4. DEMAND/CAPACITY ANALYSIS AND FACILITY REQUIREMENTS

To determine the facilities required to meet demand over the planning horizon, the demand forecast for MKE is compared with the existing capacity of each Airport system. Capacity gaps are identified and used to quantify future facility requirements for the Airport. The facility requirements reflect those improvements necessary to meet growing demand and potentially changing demand characteristics, as well as to renew necessary infrastructure, systems, and facilities.

4.1 OVERVIEW

The relationship between demand and capacity and its consequence on the planning of future facilities is complex. Numerous issues affect how efficiently a certain level of activity (i.e., demand) can be accommodated within a specific system or facility (i.e., capacity). Acceptable levels of service or convenience vary by user, facility, and airport sponsor.

The analyses described in this section define the relationship between demand and capacity in the context of various Airport systems and provide general assessments of existing facility capabilities to accommodate future demand. These assessments are translated into specific facility requirements for a series of planning horizons (2018, 2023, 2028, and 2040) based on the baseline forecast and high scenario presented in Section 3, Aviation Activity Forecasts. **Table 4-1** summarizes the forecast enplaned passenger demand at each horizon for the baseline forecast and high scenario, identifying the origin and destination and the connecting components. Similarly, **Table 4-2** summarizes the forecast aircraft operations for the baseline forecast and high scenario, by type of operation.

TABLE 4-1 ENPLANED PASSENGER FORECAST SUMMARY

	BASELINE FORECAST			HIGH SCENARIO		
YEAR	ENPLANED O&D PASSENGERS	ENPLANED CONNECTING PASSENGERS	TOTAL ENPLANED PASSENGERS	ENPLANED O&D PASSENGERS	ENPLANED CONNECTING PASSENGERS	TOTAL ENPLANED PASSENGERS
2018E	3,496,951	87,973	3,584,924	3,496,951	87,973	3,584,924
2023	3,785,839	190,883	3,976,721	4,008,112	469,839	4,477,951
2028	4,188,894	211,205	4,400,099	4,514,263	586,883	5,101,146
2040	5,171,516	260,749	5,432,265	5,883,898	1,060,569	6,944,467

NOTE: Totals may not sum due to rounding.
SOURCE: Ricondo & Associates, Inc., May 2019.

TABLE 4-2 AIRCRAFT OPERATIONS FORECAST SUMMARY

	BASELINE FORECAST OPERATIONS					HIGH SCENARIO OPERATIONS				
YEAR	PASSENGER	CARGO	GENERAL AVIATION/ OTHER AIR TAXI	MILITARY	TOTAL	PASSENGER	CARGO	GENERAL AVIATION/ OTHER AIR TAXI	MILITARY	TOTAL
2018E	77,306	13,477	21,457	2,059	114,299	77,306	13,477	21,457	2,059	114,299
2023	79,589	16,108	21,763	2,059	119,519	88,111	18,108	21,763	2,059	130,042
2028	84,749	18,386	22,080	2,059	127,274	96,283	21,823	22,080	2,059	142,245
2040	98,689	23,017	22,877	2,059	146,642	122,167	28,798	22,877	2,059	175,901

NOTE: Totals may not sum due to rounding.
SOURCE: Ricondo & Associates, Inc., May 2019.

The documented analyses are organized by functional system, with each system assessed separately. The facility requirements for each system provide the foundation for the subsequent definition of alternative development concepts to meet the forecast demand through the 2040 planning horizon. The following functional components were analyzed:

- **Airfield Facilities** include airfield elements that support the arrival, departure, ground circulation, overnight parking, and deicing of aircraft beyond the terminal apron area. The assessment of required facilities addresses the airfield configuration (runway locations and runway lengths), the supporting taxiway network, and aircraft overnight parking and deicing capabilities. The ability of the existing airfield to accommodate forecast operational demand (magnitude and characteristics), in terms of both runway capacity and design standards, was evaluated.
- **Aircraft Gates** include the contact gate positions at which aircraft park for passenger enplaning, deplaning, and aircraft ground servicing. International aircraft gates are securely connected to international passenger processing facilities in terminal.
- **Passenger Terminal Facilities** include the passenger processing, baggage screening and handling, airline, and security facilities from the terminal curbside to the aircraft gates. Enplaning, deplaning, and connecting passenger demands define the need for various facilities, such as passenger holdrooms, baggage claim facilities, public circulation areas, airline leased space (ticket counters, operations area, baggage makeup area), security screening space, concessions, and other terminal space (administration, etc.). Terminal gates/aircraft parking requirements were established according to peak demand for commercial passenger aircraft serving, and anticipated to serve, the Airport.
- **Terminal Curbside/Landside Facilities** include the size and configuration of the curbside in front of the terminal. The ability of the existing terminal curbside configuration to accommodate forecast demand, in terms of numbers and types of vehicles, as well as vehicle dwell times, was the basis for establishing curbside requirements.
- **Airport Ground Access** includes on- and off-Airport vehicular roadway, access, and circulation systems. The needs of these systems are a function of passenger demand and the distribution of the various modes of transportation that serve the Airport and operate on the local roadways.
- **Parking Facilities** include all on-Airport parking facilities, such as short-term, long-term, and employee parking. Public parking requirements are established based on the forecast of originating passengers.
- **Rental Car Facilities** include the customer service areas, ready/return and onsite vehicle storage areas, and the quick turnaround areas. Rental car facility requirements are established based on the forecast of terminating passengers.
- **Cargo Facilities** include building, aircraft taxilane and apron, and vehicle maneuvering and parking facilities to support the movement of forecast cargo tonnage through the Airport.
- **General Aviation** facilities include fixed base operator, hangar (corporate, community, private), and vehicle access and parking facilities to support forecast general aviation operations.
- **Support Facilities** include facilities that are not encompassed in the previously identified functional systems. The specific facility types include:
  - Airline support facilities (aircraft maintenance)

— Airport support facilities (i.e., maintenance, administration, operations, ARFF station, and fuel storage facilities)

— Federal Aviation Administration (FAA) facilities

The methodologies used to determine facility capacity and requirements are in accordance with industry standards, FAA guidance, and planning factors adjusted as appropriate to reflect actual Airport use characteristics. In calculating demand/capacity, the information presented in Sections 2, Inventory of Existing Conditions, and 3, Aviation Activity Forecasts, of this Master Plan Update was used, along with any additional information that more accurately reflects existing or future conditions. Planning experience at, and knowledge of, other airports was also used in evaluating facility capacities. This approach ensures that capacity assessments are sensitive to the specific requirements at MKE, but also reflect industry standards and practices.

Facility requirements are defined based on the demand/activity level, rather than specific timeframes. Planning activity levels (PALs) are used in sections of this document, representing the activity that forecast to emerge in an approximate timeframe. The use of PALs is a method for representing a capacity need (typically, a facility requirement) correlated with an activity level rather than a calendar timeframe. In general terms, PAL 1 is used to represent the approximate activity forecast for 2023 (whether it occurs in 2023 or in another timeframe); similarly, PAL 2 and PAL 3 are used to represent the approximate activity forecasts for 2028 and 2040, respectively.

4.2 AIRFIELD

The planning and design of airfield facilities are based on the forecast aircraft activity and the type of aircraft expected to operate on the airfield. Airfield geometry requirements are based on the size and performance characteristics of aircraft that are forecast to use the airport. The Federal Aviation Administration (FAA) provides planning and design guidance through published Advisory Circulars (ACs), Orders, and other guidance, that are intended to promote safety, efficiency, and economy. FAA airfield planning and design standards governing the geometric layout of runways and taxiways are detailed in AC 150/5300-13A, *Airport Design (Change 1)*.

In addition to providing the appropriate geometric parameters for the airfield, Airport facilities must be planned to accommodate the activity forecast through 2040. An airfield demand/capacity analysis evaluates the capability of airfield facilities to accommodate existing and forecast aircraft operations. In analyzing the ability of MKE facilities to accommodate operational demand, airfield demand and capacity were calculated using the methodologies established in by the FAA in AC 150/5060-5, *Airport Capacity and Delay (Change 2)*.

In addition to providing the appropriate geometric parameters for the design aircraft expected to operate on the airfield, airfield facilities must also be planned and designed to provide capacity to accommodate the activity forecast to occur over the 2040 planning horizon. An airfield demand/capacity analysis is typically conducted to assess the capability of airfield facilities to accommodate existing and forecast aircraft operations. In analyzing the ability of MKE facilities to accommodate operational demand, airfield demand and capacity and potential aircraft delay were calculated using the methodologies set forth in AC 150/5060-5, *Airport Capacity and Delay (Change 2)*.

4.2.1 CRITICAL AIRCRAFT

The FAA defines Critical Aircraft, also referred to as the "design aircraft," as the "most demanding aircraft type, or grouping of aircraft with similar characteristics, that make regular use of the airport." The FAA considers "regular use" to be 500 annual operations (takeoffs or landings), as defined in AC 150/5000-17, *Critical Aircraft and Regular Use Determination*. For federally obligated airports, the Critical Aircraft establishes the dimensional standards that guide airfield planning.

The Critical Aircraft identified in the 2006 *General Mitchell International Airport Master Plan Update*[1] was an Airbus 330-200; however, the Critical Aircraft identified in the 2019 FAA-approved Airport Layout Plan Update was a Boeing 747-400[2].Changes in airline activity at MKE and the evolution of airline fleets require an update to the Critical Aircraft. Based on the FAA-approved forecast of aviation activity, the existing and future Critical Aircraft are identified as the MD-11 (Airplane Design Group [ADG] IV, Approach Category D) and the Boeing 777 Freighter (ADG V, Approach Category D), respectively. Accordingly, the existing and future Airport Reference Code (ARC) is D-IV and D-V.

FAA guidance recognizes that given aircraft fleet diversity, different aircraft may define various components of the airfield in which case multiple Critical Aircraft may be designated during the planning process and ultimately documented on the Airport Layout Plan. Multiple Critical Aircraft may result when considering runway length requirements. Not all of the Airport's existing runways can serve D-IV or D-V aircraft. **Table 4-3** summarizes the most demanding aircraft anticipated to use each runway on a regular basis over the planning horizon based on the FAA-approved forecast and the supporting Design Day Flight Schedule, under typical runway utilization. The identified aircraft are anticipated to be the designated Critical Aircraft for each of the runways at MKE; however, this is subject to confirmation during the planning process as specific airfield (runway) alternatives are identified and evaluated. The final determination of the Critical Aircraft for each runway will be a function of the final airfield configuration (runways, runway locations, and runway lengths).

TABLE 4-3 MOST DEMANDING AIRCRAFT BY RUNWAY (PRELIMINARY CRITICAL AIRCRAFT DETERMINATION)

RUNWAY	CRITICAL AIRCRAFT (2040)	RUNWAY DESIGNATION (AIRPLANE DESIGN GROUP)
1L-19R	Boeing 777F Boeing 787-8	D-V
1R-19L	Lockheed C-130	C-IV
7L-25R	Beechcraft King Air 300/350 Beech 1900	B-II
7R-25L	Boeing 777F Boeing 787-8	D-V
13-31	Beechcraft Super King 200	B-II

NOTES:
1 "F" = Freighter
2 Representative of both the baseline forecast and high scenario.
SOURCES: Ricondo & Associates, Inc., MKE Master Plan Design Day Flight Schedules, May 2019; Federal Aviation Administration, Advisory Circular 150/5300-13A Change 1, *Airport Design*, February 2014; Federal Aviation Administration, Advisory Circular 150/5000-17, June 2017).

This preliminary Critical Aircraft determination reflects the forecast number of operations (passenger, cargo, and general aviation) by the most demanding aircraft at MKE, the available runway length, and current critical aircraft designations (as documented on the ALP). As shown, Runways 1L-19R and 7R-25L are the longest available runways and are each capable of serving D-V aircraft. Runway 1R-19L serves military aircraft up to C-IV aircraft capable of

1 PB Americas, Inc. – Master Plan Update, 2006

2 Airport Layout Plan prepared by Crawford Murphy & Tilly, approved by the FAA in February 2019.

operating on a 4,000-foot runway. Runways 13-31 and 7L-25R will continue to serve general aviation (GA) aircraft up to B-II aircraft.

4.2.2 AIRFIELD GEOMETRY

In addition to a significant evolution in aircraft characteristics, many airports (including MKE) were designed long before current airfield geometry standards were implemented. As a result, airports may not meet the latest standards set forth in AC 150/5300-13A, *Airport Design (Change 1)*. Accordingly, an assessment of existing airfield elements was made as part of the facility requirements determination to evaluate determine compliance with current dimensional and geometric standards.

4.2.2.1 AIRPLANE DESIGN GROUP

As noted, the (preliminary) Critical Aircraft for each runway vary, including ADG II, IV, and V aircraft. Airfield dimensional standards that are based on the Critical Aircraft ADG are summarized in **Table 4-4**. These standards are applicable to the assessment of the compliance of the existing airfield with current design standards.

TABLE 4-4 AIRPLANE DESIGN GROUP DIMENSIONAL PLANNING STANDARDS

DIMENSION	ADG-II STANDARDS[1]	ADG-IV STANDARDS	ADG-V STANDARDS
Runway Centerline to Parallel Taxiway Centerline Separation	240 feet	400 feet	400 feet
Runway Centerline to Holding Position Marking	200 feet	257 feet	287 feet
Runway Width	75 feet	150 feet	150 feet
Runway Shoulder Width	10 feet	25 feet	35 feet
Blast Pad Width	95 feet	200 feet	220 feet
Blast Pad Length	150 feet	200 feet	400 feet
Taxiway Object Free Area	131 feet	259 feet	320 feet
Taxilane Object Free Area	115 feet	225 feet	276 feet
Taxiway Centerline to Parallel Taxiway/Taxilane Centerline Separation	105 feet	215 feet	267 feet
Taxiway Centerline to Fixed or Movable Object	65.5 feet	129.5 feet	160 feet
Taxilane Centerline to Parallel Taxilane Centerline	97 feet	198 feet	245 feet
Taxilane Centerline to Fixed or Movable Object	57.5 feet	112.5 feet	138 feet

NOTE:
1 Based on a non-precision approach with visibility minimums not lower than 3/4 mile.
SOURCE: Federal Aviation Administration, Advisory Circular 150/5300-13A Change 1, Airport Design, February 2014.

4.2.2.2 TAXIWAY DESIGN GROUP

The Taxiway Design Group (TDG) designation is based on an aircraft's overall main gear width and the cockpit-to-main gear distance. The Critical Aircraft from a TDG perspective also varies depending on the runway, consisting of

TDG 2, 3, and 6 aircraft. For taxiways that serve Runways 1L-19R and 7R-25L, the current and forecast TDG is 6, based on the McDonnell Douglas MD-11 freighter. Other taxiways range between TDG 2 and 3, varying by location.

Table 4-5 summarizes the dimensional planning standards for TDG 2, 3, and 6 aircraft. These standards are applicable to future parallel or connector taxiways intended to serve the Critical Aircraft identified for a specific runway. Consideration must also be given to overall airfield circulation in the determination of applicable TDG for each taxiway segment.

TABLE 4-5 TAXIWAY DESIGN GROUP DIMENSIONAL PLANNING STANDARDS

DIMENSION	TDG 2	TDG 3	TDG 6
Runway Centerline to Taxiway Centerline Separation (Reverse Turns from High-Speed Exit)	265 feet minimum; 300 feet recommended	350 feet	427 feet minimum; 450 feet recommended
Taxiway Width	35 feet	50 feet	75 feet
Taxiway Edge Safety Margin	7.5 feet	10 feet	15 feet
Taxiway Shoulder Width	15 feet	20 feet	30 feet
Crossover Taxiways with Direction Reversal	162 feet	162 feet	312 feet
Taxiway Fillets	See FAA AC 150/5300-13A, *Change 1,* Tables 4-9 and 4-5		

SOURCE: Federal Aviation Administration, Advisory Circular 150/5300-13A, *Airport Design, Change 1*, February 2014.

4.2.2.3 AREAS OF NON-COMPLIANT GEOMETRY AND DIMENSIONS

The MKE airfield was reviewed to assess compliance with current dimensional and geometric standards set forth in FAA AC 150/5300-13A, *Airport Design (Change 1)* for the identified preliminary Critical Aircraft for each runway. **Exhibit 4-1** identifies the preliminary recommended design designations for both runways and taxiways based on the activity forecast and the Design Day Flight Schedule. For the purposes of this review, it was assumed that supporting taxiways (i.e., parallel or connector) would carry the same ADG designation as the corresponding runway.

Airfield pavements that exclusively serve military operations were not considered as part of this evaluation; however, the transition between the airfield and adjacent military apron pavement was evaluated (Taxiways N and W).

Airplane Design Group

Applying the corresponding ADG dimensional standards, a total of 18 areas with opportunities for improved alignment with FAA guidance were identified, as shown on **Exhibit 4-2**. These areas include:

- Area 1 – Runway 19R: insufficient blast pad length and width.
- Area 2 – Runway 7R: compliant with RDC (ACC and ADG) D-IV blast pad dimensional standards; insufficient blast pad length and width under RDC D-V standards.
- Area 3 – Runway 25L: compliant with RDC D-IV blast pad dimensional standards; insufficient blast pad length and width under RDC D-V standards.
- Area 4 – Taxiways A and B: insufficient separation in the segment between Taxiways R and A1.
- Area 5 – Runway 1R-19L: insufficient runway shoulders and blast pads (based on current designation as a C-IV runway, to be confirmed as part of emerging alternatives in later stages).

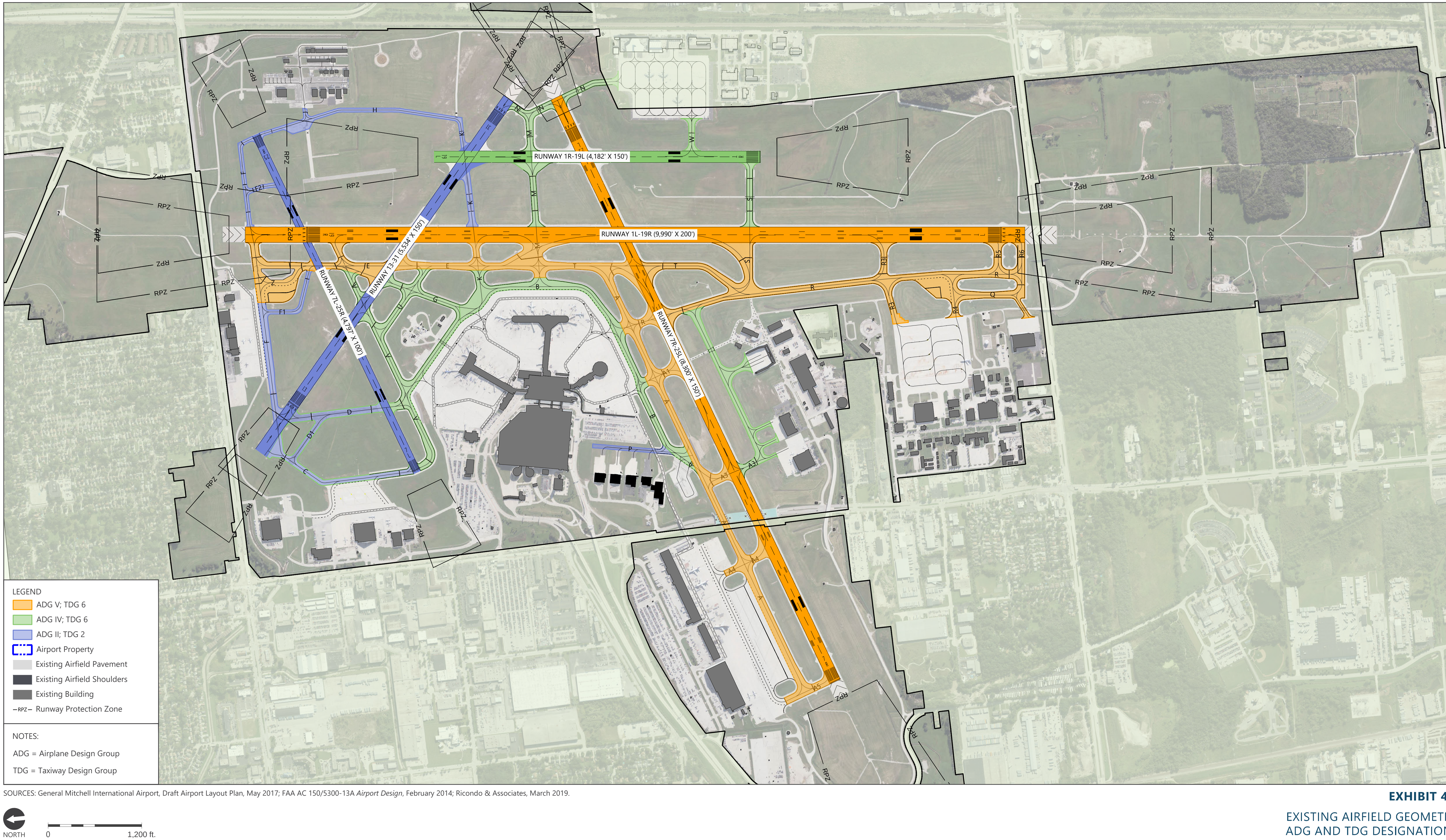
- Area 6 – Runway 13: no blast pad; although a blast pad is not required given the standards for RDC B-II, this runway is used occasionally by RDC C-III aircraft. If this runway is a component of the future airfield, a blast pad would be recommended to provide blast/erosion protection at the Runway 13 end.
- Area 7 – Taxiway N: direct access from apron to runway.
- Area 8 – Taxiways E and V: wide expanse of pavement.
- Area 9 – Taxiways E and M: wide expanse of pavement and insufficient runway/taxiway centerline separation for high-speed exit direction reversal.
- Area 10 – Taxiways E and Z and Taxiways Z and F1: insufficient taxiway to taxiway centerline separation.
- Area 11 – Taxiway K: direct access from apron to runway.
- Area 12 – Taxiway M: direct access from apron to runway.
- Area 13 – Taxiway R: direct access from apron to runway.
- Area 14 – Taxiway A1: direct access from apron to runway.
- Area 15 – Taxiway A3: direct access from apron to runway.
- Area 16 – Taxiway A4: direct access from apron to runway.
- Area 17 – Taxiway A5: direct access from apron to runway.
- Area 18 – Taxiway W: direct access from apron to runway.

Resolution of these areas of non-compliance will be addressed in the development of airfield alternatives and ultimately the refinement of the preferred alternative.

Additionally, the taxiway network that serves the passenger terminal complex and Runway 7R deice pad does not comply with ADG V object free area (OFA) design standards. The application of these standards could adversely impact adjacent facilities and aircraft parking positions. If MKE is unable to comply with these standards, they could be required to prepare a Modification of Standards (MOS) in order to get FAA approval of the ALP (or commit to preparing one once they reach 500 annual ops for ADG V aircraft).

Although not specifically depicted in Exhibit 4-2, there are three runways that exceed the runway width standards based on the existing critical aircraft for each runway as documented in the currently approved ALP drawing set (approved in January 2019). Specifically, the following runways exceed current width requirements:

- Runway 7L-25R – This 100-foot runway is currently designated as a B-II runway, exceeding the minimum width requirement defined in FAA guidance. As defined in Advisory Circular (AC) 150/5300-13A, this runway requires a 75-foot wide runway.
- Runway 13-31 – This 150-foot runway is currently designated as a B-II runway, exceeding the minimum width requirement defined in AC 150/5300-13A. Current FAA guidance indicates that a 75-foot runway is the minimum required width.
- Runway 1L-19R – This 200-foot runway is currently designated as a D-V runway, exceeding the minimum width requirement defined in AC 150/5300-13A. The minimum width required for a D-V runway is 150 feet.



SOURCES: General Mitchell International Airport, Draft Airport Layout Plan, May 2017; FAA AC 150/5300-13A *Airport Design*, February 2014; Ricondo & Associates, March 2019.

