39%	97.86%	94.08%
Runway 11-29	136	13	96.33%	98.90%	96.10%
Runway 11-29	136	10.5	94.39%	97.86%	94.08%
Runway 3-21	046	10.5	94.94%	95.13%	94.92%
Runway 3-21 & Runway 12-30	046 / 136	10.5 / 16	99.78%	99.86%	99.77%
Runway 3-21 & Runway 11-29	046 / 136	10.5 / 13	99.52%	99.72%	99.50%
Runway 12-30, Runway 11-29, & Runway 3-21	046 / 136 / 136	16 / 13 / 10.5	99.78%	99.86%	99.77%

Source of Data: ASOS (KBZN) at BZN, for years 2008, 2009, 2010, 2011, 2012, 2013, 2015, 2016, 2017, 2018 – 46,052 observations

The analysis based on runway design group shows the wind coverage for the three sets of weather data as well as all the possible combinations for existing runway configuration. The wind data set that is the most applicable is the VFR wind data set since the crosswind runway does not currently have IFR approaches.

As shown in **Table 3-13**, the wind coverage for Runway 12-30 or Runway 11-29 alone is less than 95 percent under all weather and VFR conditions for the 10.5 knot crosswind component. This indicates that crosswind Runway 3-21 is necessary to achieve the desired 95 percent wind coverage required for general aviation A-1 and B-I aircraft that regularly use the airport. With the current configuration of Runway 12-30, Runway 11-29 and Runway 3-21, 99.78 percent wind coverage is provided in all weather conditions, 99.86 percent in IFR conditions and 99.77 percent in VFR conditions. No additional runway orientations or configurations are required.

Runway Width

The width of the existing runway was also examined to determine if it meets the needs for aircraft that currently, and are forecasted to, use the airfield. Currently, Runway 12-30 is 150 feet wide. FAA design standards call for a minimum runway width of 150 feet for Runway Design Group (RDG) D-III and D-IV, therefore, the 150-foot runway width should be sufficient for the planning period. It should be noted that airlines operating at BZN have internal policies requiring a minimum of 150 feet of runway width, even for their C–III aircraft, unless specific exemptions are made on the basis of operational necessity.

Runway 11-29 is currently 75 feet wide. This width is sufficient for the current RDC of B-II small for the runway. If and when Runway 11-29 is upgraded to the planned future RDC of D-IV, a width of 150 feet will be required in order to comply with FAA standards and to accommodate airline minimum runway width requirements.

Runway 3-21, with a current width of 75 feet is wide enough to meet standards for the current RDC of B-I small and the future RDC of B-II small.

Runway Pavement Strength

The FAA Airport Master Record 5010 form indicates Runway 12-30 has a pavement strength rating of 120,000 pounds single wheel loading, 250,000 pounds dual wheel loading, 550,000 dual wheel tandem loading and 1,120,000 dual wheel in double tandem loading. This strength rating is sufficient to serve the aircraft currently operating and expected to operate on the runway in the future.

Runway 11-29 has a documented pavement strength rating of 12,500 pounds single wheel loading. This strength rating is sufficient to serve the small aircraft currently operating on the runway, however, the runway will need to be strengthened to a strength consistent with Runway 12-30 when it is upgraded to serve aircraft over 12,500 pounds in the future.

Runway 3-21 has a documented pavement strength rating of 12,500 pounds single wheel loading. This strength rating is sufficient to serve the aircraft currently operating on and expected to operate on the runway in the future.

The FAA began using the standardized International Civil Aviation Organization (ICAO) method, to report airport runway strength in 2014. The standardized method is used to determine a Pavement Classification Number (PCN) which represents the load carrying capacity of a pavement for unrestricted operations. The PCN is a five-part code, describing the piece of pavement. The first part is the PCN numerical value which indicates the load-carrying capacity of the pavement in thousands of pounds. The second part calls out whether the pavement is rigid or flexible. The third part is a code that indicates the strength of the subgrade. The fourth part calls out the maximum tire pressure the pavement can support. The fifth part describes how the first part, the load-carrying capacity, was determined, either technical evaluation or a physical test.

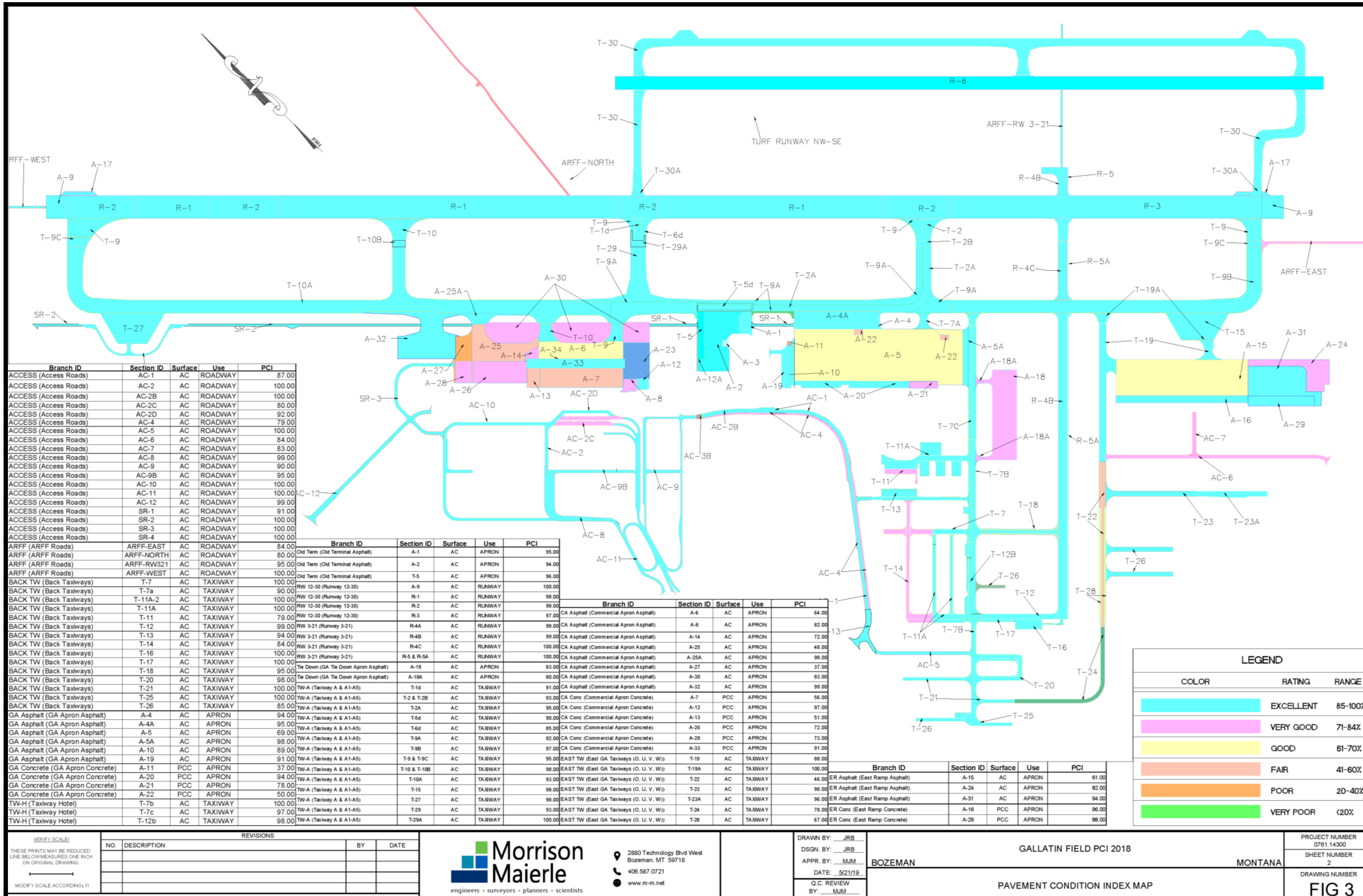
The PCN for Runway 12-30 is 123/F/A/X/T, for Runway 11-29 is 61/F/A/X/U and for Runway 3-21 is 90/F/A/X/T.

Airfield Pavement Maintenance

A runway rehabilitation project was completed in 2018 which included milling, overlaying and remarking of Runway 12-30. Runway 3-21 and GA area taxiways were overlaid in 2016. Runway 11-29, Parallel Taxiway C and connecting Taxiways C-1, C-2 and C-3 were newly constructed in 2017. The East Apron and Taxiways F were newly constructed in 2002. The East apron was expanded to the east in 2015.

In 2018, an inspection of all airport pavements was completed. Runways 12-30, 11-29 and 3-21 were found to be in the Pavement Condition Index (PCI) range of 85 to 100, which is considered “excellent”. The GA tiedown apron, the older portion of the FedEx apron and portions of the commercial apron were rated between 71 and 84, which is considered “very good”. The oldest portion of the commercial apron and the southern portion of Taxiway F were rated between 41 and 64, which is considered “fair”. Generalized results of the PCI inspection are shown in **Figure 3-15**.

A regular series of pavement maintenance is recommended for all airfield pavements. Based on the current condition of existing pavements, a general schedule for major and preventative maintenance items is presented in **Table 3-14**. Actual project timing will depend on the availability of funding and actual wear on pavement. The primary elements are listed, followed by their typical useful life.



Branch ID	Section ID	Surface	Use	PCI
ACCESS (Access Roads)	AC-1	AC	ROADWAY	87.00
ACCESS (Access Roads)	AC-2	AC	ROADWAY	100.00
ACCESS (Access Roads)	AC-2B	AC	ROADWAY	100.00
ACCESS (Access Roads)	AC-2C	AC	ROADWAY	80.00
ACCESS (Access Roads)	AC-2D	AC	ROADWAY	92.00
ACCESS (Access Roads)	AC-4	AC	ROADWAY	79.00
ACCESS (Access Roads)	AC-5	AC	ROADWAY	100.00
ACCESS (Access Roads)	AC-6	AC	ROADWAY	84.00
ACCESS (Access Roads)	AC-7	AC	ROADWAY	83.00
ACCESS (Access Roads)	AC-8	AC	ROADWAY	99.00
ACCESS (Access Roads)	AC-9	AC	ROADWAY	90.00
ACCESS (Access Roads)	AC-9B	AC	ROADWAY	95.00
ACCESS (Access Roads)	AC-10	AC	ROADWAY	100.00
ACCESS (Access Roads)	AC-11	AC	ROADWAY	100.00
ACCESS (Access Roads)	AC-12	AC	ROADWAY	99.00
ACCESS (Access Roads)	SR-1	AC	ROADWAY	91.00
ACCESS (Access Roads)	SR-2	AC	ROADWAY	100.00
ACCESS (Access Roads)	SR-3	AC	ROADWAY	100.00
ACCESS (Access Roads)	SR-4	AC	ROADWAY	100.00
ARFF (ARFF Roads)	ARFF-EAST	AC	ROADWAY	84.00
ARFF (ARFF Roads)	ARFF-NORTH	AC	ROADWAY	80.00
ARFF (ARFF Roads)	ARFF-RW321	AC	ROADWAY	95.00
ARFF (ARFF Roads)	ARFF-WEST	AC	ROADWAY	100.00
BACK TW (Back Taxiways)	T-7	AC	TAXIWAY	100.00
BACK TW (Back Taxiways)	T-7a	AC	TAXIWAY	90.00
BACK TW (Back Taxiways)	T-11A-2	AC	TAXIWAY	100.00
BACK TW (Back Taxiways)	T-11A	AC	TAXIWAY	100.00
BACK TW (Back Taxiways)	T-11	AC	TAXIWAY	79.00
BACK TW (Back Taxiways)	T-12	AC	TAXIWAY	99.00
BACK TW (Back Taxiways)	T-13	AC	TAXIWAY	94.00
BACK TW (Back Taxiways)	T-14	AC	TAXIWAY	84.00
BACK TW (Back Taxiways)	T-16	AC	TAXIWAY	100.00
BACK TW (Back Taxiways)	T-17	AC	TAXIWAY	100.00
BACK TW (Back Taxiways)	T-18	AC	TAXIWAY	95.00
BACK TW (Back Taxiways)	T-20	AC	TAXIWAY	98.00
BACK TW (Back Taxiways)	T-21	AC	TAXIWAY	100.00
BACK TW (Back Taxiways)	T-25	AC	TAXIWAY	100.00
BACK TW (Back Taxiways)	T-26	AC	TAXIWAY	85.00
GA Asphalt (GA Apron Asphalt)	A-4	AC	APRON	94.00
GA Asphalt (GA Apron Asphalt)	A-4A	AC	APRON	95.00
GA Asphalt (GA Apron Asphalt)	A-5	AC	APRON	69.00
GA Asphalt (GA Apron Asphalt)	A-5A	AC	APRON	98.00
GA Asphalt (GA Apron Asphalt)	A-10	AC	APRON	89.00
GA Asphalt (GA Apron Asphalt)	A-19	AC	APRON	91.00
GA Concrete (GA Apron Concrete)	A-11	PCC	APRON	37.00
GA Concrete (GA Apron Concrete)	A-20	PCC	APRON	94.00
GA Concrete (GA Apron Concrete)	A-21	PCC	APRON	78.00
GA Concrete (GA Apron Concrete)	A-22	PCC	APRON	50.00
TW-H (Taxiway Hotel)	T-7b	AC	TAXIWAY	100.00
TW-H (Taxiway Hotel)	T-7c	AC	TAXIWAY	97.00
TW-H (Taxiway Hotel)	T-12b	AC	TAXIWAY	98.00