EXHIBIT 4-1

EXISTING AIRFIELD GEOMETRY
ADG AND TDG DESIGNATIONS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\06 - facility requirements\6.1 - Airfield_Airspace\CAD\Exh3-1_Existing Airfield Geometry_2022-03-11.dwgLayout: 11x17L Plotted: Mar 29, 2022, 10:32AM

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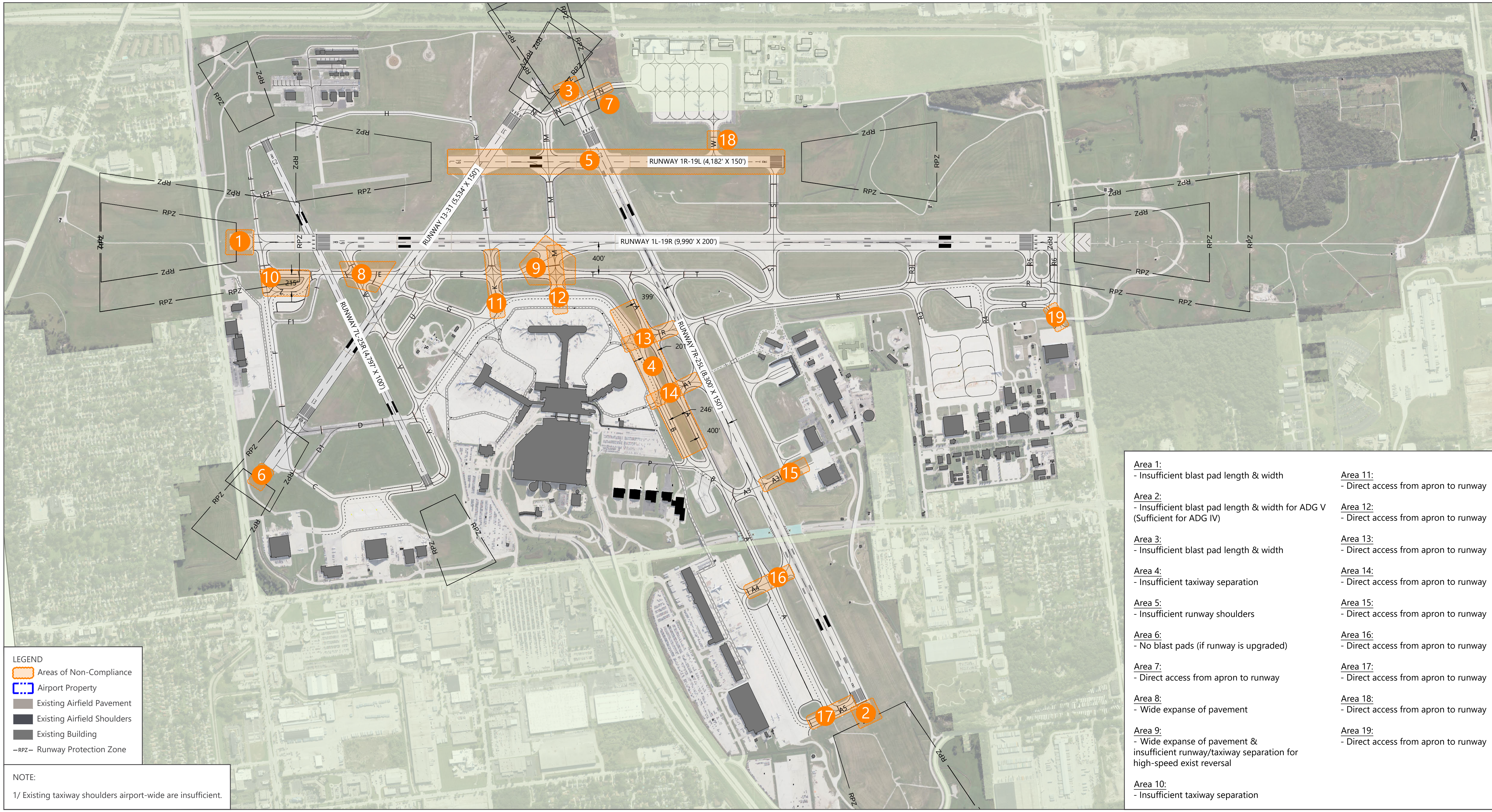

SOURCES: General Mitchell International Airport, Draft Airport Layout Plan, May 2017; FAA AC 150/5300-13A *Airport Design*, February 2014; Ricondo & Associates, March 2019.

NORTH 0 1,200 ft.

EXHIBIT 4-2

EXISTING AIRFIELD GEOMETRY
AREAS OF NON-COMPLIANCE

Drawing: P:\project-chicago\mke\mke master plan update\master plan project 2018\06 - Facility Requirements\6.1 - Airfield_Airspace\CAD\Exh3-2_Areas of Non-Compliance.dwgLayout: 11x17L Plotted: May 12, 2022, 10:05AM

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In assessing the alignment of the existing airfield with current FAA standards, it is not yet known which runways will remain components of the future Airport Development Plan documented in the Airport Layout Plan drawing set. Should the future airfield encompass either or both of the runways that exceed current runway width requirements without an attendant change in the runway-specific critical aircraft, it is not anticipated that either would be recommended for a reduction in width due to the cost and complexity of the infrastructure changes that would be necessary. Significant capital cost would be incurred to reduce the width of either runway, including shoulder reconstruction, lighting revisions, signage adjustments, electrical modifications, drainage modifications, access/exit taxiway reconfigurations, regrading, restriping, and earthwork. The exploration of alternatives will consider various runways necessary to meet forecast capacity needs; however, reductions in runways widths will not be considered in the refinement of the Airport Development Plan (preferred alternative).

Taxiway Design Group

The existing taxiways either meet or exceed the width requirements of 35 and 75 feet for the respective TDG designations. However, the existence of dedicated shoulders varies by taxiway. Most of the TDG 2 taxiways are not configured with dedicated shoulders. The TDG 6 taxiways have dedicated shoulders, but do not comply with the current standard width of 30 feet. **Table 4-6** summarizes the existing width dimensions by taxiway. Future taxiways identified as part of the airfield alternatives should comply with the associated TDG design standards.

TABLE 4-6 EXISTING TAXIWAY DIMENSIONS

TAXIWAY	TAXIWAY WIDTH	TAXIWAY SHOULDER WIDTH
A	75 feet	25 feet
A1, A3, A4 & A5	Varies	25 feet
B	75 feet	25 feet
C	75 feet	25 feet where available
D	98 feet	No Shoulder
D1	75 feet	No Shoulder
E	75 feet	25 feet
F	50 – 100 feet	No Shoulder
F1 & F2	50 feet	No Shoulder
G	75 feet	25 feet
H	50 feet	No Shoulder
J	50 feet	No Shoulder
K	50 – 75 feet	No Shoulder
M	75 feet	25 feet
N	75 – 95 feet	25 feet where available
Q	75 feet	25 feet
R	75 feet	25 feet
S	75 feet	25 feet
T	75 feet	25 feet
U	75 feet	25 feet
V	75 feet	25 feet
W	75 feet	25 feet where available
Y	75 feet	No Shoulder
Z	75 feet	25 feet

NOTE: Taxiway A2 was removed following the inventory/data collection and is not included in this table.
SOURCE: Milwaukee Mitchell International Airport, Airport Layout Plan, approved February 2019.

4.2.2.4 RUNWAY SEPARATIONS

Airfield capacity is dependent upon the ability to provide multiple arrival and departure streams. A variety of airfield use configurations can accommodate multiple streams; however, per FAA AC 150/5060-5, *Airport Capacity and Delay*, maximum capacity can be achieved with parallel runways. During most instrument meteorological conditions, multiple arrival streams can only be accommodated on parallel runways.

Required separations for simultaneous operations vary, depending on the number of runways, operational dependency, and meteorological conditions. **Table 4-7** details recommended and minimum runway separations for a range of possible operational conditions under current air traffic rules and FAA design criteria that may be applicable to MKE.

TABLE 4-7 RUNWAY SEPARATION STANDARDS

OPERATIONAL CONFIGURATION	RUNWAY CENTERLINE SEPARATION (FEET)	
	FAA RECOMMENDED	MINIMUM
Visual Meteorological Conditions		
Simultaneous arrivals and departures [1]	1,200	700
Simultaneous arrivals and departures (wake turbulence)	2,500	2,500
Instrument Meteorological Conditions		
Simultaneous departures [2]	3,500	2,500
Simultaneous arrivals and departures[3]	2,500	1,000

NOTES:
1 Runway separations less than 2,500 feet are subject to air traffic control restrictions when wake turbulence is a factor.
2 Simultaneous non-radar departures require 3,500 feet of separation. This separation requirement can be reduced to 2,500 feet with radar in use.
3 Simultaneous radar-controlled approaches and departures can be approved for separations of 2,500 feet for non-staggered thresholds. Separations down to 1,000 feet can be achieved with staggered thresholds. A minimum of 1,200 feet of separation is recommended for ADG-V and -VI runways.
SOURCE: Federal Aviation Administration, Advisory Circular 150/5300-13A, *Airport Design, Change 1*, February 2014.

The MKE airfield is configured with two sets of parallel runways. The existing separation for Runways 7L-25R and 7R-25L is 3,680 feet; and the existing separation for Runways 1L-19R and 1R-19L is 1,000 feet. Runways 7L-25R and 7R-25L can operate independently in all conditions, if needed, to accommodate the activity forecast through the planning horizon.

4.2.3 RUNWAY LENGTH ANALYSIS

The runway length analysis determines the maximum runway length required to accommodate the Critical Aircraft in terms of maximum certified takeoff weight (MTOW) projected to operate at MKE through the planning horizon. This analysis also identifies the runway length needed to serve existing nonstop cargo routes, as identified in **Table 4-8**. Considerations were also given to potential future nonstop passenger and cargo routes.

TABLE 4-8 NONSTOP CARGO MARKETS SERVED

FORECAST SCENARIO	NONSTOP MARKET	DISTANCE FROM MKE (NAUTICAL MILES)	AIRCRAFT TYPE[1]
Baseline/High	IND (Indianapolis, IN)	206	MD-11F, Boeing 777F, Boeing 767-300F
Baseline/High	SDF (Louisville, KY)	302	MD-11F, Boeing 777F, Boeing 767-300F
Baseline/High	MEM (Memphis, TN)	484	MD-11F, Boeing 777F, Boeing 767-300F
Baseline/High	EWR (Newark, NJ)	630	MD-11F, Boeing 777F, Boeing 767-300F
Baseline/High	AFW (Fort Worth, TX)	750	MD-11F, Boeing 777F, Boeing 767-300F

NOTE:
1 Represents the most demanding cargo aircraft in terms of runway length anticipated to operate at MKE.
SOURCE: Ricondo & Associates, Inc., MKE Master Plan Design Day Flight Schedules, May 2019.

According to FAA planning guidance, the recommended length of a primary runway is determined based on either the family of aircraft with similar performance characteristics or a specific aircraft type needing the longest runway. In either case, the choice should be based on aircraft that are reasonably expected to use the runway on a regular basis, which is considered to be at least 500 operations a year (landings and takeoffs combined), as defined in AC 150/5325-4B, *Runway Length Requirements for Airport Design*.

4.2.3.1 METHODOLOGY

Two methodologies were used to determine the appropriate runway length to accommodate aircraft projected to operate at the Airport through the design period, as identified in the 2023, 2028, and 2040 Design Day Flight Schedules (DDFSs). These methodologies included:

- **Maximum Certified Takeoff Weight (MTOW).** MTOW is the maximum certified weight at which an aircraft is allowed to takeoff, based on structural and engineering requirements. This methodology was used to evaluate the performance of aircraft forecast to operate at MKE under the forecast horizons and scenarios. The takeoff runway length requirements presented in this section are based on the ability to accommodate these aircraft departures at the MTOW prescribed by the aircraft manufacturers.
- **Cargo Stage Length.** This methodology was used to identify the runway lengths necessary to accommodate cargo aircraft departures from MKE under the forecast horizons and scenarios. These values reflect the takeoff weight of an aircraft with the fuel payload needed to reach the destinations included in the DDFS for 2040 (under both the baseline forecast and high scenario). Considering the longest stage length of the aircraft fleet identified in the forecast, the distance used for this analysis is 1,000 nautical miles (NM) for both the baseline and high scenario forecasts. In addition to stage lengths, the potential range of an ADG-V aircraft anticipated to utilize the Airport throughout the planning horizons were assessed and noted in the following section.

These runway length requirements were also defined in accordance with the *Aircraft Characteristics for Airport Planning* manuals, distributed by aircraft manufacturers. These manuals provide information on most of the factors influencing the required runway length for aircraft operations. Other sources, such as FAA ACs and independent analyses conducted by the aircraft manufacturers, were used to address factors not covered in the manuals.

The planning factors that were used in the runway length determination included, but were not limited to:

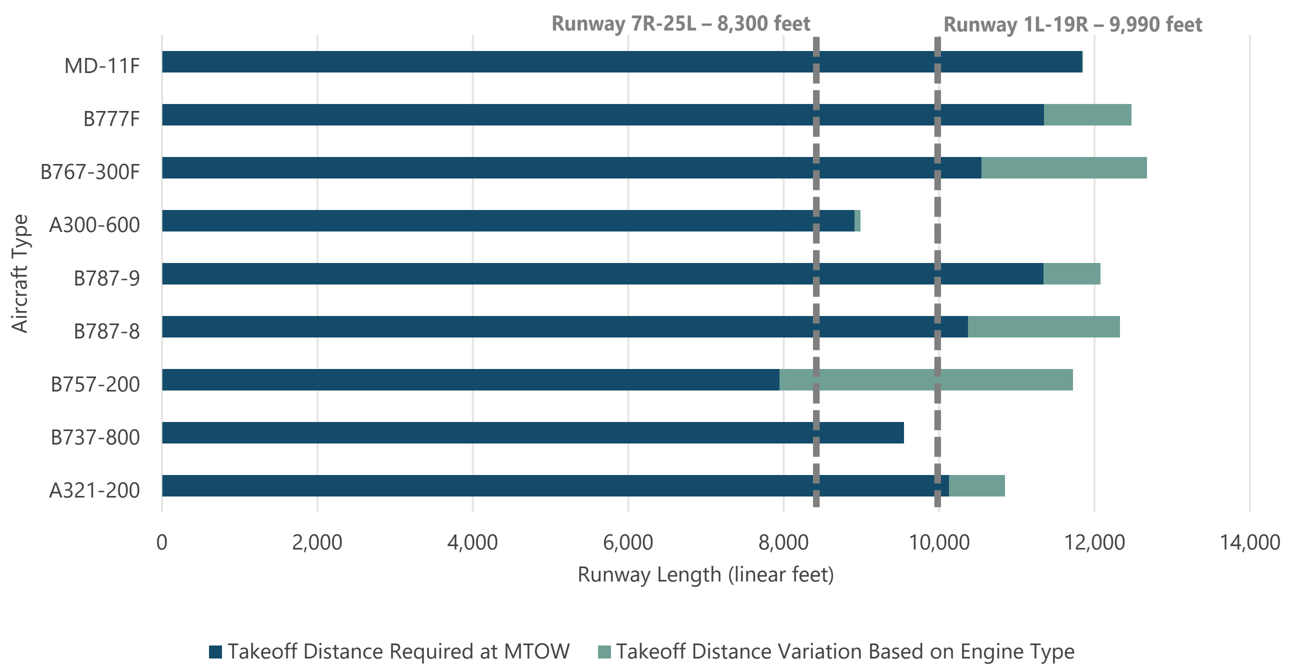
- **Aircraft Type.** The runway length analysis is based on the aircraft fleet mix identified in the DDFSs for the baseline forecast and the high scenario. Runway length requirements were considered for the largest aircraft or family of aircraft, as well as the aircraft expected to be operated most frequently at MKE based on the forecast.
- **Aircraft Weight.** Aircraft weight is the single most important factor to consider when conducting a runway length analysis. The heavier the aircraft type, the longer the required runway length for a given condition. The weight of each aircraft type can vary considerably depending on payload (passengers, baggage, and cargo) and the amount of fuel on board to fly a defined stage length.
- **Engine Model.** Because specific engine models for aircraft operating and forecast to operate at MKE cannot be identified at this point, all engine model variations were considered in this evaluation.
- **Weather (temperature, prevailing winds, etc.).** Performance characteristics under the most demanding weather conditions that typically occur at the Airport were considered. The runway length requirements reflect aircraft performance characteristics during the manufacturer-defined "hot day" (84 to 92 degrees Fahrenheit), and zero wind conditions. According to the National Oceanic and Atmospheric Administration (NOAA), the mean maximum temperature of the hottest month at MKE is 81 degrees Fahrenheit (July).
- **Flap Settings.** Most aircraft have a variety of flap settings that affect runway length requirements. This analysis was based on the optimal flap settings for takeoff performance for each aircraft type.
- **Airport Elevation.** Aircraft performance is also affected by the elevation of the airfield. Runway length requirements were based on MKE's published Airport airfield elevation of 728.4 feet above mean sea level.
- **Runway Surface Conditions:** AC 150/5325-4B addresses the impact of wet, slippery pavement conditions on runway length requirements. In accordance with this document, landing runway length requirements are to be increased to account for wet pavement conditions when assessing the needs of turbojet-powered aircraft. Where data pertaining to landing distances on wet runways are unavailable, a net increase in required runway length of 15 percent is recommended by AC 150/5325-4B. Takeoff runway length requirements prescribed by the aircraft manufacturers do not include adjustments to account for wet pavement conditions.
- **Runway Gradient:** The runway length requirements from the *Aircraft Characteristics for Airport Planning* manuals were increased 360 feet to account for approximately 36 feet of elevation difference between the highest and lowest points of the most demanding runway (Runway 1L-19R) centerline, as prescribed in AC 150/5325-4B.
- **Aircraft Fleet Mix:** Because aircraft performance characteristics vary, establishing a recommended runway length does not require evaluation of every aircraft type. Only the most demanding aircraft types, in terms of runway length and width, need to be evaluated. For the purposes of this analysis, the aircraft fleet mixes in the 2040 DDFSs were sorted to identify the most demanding aircraft, as the most frequent aircraft types operating at MKE.

4.2.3.2 TAKEOFF LENGTH REQUIREMENTS

Maximum Certified Takeoff Weight Requirements

Exhibit 4-3 presents the required takeoff runway lengths for various aircraft operating at MTOW on a hot day as defined above. This information is presented as a bar graph, reflecting the takeoff runway length required for the most frequently operated family of aircraft (narrow body) as well for the Critical Aircraft, operating at MKE through 2040. As the runway length requirements for each aircraft can vary considerably by engine type, the results are shown as a range reflecting the minimum and maximum runway lengths needed to accommodate MTOWs for the conditions stated. As Exhibit 4-3 shows, only the Airbus A300-600, Boeing 737-800, and Boeing 757-200 (based on engine type) could takeoff at MTOW on Runway 1L-19R, and only certain variations of the B757-200 could takeoff at MTOW on Runway 7R-25L.

EXHIBIT 4-3 MAXIMUM CERTIFIED TAKEOFF WEIGHT RUNWAY LENGTH REQUIREMENTS



NOTES:
1 Runway length requirements increased by 360 feet to account for the most demanding difference in runway centerline elevation (difference between the highest and lowest points along the Runway 1L-19R centerline).
2 Hot day temperature is the mean maximum temperature of the hottest month at MKE is 81degrees Fahrenheit, according to the National Oceanic and Atmospheric Administration.

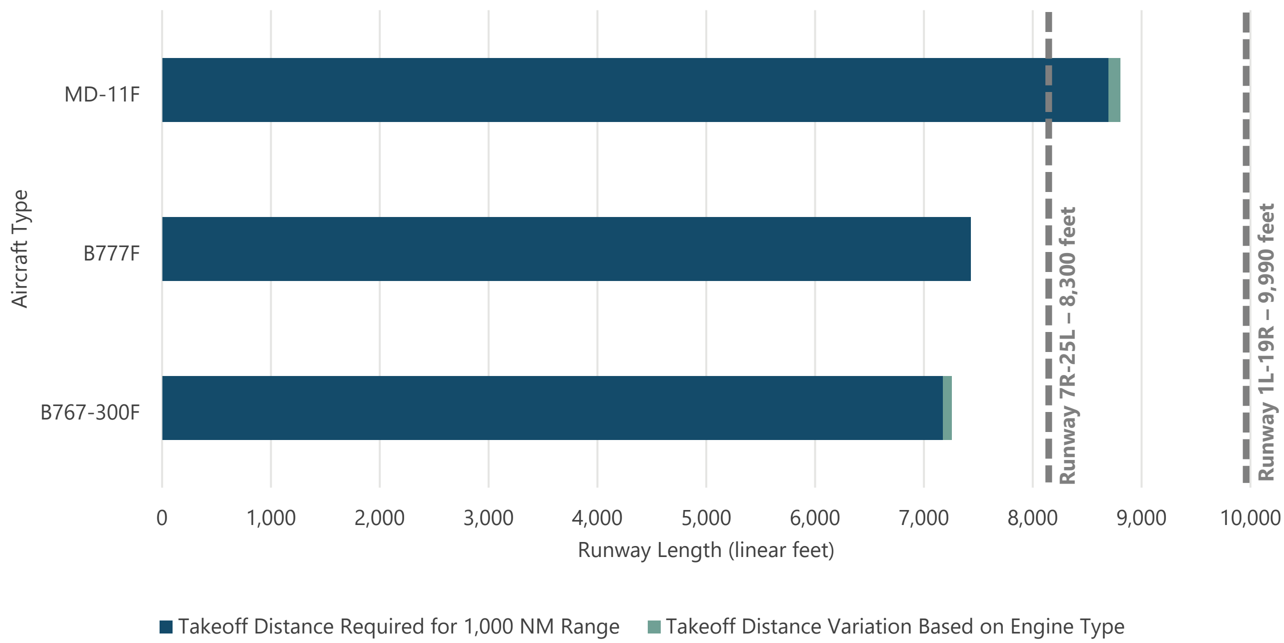
SOURCES: Various Aircraft Characteristics for Airport Planning manuals, February 2019.

Cargo Stage Length Requirements

Exhibit 4-4 presents the takeoff runway length required to reach the most distant stage for cargo aircraft under the baseline and high forecasts (estimated stage length of 1,000 nm) on a hot day, at the maximum allowable takeoff weight (MATOW). MATOW is the maximum weight at which an aircraft is allowed to takeoff, based on operational requirements. This information is presented as a bar graph reflecting the takeoff runway length required for the most demanding cargo aircraft forecast to operate at MKE through 2040. As the runway length requirements for each aircraft can vary considerably by engine type, the results are shown as a range of the minimum and maximum runway length to reach the desired range.

As shown, all three cargo aircraft (MD-11F, Boeing 777F, and Boeing 767-300F) could take off on a hot day on Runway 1L-19R at MATOW and reach a destination 1,000 nm from MKE. Only the MD-11F would not be able to operate on Runway 7R-25L under these conditions.

EXHIBIT 4-4 CARGO STAGE LENGTH TAKEOFF LENGTH RUNWAY REQUIREMENTS



NOTES:

1 Runway length requirements increased by 360 feet to account for the most demanding difference in runway centerline elevation (Runway 1L-19R).

2 Hot day temperature is the mean maximum temperature of the hottest month at MKE is 81degrees Fahrenheit, according to the National Oceanic and Atmospheric Administration.

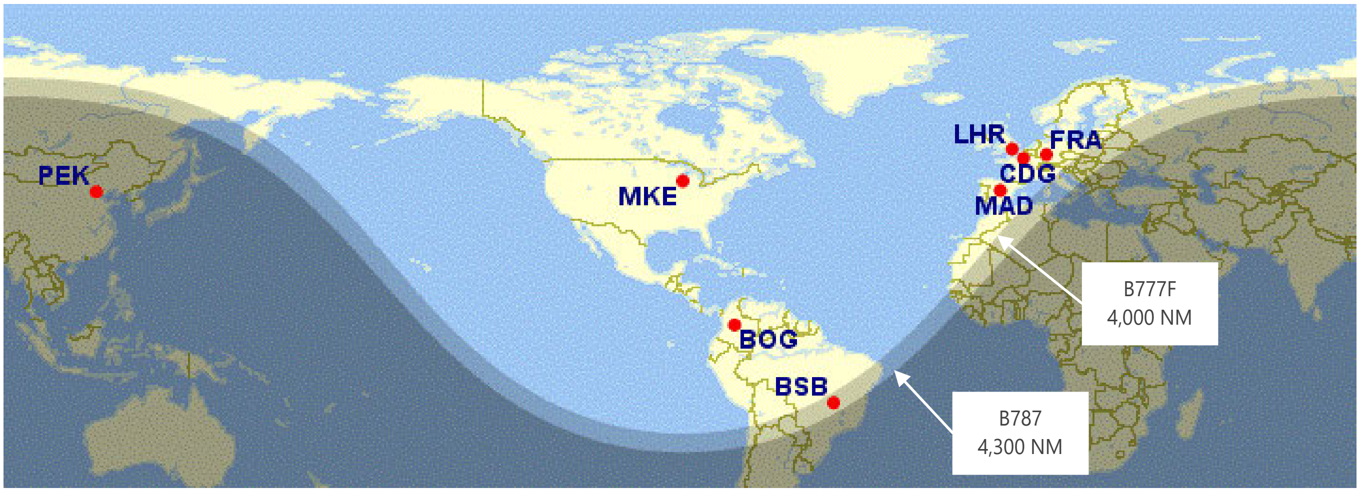
SOURCES: Various Aircraft Characteristics for Airport Planning manuals, February 2019.

Potential Future Nonstop Cargo and Passenger Markets

While a detailed take-off runway length analysis was conducted based on the design day flight schedule, which included representative destinations based on existing and predicted route networks and airline service patterns, a supplemental high-level runway length analysis was conducted to approximate the maximum range of the Boeing 787 and the Boeing 777F based on the available runway length.

As shown on **Exhibit 4-5**, these aircraft have approximate ranges of over 4,000 NM based on the available runway length at MKE. While additional detailed analysis would be required to refine these range approximations if forecast or future activity included destinations nearing these identified ranges, the approximated ranges indicate that available runway length would potentially accommodate changes in air service that include many non-stop international destinations.

EXHIBIT 4-5 POTENTIAL FUTURE NONSTOP CARGO AND PASSENGER MARKET STAGE LENGTHS



NOTES: BOG – El Dorado International Airport; BSB – International Airport of Brasilia; CDG – Charles de Gaulle Airport; FRA – Frankfurt Airport; LHR – London Heathrow Airport; MAD – Madrid-Barajas International Airport.