Branch ID	Section ID	Surface	Use	PCI
Old Term (Old Terminal Asphalt)	A-1	AC	APRON	95.00
Old Term (Old Terminal Asphalt)	A-2	AC	APRON	94.00
Old Term (Old Terminal Asphalt)	T-5	AC	APRON	96.00
RW 12-30 (Runway 12-30)	A-9	AC	RUNWAY	100.00
RW 12-30 (Runway 12-30)	R-1	AC	RUNWAY	98.00
RW 12-30 (Runway 12-30)	R-2	AC	RUNWAY	98.00
RW 12-30 (Runway 12-30)	R-3	AC	RUNWAY	97.00
RW 3-21 (Runway 3-21)	R-4A	AC	RUNWAY	98.00
RW 3-21 (Runway 3-21)	R-4B	AC	RUNWAY	99.00
RW 3-21 (Runway 3-21)	R-4C	AC	RUNWAY	100.00
RW 3-21 (Runway 3-21)	R-5 & R-5A	AC	RUNWAY	100.00
Tie Down (GA Tie Down Apron Asphalt)	A-18	AC	APRON	83.00
Tie Down (GA Tie Down Apron Asphalt)	A-18A	AC	APRON	80.00
TW-A (Taxiway A & A1-A5)	T-1d	AC	TAXIWAY	91.00
TW-A (Taxiway A & A1-A5)	T-2 & T-2B	AC	TAXIWAY	93.00
TW-A (Taxiway A & A1-A5)	T-2A	AC	TAXIWAY	95.00
TW-A (Taxiway A & A1-A5)	T-5d	AC	TAXIWAY	90.00
TW-A (Taxiway A & A1-A5)	T-6d	AC	TAXIWAY	85.00
TW-A (Taxiway A & A1-A5)	T-9A	AC	TAXIWAY	92.00
TW-A (Taxiway A & A1-A5)	T-9B	AC	TAXIWAY	97.00
TW-A (Taxiway A & A1-A5)	T-9 & T-9C	AC	TAXIWAY	95.00
TW-A (Taxiway A & A1-A5)	T-10 & T-10B	AC	TAXIWAY	98.00
TW-A (Taxiway A & A1-A5)	T-10A	AC	TAXIWAY	93.00
TW-A (Taxiway A & A1-A5)	T-15	AC	TAXIWAY	98.00
TW-A (Taxiway A & A1-A5)	T-27	AC	TAXIWAY	98.00
TW-A (Taxiway A & A1-A5)	T-29	AC	TAXIWAY	93.00
TW-A (Taxiway A & A1-A5)	T-29A	AC	TAXIWAY	100.00

Branch ID	Section ID	Surface	Use	PCI
CA Asphalt (Commercial Apron Asphalt)	A-6	AC	APRON	64.00
CA Asphalt (Commercial Apron Asphalt)	A-8	AC	APRON	82.00
CA Asphalt (Commercial Apron Asphalt)	A-14	AC	APRON	72.00
CA Asphalt (Commercial Apron Asphalt)	A-25	AC	APRON	48.00
CA Asphalt (Commercial Apron Asphalt)	A-25A	AC	APRON	98.00
CA Asphalt (Commercial Apron Asphalt)	A-27	AC	APRON	37.00
CA Asphalt (Commercial Apron Asphalt)	A-30	AC	APRON	83.00
CA Asphalt (Commercial Apron Asphalt)	A-32	AC	APRON	99.00
CA Conc (Commercial Apron Concrete)	A-7	PCC	APRON	56.00
CA Conc (Commercial Apron Concrete)	A-12	PCC	APRON	97.00
CA Conc (Commercial Apron Concrete)	A-13	PCC	APRON	51.00
CA Conc (Commercial Apron Concrete)	A-26	PCC	APRON	72.00
CA Conc (Commercial Apron Concrete)	A-28	PCC	APRON	73.00
CA Conc (Commercial Apron Concrete)	A-33	PCC	APRON	91.00
EAST TW (East GA Taxiways (O, U, V, W))	T-19	AC	TAXIWAY	88.00
EAST TW (East GA Taxiways (O, U, V, W))	T-19A	AC	TAXIWAY	100.00
EAST TW (East GA Taxiways (O, U, V, W))	T-22	AC	TAXIWAY	46.00
EAST TW (East GA Taxiways (O, U, V, W))	T-23	AC	TAXIWAY	98.00
EAST TW (East GA Taxiways (O, U, V, W))	T-23A	AC	TAXIWAY	96.00
EAST TW (East GA Taxiways (O, U, V, W))	T-24	AC	TAXIWAY	78.00
EAST TW (East GA Taxiways (O, U, V, W))	T-28	AC	TAXIWAY	67.00

Branch ID	Section ID	Surface	Use	PCI
ER Asphalt (East Ramp Asphalt)	A-15	AC	APRON	61.00
ER Asphalt (East Ramp Asphalt)	A-24	AC	APRON	82.00
ER Asphalt (East Ramp Asphalt)	A-31	AC	APRON	94.00
ER Conc (East Ramp Concrete)	A-16	PCC	APRON	96.00
ER Conc (East Ramp Concrete)	A-29	PCC	APRON	88.00

Figure 3-15: Pavement Condition Index Map

Table 3-14: Airfield Pavement Maintenance

Recommended Maintenance Program	Approximate Life Expectancy
Asphalt Pavement Mill & Overlay	15 to 20 years
Concrete Reconstruction	40 years
Sealcoat	4 years
Crack Sealing	4 years

Pavement	Last Major Maintenance/ Construction	Asphalt Mill & Overlay / * Concrete Reconstruction	Sealcoat / Spall Repair	Crack Sealing / Joint Repair*
Runway 12-30	2018	2033	2022	4 year cycle
Runway 11-29	2017 (new const)	2032	2021	4 year cycle
Runway 3-21	2017	2032	2021	4 year cycle
Parallel Taxiway A	2017	2032	2021	4 year cycle
Parallel Taxiway C	2017 (new const)	2032	2021	4 year cycle
Parallel Taxiway F	2004 (new const)	2022	2026	4 year cycle
Parallel Taxiway H	2017	2032	2021	4 year cycle
Taxiway G	2017	2032	2021	4 year cycle
Taxiway J	2017	2032	2021	4 year cycle
Taxiways K,L,M,N	2017	2032	2021	4 year cycle
Taxiways P,QRST	2017	2032	2021	4 year cycle
Unnamed (north GA hangar access)	2017	2032	2021	4 year cycle
Taxiway U, V, W	2004 (new const)	2024	2028	4 year cycle
Taxiway Y, Z	2020	2035	2024	
Commercial Apron – Original (Concrete)	1977	*TBD	2026	4 year cycle
Commercial Apron – East (Asphalt)	2005	2022	2026	4 year cycle
Commercial Apron – West (Concrete)	2018	*TBD	2026	4 year cycle
General Aviation Apron (Asphalt)	1984	2024	2028	4 year cycle
Based Aircraft Tie Down Apron	2004	2024	2028	4 year cycle
East Ramp (West)	2002	2024	2028	4 year cycle
East Ramp (East)	2015	2024	2028	4 year cycle

*Concrete pavements to be reconstructed as needed per PCI observations

Note: Maintenance on exit and connecting taxiways and taxilanes should be done as part of related runway, parallel taxiway, or apron projects.

Taxiway Requirements

Taxiways are constructed primarily to facilitate aircraft movement to and from the runway system. Some taxiways are necessary simply to provide access between aprons and runways, while other taxiways become necessary as activity increases and safer and more efficient use of the airfield is needed.

Under former guidance, taxiway design was based on Airplane Design Groups (ADG). In the updated Advisory Circular AC 150/5300-13A, taxiway design is also based on newly established Taxiway Design Groups (TDG), which are based on the overall Main Gear Width (MGW) and the Cockpit to Main Gear (CMG) distance.

Runway 12-30 is served by one parallel taxiway located southwest of the runway. Taxiway A is located 750 feet from the runway centerline and is 75 feet wide. Connecting taxiways are 75 to 90 feet wide.

The existing 75-foot taxiway width of Parallel Taxiway A is adequate for the existing and planned future Taxiway Design Group 5.

Bypass and secondary parallel taxiways can improve the efficiency of the taxiway system. Bypass taxiways allow traffic ready for departure to bypass aircraft preparing for departure. Secondary parallel taxiways allow for separation between larger and faster aircraft from smaller and slower aircraft and offer the possibility of bi-directional taxiing. There are currently no bypass or secondary parallel taxiways on the airfield. Consideration should be given to constructing bypass and secondary taxiways to serve the existing runway system.

Likewise, acute angled high-speed taxiway exits reduce time on the runway by landing aircraft, improving the operational efficiency of the airfield. Acute angled high-speed taxiway exits should be considered to serve the runway system within the planning period.

Runway 11-29 is served by full length parallel Taxiway C located northeast of the runway. Taxiway C is located 307.5 feet from the runway centerline and is 35 feet wide. Connecting taxiways are also 35 feet wide. At the time Runway 11-29 is upgraded to accommodate D-IV aircraft, a width of 75 feet and an offset of at least 400 feet will be required from all parallel runways.

The existing 35-foot taxiway width of Parallel Taxiway C is adequate for the current use by TDG 2 aircraft associated with the current RDC of B-II small for Runway 11-29. If and when Runway 11-29 is upgraded to the planned future RDC of D-IV, serving TDG 5 aircraft, a width of 75 feet will be required.

Runway 3-21 is served by partial parallel Taxiway H located southwest of the runway. Taxiway H is located 300 feet from the runway centerline and is 35 feet wide. Connecting taxiways are 25 to 35 feet wide.

The existing 35-foot taxiway width of Parallel Taxiway H is adequate to meet standards for the existing TDG 2 associated with RDC of B-I small and the future RDC of B-II small for Runway 3-21.

Airport Design AC 150/5300-13A states that taxiway connectors that cross over a parallel taxiway from an apron and directly onto a runway are not recommended. To prevent runway incursion and promote good situational awareness by pilots, a staggered layout when taxiing from an apron onto a parallel taxiway and then onto a stub-taxiway or taxiway connector to a runway is recommended. Per FAA recommendations, the general aviation apron access taxiway that aligns with connecting Taxiway A-2 should be removed to create a staggered layout. A staggered layout will be created with consideration of future high speed taxiway exit(s).

Holding aprons and bypass taxiways can improve the efficiency of the taxiway system. Holding aprons allow aircraft to prepare for departure in an area off the taxiway. Bypass taxiways allow traffic ready for departure to bypass aircraft preparing for departure. There are currently holding aprons at both ends of Runway 12-30 and Runway 11-29. Consideration should be given for holding aprons or bypass taxiways as these runways are extended in the future as well improvements to parallel taxiways serving Runway 3-21. According to Order 5090.5, Formulation of the NPIAS and ACIP, Table 4-4, planning and development of holding aprons and bypass taxiways should begin at 75,000 total operations, 20,000 itinerant operations, or 30 peak hour operations per runway.

As facilities are built to accommodate growing demand in the general aviation and executive hangar areas, taxiways and taxilanes will need to be extended to provide access from those areas to the airfield.

FAA Design Standards

One of the key considerations of any airport planning effort is to evaluate the dimensional standards for the airfield layout, established by the FAA. **Table 3-15** presents a summary of significant FAA design standards that need to be compared with existing conditions to evaluate whether BZN meets criteria for the aircraft currently being served. The application of these design standards establishes airport geometry. The airport currently operates as a D-III facility and is planned to ultimately be a D-IV facility. Runway 12-30 and Runway 11-29 are planned to accommodate the most demanding aircraft while Runways 3-21 and the turf runway provide operational alternatives for less demanding aircraft types.

Table 3-15: FAA Design Standards

	RW 12-30		RW 11-29		RW 3-21		Turf
	Existing	Ultimate	Existing	Ultimate	Existing	Ultimate	Existing / Ultimate
ARC	D-III	D-IV	B-II (Small)	D-IV	B-I (Small)	B-II (Small)	B-I (Small)
Approach Visibility Minimum	<3/4 mile	<3/4 mile	Visual	> 1 mile	Visual	Visual	Visual
Runway Object Free Area							
Width	800′	800′	500′	800′	250′	500′	250′
Length Beyond Runway End	1000′	1000′	300′	1000′	240′	300′	240′
Runway Safety Area							
Width	500′	500′	150′	500′	120′	150′	120′
Length Beyond Runway End	1,000	1,000	300	1,000	240	300	240
Runway Obstacle Free Zone							
Width	400′	400′	250′	400′	250′	250′	250′
Length Beyond Runway End	200′	200′	200′	200′	200′	200′	200′
Taxiway Object Free Area							
Width	186′	259′	131′	259′	89′	131′	89′
Taxiway Safety Area							
Width	118′	171′	79′	171′	49′	79′	49′
Design Criteria							
Runway Width	150′	150′	75′	150′	60′	75′	80
Taxiway Width	75′(TDG 5)	75′(TDG 5)	35′ (TDG 2)	75′(TDG 5)	35′ (TDG 2)	35′ (TDG 2)	35′ (TDG 2)
Runway Centerline to Parallel T/W Centerline	400′	400′	240′	400′	300′	240′	150′
Runway Centerline to Holdline	295′	295′	125′	295′	125′	125′	125′
Runway Centerline to Edge of Aircraft Parking	500′	500′	250′	500′	125′	250′	125′
Taxiway centerline to Fixed or Movable Object	93′	129.5′	65.5′	129.5′	44.5′	65.5′	44.5′

Runway Object Free Area (OFA): The Runway Object Free Area is a two-dimensional ground area surrounding the runway. The runway OFA clearing standard precludes parked airplanes and objects except those whose location is fixed by function such as a navigational aid. As shown in **Table 3-15**, the OFA for Runway 12-30 and the turf runway will remain at their existing sizes. The OFA for Runway 11-29 will ultimately need to enlarge from 500 feet wide and 300 feet beyond the runway end (B-II small facility) to 800 feet wide and 1,000 feet beyond the runway end (D-IV facility). The OFA for Runway 3-21 will ultimately need to enlarge from 250 feet wide and 240 feet beyond the runway end (B-I small facility) to 500 feet wide and 300 feet beyond the runway end (B-II small facility).

Runway Safety Area (RSA): The Runway Safety Area is a defined surface surrounding the runway prepared or suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or excursion from the runway. The RSA should be cleared and graded and have no potentially hazardous ruts, humps, depressions, or other surface variations. As shown in **Table 3-15**, the RSA for Runway 12-30 and the turf runway will remain at their existing sizes. The RSA for Runway 11-29 will ultimately need to enlarge from 150 feet wide and 300 feet beyond the runway end (B-II small facility) to 500 feet wide and 1,000 feet beyond the runway end (D-IV facility). The OFA for Runway 3-21 will ultimately need to enlarge from 120 feet wide and 240 feet beyond the runway end (B-I small facility) to 150 feet wide and 300 feet beyond the runway end (B-II small facility).

Runway Obstacle Free Zone (OFZ): The runway OFZ is a defined volume of airspace centered above the runway centerline. It is the airspace above a surface whose elevation at any point is the same as the elevation of the nearest point on the runway centerline. For runways serving small aircraft under 12,500 pounds, the OFZ is 250 feet wide and 200 feet beyond the runway end. For runways serving aircraft over 12,500 pounds the OFZ is 400 feet wide and 200 feet beyond the runway end.

Taxiway Object Free Area (TOFA): The TOFA is a two-dimensional ground area adjacent to taxiways. The taxiway OFA clearing standard precludes vehicle service roads, parked airplanes, and objects except those whose location is fixed by function such as a navigational aid. The FAA standard TOFA for Taxiways serving Group IV aircraft is 259 feet, for Group III aircraft is 186 feet wide, for Group II aircraft 139 feet and for Group I aircraft is 89 feet centered on the taxiway centerline.

Taxiway Safety Area (TSA): The TSA is a defined surface alongside the taxiway prepared or suitable for reducing risk of damage to an airplane unintentionally departing the taxiway. The FAA standard TSA for Taxiways serving Group IV and Group III aircraft is 118 feet, for Group II aircraft 79 feet and for Group I aircraft is 49 feet centered on the taxiway centerline.

Design Criteria

Line of Sight: FAA line of sight standards require that two points five feet above the centerline of a runway, without a parallel taxiway, be mutually visible for the entire runway. For runways with a full parallel taxiway, the standard requires that two points, five feet above the centerline, be mutually visible for one half of the runway length. Further, there is a requirement that for intersecting runways, points five feet above the centerline must be mutually visible within the Runway Visibility Zone (RVZ).

Line of sight requirements are currently met at BZN; however, care must be taken not to create a problem in the course of future development.

Runway Centerline to Parallel Taxiway Centerline: This design criterion establishes the minimum separation between the centerline of the runway and the centerline of the parallel taxiway. The existing parallel taxiways for Runways 12-30, 11-29 and 3-21 are separated from their runway centerlines by 750 feet, 307.5 feet and 300 feet respectively. These separations exceed the separation standards for the existing categories for the runways shown in **Table 3-15.** When Runway 11-29 is upgraded to a D-IV facility, a runway centerline to taxiway centerline separation of at least 400 feet will be required.

Runway Centerline to Holdline: This standard provides for marking on pavement and placing signs at locations on taxiways where aircraft hold prior to entering the runway. These locations are chosen to ensure that aircraft are clear of the RSA and OFZ during operations by other aircraft on the runway. Hold positions for Runways 12-30, 11-29 and 3-21 are separated from their runway centerlines by 300 feet, 250 feet and 125 feet respectively. These separations exceed the separation standards for the existing design categories for the runways shown in **Table 3-15**. When Runway 11-29 is upgraded to a D-IV facility, a runway centerline to holdline separation of at least 295 feet will be required.

Runway Centerline to Edge of Parking Area: This standard is designed to allow additional clearance between aircraft parking areas and aircraft operations on the runway, while protecting space between these areas for a parallel taxiway. The airport's aircraft parking separation currently exceed the minimum required distances for the ultimate runway design groups. No construction of aircraft parking aprons should be permitted within the designated area in the future.

3.3.2 Airfield Marking, Lighting and Signage

Pavement markings, lighting and signage facilitate the safe movement of aircraft about the airfield by directing pilots to their destinations. Runway markings are designed according to the type of instrument approach available on the runway. FAA Advisory Circular (AC) 150/5340-1L, Standards for Airport Markings, provides the guidance necessary to design an airport's markings.

Runway 12-30 has Precision Instrument markings which will accommodate future approaches below ¾ mile visibility minimums for the runway. Besides routine maintenance of the runway markings, these markings should suffice for the planning period.

Runway 11-29 has Non-Precision Instrument markings which will accommodate future approaches down to ¾ mile visibility minimums for the runway. Besides routine maintenance of the runway markings, these markings should suffice for the planning period.

Runway 3-21 has basic markings. Besides routine maintenance of the runway markings, these markings should suffice for the planning period.

Taxiway and apron areas also require marking. Yellow centerline stripes are currently painted on all taxiway and taxilane surfaces at the airport to provide guidance to pilots. Runway, taxiway and taxilane markings should be maintained in conjunction with the routine maintenance of the pavement surface.

Airport lighting systems provide critical guidance to pilots during nighttime and low visibility operations. Runway 12-30 is equipped with high intensity runway edge lighting (HIRL), Runway 11-29 is equipped with medium intensity runway edge lighting (MIRL) and Runway 3-21 is not equipped with runway lighting. The existing runway lighting systems on Runway 12-30 and Runway 11-29, while adequate in intensity, will need routine maintenance during the planning period. Runway 3-21 is planned as a daytime operation runway, therefore no additional lighting is planned.

BZN is pursuing installation of a Runway Visual Range (RVR) system with a goal of reaching a 1,200-foot visual range for Runway 12-30. As noted in AC 150/5340-30J *Design and Installation Details for Airport Visual Aids*, runway centerline lights and touchdown lights are required for landing operations below 2,400 ft RVR. Therefore, runway centerline lights and touchdown zone lights should be planned for Runway 12-30 within the planning horizon.

Effective ground movement at night is enhanced by the availability of taxiway lighting. The taxiway system is currently served by medium intensity taxiway lighting (MITL). Taxiway lights have been upgraded to light emitting diode (LED). The existing taxiway lighting systems, while adequate in intensity, will need routine maintenance during the planning period.

Airfield signage provides another means of notifying pilots as to their location on the airport. A system of signs placed at several airfield intersections on the airport is the best method available to provide this guidance. Signs located at intersections of runways and taxiways provide crucial information to avoid conflicts between moving aircraft. Directional signage instructs pilots as to the location of taxiways and terminal aprons.

Signage for BZN includes hold position signs, and directional signs. The airfield signage system was replaced in 2016. Airfield signs are internally lighted and reflect current FAA standards. Airfield signage should be reviewed and replaced as needed with applicable projects at the airport.

3.3.3 Navigational and Approach Aids

Electronic and visual approach aids provide guidance to arriving aircraft and enhance the safety and capacity of the airfield. While instrument approach aids are especially helpful during poor weather, they are often used by commercial pilots when visibility is good.

Instrument Approach Procedures

While instrument approach aids are especially helpful during poor weather, they are often used by commercial pilots when visibility is good. Instrument approaches are categorized as either precision or non-precision. Precision instrument approach aids provide an exact alignment and decent path for an aircraft on final approach to a runway while non-precision instrument approach aids provide only runway alignment information. Most existing instrument approaches in the United States are global positioning systems (GPS) or instrument landing systems (ILS).