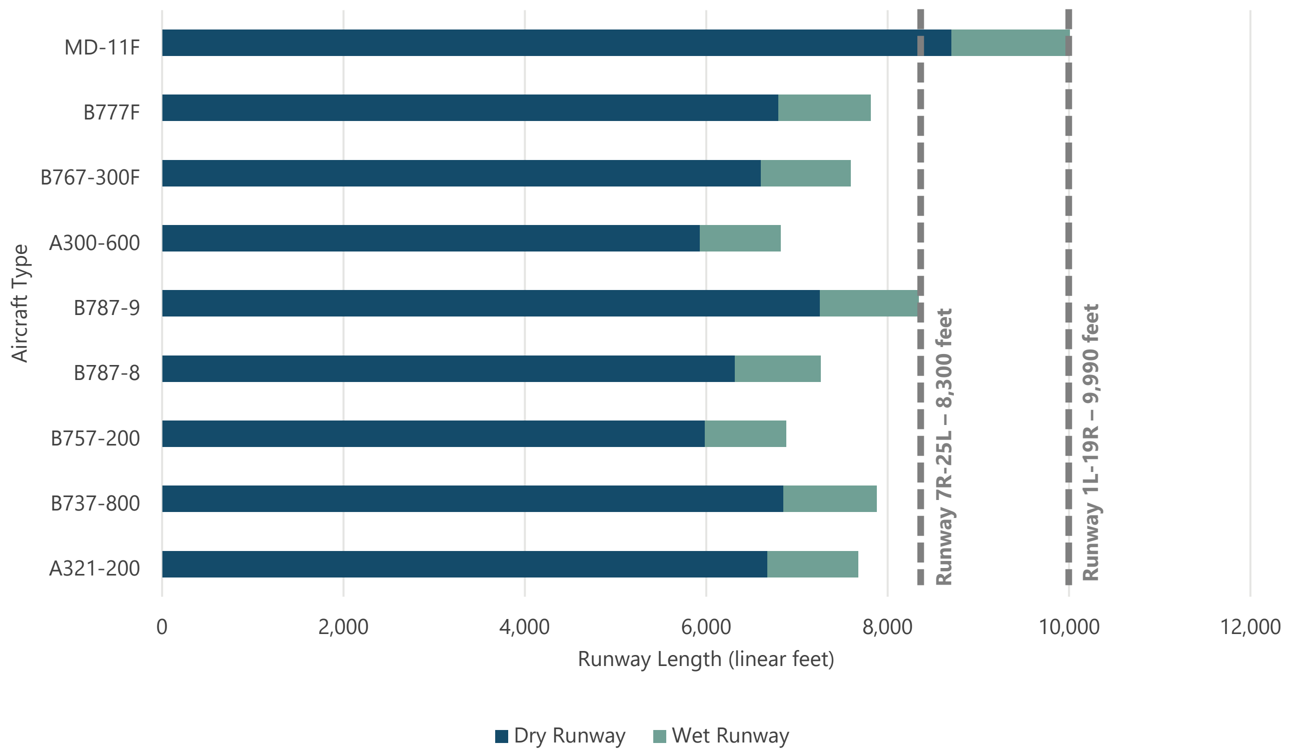
SOURCES: Various Aircraft Characteristics for Airport Planning manuals, February 2019; http://www.gcmap.com/ (accessed January 4, 2021).

4.2.3.3 LANDING LENGTH REQUIREMENTS

Although the runway length requirements for takeoffs typically exceed those for aircraft landings, a landing distance requirements analysis was conducted to determine whether Runway 1L-19R could accommodate forecast aircraft operations at maximum gross landing weight (MGLW). The same aircraft in the takeoff length requirements analysis were evaluated. As shown on **Exhibit 4-6**, all evaluated aircraft can land on Runways 1L-19R and 7R-25L in dry conditions. In wet conditions, all evaluated aircraft can land on both Runways 1L-19R and 7R-25L, except the MD-11F, which has a landing length requirement (10,010 feet) that exceeds the length of Runway 1L-19R (9,990 feet). Given that the analysis considered length requirements at MGLW, it is reasonable cargo operators would make the necessary payload adjustment to ensure that the MD-11F will be able to safely land on Runway 1L-19R during wet conditions without requiring a 20-foot runway extension.

Because MKE accepts aircraft that are diverted from other airports in the region when weather or other conditions do not allow their arrival at the scheduled airport, aircraft beyond those analyzed in the runway length analysis or those identified in the forecast may operate at the Airport. No analysis of the length requirements of unscheduled commercial aircraft was made because of the unpredictable and infrequent nature of these operations.

EXHIBIT 4-6 LANDING DISTANCE REQUIREMENTS AT MAXIMUM GROSS LANDING WEIGHT



NOTES:
1 Runway length requirements increased by 360 feet to account for the most demanding difference in runway centerline elevation (Runway 1L-19R).
2 Hot day temperature is the mean maximum temperature of the hottest month at MKE is 81degrees Fahrenheit, according to the National Oceanic and Atmospheric Administration.
SOURCES: Various Aircraft Characteristics for Airport Planning manuals, February 2019.

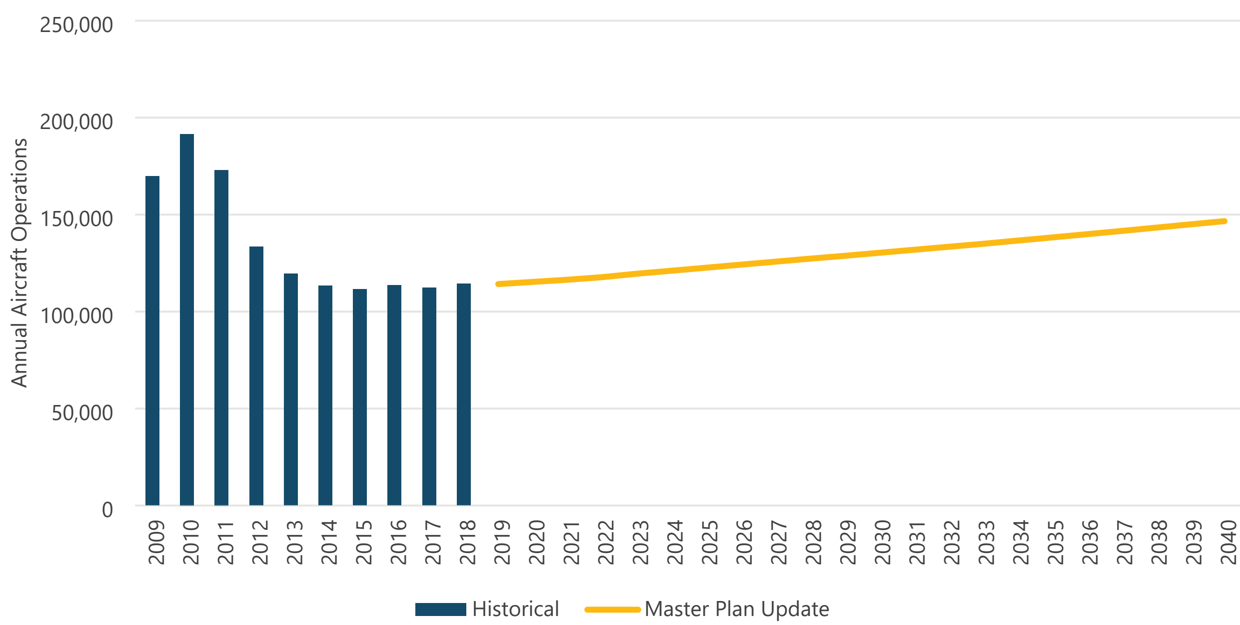
4.2.3.4 SUMMARY OF RUNWAY LENGTH FINDINGS

The 767-300F, 777F, and MD-11F have the capability to take off from Runway 1L-19R on a 1,000 NM flight on a hot day. However, the Critical Aircraft for cargo (MD-11F and 777F) are not capable of taking off at MTOW using the existing runways without taking range or payload penalties. In addition, several aircraft would not be able to operate on Runway 7R-25L, without taking range or payload penalties, if Runway 1L-19R is out of service for any period of time. Runway 7R-25L can accommodate all forecast landing aircraft, with the exception of the MD-11F, in dry or wet conditions at maximum landing weight. Several of the aircraft considered in this analysis are currently operated at the Airport. To continue operating nonstop flights without payload or range restrictions, additional runway length is necessary. If Runway 1L-19R should be taken out of service for rehabilitation or other reasons, it is reasonable to conclude that certain departures (depending on aircraft type and intended range) would be temporarily subject to reduced payloads, if limited to the available length of Runway 7R-25L.

4.3 AIRFIELD DEMAND/CAPACITY ANALYSIS

An airfield demand/capacity analysis was conducted to assess the capability of the MKE airfield facilities to accommodate forecast aircraft operations through the 2040 planning horizon for both the baseline forecast and the high scenario, depicted on **Exhibit 4-7**. Hourly runway capacity estimates were identified and compared to the peak hour activity detailed in the DDFSs derived from the forecast (baseline and high scenario), as presented in Section 3, Forecast of Aviation Activity, to determine if any airfield capacity enhancement measures may be required through the planning period.

EXHIBIT 4-7 HISTORICAL AND FORECAST AIRCRAFT OPERATIONS



SOURCES: Milwaukee Mitchell International Airport (historical); Ricondo & Associates, Inc. (forecast), May 2019.

Airfield capacity, also referred to as "throughput," is defined as the maximum number of aircraft operations that can be accommodated on an airfield during a specific period without incurring an unacceptable level of delay. Airfield capacity is affected by weather conditions, the types of aircraft operating on the airfield, the airfield configuration, and air traffic control (ATC) procedures. The number and location of runway exits, and the share of operations that are touch-and-go operations influence airfield capacity as well. Delays increase exponentially as the number of aircraft operations (i.e., demand) nears or exceeds the airfield capacity under a specific operating condition.

The following terms, as defined by the FAA, are used in describing the demand/capacity analysis:

- **Annual Service Volume (ASV).** As defined in AC 150/5060-5, *Airport Capacity and Delay (Change 2)*, ASV "is a reasonable estimate of an airport's annual capacity." An ASV estimate considers hourly, daily, and seasonal fluctuations in airfield demand, as well as the occurrence of low visibility and/or cloud ceiling heights which require modified ATC procedures to maintain aircraft operational safety.
- **Average Annual Delay per Operation.** This is an estimate of the average delay that each aircraft operation is expected to experience in a given year. Some aircraft operations, (e.g., during peak operating hours), would

likely experience higher delays, while other operations (e.g., nighttime operations), may experience little or no delay.

4.3.1 FACTORS AFFECTING AIRFIELD CAPACITY

The capacity of an airfield, including the runways and associated exit taxiways, is not constant. A number of factors that affect airfield capacity include:

- airfield layout
- percentage of time the airport experiences poor weather conditions (i.e., low cloud ceilings and/or low visibility)
- aircraft fleet mix (types of aircraft operating at the airport)
- frequency of touch-and-go operations
- airfield operating configuration (including runway use restrictions)
- existing airfield demand/capacity and delay relationships
- hourly airfield capacity (influences annual capacity)

4.3.1.1 AIRFIELD LAYOUT

The number and orientation of runways, the locations of runway intersections, and the lateral separation between parallel runways are primary factors affecting airfield capacity. The number and locations of runway exits, as well as the types of exits (high speed [oblique angle], 90 degree, etc.) also affect airfield capacity.

Aircraft operations on intersecting runways are typically considered “dependent” operations. Aircraft in-trail separation, or spacing, must be increased to allow adequate time for aircraft operations on intersecting runways to be conducted safely. There are several runway intersections at MKE, but these dependencies are minimized by use of various airfield operating (runway use) configurations that do not result in intersecting operations. For those airfield configurations with intersecting operations, the dependencies and resulting constraints on runway throughput were adequately accounted for in the demand/capacity analysis.

When an airfield configuration includes parallel runways, the lateral spacing between these runways also affects airfield capacity. The separation between the centerlines of Runways 7L-25R and 7R-25L at MKE is 3,681 feet. Parallel runways with a lateral centerline-to-centerline separation of 3,500 feet or more can operate as independent runways in all conditions. This separation allows aircraft to takeoff or land on each runway simultaneously.

Airfield capacity is also affected by the amount of time an aircraft occupies a runway. Runway occupancy time (ROT) for arriving aircraft is affected by the number, type, and location of runway exits, as well as aircraft performance. Typically, lighter aircraft require shorter runway distances to land and, therefore, have a lower ROT. However, if a runway exit is not available once the aircraft has decelerated to a speed that allows for safe maneuvering off the runway, airfield capacity is reduced because that aircraft must remain on the runway until it reaches an exit thereby increasing the ROT.

Obliquely angled exit taxiways, when properly located along a runway, are more effective at reducing ROTs than 90-degree exit taxiways. These angled exit taxiways are aligned at an oblique angle relative to the runway centerline, typically between 30 and 45 degrees. This configuration allows landing aircraft to exit at a higher speed and therefore more quickly than allowed by standard exit taxiways that are perpendicular to the runway, resulting in lower ROT and increased airfield capacity. MKE currently has a very limited number of obliquely angled exit taxiways.

4.3.1.2 WEATHER CONDITIONS

Airfield capacity can vary significantly based on the weather conditions at an airport. Prevailing winds (direction and speed) dictate which runways can be used for aircraft that are landing and taking off. Aircraft typically land and take off into the wind and can accommodate a limited amount of crosswind and tailwind. If the maximum crosswind or tailwind for a runway is exceeded, the aircraft may not operate safely on that runway. Therefore, wind conditions may prevent the use of a higher-capacity runway operating configuration, thereby increasing aircraft delay.

Other meteorological conditions affecting airfield capacity include cloud ceiling height and visibility. Low cloud ceilings and poor visibility require increased spacing between aircraft in the surrounding airspace. These conditions may also restrict the use of certain runways by requiring arriving flights to use instrument landing systems. Visual flight rules govern the procedures used to conduct aircraft operations in visual meteorological conditions (VMC), while instrument flight rules govern the procedures used to conduct aircraft operations in instrument meteorological conditions (IMC). The criteria for VMC and IMC operating conditions are summarized in **Table 4-9**.

TABLE 4-9 OPERATING CONDITIONS FOR AIRFIELD CAPACITY AND AIRCRAFT DELAY ANALYSIS

CLASSIFICATION	WEATHER CONDITIONS		
	VISIBILITY		CLOUD CEILING
Visual Meteorological Conditions	Greater than or equal to 3 statute miles	and	Greater than or equal to 1,000 feet above ground level
Instrument Meteorological Conditions	Less than 3 statute miles	and/or	Less than 1,000 feet above ground level

SOURCE: Federal Aviation Administration Advisory Circular 150/5060-5 Change 2, *Airport Capacity and Delay*, December 1995.

4.3.1.3 AIRCRAFT FLEET MIX

The aircraft fleet mix operating at an airport is an important factor in determining airfield capacity. As the diversity of approach speeds and aircraft weights increases, airfield capacity decreases, because of the increased in-trail separation required to avoid wake vortices or wake turbulence. Although more prevalent during departures than arrivals, wake vortices are considered a significant safety hazard during any airborne operation. Heavier aircraft produce more severe wake vortices than lighter aircraft.

To alleviate the risk of wake vortices to the in-trail (following) aircraft, aircraft are spaced according to the difference in their airspeeds and weights. Because light aircraft are more susceptible to the impacts of wake vortices than heavy aircraft, they are typically required to wait up to two minutes before operating on a runway when trailing a heavy aircraft, reducing airfield capacity. The greater the size and weight differential of the aircraft fleet using a specific runway, the greater the separation required between successive aircraft operations on that runway.

AC 150/5060-5, Airport Capacity and Delay (Change 2) uses a “Mix Index” to account for aircraft fleet composition. The Mix Index is represented as a percentage, reflecting the share of large aircraft in the fleet mix. To establish the Mix Index, aircraft are assigned to one of five categories based on the MTOW. Based on the number of operations in each classification, a percentage is established to quantify the share of total aircraft operations at an airport by aircraft type that result in wake turbulence hazards. **Table 4-10** summarizes the aircraft classifications based on maximum certificated takeoff weight of the aircraft in the fleet mix.

TABLE 4-10 AIRCRAFT CLASSIFICATIONS FOR ESTABLISHING AIRCRAFT MIX INDEX

AIRCRAFT CLASSIFICATION	MTOW (POUNDS)	REPRESENTATIVE AIRCRAFT
Small	12,500 or less	Piper P23, Cessna C-180, Cessna C-207, and King Air
Small+	12,501 to 41,000	Learjet 25, Cessna Citation, and Grumman G-1
Large	41,001 to 225,000	Gulfstream IV, Fokker F-28, Bombardier Dash 8, Boeing 737, and Boeing 727
B757[9]	225,001 to 300,000	Boeing 757-200/300
Heavy	300,001 or more	Boeing 767, DC-10, Airbus A380, Boeing 747-8

NOTE: The Boeing 757 does not fall into either the Large and Heavy category and has been identified as separate standalone category from a weight and wake turbulence perspective.

SOURCE: Federal Aviation Administration Advisory Circular 150/5060-5 Change 2, *Airport Capacity and Delay*, December 1995.

4.3.1.4 TOUCH-AND-GO OPERATIONS

Touch-and-go operations are defined as operations by a single aircraft that lands and departs without stopping or exiting the runway. Pilots conducting touch-and-go operations are usually conducting training exercises and, therefore, stay in the airport traffic pattern. Airfield capacity increases as the percentage of touch-and-go operations increases because aircraft land and take off without incurring significant ROT. A touch-and-go operation is counted as two operations: one arrival and one departure. However, continuous touch-and-go operations reduce the availability of the runway for other non-training operations and may impede aircraft operations on adjacent or intersecting runways. Although touch-and-go operations occur at MKE, it was assumed that there would be no touch-and-go operations during the peak hour.

4.3.1.5 AIRFIELD OPERATING CONFIGURATION

As discussed, an airfield layout can accommodate numerous operating configurations. Weather is a primary factor in dictating which operating configuration is used, but other factors influencing the airfield configuration include the lengths of available departure and arrival runways, the proximity of obstructions (structures and terrain), the proximity of other airports, and airspace constraints and interactions.

Aircraft performance characteristics may restrict aircraft operations on a runway, as described above. For departures, the runway length must equal or exceed the minimum specified runway length for each departing aircraft. These requirements include the runway length needed for the takeoff ground roll, the length needed to clear an obstruction of a specified height—typically 35 feet above ground level—and the aircraft's accelerate-stop distance. If the available runway length is insufficient to accommodate an aircraft, that aircraft must either depart from another runway that provides adequate departure length, or the aircraft's payload must be reduced. Similarly, the landing distance available on the runway must exceed the landing distance requirements prescribed for the aircraft. Otherwise, the aircraft will be required to land on a longer runway.

Aircraft departures may also be restricted by the presence of obstacles on and around the airfield. These restrictions are based on the climb performance of the aircraft and the location of obstacles relative to the departure route of the aircraft. Potential obstructions to aircraft during takeoff and the initial departure climb are of particular importance. Aircraft operations conducted under Title 14 Code of Federal Regulations (CFR) Part 121, *Operating*

Requirements: Domestic, Flag, and Supplemental Operations, or 14 CFR Part 135, *Operating Requirements: Commuter and On-Demand Operations and Rules Governing Persons on Board Such Aircraft,* must adhere to an airport obstacle analysis prior to departure. If an obstacle is identified that would not allow the departing aircraft to meet the FAA's minimum obstacle clearance requirements, the departure will not be permitted. As such, the presence of these obstacles would restrict the use of the runway, limiting the airfield's available operating configurations.

Runway use may also be predicated on regional ATCT procedures at nearby airports. The presence of neighboring airports often requires the shared use of navigational facilities and approach/departure fixes. This requires strict coordination between ATCT facilities, potentially restricting the capacity of the overall regional airspace system. In some instances, specific operating configurations at one airport may take precedence over operations at the other airport, which could restrict the use of certain operating configurations at the airport that has lower priority.

There are no obstacle constraints or proximity constraints associated with other airports that influence airfield operating configurations at MKE.

4.3.2 AIRFIELD DEMAND/CAPACITY

The estimated capacity of the existing airfield is presented in terms of hourly capacity and ASV for 2018 (existing) and for specific intermediate horizons through the 2040 planning horizon, under the baseline forecast and high scenario.

For each runway use configuration, hourly capacities were established for operations during both VMC and IMC. Historical weather and runway use data, obtained from the FAA, were used to determine how often each configuration has been used. A weighted hourly capacity was then established, based on the occurrence rate of each runway use configuration/weather condition and the respective hourly capacity. The weighted hourly capacity formed the basis of the airfield's ASV calculation.

ASV represents the estimated annual number of aircraft operations an airport can efficiently accommodate taking hourly, daily, and monthly operational patterns into consideration. The formula for calculating ASV contains three variables: CW (weighted hourly capacity), D (the ratio of annual demand to average daily demand in the peak month), and H (the ratio of average daily demand to average peak hour demand during the peak month). These variables are multiplied (CW x D x H) to obtain the ASV for the Airport.

4.3.2.1 METHODOLOGY

When hourly demand approaches hourly capacity, aircraft delays grow at an increasing rate. These delays consist of extended arrival traffic patterns and departure queue delays during VMC or holding patterns and flow control delays during IMC. Because aircraft delays are most prevalent during peak demand periods, the demand/capacity analysis compares hourly airport throughput to peak hour demand. Peak hour demand that equals or exceeds hourly capacity is likely to result in delays during the peak demand period. The rate at which an airfield can "recover" from peak period delays depends on the operational demand profile throughout the day.

Hourly runway capacity estimates were developed using runwaySimulator, which recently replaced the FAA's Airfield Capacity Model. Outputs from runwaySimulator represent the most efficient airfield possible and, as such, the highest potential hourly capacities for specific airfield configurations. These configurations do not, however, necessarily represent current airfield operations.

The runwaySimulator system is a Monte Carlo simulation designed to estimate an hourly throughput capacity, not aircraft delay, of a runway system. The simulation incorporates a number of inputs that includes, but is not limited to, the following:

- **Airfield Configuration.** Runway geometry data (e.g., locations, dimensions, exits, fixes, etc.) imported from the FAA's AVNIS database or created manually.
- **Arrival and Departure Procedures.** Dependent upon the airfield configuration, establishing a template for flight movements based on arrival and departure procedure assignments.
- **Aircraft Fleet Mix.** Makeup of aircraft demand (derived from the baseline forecast and high scenario) generated for the capacity mode scenarios.
- **Procedure Eligibility.** Assigns specific aircraft types to individual runways via defined arrival and departure procedures.
- **Separation Rules.** Dictates the timing of operations in the simulation, as constrained by FAA rules and regulations.

To calculate the hourly throughput capacity, runwaySimulator assumes a saturated-conditions schedule, represented by a continuous arrival and departure stream in proportion to the input aircraft fleet mix. Under the continuous arrival and departure stream, aircraft are always waiting to land and take off (i.e., a continuous demand for service with no slack periods). These hourly capacity estimates only account for the airspace constraints that impact the final approach spacing to the runways, dependent runway operations, and the taxiways that serve as runway exits. The estimates do not account for any other airspace or ground constraints. Further, runwaySimulator does not provide an estimate of average aircraft delay.

The resulting hourly capacity estimates were then compared to the aircraft operations peak hour in the baseline forecast and high scenario (see Section 3, Forecast of Aviation Activity) to determine if the projected peak hour demand at any of the interim planning horizons (2018, 2023, 2028, or 2040) would exceed the estimated existing hourly airfield capacity, which would trigger the need to consider measures that would increase airfield capacity.

4.3.2.2 AIRFIELD OPERATING CONFIGURATIONS AND PROCEDURES

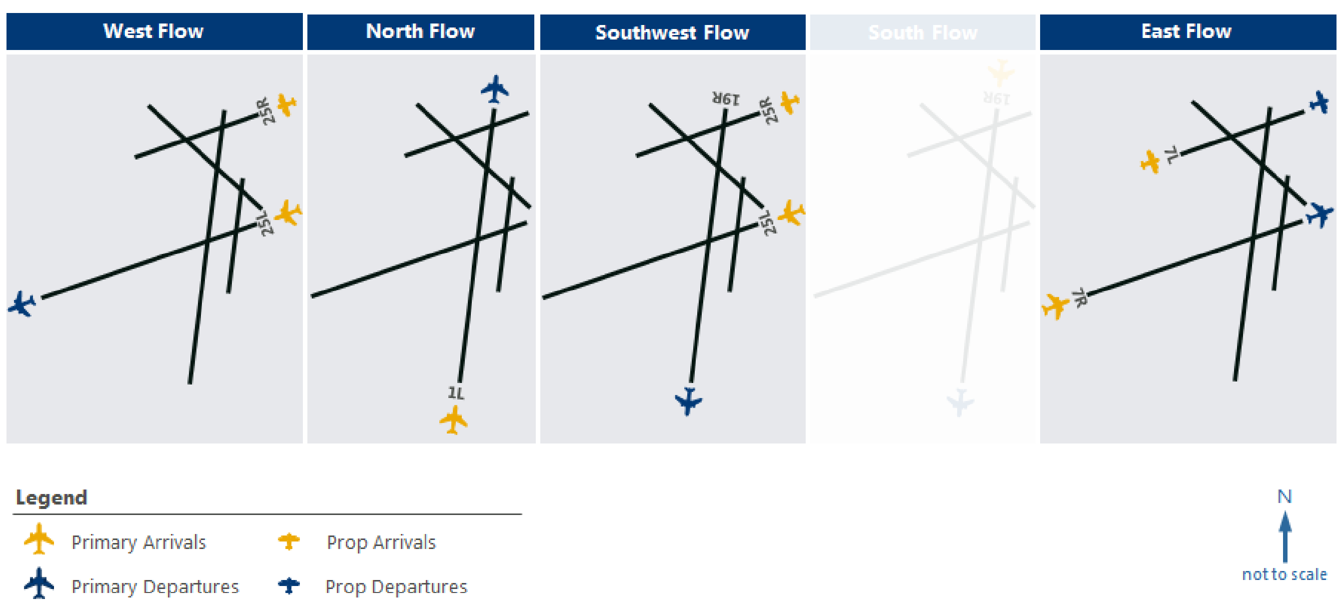
To estimate MKE's existing hourly airfield capacity, various airfield operating configurations were considered. These configurations included South, North, East, West, and Southwest Flows in both VMC and IMC, as presented in **Table 4-11** and depicted on **Exhibit 4-8**. These configurations were considered the most predominant based on input received from ATC. The configurations were simulated to determine the hourly capacities for each.

TABLE 4-11 MODELED AIRFIELD OPERATING CONFIGURATIONS

VISUAL METEOROLOGICAL CONDITIONS	INSTRUMENT METEOROLOGICAL CONDITIONS
SOUTH FLOW	SOUTH FLOW
A 19R, D 19R	A 19R, D 19R
NORTH FLOW	NORTH FLOW
A 1L, D 1L	A 1L, D 1L
EAST FLOW	EAST FLOW
A 7L/7R, D 7L/7R	A 7L/7R, D 7L/7R
WEST FLOW	WEST FLOW
A 25L/25R, D 25L	A 25L/25R, D 25L
SOUTHWEST FLOW	SOUTHWEST FLOW
A 25L/25R, D 19R	A 25L/25R, D 19R

NOTES:
1 A = Arrival, D = Departure
2 Configurations chosen for simulation were intended to represent the most efficient operation of the runways for the identified operational flows.
SOURCE: Ricondo & Associates, Inc., February 2019.

EXHIBIT 4-8 MODELED AIRFIELD OPERATING CONFIGURATIONS



NOTE:
1 The North and South Flow configurations are identical in terms of hourly capacity, therefore only the North Flow configuration was modeled for the purposes of this analysis.
SOURCES: Federal Aviation Administration, Aviation System Performance Metrics, Airport Efficiency, Daily Weather by Hour Report, January 2008 through December 31, 2017; Ricondo & Associates., December 2018.

4.3.2.3 AIRCRAFT FLEET MIX ASSUMPTIONS

The VMC and IMC aircraft fleet mixes were derived from the DDFS forecast. The runwaySimulator model provides a finite number of available aircraft types that generally correspond with the "Mix Index" aircraft classifications set forth in AC 150/5060-5. To establish a useable fleet mix for the simulation, the DDFS aircraft types were categorized in alignment with the runwaySimulator aircraft classifications where applicable. **Table 4-12** presents the runwaySimulator DDFS aircraft mappings for the baseline forecast and high scenario.

TABLE 4-12 RUNWAYSIMULATOR AIRCRAFT FLEET MIX MAPPING

RUNWAYSIMULATOR AIRCRAFT CLASSIFICATION [3]	DDFS AIRCRAFT TYPES
Airbus 380 (A388)	N/A
Boeing 777 (B772)	Boeing 777, Boeing 787
Boeing 767 (B763)	Boeing 767, McDonnell Douglas MD-11, McDonnell Douglas DC-10, Airbus A300
Boeing 757 (B752)	Boeing 757
Boeing 737 (B737)	MD-80, MD-90, Airbus A319, Airbus A321, Airbus A320, Boeing 737, Boeing 717
Dash 8-400 (DH8D)	N/A
CRJ-200 (CRJ2)	Bombardier CRJ-200, CRJ-700, CRJ-900, Embraer ERJ 145, ERJ 175
Dash 8-100 (DH8A)	N/A
Embraer 120 (E120)	N/A
Cessna Citation V (C560)	Cessna Citation V, Cessna Citation Sovereign, Gulfstream IV, Learjet 40, Learjet 45, Learjet 60, Dassault Falcon 900
Cessna Citation II (C550)	N/A
Piper Navajo PA-31 (PA31)	Cessna 310
Beech Super King Air 200 (BE20)	Beech Super King Air 350
Beech King Air 90 (BE9L)	Beech Model 99
Piper Cherokee (P28A)	Piper Cherokee, Pilatus PC-12
Cessna Caravan (C208)	Cessna 172, Cessna 208,
Antonov AN-124 (A124)	N/A
Boeing C-135 Stratolifter (C135)	Lockheed C-130 Hercules, Boeing KC-135

NOTES:
DDFS – Design Day Flight Schedule
DDFS aircraft types reflect both the baseline forecast and the high scenario projected aircraft fleet.
SOURCES: MITRE, runwaySimulator v1.3.0, February 2019; Ricondo & Associates, Inc., May 2019.

3 runwaySimulator only includes aircraft types with distinguishing characteristics that differentiate their impact on runway throughput/capacity (e.g., wake turbulence category). All aircraft types in the forecast fleet mixes (baseline and high scenario) are "reduced" and "mapped" to align with these aircraft types in runwaySimulator so that the capacity analysis accurately reflects the impact of the fleet mix.

Using the mappings presented in Table 4-12, VMC and IMC peak hour fleet mixes were developed for operational configurations under the baseline forecast and high scenario. The 2018 (existing) and forecast peak hours for arrivals and departures are shown in **Table 4-13**.

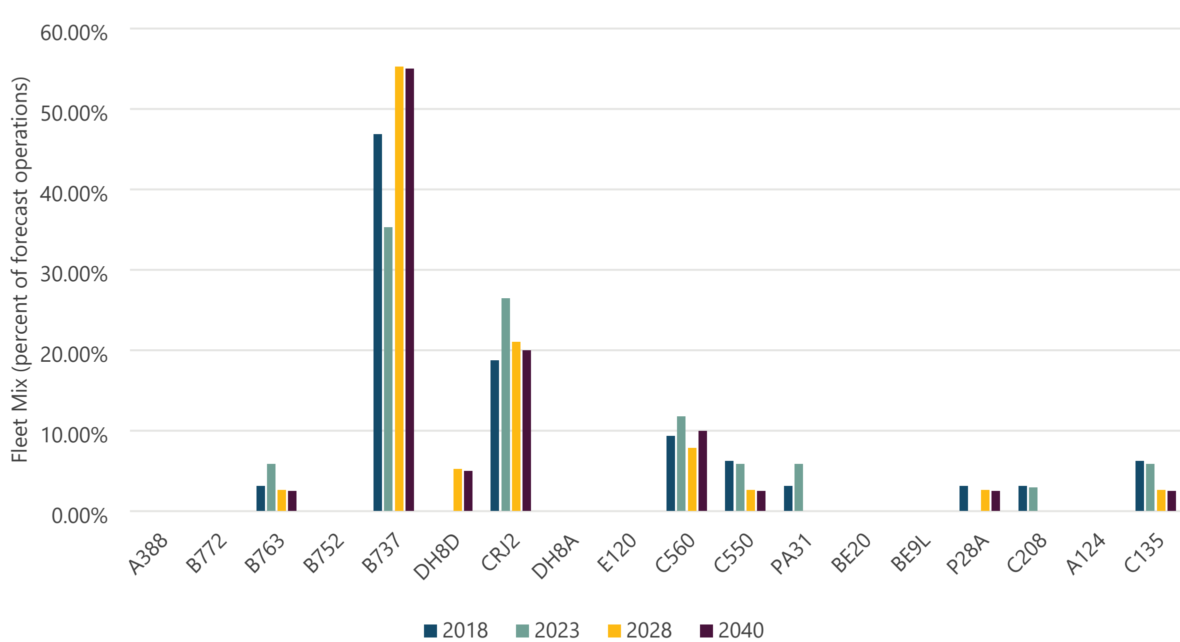
TABLE 4-13 FORECAST PEAK HOUR BY TYPE OF OPERATION

YEAR	FORECAST	ARRIVALS	TIME	DEPARTURES	TIME	TOTAL	TIME
2018	Baseline	20	16:50 – 17:49	24	6:40 – 7:39	33	16:50 – 17:49
2023	Baseline	21	16:50 – 17:49	26	6:40 – 7:39	35	15:40 – 16:39
	High Scenario	23	16:50 – 17:49	26	6:40 – 7:39 7:00 – 7:59	37	16:50 – 17:49
2028	Baseline	25	16:50 – 17:49	26	6:40 – 7:39 7:00 – 7:59	38	16:50 – 17:49
	High Scenario	24	16:50 – 17:49	28	7:00 – 7:59	39	16:50 – 17:49
2040	Baseline	26	16:50 – 17:49	29	6:40 – 7:39 7:00 – 7:59	40	16:50 – 17:49
	High Scenario	27	16:50 – 17:49	33	6:40 – 7:39	44	15:20 – 16:19 17:40 – 18:39

SOURCE: Ricondo & Associates, Inc., MKE Design Day Flight Schedules, May 2019.

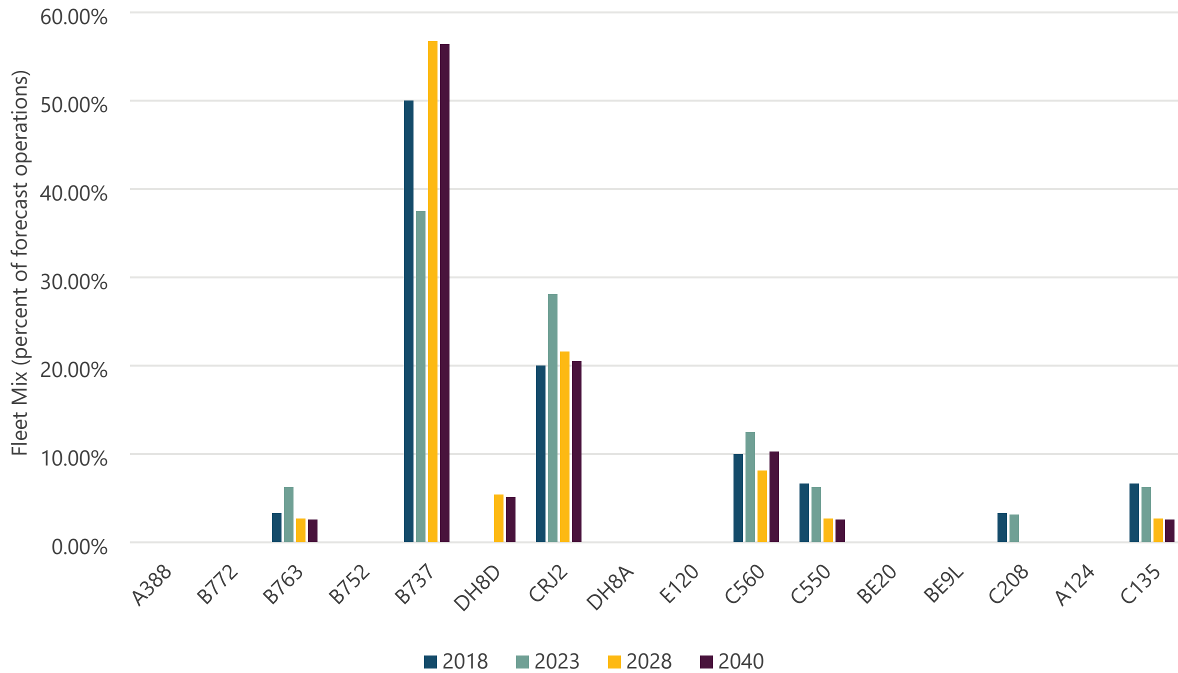
The modeled VMC and IMC peak hour fleet mixes for total operations are presented on **Exhibits 4-9** through **4-12**, for the baseline and high scenario forecasts. As shown in these exhibits, the fleet mixes are very similar under both the baseline forecast and high scenario; both forecasts show an increase in narrowbody aircraft, and a decrease in regional, and GA aircraft through 2040.

EXHIBIT 4-9 MODELED VMC TOTAL OPERATIONAL PEAK HOUR FLEET MIX – BASELINE FORECAST



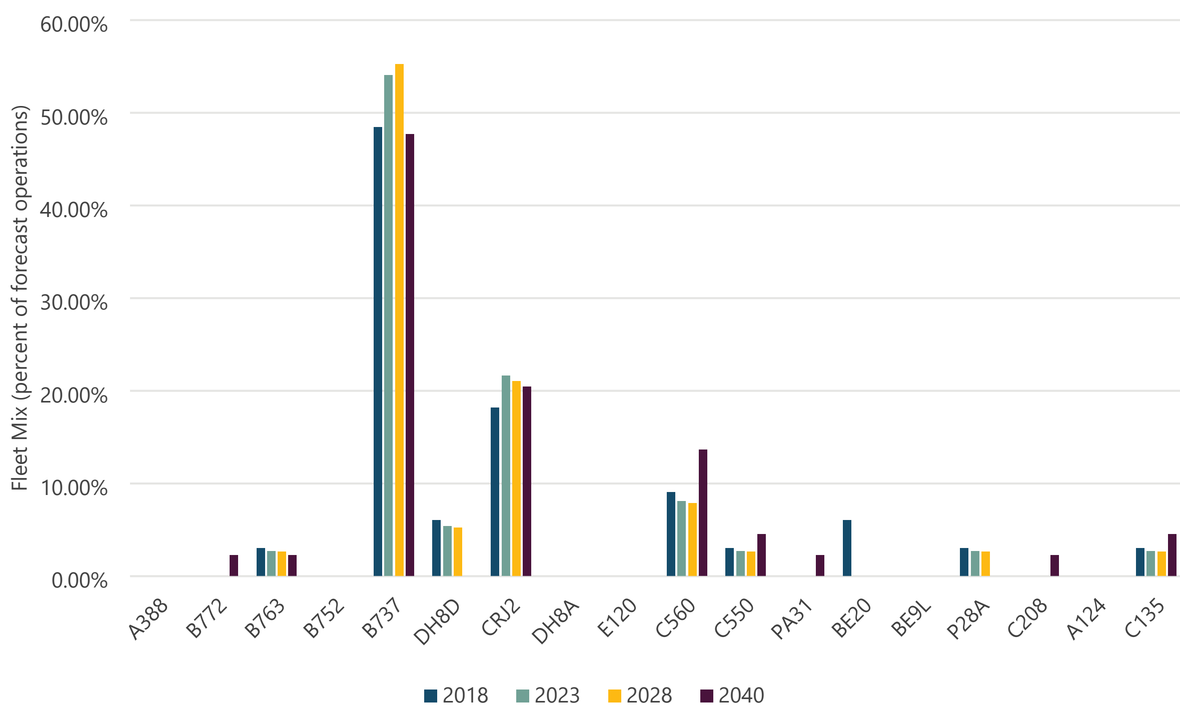
SOURCE: Ricondo & Associates, Inc., MKE Master Plan Design Day Flight Schedules, May 2019.

EXHIBIT 4-10 MODELED IMC TOTAL OPERATIONAL PEAK HOUR FLEET MIX – BASELINE FORECAST



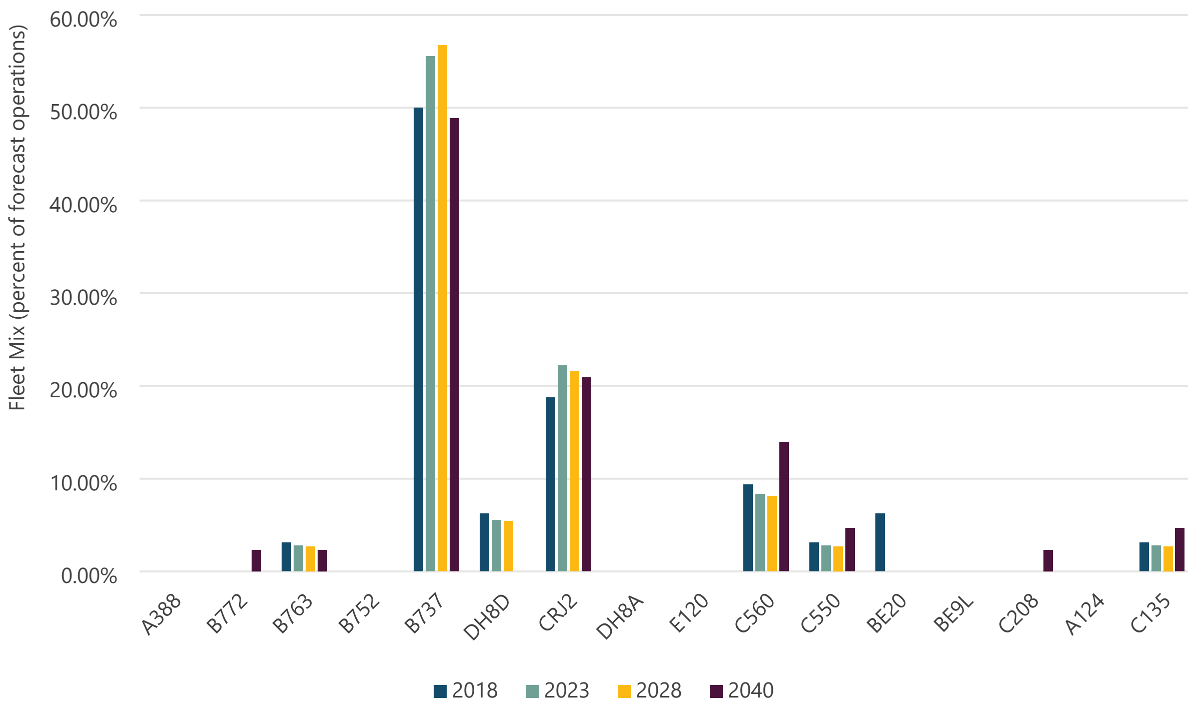
SOURCE: Ricondo & Associates, Inc., MKE Master Plan Design Day Flight Schedules, May 2019.

EXHIBIT 4-11 MODELED VMC TOTAL OPERATIONAL PEAK HOUR FLEET MIX – HIGH SCENARIO



SOURCE: Ricondo & Associates, Inc., MKE Master Plan Design Day Flight Schedules, May 2019.

EXHIBIT 4-12 MODELED IMC TOTAL OPERATIONAL PEAK HOUR FLEET MIX – HIGH SCENARIO



SOURCE: Ricondo & Associates, Inc., MKE Master Plan Design Day Flight Schedules, May 2019.

4.3.2.4 HOURLY CAPACITY ESTIMATES

Peak hour activity for each of the airfield operating configurations previously identified in Table 4-11 (North, West, Southwest, South, and East Flows) was modeled, using runwaySimulator, for the 2018, 2023, 2028, and 2040 horizons, encompassing the peak hour total aircraft operations, peak hour aircraft arrivals, and peak hour aircraft departures. This was done for the baseline forecast and the high scenario.

Table 4-14 summarizes the hourly airfield capacity estimates for VMC and IMC for the operating configurations, with the highest hourly capacity in each flow under both the baseline forecast and high scenario. It should be noted that the demand/capacity analysis focused on hourly capacity estimates that assumed a mix of 50 percent arrivals and 50 percent departures.

As shown in Table 4-14, the hourly airfield capacities remain relatively constant through the 2040 forecast scenarios with only slight differences between the 2018 and 2040 forecast scenarios. Both the 2040 baseline forecast and high scenario hourly capacities are slightly lower than the 2018 hourly capacities. This reduction in hourly capacity is related to an evolution in fleet mix where regional jets are replaced with larger narrowbody aircraft such as the Boeing 737. Other factors include continued growth in air cargo aircraft operations and operations of larger cargo aircraft, such as the Boeing 777.

TABLE 4-14 ESTIMATED HOURLY CAPACITIES OF EXISTING AIRFIELD CONFIGURATIONS - SUMMARY

WEATHER	FLOW	OCCURRENCE	2018	2023		2028		2040	
				BASELINE	HIGH	BASELINE	HIGH	BASELINE	HIGH
VMC	West	21.1%	71	70	68	68	68	68	68
	North	19.6%	67	67	66	67	67	66	67
	Southwest	16.2%	74	73	72	72	72	71	71
	South [1]	13.5%	67	67	66	67	67	66	67
	East	11.2%	74	73	68	68	68	68	70
IMC	North	6.2%	54	54	54	55	55	54	54
	South [1]	4.4%	54	54	54	55	55	54	54
	East	3.4%	55	55	54	55	55	54	55
	West	2.4%	55	55	54	55	55	53	54
	Southwest	2.0%	47	47	46	47	47	47	47
	Total	**100.0%**	**67**	**67**	**65**	**66**	**66**	**65**	**66**

NOTES:
VMC – Visual Meteorological Conditions
IMC – Instrument Meteorological Conditions
1 South Flow was not modeled, but both the North and South Flows are single-runway configurations that would have the same hourly capacity.
SOURCE: MITRE, runwaySimulator v1.3.0, February 2019; Ricondo & Associates, Inc., May 2019.

4.3.2.5 HOURLY DEMAND/CAPACITY COMPARISONS

As discussed in Section 3, Forecast of Aviation Activity, the peak hour demands for the 2040 baseline forecast and high scenario range from 40 to 43 total operations per hour. This 2040 peak demand is well below the projected 2040 airfield capacity estimates that range between 66 and 70 aircraft operations per hour as shown in Table 4-14.

4.3.2.6 ANNUAL SERVICE VOLUME

The peak hour airfield capacity estimates provide the basis for establishing the ASV of the existing airfield, which can then be compared with the annual aircraft operational demand forecast for 2040. As annual demand approaches and exceeds the airfield ASV, aircraft delays increase exponentially. To minimize these delays, the FAA recommends that planning for additional airfield capacity should begin when the airfield's annual demand reaches 60 percent to 75 percent of its ASV. **Table 4-15** compares the airfield's ASV to operational demand for 2018, as well as the interim forecast horizons for both the baseline forecast and the high scenario over the 2040 planning horizon. The table presents estimated peak hour demand under both VMC and IMC and shows annual demand for total aircraft operations as a percentage of the ASV.

TABLE 4-15 COMPARISON OF CAPACITY/DEMAND AND ANNUAL SERVICE VOLUME

CAPACITY/DEMAND METRIC	EXISTING 2018	2023 BASELINE FORECAST	2023 HIGH SCENARIO	2028 BASELINE FORECAST	2028 HIGH SCENARIO	2040 BASELINE FORECAST	2040 HIGH SCENARIO
ANNUAL SERVICE VOLUME (annual operations)	200,000	200,000	199,000	192,000	214,000	207,000	227,000
ANNUAL DEMAND							
Aircraft Operations	111,700	119,500	130,000	127,300	142,200	146,600	175,900
Percent of Annual Service Volume	56%	60%	65%	66%	66%	71%	77%

NOTE: Annual service volume and aircraft operations rounded to the nearest thousand.
SOURCES: Federal Aviation Administration Advisory Circular 150/5060-5 Change 2, *Airport Capacity and Delay*, December 1995; Ricondo & Associates, Inc., May 2019.

As shown, the annual demand in 2018 was approximately 56 percent of the ASV, indicating that the existing MKE airfield provides adequate capacity for the base year. For the 2040 baseline and high forecasts, the annual demand is not anticipated to exceed capacity, although annual demand is forecast to reach and potentially exceed 60 percent of the projected ASV by 2023.

4.3.2.7 AIRFIELD DEMAND/CAPACITY CONCLUSIONS

The airfield demand/capacity analysis determined that the existing runway layout is adequate to accommodate existing (2018) and future (2040) operational demand at the Airport under the baseline forecast and high scenario. Accordingly, there is no need for additional airfield capacity throughout the planning horizon. However, planning for additional airfield capacity will be necessary within the 2040 planning horizon, as annual demand approaches 60 to 75 percent of the calculated ASV.

4.3.3 AIRSPACE CAPACITY

The airspace does not currently constrain traffic to or from MKE, nor is it expected that the airspace will impose a constraint on Airport traffic through the planning horizon.

4.4 AIRCRAFT GATE REQUIREMENTS

Aircraft gate requirements were analyzed based on the gate assignments and gate capabilities (size and configuration that determines the range of aircraft that can utilize a particular gate) that were documented during a separate gate utilization study then underway[4]. In the analysis of gate requirements, existing Concourse E gates were not analyzed given that this concourse has been taken out of service in anticipation of its pending redevelopment.

4.4.1 AIRCRAFT GATE REQUIREMENTS

A gating analysis was conducted to determine the number of gates and remote aircraft parking positions needed to accommodate future passenger aircraft operations over the 2040 planning horizon, including at interim horizons 2023 and 2028. Gate capability for planning purposes is typically defined by the maximum allowable wingspan of

[4] Mead & Hunt, May 2019.

aircraft that can be accommodated at a particular gate, considering both the final parked position and gate entry/exit maneuvering, identified by either ADG or a specific aircraft model. Initial conclusions in the emerging 2019 gate utilization study determined all gates on Concourses C and D to be ADG III-capable (e.g., accommodating aircraft with wingspans up to 117 feet such as Boeing 737-900W[5] or the Airbus A321 aircraft). Gate D35 is the only single ADG V-capable gate at the Airport and can accommodate an aircraft with a wingspan up to 212 feet (e.g., Boeing 777-300ER). A Multiple Apron Ramp System (MARS) gate allows for a widebody aircraft to be serviced between Gates D48 and D49 (noted as Gate D48W) and requires the closure of D48 and D49 when in use.

Two apron-loading gates (D27A and D27B) are located on Concourse D. These positions, which have been operated intermittently as airline fleets dictated, most recently accommodated small ADG II aircraft (wingspan less than 49 feet) operated by OneJet Airlines which ceased operations at MKE in 2018. These two apron-loaded positions were not utilized as part of the master plan gating analysis due to an absence of fleet in the DDFS that can efficiently utilize them and consequently, remain vacant as a part of this analysis. Gate D52A and Gate D52B provide two aircraft parking positions served by a single passenger boarding bridge. In the gating analysis, these gate positions were considered as a single ADG III-capable gate to ensure passenger boarding bridge loading and unloading of the aircraft (i.e., simultaneous occupancy of these positions would require the ground-loading/unloading of one).

Although international aircraft currently arrive to the International Arrivals Building (IAB), Milwaukee County has committed to the redevelopment of Concourse E to include international passenger processing facilities. Consequently, it was assumed that the IAB would be closed prior to 2023 (the initial interim planning horizon) and international arriving passengers would be processed through the redeveloped Concourse E. **Table 4-16** summarizes the gate-specific aircraft capability used in the gating analysis, based on survey information gathered to support the gate utilization study. **Exhibit 4-13** illustrates the airline gate allocations (assignments)[6] and the corresponding aircraft arrangement.