With the advent of GPS, stand-alone instrument assisted approaches will eventually be established that provide vertical guidance down to visibility minimums currently associated with precision runways. As a result, airport design standards that formerly were associated with a type of instrument procedure (precision/non-precision) are now revised to relate instead to the designated or planned approach visibility minimums.

An ILS instrument approach is available to Runway 12. This Category I approach to Runway 12 consists of a glide-slope, localizer and a Medium-intensity Approach Lighting System with Runway alignment indicator (MALSR). The approach may be flown with cloud ceilings as low as 200 feet and visibility reduced to one-half mile.

Runway 12 also has two RNAV approaches. An RNAV GPS approach to Runway 12 has been established, which may be flown with visibility reduced to 1/2 mile and cloud ceilings as low as 300 feet. In addition, an RNAV RNP approach to Runway 12 may be flown with visibility reduced to 1 mile and cloud ceilings as low as 400 feet.

Runway 30 does not have a straight in precision instrument approach, but has two RNAV approaches. An RNAV RNP approach to Runway 30 may be flown with visibility reduced to 1 mile and cloud ceilings as low as 300 feet. In addition, an RNAV GPS circling approach to Runway 30 is available may be flown with visibility reduced to between 1 ¼ and 3 statute miles depending on aircraft speed.

A published VOR approach makes use of the VHF Omnidirectional Range (VOR) which is located in alignment with Runway 11-29 approximately 1,200 feet northwest of the Runway 11 threshold. A VOR approach does not align the aircraft with the runway, so it is a "circling" approach. This means that after the aircraft makes visual contact with the runway, a circling maneuver is required to line up with the runway and execute the landing. This approach allows the aircraft to descend to approximately 1000 feet above the threshold. Visibility minimums are between 1 ¼ and 3 statute miles.

Straight in instrument approaches are not available to Runway 11-29 and Runway 3-21.

The following are recommendations for improvements to the instrument approach procedures for the runways at BZN:

Runway 30:
- Add ILS
- Add MALSR

Runway 11:
- Add "Sidestep" ILS Approach from Runway 12
- Add GPS approach

Runway 29
- Add "Sidestep" ILS Approach from Runway 30
- Add GPS approach

Visual Approach Aids

In most instances, the landing phase of any flight must be conducted in visual conditions. To provide pilots with visual guidance information during landings to the runway, electronic visual approach aids are commonly provided at airports. The existing visual approach aids consist of four-box Precision Approach Path Indicators (PAPI-4) on Runway 12-30 and Runway 11-29.

Existing PAPIs require routine maintenance and should be replaced at the end of their useful life. (FAA considers the minimum useful life for airfield lighting and signage to be ten years for grant eligibility under the Airport Improvement Program per Table 308 of FAA Order 5100.38D). New PAPIs should be planned for Runway 3-21.

Runway End Identifier Lights (REILs) provide rapid and positive identification of the approach end of the runway. Runway 30 at BZN is equipped with REILs. Like other airfield equipment, REILs require routine maintenance and should be replaced at the end of their useful life. Both ends of Runway 11-29 should ultimately be equipped with REILs.

Approach lighting systems provide the basic means to transition from instrument flight to visual flight for landing. The existing MALSR system on the Runway 12 approach is adequate for future instrument approaches to Runway 12. MALSR approach lighting should ultimately be added to Runway 30 with its upgrade to an ILS approach.

Runway 3-21 is planned as a daytime operation runway, therefore no additional lighting is planned.

Weather Observation & Wind Indicators

Weather information is provided to pilots through an Automated Surface Observing System (ASOS) on site. This system is functioning well and is adequate to meet the airport's needs with routine maintenance and ultimate replacement at the end of its useful life.

Wind indicating devices provide pilots with information as to ground level wind conditions while segmented circles indicate airport traffic patterns.

BZN does not have a primary windcone, but has lighted supplemental windcones at the end of runways 12, 30, 11 and 29 and an unlit supplemental windcone at the end of Runway 3. Per AC 150/5340-30H Design and Installation Details for Airport Visual Aids, as an airport certificated under Part 139, Certification of Airports, a primary wind cone is required at BZN.

FAR Part 139 requires that, for airports serving any air carrier operation when there is no control tower operating, a segmented circle, a landing strip indicator and a traffic pattern indicator must be installed around a wind cone for each runway with a right-hand traffic pattern. Because BZN does not serve air carrier operations while the tower is not operational, a segmented circle is not required.

Air Traffic Control

The FAA Air Traffic Control Tower (ATCT) serving the airport is located on the south side of the airfield and is operated under the FAA's contract tower program. The facility is centrally located with good visibility to movement areas. The tower was constructed in 1997 and is currently in good condition.

The ATCT at BZN utilizes an interrogator beacon radar which relies on aircraft transponders to provide aircraft location. While beneficial for locating a significant majority of aircraft utilizing the airport, the system does not achieve coverage of aircraft without transponder equipment, as a traditional primary radar would. Because it cannot account for all aircraft, the current system cannot be counted as true radar in calculating the airport's annual service volume for capacity determinations. An upgrade to a traditional primary radar system would ultimately improve the airport's capacity.

The following are recommendations for improvements to the ATCT at BZN:

- Add traditional primary radar coverage
- Upgrade to 24/7 operation
- Conduct a tower siting study in conjunction with the planning and environmental documentation for the extension to Runway 11-29 to determine whether the height and location of the ATCT adequately serves planned runway configurations.

RUNWAYS AND TAXIWAYS		
EXISTING	**SHORT TERM (2024)**	**ULTIMATE (2039)**
Runway 12-30 150' X 8,994' 120,000 lbs SWL 250,000 lbs DWL 550,000 lbs DTL 1,120,000 DDTTL Full Length Parallel TW A – 75'W	Runway 12-30 150' X 8,994' 120,000 lbs SWL 250,000 lbs DWL 550,000 lbs DTL 1,120,000 DDTTL Full Length Parallel TW A – 75'W	Runway 12-30 150' X 10,828' 120,000 lbs SWL 250,000 lbs DWL 550,000 lbs DTL 1,120,000 DDTTL Full Length Parallel TW A – 75'W
Runway 11-29 75' X 5050' 12,500 SWL Full Length Parallel TW C – 35' W	Runway 11-29 150' X 8,500' 120,000 SWL 120,000 lbs SWL 250,000 lbs DWL 550,000 lbs DTL 1,120,000 DDTTL Full Length Parallel TW C – 75'W / 400' Offset	Runway 11-29 150' X 8,500' 120,000 SWL 120,000 lbs SWL 250,000 lbs DWL 550,000 lbs DTL 1,120,000 DDTTL Full Length Parallel TW C – 75'W / 400' Offset
Runway 3-21 75' X 2650' 12,500 SWL Partial Parallel TW B – 35' W	Runway 3-21 75' X 5,700' 12,500 SWL Partial Parallel TW B – 35' W	Runway 3-21 75' X 5,700' 12,500 SWL Partial Parallel TW B – 35' W
Turf Runway 80' X 2,802'	Turf Runway 80' X 2,802'	Turf Runway 80' X 2,802'
NAVIGATIONAL AIDS		
Runway 12-30 ILS (12) VOR/DME RNAV GPS	Runway 12-30 ILS (12 / 30) VOR/DME RNAV GPS	Runway 12-30 ILS (12 / 30) VOR/DME RNAV GPS
Runway 11-29 Visual	Runway 11-29 ILS – Sidestep Approach (12/30) GPS (12/30)	Runway 11-29 ILS – Sidestep Approach (12/30) GPS (12/30)
Runway 3-21 Visual	Runway 3-21 Visual	Runway 3-21 Visual
Turf Runway Visual	Turf Runway Visual	Turf Runway Visual
LIGHTING AND MARKING		
Runway 12-30 Precision Markings HIRL, MITL MALSR (12) 4- Box PAPI	Runway 12-30 Precision Markings HIRL, MITL MALSR (12/30) 4- Box PAPI	Runway 12-30 Precision Markings HIRL, MITL MALSR (12/30) 4- Box PAPI Centerline Lights Touchdown Zone Lights
Runway 11-29 Nonprecision Instrument Markings MIRL, MITL 4- Box PAPI REIL	Runway 11-29 Precision Markings MIRL, MITL 4- Box PAPI REIL	Runway 11-29 Precision Markings MIRL, MITL 4- Box PAPI REIL
Runway 3-21 Basic Markings	Runway 3-21 Basic Markings 4 - Box PAPI	Runway 3-21 Basic Markings 4 – Box PAPI
Turf Runway NA	Turf Runway NA	Turf Runway NA

Figure 3-16: Airfield Facility Requirements

3.4 Terminal Area Requirements

Components of the terminal area complex include the terminal apron, airline gate positions, and the various functional elements within the terminal building. In addition, the terminal area is served by various access, auto parking, and rental car facilities. This section identifies the terminal area facilities required to meet the airport's needs through the planning period.

The existing terminal facility was originally constructed in 1977 and has undergone numerous expansions since that time.

The requirements for various terminal complex functional areas were determined with the guidance of Federal Aviation Administration AC 150/5360-13A, Airport Terminal Planning. This advisory circular combined and superseded two previous FAA ACs on this topic: AC 150-5360-13, *Planning and Design Guidelines for Airport Terminal Facilities*, and AC 150/5360-9, *Planning and Design Guidelines for Airport Terminal Facilities at Non-hub Locations*. In addition, Airport Cooperative Research Program (ACRP) Report 25, *Airport Passenger Terminal Planning and Design*, and Transportation Security Administration's (TSA) *Recommended Security Guidelines for Airport Planning, Design and Construction* were consulted. These documents, along with updated forecasts, were used to prepare estimates of various terminal complex requirements.

Facility requirements were developed for the forecast years of 2024, 2029, 2034 and 2039. It should be noted that actual need for construction of facilities will be based upon enplanement levels and airline service characteristics, rather than a forecast year.

Based upon the enplanements forecasted in Chapter 2 the BZN is projected to serve 1.8 million plus enplaned passengers annually within the 20-year planning horizon.

3.4.1 Aircraft Parking

The principal factors of parking air carrier aircraft at the terminal relate to the number of positions, and the apron layout.

Number of Aircraft Parking Positions

At the present time, there are twelve marked positions on the terminal ramp, corresponding with terminal gates. The terminal apron was expanded in the summer of 2019. New marked aircraft parking positions will need to be added to correspond with future gate additions and to accommodate aircraft that are scheduled to remain overnight (RON).

Apron Design

The terminal apron parking positions are designed for ADG II, ADG III and ADG IV aircraft. The projected commercial mix indicates future operations by ADG II, ADG III and ADG IV aircraft. The terminal apron has been designed and constructed to meet the weight and dimensional standards of these aircraft and should meet commercial aircraft parking requirements for the planning horizon. Future expansion of the terminal apron should continue to accommodate the dimensions and weights of these aircraft types.

Infrastructure & Lighting

Apron design must consider the utilities and infrastructure needed for servicing aircraft parked at the terminal. Examples include fueling, grounding systems, power, conditioned air, storm water, deicing, and fire deluge systems and apron lighting.

AC 150/5360-13A provides the following guidance on terminal apron lighting:

> Most outdoor areas associated with the terminal apron require some degree of illumination during nighttime and low-visibility conditions. Lighting levels in the vicinity of aircraft parking areas and the terminal apron should be of sufficient intensity to provide a safe, secure, and efficient operating environment for airport operations during nighttime conditions and inclement weather (e.g. to permit deicing at the gate).

The commercial apron is equipped with mounted floodlights, which are the preferred method of lighting the apron area.