[5] "W" indicates aircraft with blended winglets (e.g., Boeing 757-300W.)

[6] Current as of January 2019.

TABLE 4-16 EXISTING GATE INVENTORY

GATE	LARGEST AIRCRAFT (WINGSPAN - FT)	AIRLINES[3]	TYPE[1]	GATE	LARGEST AIRCRAFT (WINGSPAN - FT)	AIRLINES[3]	TYPE
	Concourse C				Concourse D		
C09	ADG III (117.9)	UA, UA-C5, UA-EV, UA-OO, UA-YX, UA-ZW	1	D30	ADG III (117.9)	CHT	1
C10	ADG III (117.9)	AC, AC-ZX	1	D35	ADG V (213.9)	CHT	1
C11	ADG III (117.9)	UA, UA-C5, UA-EV, UA-OO, UA-YX, UA-ZW	1	D36	ADG III (117.9)	CHT, F9	1
C12	ADG III (117.9)	CHT	1	D39	ADG III (117.9)	CHT	1
C14	ADG III (117.9)	WN	1	D42	ADG III (117.9)	CHT	1
C18	ADG III (117.9)	WN	1	D43	ADG III (117.9)	F9	1
C19	ADG III (117.9)	WN	1	D44	ADG III (117.9)	DL, DL-9E, DL-OO, DL-YX	1
C20	ADG III (117.9)	WN	1	D45	ADG III (117.9)	DL, DL-9E, DL-OO, DL-YX	1
C21	ADG III (117.9)	WN	1	D46	ADG III (117.9)	DL, DL-9E, DL-OO, DL-YX	1
C22	ADG III (117.9)	WN	1	D47	ADG III (117.9)	DL, DL-9E, DL-OO, DL-YX	1
C23	ADG III (117.9)	WN	1	D48	ADG III (117.9)	DL, DL-9E, DL-OO, DL-YX	1
C24	ADG III (117.9)	WN	1	D49	ADG III (117.9)	DL, DL-9E, DL-OO, DL-YX	1
C25	ADG III (117.9)	CHT	1	D51	ADG III (117.9)	AS	1
C15	ADG III (117.9)	UA, UA-C5, UA-EV, UA-OO, UA-YX, UA-ZW	1	D52	ADG III (117.9)	AA, AA-OH, AA-PT, AA-YX, AA-OO	1
	Concourse E[3]			D53	ADG III (117.9)	CHT	1
N-E01	ADG III (117.9)	International Arrivals	2	D54	ADG III (117.9)	G4	1
N-E02	ADG III (117.9)	International Arrivals	2	D55	ADG III (117.9)	AA, AA-OH, AA-PT, AA-YX, AA-OO	1
N-E03	ADG III (117.9)	International Arrivals	2	D56	ADG III (117.9)	AA, AA-OH, AA-PT, AA-YX, AA-OO	1

NOTES:

1 Gate Types:
- Type 1 allows for domestic arrivals and domestic or international departures (no international arrivals).
- Type 2 allow for international or domestic arrivals and international or domestic departures.

2 Airlines with a hyphen are regional airline operators that provide service for mainline operators.

3 Redeveloped Concourse E assumed to provide 3 passenger boarding bridge-equipped gates prior to PAL 1 (2023). "N" designates new/redeveloped gate on Concourse E.

4 CHT - Charter operator. These aircraft are accommodated on Milwaukee County-owned gates that are not preferential to any specific airline.

SOURCE: Ricondo & Associates, Inc., June 2019.

EXHIBIT 4-13 EXISTING GATE LAYOUT AND AIRLINE ALLOCATIONS

SOURCE: Mead & Hunt, January 2019 (gate assignments); Milwaukee Mitchell International Airport, January 2019 (gate assignments); Ricondo & Associates, Inc., June 2019.

Methodology and Assumptions

vGates is a proprietary gate-scheduling software developed by Ricondo. This software was used to explore and establish aircraft gate requirements based on appropriate configurations and operational characteristics. A vGates model of the Airport was developed to support the analysis of gate requirements by assigning flights in each interim horizon DDFS (2023, 2028, and 2040) to gates based on the following criteria.

- Gate Characteristics
  - maximum aircraft size (maintaining 25 feet of clearance between adjacent parked aircraft wingtips)
  - airline gate assignments

  - time required between flights ("intergate" time)
  - type of flights accommodated (domestic or international)
- Aircraft Characteristics
  - aircraft size/model
  - airline and/or aircraft operator
  - international arrival status

The vGates software utilizes a hierarchal decision tree methodology to assign gates iteratively by (1) time available based on scheduled flight arrival and departure times and intergate requirements, (2) airline assignment, (3) aircraft size, and (4) flight type (typically domestic or international). The program processes a schedule and attempts to assign all flights to a gate. Flights that the software is unable to assign to a gate are identified as unassigned. After the initial software-automated gating, subsequent manual iterations are completed to reassign flights to optimize (increase or decrease) gate utilization.

Specific assumptions were incorporated into the vGates program to reflect the unique physical and operational environment at the Airport. To optimize gate utilization, manually adjusted flights were first assigned to a gate of similar wingspan (e.g., a Boeing 737-700 is assigned first to an ADG III gate rather than a gate that has the capability to accommodate larger aircraft). An aircraft was assigned to a gate that can accommodate larger aircraft only after all of the largest aircraft that could be accommodated at the gate were gated. For example, an ADG II aircraft would be assigned to an ADG III-sized gate if all ADG III aircraft remaining in the schedule have been assigned gates.

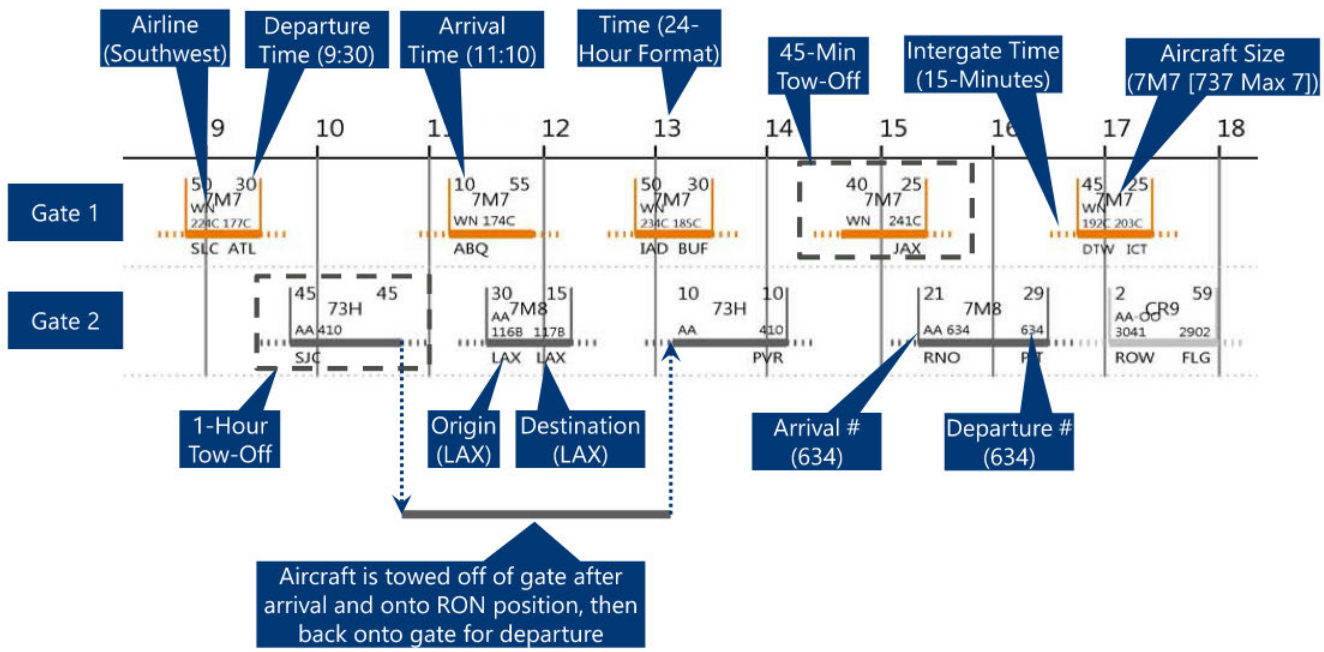
Three Airport-specific gating scenarios were defined to establish a range of future gate requirements for each interim horizon DDFS. Each gating scenario adjusts operational metrics outlined below but do not alter the baseline forecast or high scenario DDFSs.

- **Tow Time (minimum gate occupancy):** When warranted, aircraft parked at a gate for an extended period could be towed to a remote parking position allowing other arriving or departing aircraft to use that gate. In these instances, the aircraft would be towed to the remote position after a period of time established to deplane passengers, remove baggage, and similarly towed from the remote parking position back to a gate prior to departure. Tow operations also include aircraft that arrive to the redeveloped Concourse E international facility and are towed to an airline's domestic concourse gates (e.g., Delta Air Lines, Southwest Airlines, and Frontier Airlines). Foreign flag carriers and international charter operators that do not have a domestic gate (e.g., Volaris) would remain at Concourse E for subsequent departure.
- **Intergate Time:** The amount of time a gate is unoccupied between a departure and subsequent arrival (intergate time) reflects airline practices/operations and/or aircraft types. Since airlines use different scheduling parameters and strategies, there can be variations in intergate times.
- **Turns per Gate:** Aircraft turns per gate is a metric that defines the number of times an aircraft arrives and subsequently departs or is towed to or from a gate over the course of the design day. In other words, it is a measure of the number of how many scheduled flights operate at each gate on the design day and is used to assess the overall utilization of each. Average turns per gate for each airline on a given concourse were limited through manual iteration. Exceeding the defined limit of turns per gate may introduce operational challenges such as the inability to efficiently respond to delays or irregular operations.

- **Airline Allocation:** reallocating or reassigning airlines from existing gates to alternate gates may provide better overall usage of existing gates, prior to establishing a requirement for gate expansion or development. This may allow for airlines with few daily operations to share with other airlines. Any gate reallocation preserves an operator on the same concourses except for those utilizing redeveloped Concourse E for international arrivals.

A sample ramp chart is shown on **Exhibit 4-14**. A ramp chart illustrates aircraft activity at each gate, identifying aircraft type, operator, flight number, origination airport, destination airport, and scheduled arrival and departure times. Complete ramp charts illustrating each gating scenario conducted as part of this analysis are provided in **Appendix C**.

EXHIBIT 4-14 SAMPLE RAMP CHART



SOURCE: Ricondo & Associates, Inc., June 2019.

4.4.1.1 GATING SCENARIO 1 – STATUS QUO

Gating Scenario 1 continues the existing operational metrics that are currently in use. These metrics could be considered less efficient compared to some other medium and large hub airports. This in part reflects current gate availability and schedule demand. Concourse C currently accommodates 2 charter gates; however, because charter airlines can operate from Concourse D, these Concourse C charter gates were allocated to Southwest Airlines (C12) and United Airlines (C25) in this gating analysis. Other gates remain allocated as shown in Exhibit 4-13. A summary of the Gate Scenario 1 metrics is shown in **Table 4-17**.

TABLE 4-17 GATING SCENARIO 1 OPERATIONAL CHARACTERISTICS

SCENARIO 1 SUMMARY		
Airline Allocations	No Change	
INTERGATE TIME		
Maximum	40 min	
Minimum	30 min	
AIRCRAFT TOWS		
	Arrival	Departure
ADG II	30 min	50 min
ADG III	45 min	60 min
International	60 min	60 min
AVERAGE TURNS PER GATE		
Mainline	5-6	
Southwest/ULCC	6-7	
Regional Jet	7	

SOURCE: Ricondo & Associates, Inc., June 2019.

Table 4-18 provides a summary of the number of utilized gates and additional gates required to accommodate the baseline forecast and high scenario DDFSs over the interim planning horizons under the first gating scenario. Specific observations include:

- Three international-capable gates are required (shown as Concourse E) at PAL 1 (2023), with a total of 5 gates required in PAL 3 (2040) for both baseline forecast and high scenario DDFSs.
- Some gates on Concourse C demonstrate a low average utilization, while requiring two additional gates at PAL 3 (2040) under the baseline forecast DDFS and 5 gates at PAL 3 (2040) under the high scenario DDFS.
- Gates on Concourse D demonstrate low average utilization, with several gates experiencing only one or two daily operations under the baseline forecast and high scenario DDFSs.

TABLE 4-18 SCENARIO 1 GATE REQUIREMENTS FOR BASELINE AND HIGH SCENARIO DESIGN DAY FLIGHT SCHEDULES

BASELINE FORECAST DDFS						HIGH SCENARIO DDFS					
CONCOURSE	GATES	TOTAL DAILY OPERATIONS	AVERAGE TURNS PER GATE	ADDITIONAL GATES REQUIRED FROM PREVIOUS PAL	TOTAL GATES REQUIRED	CONCOURSE	GATES	TOTAL DAILY OPERATIONS	AVERAGE TURNS PER GATE	ADDITIONAL GATES REQUIRED FROM PREVIOUS PAL	TOTAL GATES REQUIRED
PAL 1 (2023)						PAL 1 (2023)					
C	14	66.5	4.75	-	+3 Gates	C	14	71.0	5.07	-	+3 Gates
D	18	58.5	3.25	-		D	18	67.5	3.75	-	
E	3	6.0	2.00	+3 Gates		E	3	6.5	2.17	+3 Gates	
PAL 2 (2028)						PAL 2 (2028)					
C	14	70.5	5.04	-	+4 Gates	C	15	79.0	5.27	+1 Gate	+5 Gates
D	18	64.5	3.58	-		D	18	72.5	4.03	-	
E	4	7.0	1.75	+1 Gate		E	4	7.5	1.88	+1 Gate	
PAL 3 (2040)						PAL 3 (2040)					
C	15	82.5	5.50	+1 Gate	+6 Gates	C	19	103.5	5.45	+4 Gates	+10 Gates
D	18	73.5	4.08	-		D	18	89.0	4.94	-	
E	5	9.0	1.80	+1 Gate		E	5	9.5	1.90	+1 Gate	

NOTE:
Gate requirements include future redeveloped Concourse E gates. The number of gates included in this redevelopment will reduce the future gate requirement by the same number.
SOURCE: Ricondo & Associates, Inc., June 2019.

Table 4-19 summarizes the number of towed aircraft for each of the DDFSs for Gate Scenario 1. These tows are required to allow other aircraft to utilize their allocated gate or are international arrivals that are towed to a domestic gate for subsequent departure. The number of total tows reflects that maximum requirement for remote aircraft positions but could be reduced with towing operational rules such as allowing aircraft to tow to an available adjacent gate as opposed to towing to a remote position.

TABLE 4-19 GATING SCENARIO 1 AIRCRAFT TOW OPERATIONS

	BASELINE FORECAST			HIGH SCENARIO		
AIRLINE	PAL 1 (2023)	PAL 2 (2028)	PAL 3 (2040)	PAL 1 (2023)	PAL 2 (2028)	PAL 3 (2040)
American (AA)	4	6	6	5	6	5
Charter (CHT)	3	3	4	4	4	6
Delta (DL)	5	4	4	5	5	4
Frontier (F9)	1	1	1	1	1	2
Spirit (NK)	-	-	-	-	-	1
United (UA)	3	3	4	3	4	4
Southwest (WN)	4	4	8	6	6	4
Total Tows	**20**	**21**	**27**	**24**	**26**	**26**

SOURCE: Ricondo & Associates, Inc., June 2019.

4.4.1.2 GATING SCENARIO 2 – INCREASE OPERATIONAL METRICS

Gating Scenario 2 increases the operational metrics associated with Gating Scenario 1 (continuation of existing operational parameters) to more closely approximate gate metrics at typical medium and large hub airports. This includes a reduction in the intergate times and a reduction in the departure tow times (the number of minutes prior to a scheduled departure that an aircraft is towed to a gate for servicing, passenger boarding, and eventual departure. It also includes an increase in the average turns per gate. Enhancing the efficiency of gate utilization reduces the number of additional gates required over the planning horizon. Airline allocation strategies are the same as in Gating Scenario 1 and depicted in Exhibit 4-13, allocating airlines to adjacent common use gates if available. This scenario also allows airlines to utilize other preferential gates on the same concourse that have a low number of daily operations (e.g., Southwest can use Air Canada gates when no Air Canada operations are scheduled). A summary of the Gate Scenario 2 metrics is shown in **Table 4-20**.

TABLE 4-20 GATING SCENARIO 2 OPERATIONAL CHARACTERISTICS

SCENARIO 2 SUMMARY		
Airline Allocations	No Change	
INTERGATE TIME		
Maximum	**30 min**	
Minimum	**20 min**	
AIRCRAFT TOWS		
	Arrival	Departure
ADG II	30 min	**30 min**
ADG III	**30 min**	**45 min**
International	60 min	60 min
AVERAGE TURNS PER GATE		
Mainline	**6-7**	
Southwest/ULCC	**7-8**	
Regional Jet	**8**	

NOTE Bold denotes change from Gating Scenario 1.
SOURCE: Ricondo & Associates, Inc., June 2019.

The average turns per gate and the overall gate requirements to accommodate the baseline forecast and high scenario DDFSs for Gate Scenario 2 are presented in **Table 4-21**. The following summarizes the Scenario 2 results:

- Three international-capable gates are required (shown as Concourse E) at PAL 1 (2023), with a total of 4 gates required at PAL 2 (2028) for both baseline forecast and high scenario DDFSs. No additional international gates are required at PAL 3 (2040).
- Concourse C airlines utilize all available gates on the concourse and do not require additional gates within the 2040 planning horizon under either the baseline forecast or the high scenario.
- One gate on Concourse D is identified as surplus (does not require that any flights are assigned to it based on the operational assumptions associated with Gate Scenario 2) in the baseline forecast PAL 3 (2040) DDFS while all gates are utilized in the high scenario PAL 3 (2040) DDFS.

Table 4-22 summarizes the number of towed aircraft for each of the DDFSs for Gate Scenario 2. Similar to Gate Scenario 1, these tows are required to allow other aircraft to utilize their allocated gate or are international arrivals that are towed to a domestic gate for departure. The maximum requirement of remote aircraft parking positions is listed in the total but could be reduced with towing operational rules.

TABLE 4-21 SCENARIO 2 GATE REQUIREMENTS FOR BASELINE AND HIGH SCENARIO DESIGN DAY FLIGHT SCHEDULES

BASELINE FORECAST DDFS						HIGH SCENARIO DDFS					
CONCOURSE	GATES	TOTAL DAILY OPERATIONS	AVERAGE TURNS PER GATE	ADDITIONAL GATES REQUIRED FROM PREVIOUS PAL	TOTAL GATES REQUIRED	CONCOURSE	GATES	TOTAL DAILY OPERATIONS	AVERAGE TURNS PER GATE	ADDITIONAL GATES REQUIRED FROM PREVIOUS PAL	TOTAL GATES REQUIRED
PAL 1 (2023)						PAL 1 (2023)					
C	14	66.5	4.75	-	+3 Gates	C	14	71	5.07	-	+3 Gates
D	16	58.5	3.66	2 Surplus Gates		D	16	67.5	4.22	2 Surplus Gates	
E	3	6	2.00	+3 Gates		E	3	6.5	2.17	+3 Gates	
PAL 2 (2028)						PAL 2 (2028)					
C	14	70.5	5.04	-	+4 Gates	C	14	79	5.64	-	+4 Gates
D	17	64.5	3.79	1 Surplus Gate		D	17	72.5	4.26	1 Surplus Gate	
E	4	7	1.75	+1 Gate		E	4	7.5	1.88	+1 Gate	
PAL 3 (2040)						PAL 3 (2040)					
C	14	82.5	5.89	-	+4 Gates	C	14	103.5	7.39	-	+4 Gates
D	17	73.5	4.32	1 Surplus Gate		D	18	89	4.94	-	
E	4	9	2.25	-		E	4	9.5	2.38	-	

NOTES: Gate requirements include future redeveloped Concourse E gates. The number of gates included in this redevelopment will reduce the future gate requirement by the same number.
SOURCE: Ricondo & Associates, Inc., June 2019.

TABLE 4-22 GATING SCENARIO 2 AIRCRAFT TOW OPERATIONS

AIRLINE	BASELINE PAL 1 (2023)	BASELINE PAL 2 (2028)	BASELINE PAL 3 (2040)	HIGH SCENARIO PAL 1 (2023)	HIGH SCENARIO PAL 2 (2028)	HIGH SCENARIO PAL 3 (2040)
American (AA)	4	5	5	5	5	5
Charter (CHT)	3	3	4	4	4	5
Delta (DL)	5	5	4	5	5	4
Frontier (F9)	1	1	1	1	1	2
Spirit (NK)	-	-	-	-	-	1
United (UA)	3	3	6	3	4	6
Southwest (WN)	5	5	7	6	8	7
Total Tows	**21**	**22**	**27**	**24**	**27**	**30**

SOURCE: Ricondo & Associates, Inc., June 2019.

4.4.1.3 GATING SCENARIO 3 – INCREASE OPERATIONAL METRICS

Gating Scenario 3 includes the reallocation of a portion of the existing gates to maximize overall gate utilization, relying on the same operational metrics as with Gating Scenario 2. Gate reallocation is made when a resulting efficiency improvement is identified. Optimizing utilization through gate reallocations may reduce the number of additional gates required over the planning horizon, as well as drive more even utilization among gates. A summary of the Gating Scenario 3 metrics is shown in **Table 4-23** and the gate allocation is depicted on **Exhibit 4-15**.

TABLE 4-23 GATING SCENARIO 3 OPERATIONAL CHARACTERISTICS

SCENARIO 3 SUMMARY		
Airline Allocations	Reallocation of Airlines to Gates to Increase Gate Utilization	
INTERGATE TIME		
Maximum	**30 min**	
Minimum	**20 min**	
AIRCRAFT TOWS		
	Arrival	Departure
ADG II	30 min	**30 min**
ADG III	**30 min**	**45 min**
International	60 min	60 min
AVERAGE TURNS PER GATE		
Mainline	**6-7**	
Southwest/ULCC	**7-8**	
Regional Jet	**8**	

NOTE: Bold denotes change from Gating Scenario 1.
SOURCE: Ricondo & Associates, Inc., June 2019.

EXHIBIT 4-15 GATING SCENARIO 3 AIRLINE ALLOCATIONS

SOURCE: Mead && Hunt, January 2019 (gate assignments); Ricondo & Associates, Inc., June 2019.

The average turns per gate and the overall gate requirements to accommodate the baseline forecast and high scenario DDFSs for Gating Scenario 3 are presented in **Table 4-24**.

TABLE 4-24 SCENARIO 3 GATE REQUIREMENTS FOR BASELINE AND HIGH SCENARIO DESIGN DAY FLIGHT SCHEDULES

BASELINE FORECAST DDFS						HIGH SCENARIO DDFS					
CONCOURSE	GATES	TOTAL DAILY OPERATIONS	AVERAGE TURNS PER GATE	ADDITIONAL GATES REQUIRED FROM PREVIOUS PAL	TOTAL GATES REQUIRED	CONCOURSE	GATES	TOTAL DAILY OPERATIONS	AVERAGE TURNS PER GATE	ADDITIONAL GATES REQUIRED FROM PREVIOUS PAL	TOTAL GATES REQUIRED
PAL 1 (2023)						PAL 1 (2023)					
C	14	54.5	3.89	-	+3 Gates	C	14	57	4.07	-	+3 Gates
D	18	70.5	3.92	-		D	18	80.5	4.47	-	
E	3	6	2.00	+3 Gates		E	3	7.5	2.50	+3 Gates	
PAL 2 (2028)						PAL 2 (2028)					
C	14	56.5	4.04	-	+4 Gates	C	14	63	4.50	-	+4 Gates
D	18	77.5	4.31	-		D	18	86.5	4.81	-	
E	4	8	2.00	+1 Gate		E	4	9.5	2.38	+1 Gate	
PAL 3 (2040)						PAL 3 (2040)					
C	14	65.5	4.68	-	+4 Gates	C	14	93	6.64	-	+4 Gates
D	18	90.5	5.03	-		D	18	98	5.44	-	
E	4	9	2.25	-		E	4	11	2.75	-	

NOTES: Gate requirements include future redeveloped Concourse E gates. The number of gates included in this redevelopment will reduce the future gate requirement by the same number.
SOURCE: Ricondo & Associates, Inc., June 2019.

The following summarizes the Gating Scenario 3 results:

- The same number of gates are required as shown in Scenario 2, but with more even gate usage and the fewest number of aircraft tows.
- Scenario 3 has the least number of shared operations on a gate, allowing most airlines to maintain preferential use on their allocated gates.
- Domestic and international charter operations are located on Concourse E, increasing the new Concourse E utilization. No domestic mainline carriers could be relocated to Concourse E with the international gate priority. Any carrier relocated to this concourse would either require additional Concourse E gates (beyond the four gates for PAL 3 (2040) or split operations between Concourse C/D and Concourse E.

Table 4-25 summarizes the number of towed aircraft for each of the DDFSs for Gate Scenario 3. Similar to Gating Scenario 1 and 2, these tows are required to allow other aircraft to utilize their allocated gate or are international arrivals that are towed to a domestic gate for departure. The maximum requirement of remote aircraft parking positions is listed in the total but could be reduced with towing operational rules.

TABLE 4-25 GATING SCENARIO 3 AIRCRAFT TOW OPERATIONS

	BASELINE			HIGH SCENARIO		
AIRLINE	PAL 1 (2023)	PAL 2 (2028)	PAL 3 (2040)	PAL 1 (2023)	PAL 2 (2028)	PAL 3 (2040)
American (AA)	2	3	3	3	3	3
Charter (CHT)	3	4	5	4	5	7
Delta (DL)	4	4	4	4	4	4
Frontier (F9)	-	-	-	-	-	2
Spirit (NK)	-	-	-	-	-	3
United (UA)	3	3	5	5	4	5
Southwest (WN)	1	1	5	2	4	5
Total Tows	**13**	**15**	**22**	**16**	**20**	**29**

SOURCE: Ricondo & Associates, Inc., June 2019.

4.4.2 GATE REQUIREMENT SUMMARY

Table 4-26 compares each of the three gating scenario results. The status quo operation metrics (Gating Scenario 1) requires the most gates in both baseline and high DDFS. Increasing these operational metrics to comparable airport metrics allows one to two gates to remain underutilized at Concourse D in Gating Scenario 2. Using the metrics derived in Gating Scenario 2 and reallocating the airlines allows for the most even gate utilization of all gates, shown in Gating Scenario 3.

TABLE 4-26 GATE REQUIREMENT SUMMARY

REQUIREMENT	GATING SCENARIO 1		GATING SCENARIO 2		GATING SCENARIO 3	
	BASELINE FORECAST	HIGH SCENARIO	BASELINE FORECAST	HIGH SCENARIO	BASELINE FORECAST	HIGH SCENARIO
PAL 1 (2023) Total Gates (Additional Gates)	35 (+3)	35 (+3)	33 (+3)	33 (+3)	35 (+3)	35 (+3)
PAL 2 (2028) Total Gates (Additional Gates)	36 (+4)	37 (+5)	35 (+4)	35 (+4)	36 (+4)	36 (+4)
PAL 3 (2040) Total Gates (Total Additional Gates)	39 (+7)	42 (+10)	35 (+4)	35 (+4)	36 (+4)	36 (+4)
Total New Gates Required	7	10	4	4	4	4
Underutilized Gates	0	0	2	2	0	0
Total Tows	27	26	27	36	27	30

SOURCE: Ricondo & Associates, Inc., June 2019.

4.4.3 AIRCRAFT REMAIN OVERNIGHT PARKING

Aircraft Remain Overnight (RON) Parking requirements are a function of airline schedules and Airport gate use policies. As airline schedules increase at MKE, gate utilization will intensify as measured by the average number of daily departures or "turns" per gate (a turn is defined to be an aircraft arrival followed by its subsequent departure). Gate use policies, particularly those that encourage or require joint use of gates when airline operating profiles, staffing, and schedules allow, are a means to deferring the need for gate expansion. However, effective gate use policies often rely on the availability of hardstand or RON areas to accommodate aircraft during overnight hours or during extended ground times, when it is not necessary that these aircraft occupy a gate that could be used by another aircraft.

The total tows required to accommodate a future year Design Day Flight Schedule is not equivalent to the number of hardstand/RON positions required since required tows will occur at different time across the day/night. However, an approximation of the potential hardstand/RON positions that may be required over the planning horizon can be made based on the maximum number of aircraft on the ground in each of the forecast horizons, which typically occurs during overnight hours. **Table 4-27** depicts the maximum number of aircraft on the ground, increasing from 44 in 2018 to a maximum of up to 59 under the high scenario forecast in 2040.

TABLE 4-27 AIRCRAFT ON THE GROUND

FORECAST	EXISTING GATES	MAXIMUM AIRCRAFT ON THE GROUND			
		2018	2023	2028	2040
Baseline	32	44	44	48	53
High Scenario		44	47	52	59

SOURCE: Ricondo & Associates, Inc., Design Day Flight Schedule, June 2019.

The potential need for aircraft hardstand/RON positions, approximated by comparing the maximum aircraft on the ground to the available number of gates, ranges from 12 in 2018 to up to 21 in 2040 under the baseline forecast and up to 27 under the high scenario forecast in 2040, assuming 32 gates are available. However, the number of gates will increase over the planning horizon in response to demand and as a function of the gating scenario that is implemented. It is anticipated that future gates will be used to accommodate RON aircraft, particularly during overnight hours. **Table 4-28** summarizes the maximum RON/hardstand requirement over the planning horizon, reflecting the gate development over this same period. As anticipated, the more future gates that are constructed, the fewer RON positions are required. The actual RON requirement will be influenced by the future aircraft fleet and airline operations in and around the terminal, including airline willingness to overnight multiple aircraft in a gate area where aircraft size allows. There are currently approximately 20 remote RON positions (non-terminal gate positions, including 8 positions in the South Ramp and 5 positions in the Runway 7R deice pad. It is recognized that deice pad positions are not available to accommodate aircraft hardstanding or overnighting when needed to accommodate deice operations. It is also recognized that there are operational inefficiencies associated with RON positions that are located a significant distance from the terminal gates since aircraft using these may require towing to and from the RON facilities.

TABLE 4-28 AIRCRAFT HARDSTAND/RON REQUIREMENTS

GATING SCENARIO	MAXIMUM RON REQUIREMENTS			
	2018	2023	2028	2040
Baseline Forecast				
Gating Scenario 1	12	9	12	15
Gating Scenario 2	12	9	12	17
Gating Scenario 3	12	9	12	17
High Scenario				
Gating Scenario 1	12	12	15	17
Gating Scenario 2	12	12	16	23
Gating Scenario 3	12	12	16	23

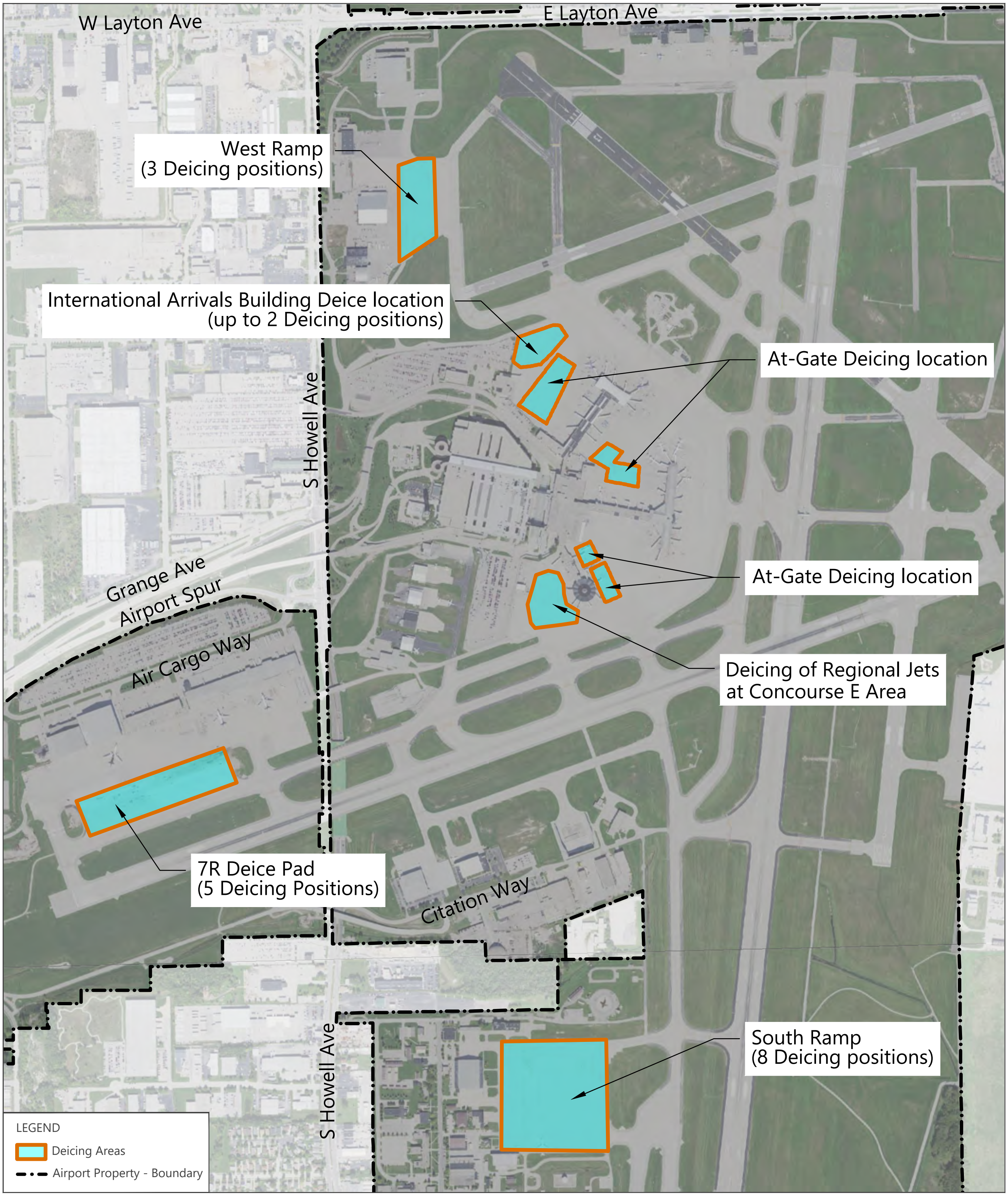
NOTE: Maximum RON requirements are approximated by comparing the maximum aircraft on the ground to the number of gates for each future horizon.
SOURCE: Ricondo & Associates, Inc., Design Day Flight Schedule, June 2019.

4.4.4 CONSOLIDATED DEICE FACILITIES

Deicing is critical for airports in northern climates like MKE. This section provides a brief review of the Airport's existing deice facilities and analyze their ability to meet forecast future demand. Future expansions or additions to deice facilities will then be discussed.

4.4.4.1 EXISTING DEICE FACILITIES

Deicing at MKE is conducted near the main terminal passenger board bridges, and at three dedicated centralized deice facilities (CDFs): The West Ramp CDF near the FBOs and Air Wisconsin on the north side of the Airport, the Runway 7R CDF near the cargo apron, and the Runway 1L South Ramp CDF near the MKE Regional Business Park. These deice facilities are shown by location in **Exhibit 4-16**. The CDFs are shown with their number of positions in **Table 4-29**.



SOURCES: Aerial Photo, National Agriculture Imagery Program (NAIP), 2015;
Deicing Locations, 2017-2018 Winter Operations Plan - Milwaukee Mitchell International Airport - October, 2017

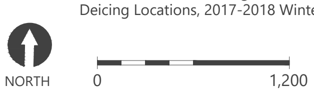


EXHIBIT 4-16

EXISTING DEICE OPERATIONS AREAS

Drawing: X:\1322800\161093.01\TECH\CAD\Facility Req\EXHIBIT 3.11-3 Existing Deicing Operation Areas.dwgLayout: Exhibit 3.11-3 Plotted: Oct 2, 2019, 02:27PM

TABLE 4-29 EXISTING CENTRALIZED DEICE AREAS AND AIRCRAFT POSITIONS

DEICE AREA	NUMBER OF POSITIONS
Runway 7R CDF	5
Runway 1L South Ramp CDF	8
West Ramp CDF	3

SOURCE: Milwaukee General Mitchell International Airport, *Winter Operations Plan 2017-2018*, October 2017.

Aircraft deicing near the gates can inhibit other aircraft from entering or exiting the terminal apron area and create congestion during peak activity periods. Therefore, deicing exclusively at CDFs would allow aircraft to maneuver more efficiently and reduce delays. The following paragraphs outline the conditions at each of the three existing CDFs, describing their capacities and limitations in more detail.

Because of its size and location near Runway 1L, the South Ramp CDF is the primary CDF although this ramp is in poor condition and obstructs expansion of the nearby facilities. While this CDF offers the greatest concentration of deice pads on the Airport, the spaces vary in size and its location near the Runway 1L end means that its use is limited primarily to aircraft departing on Runway 1L. This ramp is also set back nearly 1,000 feet from Runway 1L/19R which means that much of the space around Taxiway R is not utilized. The deice positions here are sized to serve a variety of aircraft, shown in **Exhibit 4-17**, but this CDF could be reconfigured to better meet existing needs.

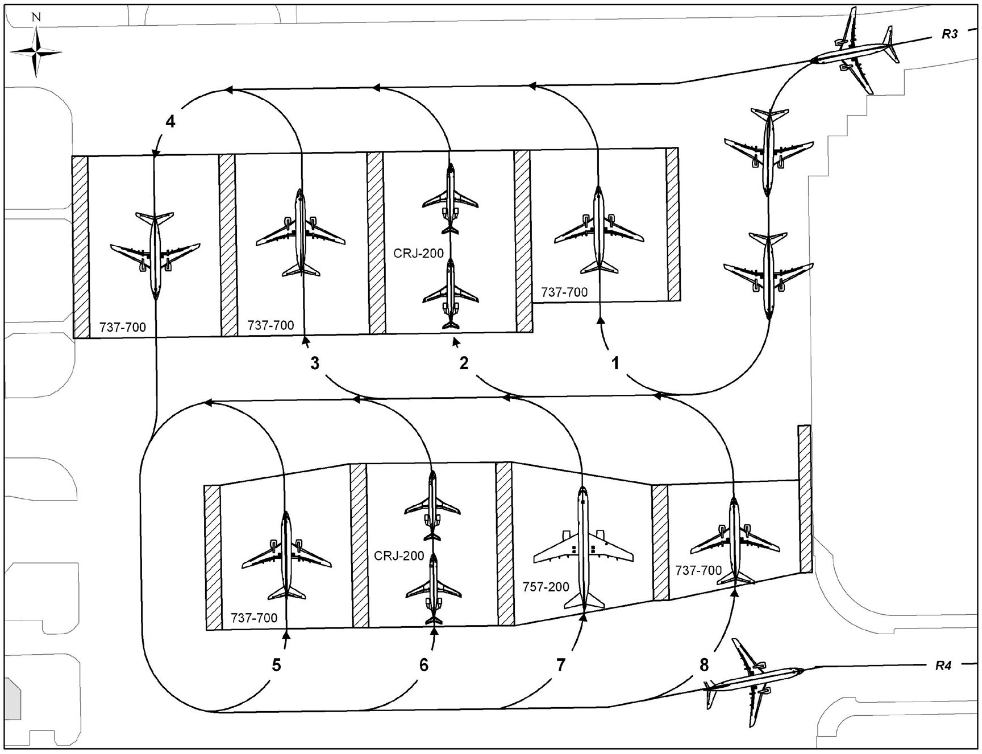
The Runway 7R CDF has five deice positions and is located near the cargo facilities prior to the Runway 7R threshold. This CDF can be used by either air carriers or cargo, although Runway 7R is not one of the primary runways used during IFR conditions. Taxiway A provides both an entrance and an exit to the CDF and nearby Runway 7R. As this CDF was only recently constructed in 2015 the pavement is in good condition and runoff from this ramp is collected by a series of trench drains that flow to a central diversion chamber, which directs glycol to a holding tank. The deice pads here are able to accommodate ADG III aircraft, although larger aircraft are able to use multiple positions to deice here.

The West Ramp CDF is located between the Runway 13 and Runway 7L thresholds on Taxiway C. This location presents constraints as the apron is immediately adjacent to the Air Wisconsin maintenance hangar to the west and on the route to the Avflight hangar to the north. These deice positions use non-standard separations but are able to accommodate ADG II aircraft.

4.4.4.2 DEICE FACILITY CRITERIA

FAA Advisory Circular (AC) 150/5300-14C, *Design of Aircraft Deicing Facilities*, provides guidance on the dimensions and separation criteria required for CDFs. Numerous variables can impact the types, sizes, and number of deice positions needed to provide sufficient deicing capacity. FAA guidance states that deicing demand correlates with the number of peak operations occurring at an airport, although the correlation varies depending on an airport's size, procedures of application, and type of treatment performed.

EXHIBIT 4-17 SOUTH RAMP DEICE PAD



SOURCE: Milwaukee Mitchell International Airport, Winter Operations Plan 2017-2018, October 2017.

Deicing at MKE is often a two-phase process determined by precipitation type and severity, with Type I fluid used to remove built-up snow or ice, and Type-IV fluid used to protect aircraft during their taxi and takeoff for departure. The time required for deicing one aircraft can vary greatly, requiring less than 10 minutes for small aircraft in light snow or up to an hour for widebody aircraft that require two-stage treatment during heavy snow conditions. For the purposes of the planning analysis, an average of 20 minutes per deicing operation at each CDF position has been used. While CDFs can often offer more efficient deicing operations, they can be a chokepoint for departing flights during busy times if they do not provide enough throughput capacity for all aircraft that require deicing. To mitigate delays, both fleet mix and peak-period operations must be considered in the calculation of required capacity for deice facilities. AC-150/5300-14C also recommends that the design of future deice facilities addresses anticipated changes in the aircraft fleet mix for at least 10 years. The planning period for this master plan extends to 2040, so this section will consider changes to the fleet mix during that time.

Deice Position Separation Criteria

Deice position sizes are based on the category of aircraft they are intended to serve. A typical deice position consists of a taxi centerline with a protected area where the aircraft parks to have deicing fluid applied. A vehicle safety zone (VSZ) usually flanks the protected area on either side. In the VSZ, vehicles can perform limited maneuvers to apply deicing fluid. The VSZ runs the entire length of a deice position but must stay clear of any taxiway/taxilane object-free areas for adjacent taxiways. The dimensions of deice positions depend on the aircraft being served and whether it is in the area that ATC controls (the movement area). **Table 4-30** shows the FAA recommended dimensions based on aircraft size and location.

TABLE 4-30 DEICE POSITION SEPARATION CRITERIA

AIRPLANE DESIGN GROUP	NON-MOVEMENT AREA		MOVEMENT AREA	
	TAXI CENTERLINE TO EDGE OF VSZ[1] (FEET)	TAXI CENTERLINE TO TAXI CENTERLINE[2] (FEET)	TAXI CENTERLINE TO EDGE OF VSZ[1] (FEET)	TAXI CENTERLINE TO TAXI CENTERLINE[2] (FEET)
ADG-I	39.5	89	44.5	99
ADG-II	57.5	125	65.5	141
ADG-III	81	172	93	196
ADG-IV	112.5	235	129.5	269
ADG-V	138	286	160	330

NOTES:
1 VSZ = Vehicle Safety Zone; includes one vehicle maneuvering area.
2 Includes two vehicle maneuvering areas and 1 vehicle safety zone.
SOURCE: FAA Advisory Circular (AC) 150/5300-14C, *Design of Aircraft Deicing Facilities*, August 2013.

4.4.4.3 DESIGN PERIOD DEPARTURES

Peak period departures for each aircraft category at MKE were determined by reviewing the Design Day Flight Schedules (DDFSs) that were developed as part of the forecasting effort. The peak hour was selected from the baseline forecast and high scenario as the design period. As it will, on average, take approximately 20 minutes for a single deicing operation, a single deice position will support three deicing departures per hour. Based on these parameters, the number of required deice positions for each of the DDFSs are shown below in **Table 4-31**. Although the High Scenario forecast has more total operations in a day compared to the Baseline forecast, this process uses the peak hourly departures to determine the number of deice positions needed and so the difference between these scenarios is less pronounced.

TABLE 4-31 PEAK HOUR DEPARTURES AND DEICE POSITION DEMAND

PEAK PERIOD	2018	2023	2028	2040
Baseline Forecast				
Peak Hourly Departures[1]	21	22	23	26
Deice Position Demand	7	8	8	10
High Scenario				
Peak Hourly Departures[1]	21	23	25	30
Deice Position Demand	7	8	8	10

NOTES:
Peak Hour Departures include Military and Cargo but exclude General Aviation aircraft.
Peak hour deicing operations assume that all aircraft departing in the DDFS peak hour require deicing during a deicing/snow event.
SOURCE: Ricondo & Associates, Inc. (design day flight schedules), 2019; Mead & Hunt, Inc. (deicing peak hour analysis), 2019.

As shown in Table 4-31, the design period departures are not expected to increase significantly. Instead, the driver of demand will be the transition to larger aircraft. This is also the primary difference between the baseline forecast and high scenario. However, designing individual deice positions for each size of aircraft is not feasible and could result in inefficient airfield layouts inaccessible to larger aircraft.

Currently, high-density narrowbody aircraft such as the Airbus A321 (ADG-III) comprise the predominant aircraft operations at MKE. Many regional jets, such as the Bombardier CRJ-900 and Embraer E175, also fall into the ADG III category. However, near the end of the planning period, operations by small widebody aircraft, like the Boeing 787 (ADG-V) are expected to increase and become more prevalent after 2028. Planning for more demanding aircraft to share multiple CDFs intended for smaller ADG III aircraft will prevent overbuilding deice facilities and promote efficiency by preventing bottlenecks. An example of this use can be seen in **Exhibit 4-18**.

4.4.4.4 DEICE FACILITY RECOMMENDATIONS

Because of the number of deicing operations occurring each year at MKE, the transition to deicing exclusively at CDFs is unlikely to occur as a single project. Instead, this transition is expected to occur over several projects as CDFs are developed or expanded. In addition to the number of deice positions required, the location of the CDFs also have an impact on meeting deicing demands. This section considers the overall number of deice positions required in consideration of the various locations and departure operations from the airfield.

Terminal Area CDFs

CDFs located near the terminal or other central areas provide greater efficiency as departing air carriers can use these facilities regardless of the runway from which they are departing. However, a potential disadvantage to CDFs located near terminal areas is that a single bottleneck may exist for all aircraft departing to various runways and congestion may occur during busy periods with significant snowfall. Another potential disadvantage is that during particularly poor conditions, when delays may occur, long taxi times from the CDF to the departure end may cause exceedance of the permitted deicing hold over times. Finally, CDFs located near the passenger terminal may be subject to constraints from nearby facilities (navigational aid critical areas, safety and object free area separation distances, line of sight standards) that limit capacity.

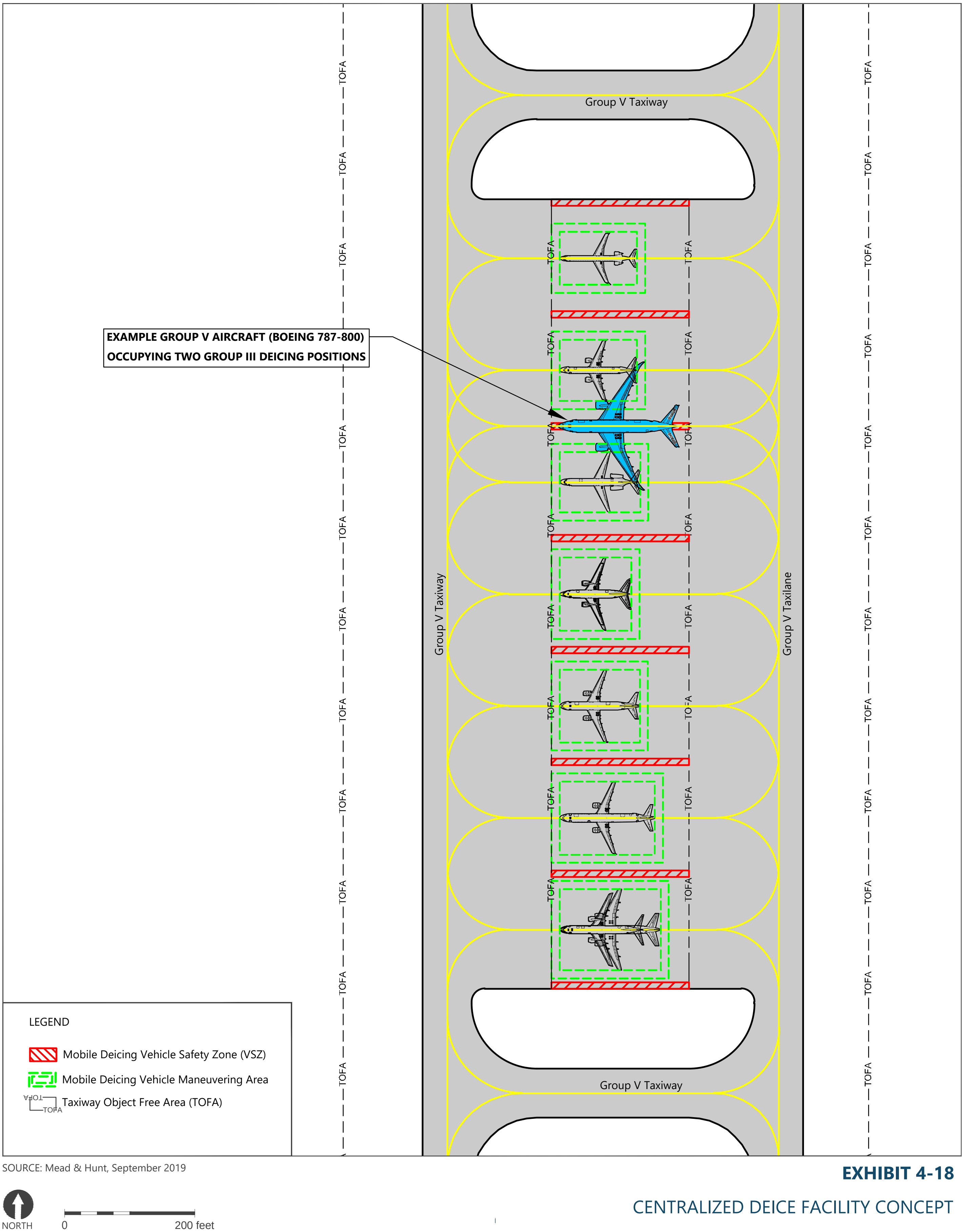
Requirements for deice positions consider the four ends of the two primary commercial service runways: Runway 1L-19R and Runway 7R-25L are summarized below.