3.4.2 Terminal Auto Parking

AC 150/5360-13A indicates that terminal parking facilities are commonly planned to accommodate volume on an average day of a peak month. In 2019, there were 95,303 enplanements in the peak month of July, averaging 3,074 passengers per day. Assuming 0.70 parking spaces per passenger (accounting for a level of ride sharing) results in a current demand for 2152 parking spaces. This is equivalent to the current number of public parking spaces in the main terminal parking lot. This is consistent with airport staff observation that the public lot is frequently at capacity and overflowing during peak periods. Assuming increased demand over the planning period proportional to forecast enplanements results in a future demand for 5,029 parking spaces by the end of the planning horizon (2039).

Employee spaces serve airport staff and tenants including the airline(s), rental car agencies, TSA, and the restaurant. The current need for employee parking is estimated at the current number provided of 441 spaces and is expected to grow proportionally with enplanements.

A newly constructed four-level parking garage located on the east end of the terminal building provides approximately 1100 spaces. 95 spaces on the ground level are paid public parking and the remainder are rental car ready and return parking spaces. In addition, there are currently approximately 250 additional paved spaces for the storage of rental ready and return cars at the rental car Quick Turn Around (QTA) facility. With the recent completion of the parking garage this capacity is greater than the demand today. The estimated current demand for ready, return and storage of rental cars is 1,000 spaces. Overall parking requirements for rental cars are anticipated to grow in proportion with enplanements.

Table 3-16 presents public, rental and employee parking requirements through the planning period as determined through the noted assumptions.

Table 3-16: Public Parking Requirements - BZN

	Requirements at Annual Passenger Thresholds				
	Existing	2024	2029	2034	2039
Annual Enplaned Passengers	785,706	1,033,679	1,295,763	1,565,899	1,836,063
Public Parking	2,152	2,831	3,549	4,289	5,029
Employee Parking	441	580	727	879	1,031
Rental Car Ready/Return and Storage	1,250	1,316	1,649	1,993	2,337
Cell Phone Lot	91	91	91	91	91
Total Parking	**3,684**	**4,818**	**6,016**	**7,252**	**8,487**

3.4.3 Terminal Curbside

The terminal curb serves as the interface between the terminal building and the ground transportation system.

Some of the key points to be considered on the design and operation of curb fronts are the following:

- Lighting
- Speed tables/humps at pedestrian crossings
- Adequate transition areas
- Sidewalk/curb width—at least 12 feet; 15 to 20 feet is desirable
- Signage—large type, lighted
- Pavement marking—reflective, raised (where possible), rumble strips

The sidewalk adjoining the curb is wide enough to allow for the swinging open of a car door plus circulation. The terminal curb is lit to provide a safe and secure environment for passengers and airport operations at night and during inclement weather.

Two curbside areas adjacent to the arrival and departure areas serve BZN's terminal building. In addition, two lanes across from the arrivals curb have dedicated curb frontage for buses, taxis, and rideshare shuttles. The arrivals curb has 320 linear feet of available vehicular curbside length, the departures curb has 330 feet, the buses lane has 342 feet and the taxi/shuttle lane has 382, for a total of 1,374 linear feet.

Terminal curbside needs are evaluated using industry planning criteria to determine linear frontage for the curb to meet Level of Service (LOS) standards. Curbside linear frontage estimates are modeled based on the methodology described in ACRP Report 25, Airport Passenger Terminal Planning and Design.

The analysis used the following assumptions to reach the curbside projections shown in **Table 3-17**:

- Peak hour traffic growth will follow design hour passenger growth.
- 30 percent of peak hour demand occurs during a 15-minute peak period.

Percent of Vehicle Type and vehicle length

- 85 percent – Private auto, 22 feet
- 8 percent – Hotel shuttles, 50 feet
- 5 percent – Taxis, 22 feet
- 1 percent –Buses (charter and public), 50 feet
- 1 percent – Other, 30 feet

- Multiple Stop Factor of 1.0 (for all vehicle types)

Vehicle Dwell Time

- Private auto, 3.0 minutes
- Hotel shuttles, 3.0 minutes
- Taxis and TNC, 1.5 minutes
- Buses (charter and public), 5.0 minutes
- Other, 1.5 minutes

Based on the existing 1,374 linear feet of available curbside, BZN will require additional curbside frontage within the short term planning period. Additional curbside can be gained by relocating designated curbside vehicle modes, and also with the addition of traffic lanes to allow for double parking.

Table 3-17: Curbside Requirements

	Existing	2024	2029	2034	2039
Annual Enplaned Passengers	785,706	1,033,679	1,295,763	1,565,899	1,836,063
Total Design Hour Vehicles	613	807	1,012	1,223	1,434
Peak 15 Minute Demand (Linear Feet)	712	937	1,174	1,419	1,664
***Required LOS C Curbside Range (Linear Feet)**	1,095	1,441	1,806	2,183	2,559
	1,294	1,703	2,135	2,580	3,025

3.4.4 Gate Capacity Requirements

The airport terminal currently has twelve commercial aircraft gate positions. Future gate requirements have been determined through formulas for growth based on historical measures of annual passenger enplanements and annual departures per gate. This approach is based on methodology described in ACRP Report 25, *Airport Passenger Terminal Planning and Design*

The enplanement per gate approach uses the current ratio of annual passengers per gate, adjusted for forecast changes in fleet mix and annual load factors. This methodology assumes that the pattern of gate utilization will remain relatively stable over the forecast period. The changes in passengers per gate would be due to changes in enplanements per departure (due to fleet seating capacity and/or passenger load factors), as opposed to increasing (or decreasing) numbers of departures per gate.

Table 3-18 shows a requirement of gates based on a measure of enplanements per gate. Using forecasts for the four planning horizons within the period, 12 gates to represent current airline schedule activity, and enplanements per gate yields a total requirement of 22 gates.

Table 3-18: Airline Gate Demand Forecast – Enplanements per Gate

Enplaned Passengers per Gate Approach					
Year	Annual Enplaned Passengers	Annual Departures	# of Gates	Enplaned Passengers per Gate	Enplaned Passengers per Dept.
2018	670,923	7,538	8	83,900	89
2019	785,706	8,790	8	98,200	89
2020	833,990	9,330	12	69,500	89
2024	1,033,679	10,773	14	74,600	96
2029	1,295,763	12,870	17	78,300	101
2034	1,565,899	15,193	20	80,200	103
2039	1,836,063	17,713	22	82,500	106

The departure operations per gate approach yields a smaller total number of gates based on a higher efficiency in gate use. **Table 3-19** shows a requirement of gates based on a measure of departures per gate. Using forecasts for the four planning horizons within the period, 12 gates to represent current airline schedule activity, and departures per gate yields a total requirement of 19 gates. This method does not take into consideration multiple departures within a short window as occurs in the first morning departures bank at BZN.

Table 3-19: Airline Gate Demand Forecast – Departures per Gate

Departures per Gate Approach					
Year	Annual Enplaned Passengers	Annual Departures	# of Gates	Annual Departures per Gate	Daily Departures per Gate
2018	670,923	7,538	8	940	3
2019	785,706	8,790	8	1,100	3
2020	833,990	9,330	12	780	2
2024	1,033,679	10,773	15	740	2
2029	1,295,763	12,870	15	880	3
2034	1,565,899	15,193	16	950	3
2039	1,836,063	17,713	19	950	3

Because the enplaned passenger method does not account for higher efficiency in gate usage over time and because the departures per gate approach does not account for requirements during the peak morning period, an average of both methods is considered prudent for long term programming purposes. The average of both methods yields a long term demand for 20 gates at BZN.

Table 3-20: Airline Gate Demand Forecast – Average of Enplanements per Gate and Departures per Gate Approaches

Average of Both Methods			
Year	Passengers per Gate	Departures per Gate	GATES
2024	14	15	14
2029	17	15	16
2034	20	16	18
2039	22	19	20

Effective space planning requires a consistent definition of "gate." By using the forecasted fleet mix and the Equivalent Aircraft (EQA) Index, a technique which estimates the number of gates needed based on aircraft seating capacity, the equivalent number of gates are calculated based on the ADG served. **Table 3-21** lists the recommended EQA by ADG for the planning period.

Table 3-21: Equivalent Aircraft (EQA) Index

	Existing	2024	2029	2034	2039
Annual Enplaned Passengers	785,706	1,033,679	1,295,763	1,565,899	1,836,063
ADG III Gates	11	13	15	16	17
ADG IV Gates	1	1	1	2	3
Total Gates	**12**	**14**	**16**	**18**	**20**
ADG III EQA (EQA Index 1)	11	13	15	16	17
ADG IV EQA (EQA Index 1.3)	1.3	1.3	1.3	2.6	3.9
Total EQA	**12.3**	**14.3**	**16.3**	**18.6**	**20.9**

3.4.5 Ticketing /Check-in Area

The Ticketing and Check-in Lobby includes ticket queuing area, cross circulation, entrance vestibules and general circulation at the main entrance to the building. AC 150/5360-13A notes that since 2001, technology and evolved security requirements have significantly changed the way passengers and airlines use the check-in lobby. Computers and personal electronic devices allow passengers to check-in off-airport, interacting with airline personnel only to drop off bags or to resolve problems. While check in lobbies of the past were traditionally grand public spaces, increasing trends toward remote self check-in has resulted in a significant change in passenger and airline approaches to the check-in process and the potential for reduced space requirements in the lobby.

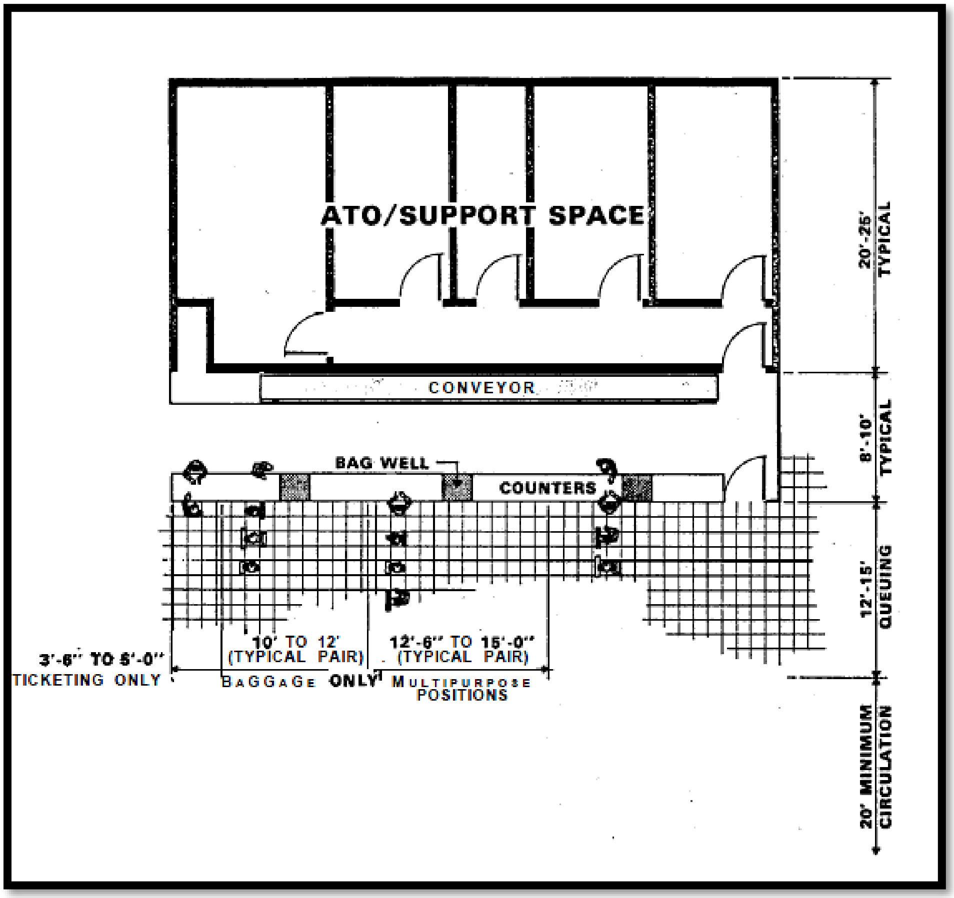
Space requirements for the ticketing / check-in lobby is typically a function of the counter width, combined with cueing and circulation area.