Runway 1L

Runway 1L currently has eight deice positions at the existing CDF near this runway threshold. This is close to the recommended 10 deice positions required by the high scenario and only two deice positions would be needed here if a significant CDF is located near the passenger terminal. However, as the existing CDF is in poor condition and obstructs the potential expansion of surrounding facilities, this CDF could be improved, and the following chapter will consider its layout in greater detail.

Runway 19R

Deice positions near this runway end are limited and existing space is constrained by 7L/25R and surrounding facilities and roadways. Therefore, while some deice positions may be situated within a CDF near this runway end, this runway would benefit from a CDF located near the passenger terminal.



SOURCE: Mead & Hunt, September 2019

EXHIBIT 4-18

CENTRALIZED DEICE FACILITY CONCEPT

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Runway 25L

Runway 25L is currently the main runway used for operations during IFR conditions. There are no existing deice pads near the end of this runway. The existing available space is limited, and unlikely to be able to accommodate all 10 deice positions required by the high scenario. Therefore, a CDF at this location would need to be supplemented by a separately located deice facility (e.g., a centrally located CDF near the passenger terminal).

Runway 7R

The existing CDF near Runway 7R has five existing deice positions but an additional five deice positions would be required to meet the demand of the high scenario. As space in this area is limited by nearby cargo facilities, it would likely require additional deice positions near the passenger terminal to meet demand.

4.5 TERMINAL AND CONCOURSE FACILITIES

4.5.1 PLANNING CRITERIA

Terminal facility requirements are derived from forecast peak period demand, industry standard passenger level-of-service (LOS) metrics, passenger attributes, and facility operating parameters. The following subsections outline the methodologies, LOS framework, activity levels, passenger attributes, and operating parameters used to develop terminal facility requirements.

4.5.1.1 METHODOLOGY

Different approaches were used to develop in-terminal requirements for each facility type. Methodologies used to define the planning parameters for the various terminal elements depended on the function of a specific element, as detailed below:

- Passenger volumes were generated from historical data and forecast DDFSs. The schedules provide flight-by-flight descriptions of service routes, aircraft equipment types, load factors, and transfer passenger percentages. Passenger volumes were profiled using passenger attributes such as show-up profile for check-in, percentage of passengers checking bags, and class of service, among other factors.
- Passenger processing facility requirements were developed using methodologies that are generally consistent with the International Air Transport Association (IATA) Airport Development Reference Manual (ADRM). Modeling was used to synthesize factors that generate demand and to correlate demand to facilities that would be required to achieve prescribed LOS standards. IATA's LOS framework, along with other LOS industry-accepted standards, address passenger experience in terms of transaction (processing) times and comfort while in process and moving between processes. Each system used to process passengers was analyzed separately because LOS standards vary among these systems.
- Performance was analyzed through modeling of individual functional areas and facility capacities and requirements were determined under optimized operating conditions (fully staffed and utilized positions; appropriately allocated passenger traffic). The analysis maintained this assumption throughout, unless otherwise noted.
- Facility space templates represent the optimal operating conditions for each passenger processing function. Templates define minimum spatial clearances for safe and efficient operations around equipment, as well as relationships between different process areas within a facility. Space templates represent an indicative configuration, highlighting critical dimensions and suggested passenger flows. Actual layouts may vary.

- The functional efficiency and actualized throughput capacity of a processing area were determined by the comparison of allocated area to the space that would be required for optimized operation.
- Variability is represented through dynamic modeling of sequential processes, using a predictive probability distribution for average transaction times. Simulation modeling was used to determine requirements for check-in and security facilities.

4.5.1.2 LEVEL-OF-SERVICE FRAMEWORK

The LOS framework is dependent on variables of space and time, and is defined by efficiency of flow, delay, and comfort levels. **Exhibit 4-19** illustrates the relationship among these variables, under both the current LOS framework (ADRM, 11th edition) and the framework presented in the previous ADRM (9th edition).[7] A table of space standards, waiting times, and a graphic of indicative LOS is illustrated on **Exhibit 4-20**. Under the IATA's framework, Optimum LOS represents an acceptable LOS characterized by adequate queuing space and reasonable waiting times during periods of peak activity. Optimum LOS equates to good service at reasonable cost, similar to LOS-C under the previous ADRM standards. Short periods of diminished LOS during the highest peak activity are considered acceptable to avoid over-designed facilities.

4.5.1.3 PLANNING ACTIVITY LEVELS

Peak period demand was calculated using DDFSs (base year [2018], PAL 1 [2023], PAL 2 [2028], and PAL 3 [2040]) to correlate with forecast annual passenger activity. The DDFS presents the daily pattern for airline service on an average weekday of the peak month (March, detailed in Section 3, Aviation Activity Forecasts) including information on a flight-by-flight basis pertaining to the time of aircraft arrival or departure, operating airline, aircraft type, domestic/international designation, points of origin and destination, seat capacity, load factor, and number of originating, terminating, and connecting passengers.

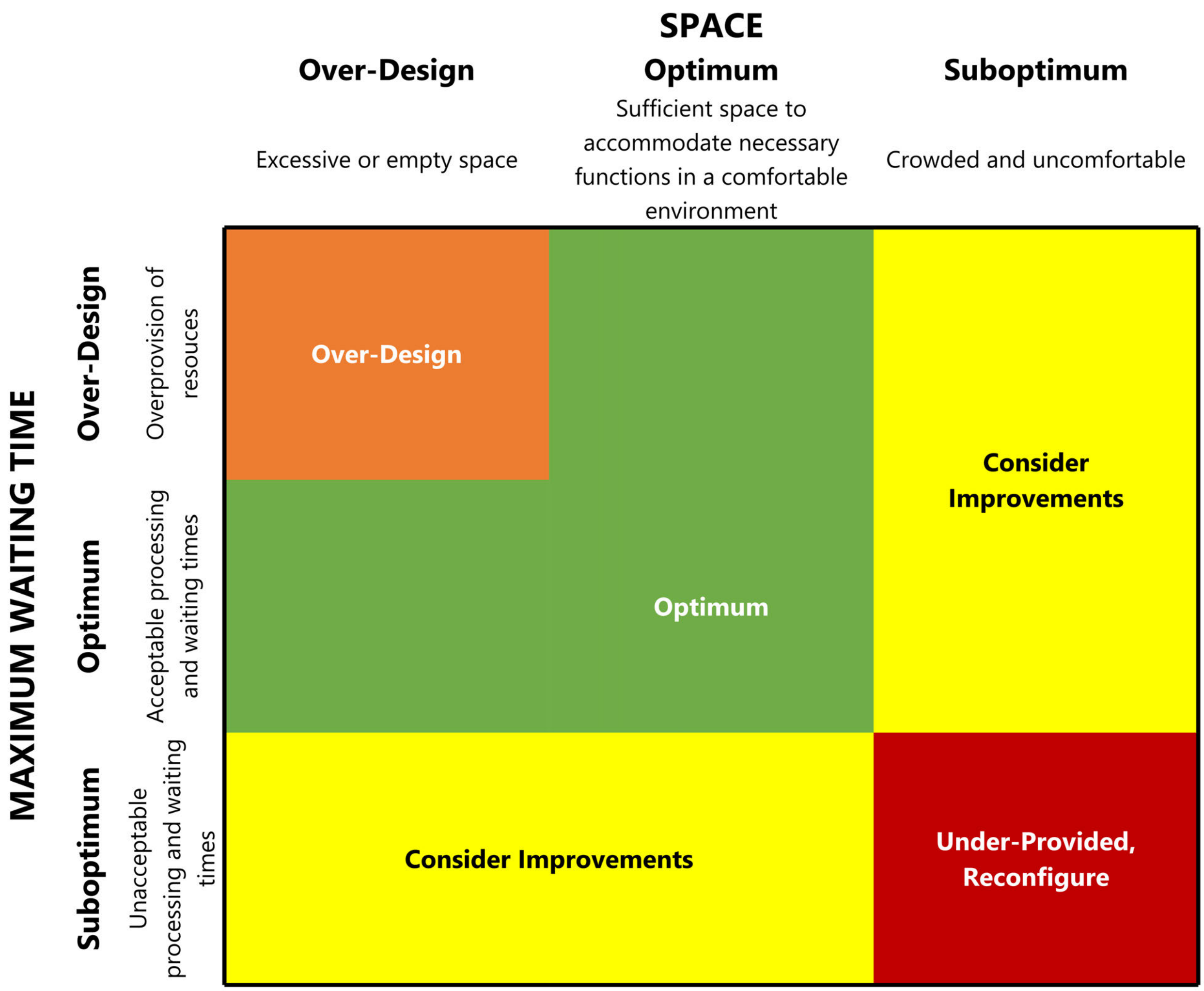
Peak hour enplaning and deplaning passenger profiles were calibrated to existing benchmarks and limited data collected by the Airport. These daily and peak period volumes include all passengers processed through the Airport and represent the principal demand on concourses and gate facilities. Origin and destination (O&D) passengers represent the demand on terminal processing facilities.

Table 4-32 lists the O&D percentages in the baseline forecast DDFS, this percentage does not change for each forecast. Although the high scenario, a derivative of the baseline forecast, is driven in part by an assumption of increased connectivity by Southwest Airlines, the percentage of O&D passengers under this scenario were maintained at the same levels as the baseline forecast in order to represent a surged peak demand period under the high scenario of activity. Accordingly, the O&D percentages in Table 4-32 are held constant in the simulations.

The forecast DDFSs (baseline and high scenario) were simulated to validate air service characteristics and resulting passenger demand volumes during the peak period and calibrated against known passenger volumes. **Table 4-33** summarizes daily and peak-hour activity and characteristics associated with each of the DDFS (base year [2018], PAL 1 [2023], PAL 2 [2028], and PAL 3 [2040]). **Exhibit 4-21** illustrates the number of departing and arriving seats and passengers throughout the day and Peak Hour for as defined in the DDFSs for the baseline forecast and the high scenario.

7 International Air Transport Association, *Airport Development Reference Manual*, 9th ed., January 2004.

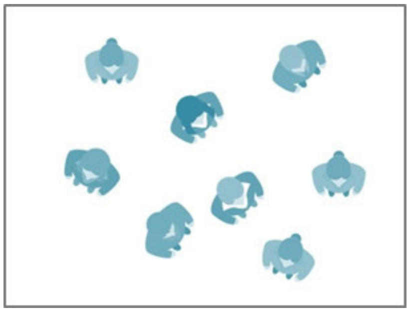
EXHIBIT 4-19 INTERNATIONAL AIR TRANSPORT ASSOCIATION LEVEL OF SERVICE SPACE-TIME DIAGRAM



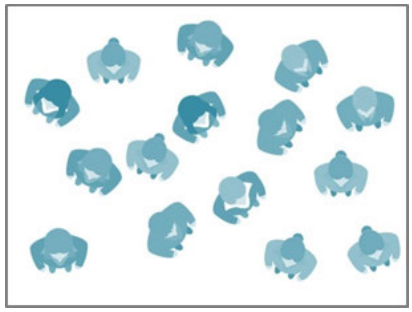
LEVEL OF SERVICE - ADRM 11TH EDITION	LEVEL OF SERVICE - ADRM 9TH EDITION	FLOWS	DELAYS	LEVEL OF COMFORT
Over-Design	A - Excellent	Free	None	Excellent
Over-Design	B - High	Stable	Very Few	High
Optimum	C - Good	Stable	Acceptable	Good
Suboptimum	D - Adequate	Unstable	Passable	Adequate
Suboptimum	E - Inadequate	Unstable	Unacceptable	Inadequate
Under-Provided	F - Failure	System Breakdown	System Breakdown	Unacceptable

NOTE: ADRM – Airport Development Reference Manual
SOURCES: International Air Transport Association, *Airport Development Reference Manual, 11th ed.*, March 2019; International Air Transport Association, *Airport Development Reference Manual, 9th ed.*, January 2004.

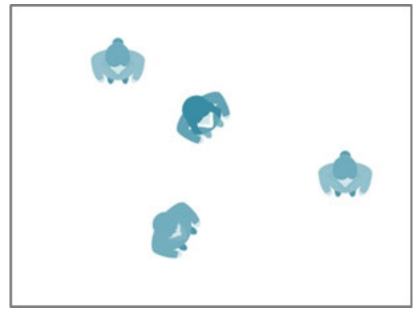
EXHIBIT 4-20 INTERNATIONAL AIR TRANSPORT ASSOCIATION LEVEL OF SERVICE METRICS



Optimum: Acceptable level of service; conditions of adequate to above-average space and reasonable to very few delays; appropriate level of comfort.



Suboptimum: Unsatisfactory level of service; conditions that provide crowded and uncomfortable spaces and present unacceptable processing and waiting times; inadequate level of comfort.



Over-Design: Poor level of service; conditions of either excessive or empty space and over provision of resources; immoderate or unacceptable level of comfort.

PASSENGER TERMINAL PROCESSOR	SPACE STANDARDS (SQ FT/PASSENGER)				WAITING TIME (MINUTES)			
ADRM 9th Edition	A B	C	D	E	A B	C	D	E
ADRM 11th Edition	Over-Design	Optimum	Suboptimum	Under-Provided	Over-Design	Optimum	Suboptimum	Under-Provided
Check-in								
Self-Service Kiosk	> 19.4	14.0-19.4	< 14.0		< 0	0-2	> 2	
Bag Drop Desk	> 19.4	14.0-19.4	< 14.0		< 0	0-5	> 5	
Check-in Desk	> 19.4	14.0-19.4	< 14.0		< 10	10-20	> 20	
Security Checkpoint	> 12.9	10.8-12.9	< 10.8		< 5	5-10	> 10	
Immigration Control	> 12.9	10.8-12.9	< 10.8		< 5	5-10	> 10	
Baggage Claim Area	> 18.3	16.2-18.3	< 16.2		< 0	0-15	> 15	

NOTE: ADRM - *Airport Development Reference Manual*

SOURCES: International Air Transport Association, *Airport Development Reference Manual*, 11th ed, March 2019; International Air Transport Association, *Airport Development Reference Manual*, 9th ed., January 2004.

TABLE 4-32 AVERAGE ORIGIN AND DESTINATION

AIRLINE	PERCENTAGE OF O&D PASSENGERS
Allegiant Airlines	95%
American Airlines	95%
Air Canada	100%
Alaska Airlines	95%
Delta Air Lines	95%
Frontier Airlines	95%
United Airlines	95%
Southwest Airlines	95%
Volaris Airlines	100%

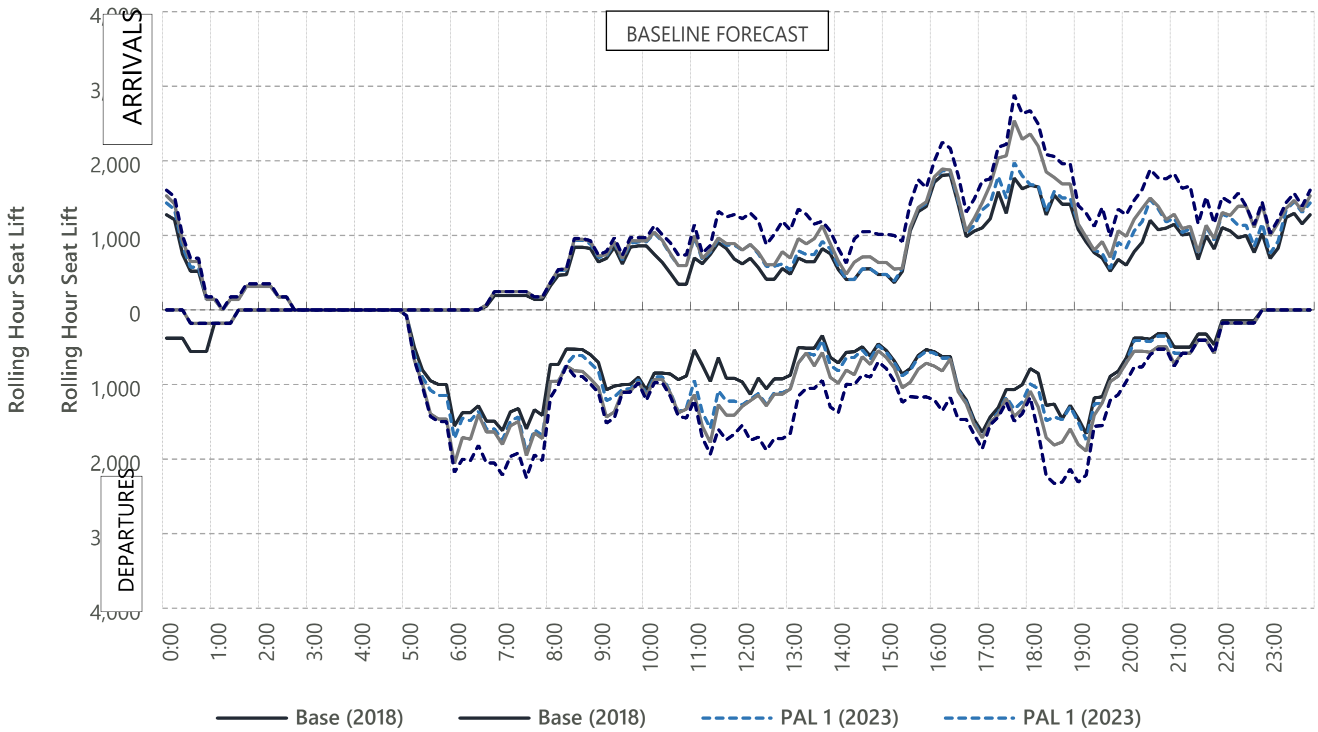
NOTE: O&D percentages were held constant between the baseline forecast and the high scenario to represent a surged peak demand under the high scenario.
SOURCE: Ricondo & Associates, Inc., June 2019.

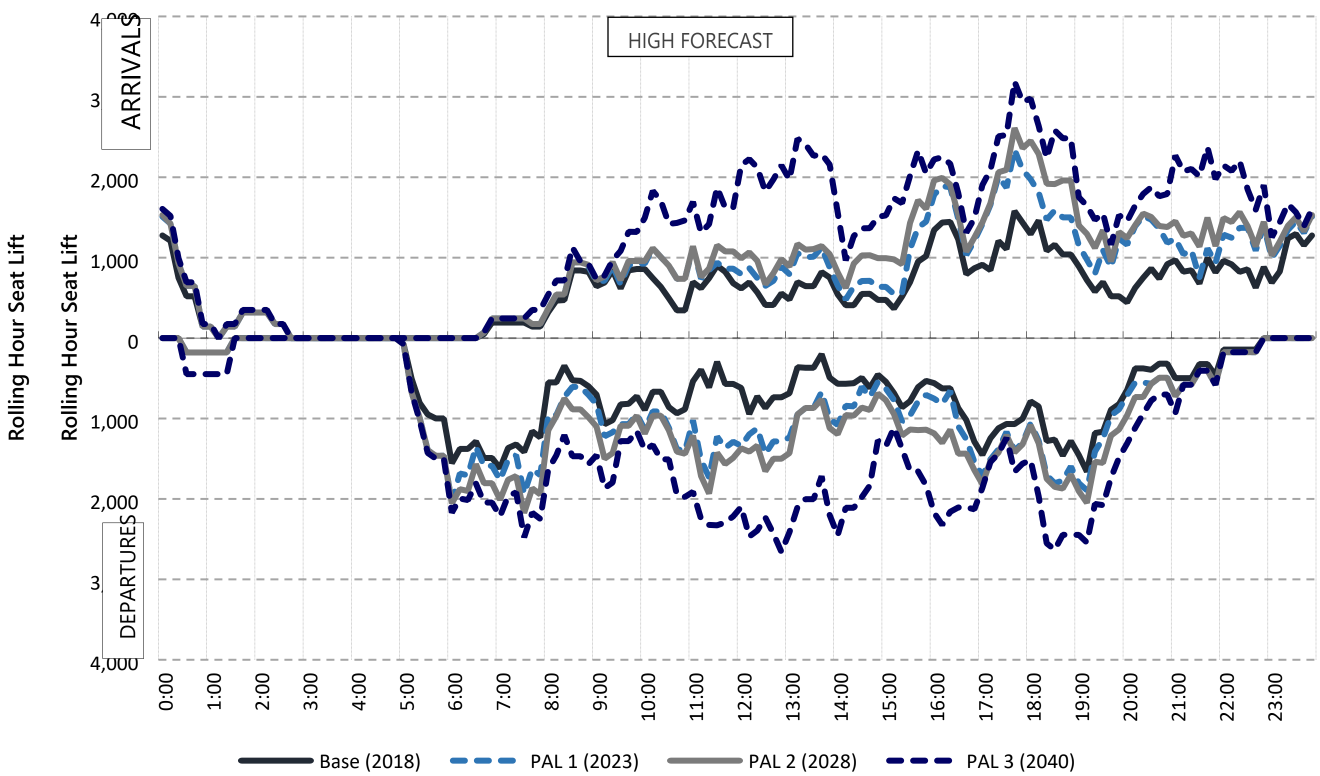
TABLE 4-33 DAILY AND PEAK HOUR ACTIVITY SUMMARY

ACTIVITY	BASE	BASELINE FORECAST			HIGH SCENARIO		
	2018	PAL 1	PAL 2	PAL 3	PAL 1	PAL 2	PAL 3
DEPARTURES							
Daily							
Departing Flights	132	136	147	170	145	159	202
Departing Seats	15,675	17,535	19,345	23,160	19,220	21,585	30,025
Enplaned Passengers	14,265	15,865	17,615	21,800	17,510	20,040	28,030
Origination Passengers	13,610	15,155	16,810	20,810	16,710	19,120	26,740
Peak Hour							
Departing Flights	16	17	17	18	17	18	19
Departing Seats	1,970	2,290	2,330	2,630	2,310	2,550	2,855
Enplaned Passengers	1,805	2,105	2,145	2,495	2,130	2,380	2,675
Origination Passengers	1,730	2,020	2,055	2,390	2,040	2,280	2,560
ARRIVALS							
Daily							
Arriving Flights	132	136	147	170	145	159	202
Arriving Seats	15,675	17,535	19,345	23,160	19,220	21,585	30,025
Deplaned Passengers	12,985	14,445	16,010	19,825	16,420	18,200	25,515
Destination Passengers	12,385	13,785	15,285	18,935	15,665	17,375	24,350
Peak Hour							
Arriving Flights	14	15	19	20	17	18	21
Arriving Seats	1,815	1,975	2,540	2,885	2,345	2,610	3,190
Deplaned Passengers	1,490	1,715	2,220	2,500	2,090	2,265	2,745
Destination Passengers	1,425	1,640	2,115	2,385	1,995	2,160	2,620

NOTE: PAL – Planning Activity Level (PAL1 – 2023; PAL2 – 2028; PAL3 – 2040).
SOURCE: Ricondo & Associates, Inc., June 2019.

EXHIBIT 4-21 DAILY DEPARTING AND ARRIVING SEATS





SOURCE: Ricondo & Associates, Inc., June 2019.

4.5.1.4 PASSENGER ATTRIBUTES

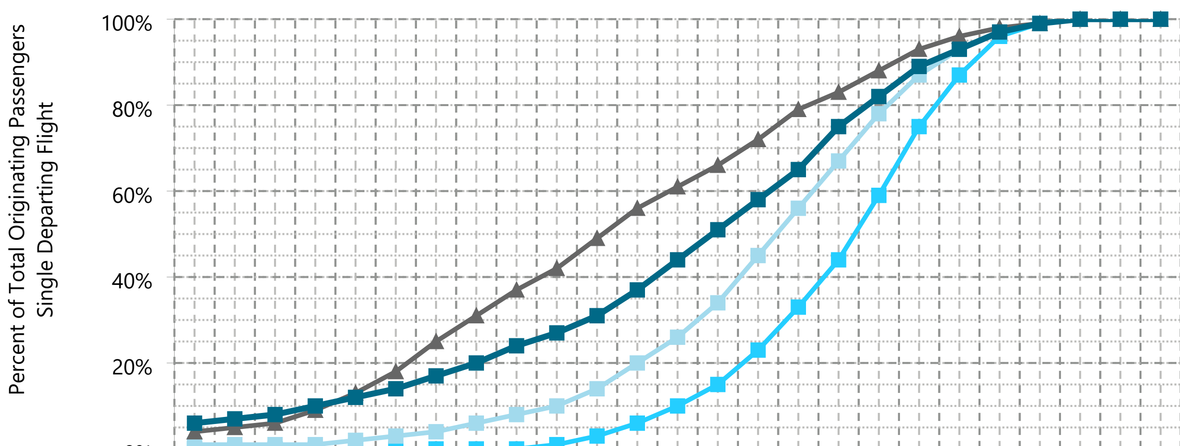
Passenger attributes are characteristics and assumptions related to the behaviors of passengers using Airport facilities. These characteristics include show-up profiles and individual traveler attributes (e.g., checked bags per passenger). Attributes incorporate Airport- and airline-specific factors as well, typically obtained through research of current industry standards and similar facility benchmarking, on-site observations, and other historical data.

Show-up Profiles

A show-up profile is a distribution curve that represents the amount of time originating passengers arrive at the terminal prior to their scheduled flight departure. Several factors affect arrival profiles, including the type of travel (domestic or international), class of service, whether the passenger is checking baggage, and time of day. This results in a metering of the flow of passengers that directly influences passenger demand throughout the system.

Exhibit 4-22 illustrates the show-up profiles used in this analysis. Show-up profiles for passengers without checked bags and with checked bags were based on TSA-provided information. Off-peak period refers to flights departing between 11 p.m. and 5 a.m.