A total of eight airlines currently provide service at BZN. It was assumed that an additional major airline, requiring four counters, and an additional secondary airline, requiring two counters, would enter the market in the near term. A total of ten additional counters were assumed over the long term timeframe. Requirements will vary, depending upon the number of airlines serving BZN in the future, as well as individual airline needs.

The ticketing lobby at BZN currently consists of approximately 10,000 square feet for ticket counters, active check-in, queuing, and circulation. This space is linear with 50 feet of unobstructed depth available from the wall to the front of the counter, for circulation, queuing, and active check-in. At the time of this report, BZN provides a total of 30 check-in positions across approximately 165 linear feet of counter space. The staff occupies a width of 10 feet from the back wall to the front of the counter, with ticket counters about 3 feet deep.

Former guidance in AC 150-5360-13 provided the illustration, shown in **Figure 3-17**, of a typical linear counter layout for ticketing agent area and Airline Ticketing Offices (ATO) area. This arrangement is typical and still appropriate for a facility like the BZN. As shown, the minimum distance from the face of the ticket counter to any obstruction should be 32 to 35 feet. This includes queuing depth of 12 to 15 feet and the remainder in cross circulation.

At BZN, the unobstructed depth of the ticketing lobby is approximately 50 feet. **Table 3-22** summarizes airline ticketing area requirements based on these assumptions.



Source: AC 150/5360-13 Figure 5-6

Figure 3-17: Linear Counter

Table 3-22: Check in / Ticketing Lobby Requirements

	Existing	2024	2029	2034	2039
Annual Enplaned Passengers	785,706	1,033,679	1,295,763	1,565,899	1,836,063
Counter positions	30	36	36	38	40
Counter (LF)	165	180	180	190	200
Counter Area (SF)	1,650	1,800	1,800	1,900	2,000
Queuing Area (SF)	2,475	2,700	2,700	2,850	3,000
Circulation (SF)	5,775	6,300	6,300	6,650	7,000
Total	9,900	10,800	10,800	11,400	12,000

3.4.6 Airline Offices and Operational Spaces

At most medium and small airport terminal buildings, airline office space is provided behind the ticket counters. Airline ticketing offices (ATOs) are typically located here and are often used by staff to handle related administrative and operational duties while monitoring the ticket counter for passengers. It is also common for airline storage and break rooms to be included in the ATOs. This office area should have access to the ticket counter and baggage makeup area. It is used primarily by the agents as a work space, and space is frequently needed for a lounge and training purposes. Sometimes a multipurpose room is used for all these functions. The airline manager's office may also be in this location.

The amount of airline leased space behind the counter is largely dependent on the length of the ticket counter with a typical overall depth of 25-30'. The area leased by airlines will largely be impacted by the number of air carriers.

Currently there is office space to accommodate the eight air carriers serving BZN. Additional office space will be required with the entry of new airlines. Calculations for additional space required are based on counter length requirements for new airline entries assuming a depth of 30 feet.

Airline office space requirements are shown in **Table 3-23.**

Table 3-23: Airline Ticketing Office

	Existing	2024	2029	2034	2039
Annual Enplaned Passengers	785,706	1,033,679	1,295,763	1,565,899	1,836,063
Airline Office (SF)	4,600	5,050	5,050	5,350	5,650

3.4.7 Outbound Baggage Screening

TSA requires that all baggage be screened before it is brought into the baggage make-up area and loaded onto an aircraft.

Outbound baggage processing includes the area and equipment required to accommodate, sort, security screen, and process checked baggage from the check-in lobby to the aircraft. At BZN, the baggage screening facilities are directly behind the ticketing counters and between the airline offices.

The size for the TSA baggage screening room is based on the expected size of the bag screening and conveying equipment. Preliminary space estimates are modeled based on the methodology described in ACRP Report 25, Airport Passenger Terminal Planning and Design.

The assumptions used to model the bag screening requirement shown in **Table 3-24** are:

- Percent of passengers checking bags: 80 percent
- Average bags/passenger: 1.2
- TSA surge factor applied: yes, on a 10-minute baggage flow rate
- Percent of over-sized bags too large for Explosive Detection System (EDS): 10 percent

- EDS screening process rate: 250 bags/hour
- EDS screening unit area: 800 square feet
- Level 2 On-Screen Resolution Rate (OSR) rate: 120 bags/operator
- Level 2 OSR station area: 40 square feet
- Level 3 ETD screening process rate: 24 bags/hour/screener
- Level 3 ETD screening unit area: 100 square feet

Table 3-24: Outbound Bag Screening

	Existing	2024	2029	2034	2039
Design Hour Passengers Departing	738	1,009	1,265	1,528	1,792
Total bags to process in peak hour	708	969	1,214	1,467	1,720
Total bags through Level 1 EDS screening (includes 1.12 surge factor)	755	1,009	1,247	1,489	1,731
Number of Level 1 EDS units	4	5	5	6	7
Level 1 EDS Area (SF)	3,200	4,000	4,000	4,800	5,600
Total bags through Level 2 EDS screening	189	252	312	372	433
Number of Level 2 EDS units	2	3	3	4	4
Level 2 EDS Area (SF)	80	120	120	160	160
Total bags through Level 3 EDS screening	24	24	24	24	24
Number of Level 3 EDS units	3	4	5	5	6
Level 3 EDS Area (SF)	300	400	500	500	600
Total Area Requirements (SF)	3,580	4,520	4,620	5,460	6,360
Existing Area (sf)	3,334	3,334	3,334	3,334	3,334
Capacity / (Defecit)	(246)	(1,186)	(1,286)	(2,126)	(3,026)

In February of 2019, a Terminal Renovation Alternatives Analysis Report was prepared which examined alternative designs for an in-line baggage handling system. As a preliminary design report, it provides detailed analyses with requirements for specific equipment types. This design analysis supersedes preliminary space allocation methodology described in ACRP Report 25, Airport Passenger Terminal Planning and Design.

3.4.8 Baggage Make-up

Baggage make-up includes manual or automated make-up units, the cart/container staging areas, and baggage tug/cart, or baggage train, maneuvering lanes. The type of system selected for a terminal depends on several factors including the number of airlines, the terminal configuration, operating policies (common use, exclusive use), and size of the terminal complex.

The area recommendations provided here are based on the size and maneuverability of baggage tugs, as well as the sizes of baggage conveyance equipment and staging areas.

At BZN, the outbound baggage makeup area overlaps with the inbound baggage, makeup area therefore requirements are based on combined arrivals and departures during the 2-4 hour makeup period for the peak hour.

Table 3-25 shows the space requirements projected for the baggage make-up area based on methodology described in ACRP Report 25, *Airport Passenger Terminal Planning and Design*.

Table 3-25: Baggage Makeup

	Existing	2024	2029	2034	2039
Annual Enplaned Passengers	785,706	1,033,679	1,295,763	1,565,899	1,836,063
Gates	12	14	16	18	20
EQA	12.3	14.3	16.3	18.6	20.9
Expected Arr / Dep. Per gate (in 2 hr staging period)	1.7	1.7	1.7	1.7	1.7
Staging Period Ar/ Dep.	21	24	28	32	36
Baggage Makeup Area	37,600	43,800	49,900	56,900	64,000
Baggage Train Circulation Allowance (sf)	5,600	6,600	7,500	8,500	9,600
Total Required (sf)	**43,200**	**50,400**	**57,400**	**65,400**	**73,600**
Existing Makeup Area (sf)	57,140	57,140	57,140	57,140	57,140
Capacity / (Defecit)	13,940	6,740	(260)	(8,260)	(16,460)

3.4.9 Passenger Security Screening

The security screening checkpoint (SSCP) area is used by TSA to screen commercial airline passengers and carry-on baggage to ensure that prohibited or harmful items are not carried onto aircraft.

AC 150/5360-13A identifies the primary components of security screening checkpoints in passenger terminals as follows:

- Queuing area – area reserved for passengers waiting to enter the screening area.
- Document check – location where TSA employees examine a passenger's bonafides (boarding pass and government issued identification) to confirm authenticity and allow them to proceed to screening.
- Divestiture area – zone where passengers must divest items such as metal objects, electronic devices, coats, belts, shoes, and baggage onto a conveyor belt for screening. This is also the area where passengers queue for screening.
- Screening area – location where passengers pass through screening equipment (advanced imaging technology or magnetometers). Baggage is screened through advanced technology machines. Secondary baggage screening is located adjacent to the primary screening. Private, manual passenger screening is provided remotely.
- Recomposure area – seating area or vacant space at the end of the screening checkpoint for passengers to gather and re-pack divested items.
- Administrative space –areas within or adjacent to the security screening checkpoints where security operates and monitor the security screening equipment. Space for detention rooms, training rooms, break rooms, and other administrative functions can be located remotely from the screening checkpoint.

The future layout of the SSCP will need to be closely coordinated with the TSA. Space requirements for a SSCP are developed according to metrics from ACRP's terminal planning guidebook and are shown in **Table 3-26** below.

Table 3-26: Security Screening Checkpoint

	Existing	2024	2029	2034	2039
Annual Enplaned Passengers	785,706	1,033,679	1,295,763	1,565,899	1,836,063
Peak 30 min Originating PAX	307	404	506	611	663
Checkpoint Lanes Required	5	5	6	8	8
Checkpoint Screening Area, 15 feet X 85 feet (sf)	1,275	1,275	1,275	1,275	1,275
Total Checkpoint Required Area	5,100	6,375	7,650	10,200	10,200
Checkpoint Queue Area (SF)	1,500	1,875	2,250	3,000	3,000
Total Required SSCP Area (SF)	6,600	8,250	9,900	13,200	13,200
Existing SSCP Area	6,600	6,600	6,600	6,600	6,600
Total Capacity (SF) (Deficiency)	-	(1,650)	(3,300)	(6,600)	(6,600)

3.4.10 Passenger Holdrooms

Since 2001, increased security requirements have resulted in passengers checking in earlier and spending more time in the secure side holdroom prior to boarding aircraft. For this reason, amenities for passenger comfort have become increasingly important for secure side holdrooms. The design of the secure holdroom should include considerations for passenger comfort such as:

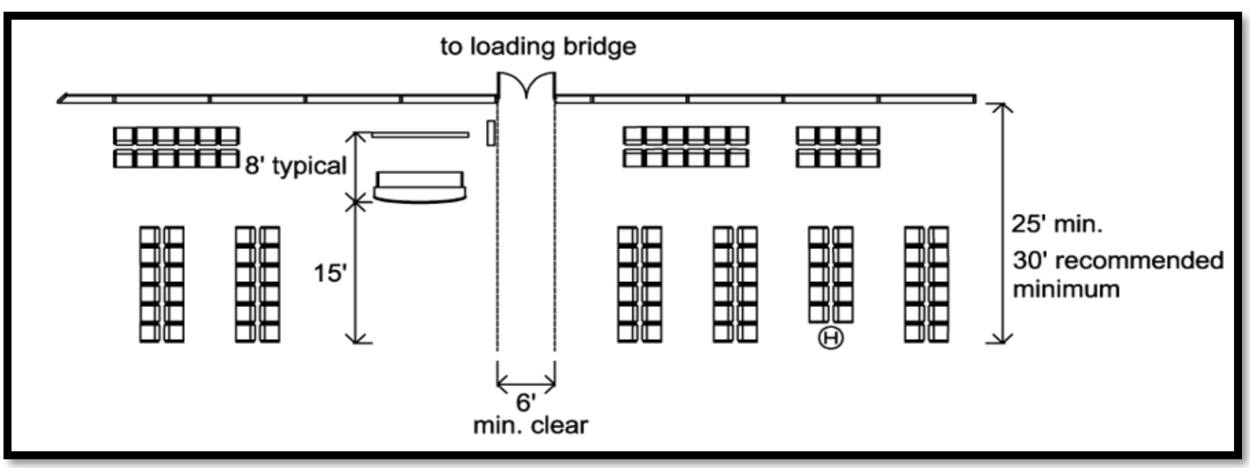
- Restroom facilities (Separate mens / womens or unisex. Handicapped accessible)
- Concessions (Staffed retail or vending)
- Wi-Fi connectivity
- Televisions
- Easily accessible power connections
- Attractive viewing of the airfield (panoramic windows)

Holdrooms or departure lounges are where passengers wait to board aircraft after they have been processed through security. These are the principal areas of the "secure" or "sterile" side of the terminal and must be designed to maintain security through monitored or controlled entrances and exits.

As noted in AC 150/5360-13A, the primary components of a departure area holdroom include:

- Waiting area – designated airline-specific space where passengers wait to board a flight. The area includes seating for passengers.
- Airline gate podium and queuing – area where passengers queue and ultimately communicate with airline representatives.
- Boarding and egress corridor – designated area near the gate used for queuing passengers to board the aircraft, and for passenger egress from the aircraft when it arrives at the gate. Individual airlines have differing boarding and egress procedures.

ACRP Report 25, *Airport Passenger Terminal Planning and Design* provides recommendations for holdroom facilities. **Figure 3-18** shows typical minimum design paramaters for a single gate holdroom from the ACRP Report.



Source: ACRP Report 25, Airport Passenger Terminal Planning and Design

Figure 3-18: Typical Single Gate Holdroom Parameters

Holdroom space requirements based on ACRP Report 25 are shown in **Table 3-27.** These numbers include holdroom floor area, gate podium area and public circulation.

The sizing of each holdroom assumes 80 percent of the total number of passengers are seated and the remaining 20 percent are standing. The required additional space for the gate podium and podium queue are also considered.

- The following assumptions were applied for planning purposes, as shown in **Table 3-27**:Design aircraft: Boeing 737-800, with 175 seats
- Seated/standing passenger mix: 80/20 (LOS B)
- Seated passenger space requirement: 15 square feet/passenger
- Standing passenger space requirement: 10 square feet/passenger
- Podiums per gate: 1, with 184 square feet of podium and queueing area
- Boarding/egress corridor area: 240 square feet of area/gate

Table 3-27: Passenger Holdrooms

	Existing	2024	2029	2034	2039
Annual Enplaned Passengers	785,706	1,033,679	1,295,763	1,565,899	1,836,063
Number of Seats on Design Aircraft	175	175	175	175	175
Load Factor	0.82	0.82	0.82	0.82	0.82
Number of Design Passengers	144	144	144	144	144
Seated and Standing Area (SF)	2,009	2,009	2,009	2,009	2,009
Allowance For Amenities (increase)	10%	10%	10%	10%	10%
Holdroom Sharing Factor (decrease)	10%	10%	10%	10%	10%
Adjusted Seated and Standing Area (SF.)	1,990	1,990	1,990	1,990	1,990
Podium and Queue Area	184	184	184	184	184
Boarding Area Corridor (SF)	240	240	240	240	240
Total Holdroom Area for One Gate (SF)	2,400	2,400	2,400	2,400	2,400
Equivalent Gate	12.3	14.3	16.3	18.6	20.9
Total Required Holdroom Area (SF)	**29,520**	**34,320**	**39,120**	**44,640**	**50,160**
Existing Holdroom Area (SF)	**27,366**	**27,366**	**27,366**	**27,366**	**27,366**
Total Capacity / (Deficiency) (SF)	**(2,154)**	**(6,954)**	**(11,754)**	**(17,274)**	**(22,794)**

3.4.11 Baggage Claim

Baggage claim length requirements can vary from location to location, and are influenced by the types of passengers who use the facility, and by changes in airline policy relating to baggage fees. The claiming facility should be situated convenient to the deplaning passenger flow patterns and in proximity to the terminal curb. Car rental counter space should be provided adjacent to the claim area. In addition, the length of belt should accommodate TSA and airline operational requirements that all baggage must be in the non-sterile area prior to turning the claim device off.

The recommendations for baggage claim device lengths in this report are based on guidance from ACRP Report 25, *Airport Passenger Terminal Planning and Design*. The recommended overall length of claim device public frontage at the airport is determined by estimating the number of peak hour terminating passengers with bags, and then applying a multiplier to account for the sizes of bags and numbers of passengers having more than one bag.

ACRP Report 25 recommends a space around the claim device that is approximately 15 feet wide to allow sufficient space for passengers to unload bags from the baggage claim device.

The baggage claim public area provides space to accommodate a variety of ancillary and shared uses. For example, this portion of the building can provide space for information kiosks, hotel boards and other related conveniences for passengers. Design of the baggage area should also accommodate meeters and greeters, who will often meet passengers in the baggage claim area. Passengers and meeters and greeters should have access to seating including minor business center improvements - 110V charging and bar top type infrastructure) and restrooms since they generally arrive in the bag claim area before their baggage is off-loaded from the aircraft. Further, the baggage claim area should be designed to be expandable to accommodate increasing demand over time.

The amount of baggage claim area needed to meet terminal requirements over the planning horizon are shown in **Table 3-28**.

The assumptions used to model the bag screening requirements are:

- Percent of passengers checking bags: 80 percent
- Average traveling party size: 1.8
- Percent additional passengers at claim: 30 percent
- Claim frontage per person: 1.5 linear feet
- Flat plate claim device + circulation area: 20 square feet/linear foot of required frontage
- Meeting and greeter lobby: 15 percent of baggage claim area required

Table 3-28: Baggage Claim Demand Requirements

	Existing	2024	2029	2034	2039
Annual Enplaned Passengers	785,706	1,033,679	1,295,763	1,565,899	1,836,063
Peak Hour Deplaning Passengers	767	1,009	1,265	1,528	1,792
Percent Deplaning in Peak 20 Min	50%	50%	50%	50%	50%
Percent Terminating Passengers	100%	100%	100%	100%	100%
Percent Passengers Checking Bags	80%	80%	80%	80%	80%
Average Traveling Party Size	1.8	1.8	1.8	1.8	1.8
Total Claim Frontage Required (LF)	317	417	523	632	741
Total Baggage Claim Area Required (SF)	6,340	8,340	10,460	12,640	14,820
Meeter/Greeter Lobby (SF) (15%)	951	1,251	1,569	1,896	2,223
Total Baggage Claim Area Required (SF)	**7,291**	**9,591**	**12,029**	**14,536**	**17,043**
Existing Baggage Claim Area (SF)	**9,436**	**9,436**	**9,436**	**9,436**	**9,436**
Total Capacity (Deficiency)	**2,145**	**(155)**	**(2,593)**	**(5,100)**	**(7,607)**

In addition to the public baggage claim space, passenger service counters and storage for late or unclaimed bags is part of the baggage service operation. Full baggage offices are typically required only by airlines with sufficient activity to warrant staffing. Other airlines often will request baggage lock-up areas to store late or unclaimed baggage and will handle passenger claims at their ATO counters. Two airlines currently have baggage service offices in the baggage claim area with a total of about 596 square feet. With eight airlines providing service at BZN, it is anticipated that baggage claim offices will be desired by additional airlines in the near future and throughout the planning horizon.

3.4.12 Restrooms

ACRP Report 130, *Terminal Restroom Planning* provides recommendations for programming restroom space.

Typical restroom components include:

- Entry area
- Sink area
- Baby diaper changing area
- Toilet stall
- Wheelchair-accessible stall
- Urinal area
- Family room
- Plumbing chase
- Janitor's closet/storage

Currently, the first level non-secure side of the terminal provides three modules of restrooms serving departing and arriving passengers and their guests: one located adjacent to the ticketing lobby, one near baggage claim and one near the rental car counters. The upper level secure concourse has seven modules of restrooms; 2 on the west half and 5 on the east half. A summary of existing bathroom fixtures is shown in **Table 3-29.**

Table 3-29: Current Terminal and Concourse Fixtures

	Male	Female	Family	Total
Non-Secure Side Restrooms				
Ticketing	4	4		8
Baggage Claim	8	7	2	17
Near Rental Cars	6	5		11
Total Non Secure Side	**18**	**16**	**2**	**36**
Secure Side Restrooms				
West Concourse (2 modules)	12	14	2	28
East Concourse (5 modules)	20	21	1	42
Total Secure Side	**32**	**35**	**3**	**70**

The number of suggested restroom fixtures is based on the peak hour passengers in the public, non-secure area, and on the number of EQA within the secure area, as shown in .

Table 3-30. The existing restrooms at BZN are evenly distributed and provide a high level of service throughout the planning period

Table 3-30: Restroom Requirements

	Existing	2024	2029	2034	2039
Annual Enplaned Passengers	785,706	1,033,679	1,295,763	1,565,899	1,836,063
Non-Secure Side Restrooms					
Peak Hour Enplaning & Deplaning Passengers	767	1009	1265	1528	1792
Percent Additional Passengers (WW & MG)	30%	30%	30%	30%	30%
Total Peak Hour Passengers	997	1312	1644	1987	2330
Men's Fixtures	9	11	12	14	16
Women's Fixtures	12	14	16	18	20
Total Non-Secure Side Fixtures Required	**21**	**25**	**28**	**32**	**36**
Secure Side Restrooms					
EQA	12.3	14.3	16.3	18.6	20.9
Total Restroom Modules (1 per 8 EQA)	2	2	3	3	3
Design Passengers	1,605	1,866	2,127	2,427	2,727
Peak 20 minute Demand	803	933	1,064	1,214	1,364
Design Factor	482	560	638	728	818
Men's Fixtures	19	22	25	28	31
Women's Fixtures	23	27	31	35	39
Total Secure Side Fixtures Required	**42**	**48**	**55**	**63**	**71**

3.5 Concessions

Terminal concessionaire services provide food, beverage and retail options to travelers on both sides of the security checkpoint. Concession services on the secure side of the checkpoint contribute to passenger convenience since passengers are often unable to leave the secure portion of the area once they have passed through the security checkpoint. In addition, airlines have reduced inflight meal services. It is therefore important for future airport terminal design to allow passengers to have food and beverage options available on both sides of the security checkpoint. Vending areas can replace or supplement staffed facilities, especially when flight times do not coincide with the operating hours of the concessions.

Concession areas should be strategically located in both the sterile and nonsterile portions of the terminal. The size of the concession area(s) varies from airport to airport, depending on individual concessionaire needs.

The following concession area functions were considered in determining the concessions space requirements as shown in **Table 3-31**.

Table 3-31: Concessions

	Existing	2024	2029	2034	2039
Annual Enplaned Passengers	785,706	1,033,679	1,295,763	1,565,899	1,836,063
Total Square Feet of Concession Space (per 1,000 enplaned passengers)	19.6	19.6	19.6	19.6	19.6
Recommended Concessions (SF)	14,794	20,260	25,397	30,692	35,987
Food / Gifts Secure (70%)	11,161	14,182	17,778	21,484	25,191
Food / Gifts Non-Secure (30%)	3,633	6,078	7,619	9,207	10,796

Concessions spaces should be designed cooperatively with concessionaires to meet the size and space needs of the industry.

3.6 Rental Car Counters

Car rental facilities at terminals generally include an office area with a front counter and queuing space in front of counters. Counters for car rental transactions are typically located in or near the baggage claim area and located to provide easy access to the car rental parking area.

Six counters serve five rental car companies currently operating at the airport. Provision for an additional three counters is assumed within the planning horizon.

Counter and space provisions for rental car agencies in the terminal are shown in **Table 3-32**.

Table 3-32: Rental Car Space

	Existing	2024	2029	2034	2039
Annual Enplaned Passengers	785,706	1,033,679	1,295,763	1,565,899	1,836,063
Counter Frontage (LF)	90	90	105	120	135
Counter Area (SF) (behind ticket counter)	720	720	840	960	1,080
Queuing Area (SF)	900	900	1,050	1,200	1,350
Office/Storage (SF)	2,160	2,160	2,520	2,880	3,240

3.7 Airport Administration

The Airport Administration terminal areas includes 6,650 square feet office and conference room space. This space is currently adequate. Administration space needs are expected to grow proportionally with enplanements over the planning horizon.

Table 3-33: Airport Administration

	Existing	2024	2029	2034	2039
Annual Enplaned Passengers	785,706	1,033,679	1,295,763	1,565,899	1,836,063
Peak Hour Enplanements	767	1,009	1,265	1,528	1,792
Admin. Office/Conference (SF)	6,651	9,080	11,382	13,755	16,128

3.8 Terminal Requirements Summary

Table 3-34 on the following page summarizes the key functional area requirements for the BZN passenger terminal through the twenty-year planning horizon.

Table 3-34: Terminal Requirements by Functional Area BZN

	Existing	2024	2029	2034	2039
Annual Enplanements	785,706	1,033,679	1,295,763	1,565,899	1,836,063
Peak Hour Enplanements	767	1,009	1,265	1,528	1,792
Curbside					
Curbside Frontage (Linear Feet)	1,374	1,703	2,135	2,580	3,025
Ticketing					
Counter positions	30	36	36	38	40
Counter (LF)	165	180	180	190	200
Counter Area (SF)	1,650	1,800	1,800	1,900	2,000
Queuing Area (SF)	2,475	2,700	2,700	2,850	3,000
Circulation	5,775	6,300	6,300	6,650	7,000
Airline Office (SF)	4,600	5,050	5,050	5,350	5,650
Baggage Make up (SF)	57,140	50,400	57,400	65,400	73,600
Baggage Screening (SF)	3,334	4,520	4,620	5,460	6,360
Hold Room					
# of Gates	12	14	16	18	20
Hold Room Waiting (SF)	27,366	34,320	39,120	44,640	50,160
Baggage Claim					
Baggage Claim Frontage (LF)	346	417	523	632	685
Claim Lobby Area (SF)	9,436	9,591	12,029	14,536	15,753
Rental Cars					
Counter Frontage (LF)	90	90	105	120	135
Counter Area (SF) - (area behind ticket counter)	720	720	840	960	1,080
Queuing Area (SF)	900	900	1,050	1,200	1,350
Office/Storage (SF)	3,240	2,160	2,520	2,880	3,240
Concessions					
Food/Gifts secure (SF)	11,161	14,182	17,778	21,484	25,191
Food/Gifts Non-secure (SF)	3,633	6,078	7,619	9,207	10,796
Total Concessions	14,794	20,260	25,397	30,692	35,987
Public Restrooms					
Public Restroom Fixtures - non-secure	36	25	28	32	36
Public Restroom Fixtures - secure	70	48	55	63	71
Security					
Passenger Screening (SF)	5,100	6,375	7,650	10,200	10,200
Security Queuing (SF)	1,500	1,875	2,250	3,000	3,000
TSA Office Support (SF)	3,591	3,591	3,591	3,591	3,591
Administration					
Office/Conference (SF)	6,651	9,080	11,382	13,755	16,128

3.9 General Aviation Facilities

The purpose of this section is to determine the space requirements for general aviation (GA) facilities including, FBO, hangar and apron parking facilities, during the planning period.

3.9.1 General Aviation Pilot Lounge

A general aviation pilot lounge can serve several functions including providing space for passenger waiting, pilot's lounge, flight planning, concessions, line service, and airport management offices.

These functions, aside from airport management offices, are currently served by the FBOs located on the airport.

As development occurs to the north side of the airport, it may be advisable to provide a public facility in that area. A pilot lounge could provide areas for passenger/pilot to rest and plan their next flight. For planning purposes, at least one area should be designated as a reserve for a future building. The pilot lounge should also be sited with easy access and visibility from the airfield, with adjacent land for possible expansion.

3.9.2 Hangars

The demand for hangar facilities typically depends on the number and type of aircraft expected to be based at the airport. For planning purposes, it is necessary to estimate hangar and apron facilities based on peak design periods. However, hangar and apron development should be based on actual demand trends and financial investment conditions.

Typical utilization of hangar space varies across the country as a function of local climate conditions, airport security and owner preferences. Nationwide trends for general aviation aircraft, whether single or multi-engine, are toward larger, more sophisticated and expensive aircraft. Owners of these types of aircraft normally desire hangar space to protect their investment. Due to climatic and security issues, it is believed that the vast majority of based aircraft owners at the BZN will desire enclosed hangar storage facilities.

Demand forecasts prepared in Chapter 2 of this study concluded that 189 new based aircraft would locate at the BZN during the planning period. An area for the development of new hangars will be identified and long range development concepts for these hangars will be options developed in *Chapter 4 Alternatives*.

3.9.3 Aircraft Parking Apron

Aircraft parking should be provided for locally-based aircraft which are not stored in hangars and transient aircraft visiting the airport. As noted previously, nationwide trends for general aviation aircraft, whether single or multi-engine, are toward larger, more sophisticated and expensive aircraft. Owners of these types of aircraft normally desire hangar space to protect their investment.

At BZN, the number of itinerant spaces was estimated to be approximately 50 percent of busy day itinerant operations. Additionally, total space requirements also assume 10 percent of the based aircraft are located on the apron for transient purposes.

Aviation forecasts were applied to project future fleet mix. Aircraft types were then split by Airplane Design Group (ADG) classification to determine the necessary parking area with required FAA setbacks. Size requirements were planned for each aircraft type as follows:

Single/Multi-Engine Piston (ADG-I) – 800 square yards per aircraft
Turboprop / Business Jet (ADG-II) – 1,700 square yards per aircraft
Business Jet (ADG-III) – 3,400 square yards per aircraft
Rotorcraft – 1,000 square yards per aircraft

The results of this analysis are presented in **Table 3-35.** There is currently approximately 151,000 square yards of parking apron in the general aviation area, which includes the general aviation ramp, the general aviation tie down area and the east ramp. The results shown in the table indicate that additional apron space and parking positions are needed immediately and through the planning period.

Table 3-35: Aircraft Parking Apron Requirements

	Currently Available	Current Need	Short Term	Intermediate Term	Long Term
Based Aircraft		344	386	434	533
10% Utilizing Apron Space *	24	36	41	45	55
Tie-down Area (s.y.)	25,577	38,791	43,320	48,422	58,941
Transient Aircraft					
Busy Day Itinerant Operations	160	163	172	180	208
Transient Parking Positions	54	82	86	91	105
Transient GA Apron Area	125,327	190,311	199,595	211,199	243,691
Total Parking Apron					
Positions	78	118	127	136	160
GA Apron Area (s.y.)**	151,000	229,103	242,915	259,621	302,632

* Includes added contingency of 2 aircraft
**Includes GA Apron, GA Tie Down Area and East Ramp

3.10 Support Requirements and Facilities

Various facilities that do not logically fall within classifications of airfield, terminal building or general aviation areas have also been identified. These other areas provide certain functions related to the overall operation of the airport and include: aircraft rescue and firefighting, fuel storage, snow removal equipment and airport maintenance facilities.

3.11 Aircraft Rescue and Firefighting

Requirements for aircraft rescue and firefighting (ARFF) services at an airport are established under Federal Aviation Regulations (FAR) Part 139. FAR Part 139 applies to the certification and operation of airports served by any scheduled or unscheduled passenger operation of an air carrier using aircraft with more than 30 seats. Paragraph 139.315 establishes ARFF index ratings based on the length of the largest aircraft with an average of five or more daily departures. The airport operates as an Index "C" facility, which includes aircraft at least 126 feet but less than 159 feet in length. It is not anticipated that the airport would increase to an Index "D" facility within the planning horizon.

Index C requires either two vehicles, one vehicle carrying at least 500 pounds of sodium-based dry chemical, halon 1211, or clean agent and 1,500 gallons of water and the commensurate quantity of Aqueous Film Forming Foam (AFFF) for foam production and one vehicle carrying water and the commensurate quantity of AFFF so the total quantity of water for foam production carried by both vehicles is at least 3,000 gallons; or three vehicles with one vehicle carrying the extinguishing agents required by Index "A" and two vehicles carrying an amount of water and the commensurate quantity of AFFF so the total quantity of water for foam production carried by all three vehicles is at least 3,000 gallons.

As noted in Chapter 1, the airport has two ARFF engines, the newest of which was purchased in 2005 and the oldest purchased in 1990. Both engines provide 1,500 gallons of water and 200 gallons of AFFF to meet fire-fighting capabilities for Index "C". ARFF vehicles are considered to have a fifteen-year life, which would require replacement of the Airport's ARFF vehicles during the planning period. The current ARFF storage facility was constructed in 2005 and provides sufficient warm storage for the existing equipment at present. However, expansion of the Airport's ARFF Building will be required with the acquisition of additional equipment.

3.12 Airport Maintenance and Snow Removal Facilities

The maintenance buildings are comprised of a maintenance shop, equipment storage building, storage garage, and two sand sheds. The 4,350 square foot maintenance shop has 1,700 square feet for maintenance personnel office space, locker room and lunch room. The remainder of the building contains a wash bay, equipment maintenance bay, and project room. In 2000, a 21,000 Snow Removal Equipment Building (SRE) was added to the maintenance shop. The SRE building houses all snow removal and maintenance equipment. It also serves as storage for a variety of supplies. The SRE building contains a large wash bay for snow plows and high speed brooms. The maintenance facilities are located adjacent to the existing access road making access for deliveries simple.

The current maintenance equipment is listed in Table 1-7 in *Chapter 1 Inventory*. Some of the equipment is getting older and should be considered for replacement in the planning period.

The FAR Part 139 specifies the adequate snow removal equipment needs that airports provide. For a commercial service airport the airport must have enough equipment to remove one inch per hour from the primary runway, primary taxiway, and the commercial service apron.

As airport surfaces are expanded and existing equipment ages, new purchases will be required. With the addition of new maintenance and snow removal equipment, expansion to the snow removal and equipment storage buildings are likely to be required.

3.13 Fuel Storage

The airport fuel farm is located outside the airport perimeter fence west of the maintenance shop. The fuel storage and dispensing system includes 25,500 gallons of avgas storage and 140,000 of jet fuel storage. A 24-hour credit card payment system is available for self-fueling.

Commercial operators averaged over 500,000 gallons of jet fuel usage monthly in 2018. As aircraft traffic increases, additional fuel storage should be provided. Planning for additional fuel storage should be conducted in the near term.

3.14 Security

A seven-foot chain link security fence with an additional foot of three-strand barbed wire encloses the airport operating area and serves as an animal control / security fence. Access to the airfield is through controlled access gates. The security fencing at BZN is functioning satisfactorily and, with routine maintenance, is expected to continue to function through the planning period. Security fencing should be extended to encompass any expansion to the air operations area (AOA) including any land the airport acquires in the future.