EXHIBIT 4-22 PASSENGER SHOW-UP PROFILES



	240	230	220	210	200	190	180	170	160	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	0
Before 8:30 a.m.	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	3%	6%	10%	15%	23%	33%	44%	59%	75%	87%	96%	99%	100%	100%	100%
Peak Domestic	1%	1%	1%	1%	2%	3%	4%	6%	8%	10%	14%	20%	26%	34%	45%	56%	67%	78%	87%	93%	97%	99%	100%	100%	100%
International	4%	5%	6%	9%	13%	18%	25%	31%	37%	42%	49%	56%	61%	66%	72%	79%	83%	88%	93%	96%	98%	99%	100%	100%	100%
Off-peak Domestic	6%	7%	8%	10%	12%	14%	17%	20%	24%	27%	31%	37%	44%	51%	58%	65%	75%	82%	89%	93%	97%	99%	100%	100%	100%

Minutes Before Scheduled Time of Departure

SOURCE: Transportation Security Administration, *Planning Guidelines and Design Standards for Checked Baggage Inspection Systems*, Version 6.0, September 29, 2017.

Checked Baggage

Table 4-34 lists the planned average checked bags per passenger. This source of this data was from TSA published documents with support data from other industry standards and similar facility benchmarking, on-site observations, and other historical data. The percentage of passengers with checked bags applies to both departing (origin) and arriving (destination) passengers. These metrics were used in the analysis of check-in, baggage make-up, and baggage claim facilities. For comparison, Table 4-34 shows the average number of bags for all passengers (those that check bags and those that proceed with only carry-on bags).

TABLE 4-34 PASSENGERS CHECKING BAGS

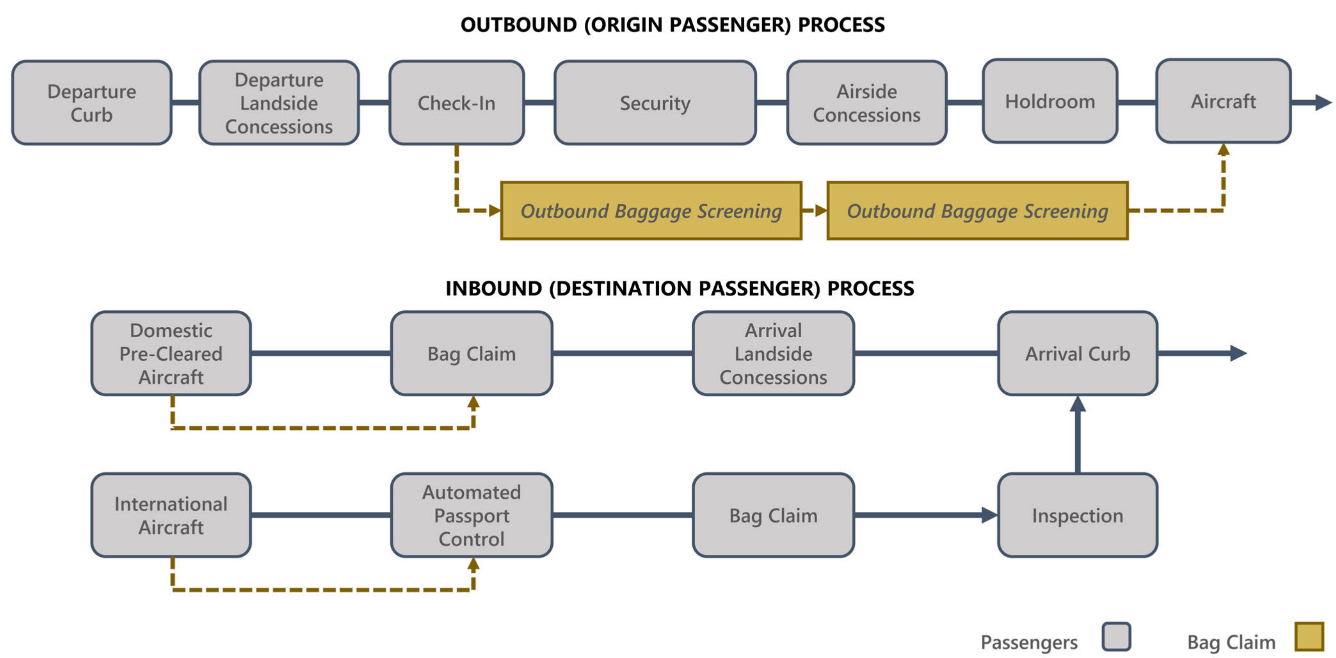
	UNITS	SOUTHWEST AIRLINES	OTHER AIRLINES	INTERNATIONAL
Percentage of passengers not checking bags	percent	30	40	10
Percentage of passengers checking bags	percent	70	60	90
Overall average bags per passenger for all Passengers	bags	0.8	0.6	1.2

SOURCE: Transportation Security Administration, *Planning Guidelines and Design Standards for Checked Baggage Inspection Systems*, Version 6.0, September 29, 2017.

4.5.2 OPERATING PARAMETERS

Operating parameters refer to the processing sequence (how departing and arriving passengers and bags travel through the Airport), and processing rates (usually measured by time and number of passengers). **Exhibit 4-23** illustrates outbound and inbound processes for O&D passengers and baggage.

EXHIBIT 4-23 PASSENGER AND BAGGAGE PROCESSES



SOURCE: Ricondo & Associates, Inc., May 2018.

A passenger's time in process is a metric representing the total time from point of entry to process completion. Transaction time refers to the time during which a passenger is actively interacting with a terminal processor to complete a task. In addition to the specific transaction time metric for each discrete activity, total time in process accounts for waiting time in queue, movement between queue and transaction area(s), and potential congestion. The time in process provides an accurate assessment of actual processing sequences and passenger activity metering, allowing for variance in wait times and transaction rates while still meeting overall LOS goals.

4.5.2.1 CHECK-IN

Check-in is the process by which passengers obtain boarding passes and/or baggage tags and check any baggage with the airline prior to going through passenger security screening checkpoints (SSCPs). As technology evolves, individual check-in counter units are becoming less critical. Subsequently, preserving the space required for processing functions and supporting equipment takes precedence.

Baggage acceptance points (BAPs) are where agents or passengers introduce checked baggage into the baggage system. Space requirements for check-in facilities are driven largely by the processing areas in front BAPs. Each BAP has spatial requirements for queueing, equipment, circulation, and active processing to accommodate passenger demand at a given LOS.

Passenger check-in types are segmented into four categories that reflect the different facilities used in the process:

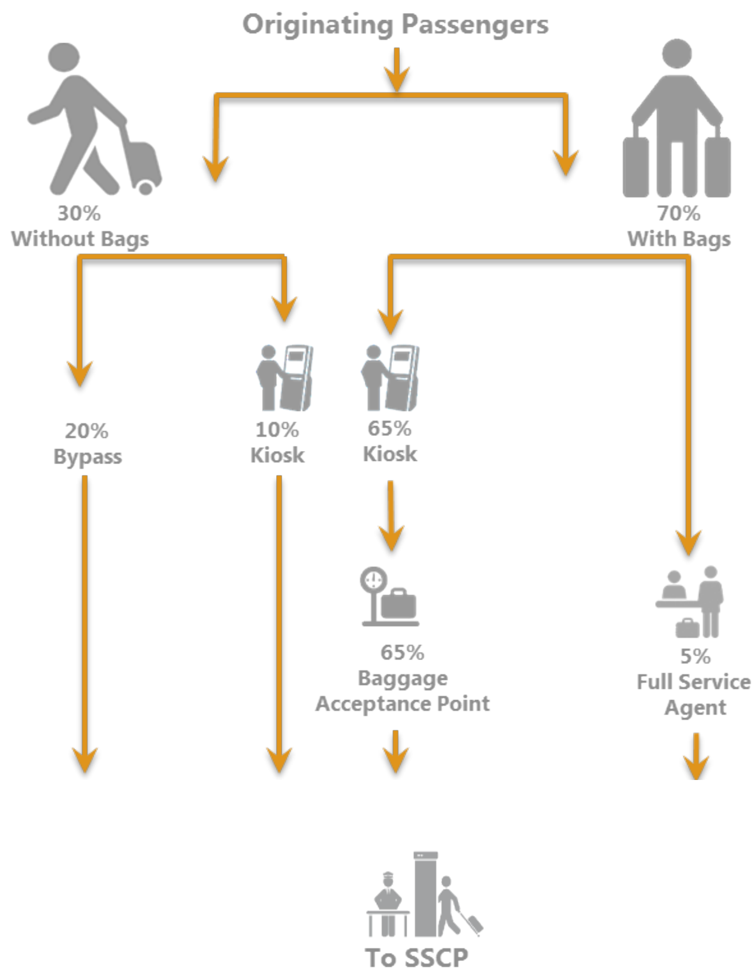
- **Bypass (Internet/Mobile Device) Check-in**. Passengers who do not check bags and check-in remotely prior to arriving at the terminal and, consequently, do not need to use terminal check-in facilities.
- **Kiosk/No Bags**. Passengers receiving boarding passes at stand-alone kiosks located in front of in-line positions or located remotely from the check-in counter.
- **Baggage Acceptance Points.** Passengers acquiring boarding passes and printing baggage tags at stand-alone kiosks located in front of in-line baggage acceptance points and providing baggage to airline staff at a BAP.
- **Full-Service Agent Positions**. Passengers using full-service positions where airline staff assist passengers needing extra time or additional services, or where airlines wish to provide product differentiation/concierge services for premium passengers.

Exhibit 4-24 through **Exhibit 4-26** illustrate passenger check-in operating parameters, including passenger check-in types and time in process goals. As shown, these parameters vary by airline and by type of travel (domestic or international).

Check-in facilities can be configured in different arrangements, which are often dependent on airline operational preferences. These configurations may include traditional linear agent counters (with or without built-in self-service kiosks), island counters, or a mix of remote self-service kiosks and baggage tag check-in positions.

Advances in check-in technology allow for fewer stationary agents through use of an automated bag-drop position. An automated configuration would allocate a greater proportion of the check-in hall for self-service kiosks with linear baggage induction belts. Space requirements among check-in configurations may differ depending on the size of the equipment. **Exhibit 4-27** shows in-line processing configurations and spatial requirements for full-service and kiosks with BAPs.

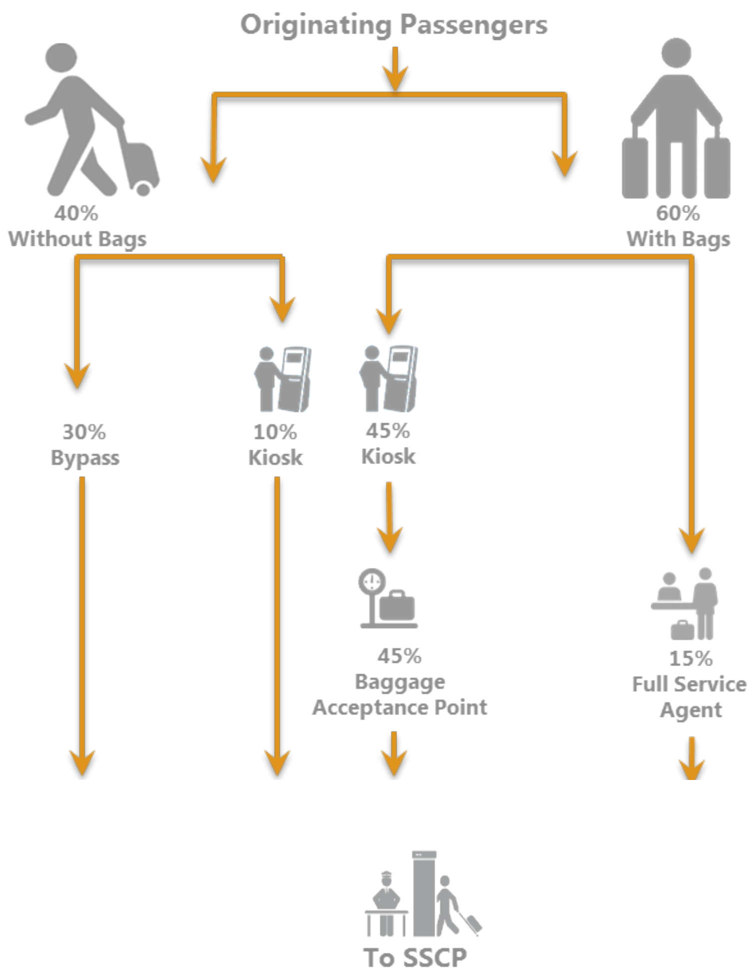
EXHIBIT 4-24 PASSENGER CHECK-IN OPERATING PARAMETERS: SOUTHWEST AIRLINES



CHECK-IN TYPE	PERCENTAGE	AVERAGE TOTAL TIME IN PROCESS
Bypass	20%	0 minutes
Kiosk	10%	6 minutes
Baggage Acceptance Point	65%	10 minutes
Full-Service Agent	5%	14 minutes

SOURCE: Ricondo & Associates, Inc. June 2019.

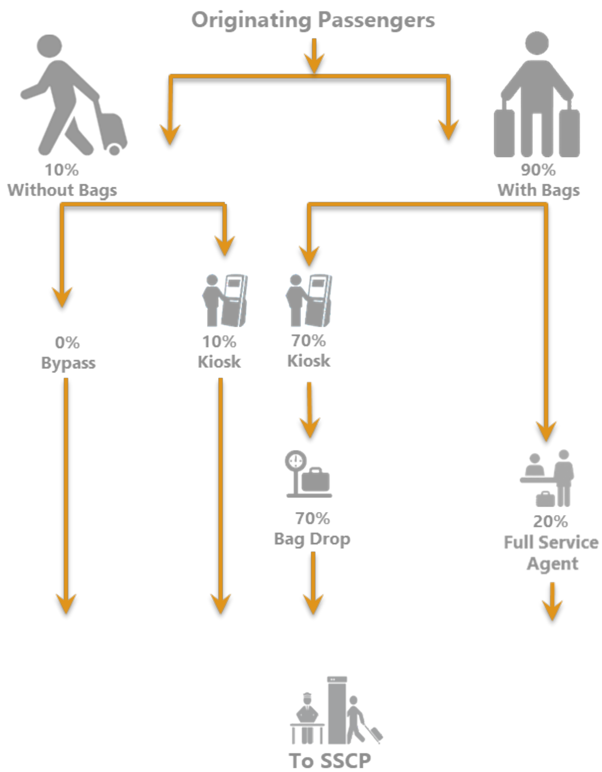
EXHIBIT 4-25 PASSENGER CHECK-IN OPERATING PARAMETERS: OTHER DOMESTIC AIRLINES



CHECK-IN TYPE	PERCENTAGE	AVERAGE TOTAL TIME IN PROCESS
Bypass	30%	0 minutes
Kiosk	10%	6 minutes
Baggage Acceptance Point	45%	10 minutes
Full-Service Agent	15%	14 minutes

SOURCES: Ricondo & Associates, Inc. June 2019.

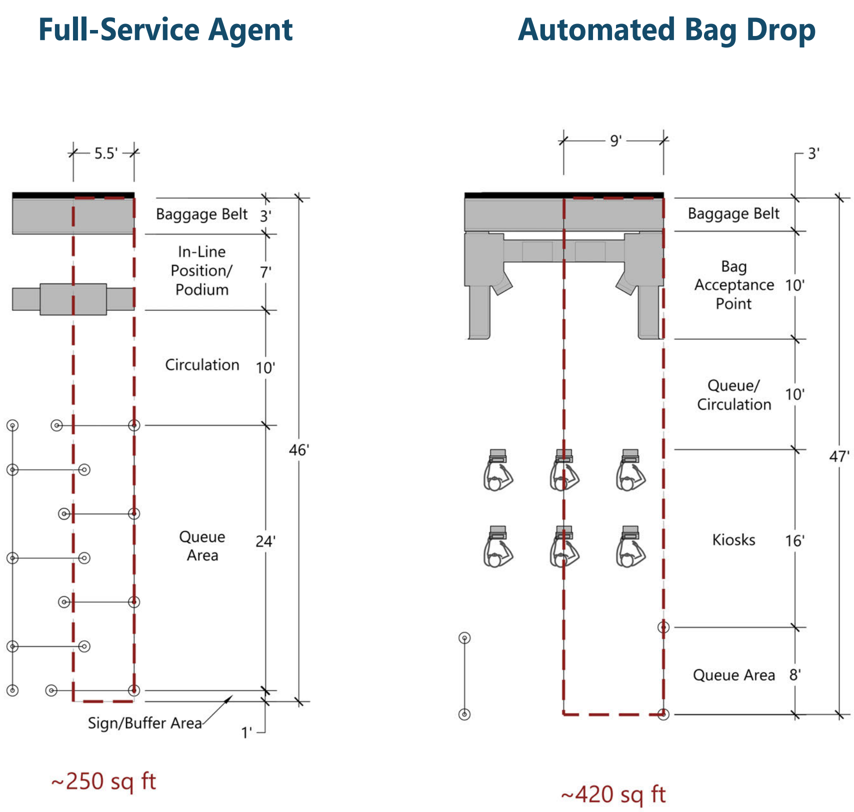
EXHIBIT 4-26 PASSENGER CHECK-IN OPERATING PARAMETERS: INTERNATIONAL AIRLINES



CHECK-IN TYPE	PERCENTAGE	AVERAGE TOTAL TIME IN PROCESS
Bypass	0%	0 minutes
Kiosk	10%	6 minutes
Bag Drop	70%	10 minutes
Full-Service Agent	20%	14 minutes

SOURCES: Ricondo & Associates, Inc. June 2019.

EXHIBIT 4-27 CHECK-IN SPACE TEMPLATE



SOURCES: Airport Cooperative Research Program, *Report 25: Air Passenger Terminal Planning and Design, Volume 1: Guidebook*, 2010 (critical dimensions); Benchmarking studies from comparable airports, Ricondo & Associates, Inc., June 2019 (throughput and space template).

4.5.2.2 BAGGAGE HANDLING SYSTEM

The Baggage Handlining System (BHS) consists of outbound and inbound baggage sortation and delivery systems. Requirements for the BHS include the necessary inbound and outbound units and the estimated area needed to sort and handle baggage at each unit. System type and conveyor/track layouts will determine space requirements for connecting and sorting elements. The requirements described in the following subsections represent individual processing areas and do not necessarily reflect total area requirements, as rights-of-way for conveyance elements depend on specific terminal configurations.

Outbound Baggage Handling Facilities

Outbound BHS facilities consist of baggage make-up equipment, areas for staging and loading baggage carts, and baggage cart drive (circulation) aisles. Outbound baggage make-up devices at the Airport currently consist of carousels that allow baggage to continuously circulate, which provides storage capacity and staging areas for carts. Carousels can be either flat plate or slope plate units. Slope plate units provide greater capacity, while flat plate units are more ergonomically-sound for agents. Make-up devices can also be configured as piers or chutes, which have less storage capacity. Carts can be staged either parallel to make-up devices or perpendicularly, if there is sufficient width in the aisles between devices. Many airlines prefer a parallel staging layout.

Bag make-up requirements were based on the maximum number of carts staged for all flights during individual airline peak periods, and the minimum area required per cart, including the outbound baggage device. Cart requirements by flight were derived using cart staging metrics indicated in **Table 4-35**. Operational parameters used to determine requirements for outbound baggage make-up carts are listed in **Table 4-36**. The area per cart includes cart area, drive lanes and belts area.

TABLE 4-35 EXAMPLE NUMBER OF CARTS PER AIRCRAFT

EXAMPLE AIRCRAFT TYPE	MAXIMUM CARTS STAGED
Airbus A319	3
Airbus A320/A321	4
Airbus A330	6
Airbus A350	8
Airbus A380	10
Boeing 737	4
Boeing 757	5
Boeing 767	6
Boeing 787	8
Canadair Regional Jet CRJ700/900	2
Embraer 190	2
McDonnell Douglas MD-82/83/88	4

SOURCES: Benchmarking studies of comparable airports, Ricondo & Associates, Inc., June 2019.

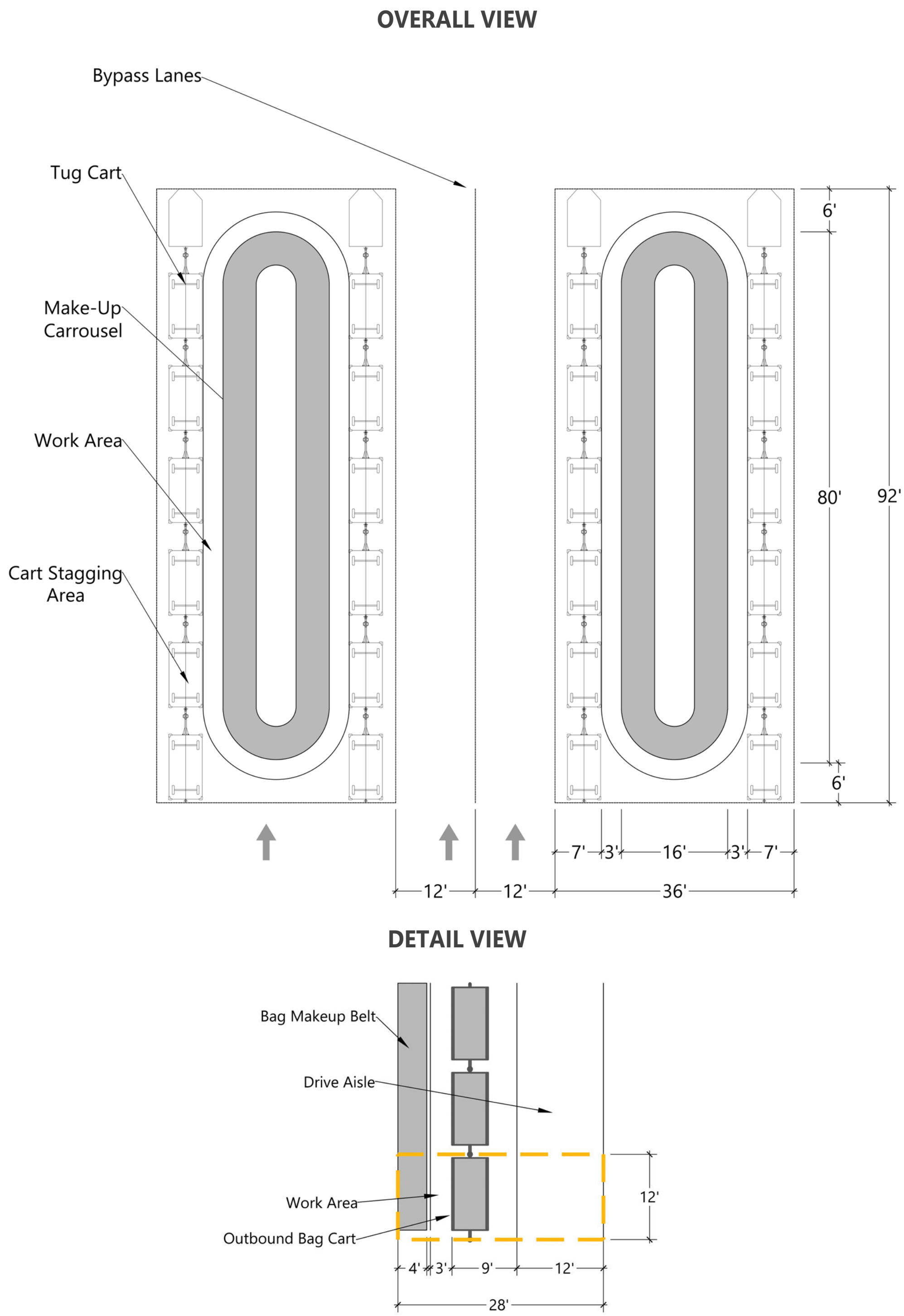
TABLE 4-36 OUTBOUND BAGGAGE MAKE-UP OPERATING PARAMETERS

MINUTES PRIOR TO SCHEDULED DEPARTURE TIME	PERCENT OF FLIGHT CARTS STAGED	AREA PER CART (SQ FT)
120-100	50%	400
90-30	100%	400

NOTE: Area per Cart includes cart area, drive lanes, and belts area.
SOURCE: Benchmarking studies of comparable airports, Ricondo & Associates, Inc., June 2019.

Exhibit 4-28 illustrates the template used to develop space requirements for a typical outbound baggage area. The make-up area includes space for baggage carts, conveyor equipment, work area, and cart staging. Adjacent bypass lanes, which provide access around outbound devices, are included as well. Drive aisles require operational clearances, which are outlined as a component of circulation.

EXHIBIT 4-28 OUTBOUND BAGGAGE MAKE-UP SPACE TEMPLATE



SOURCE: Airport Cooperative Research Program, Report 25: *Air Passenger Terminal Planning and Design, Volume 1: Guidebook*, 2010 (critical dimensions).

Critical outbound make-up dimension clearances include:

- **Baggage Carts**. Baggage carts have lengths between 11 and 15 feet (with the tow bar down) and widths of between 5 feet 7 inches to 5 feet 9 inches.
- **Baggage Containers/Dollies**. Containers/dollies are commonly used for widebody aircraft. Containers are carried on dollies that typically have a length of 13 feet 6 inches (with the tow bar down) and width of approximately 6 feet.
- **Work Area**. The area between the carousel and the staged carts, used by workers to load bags, should provide a work aisle that is at least 3 feet wide, with 7 feet of vertical clearance.

Inbound Baggage Handling Facilities

The space for the offload pier serving each baggage claim device includes baggage cart circulation and parking, work area, and offload conveyor. A minimum of one inbound feed per baggage claim device is required. **Table 4-37** lists inbound baggage offload device operating parameters. **Exhibit 4-29** illustrates the inbound baggage claim device space template that was used for developing the space requirements.

TABLE 4-37 INBOUND BAGGAGE OFFLOAD DEVICE OPERATING PARAMETERS

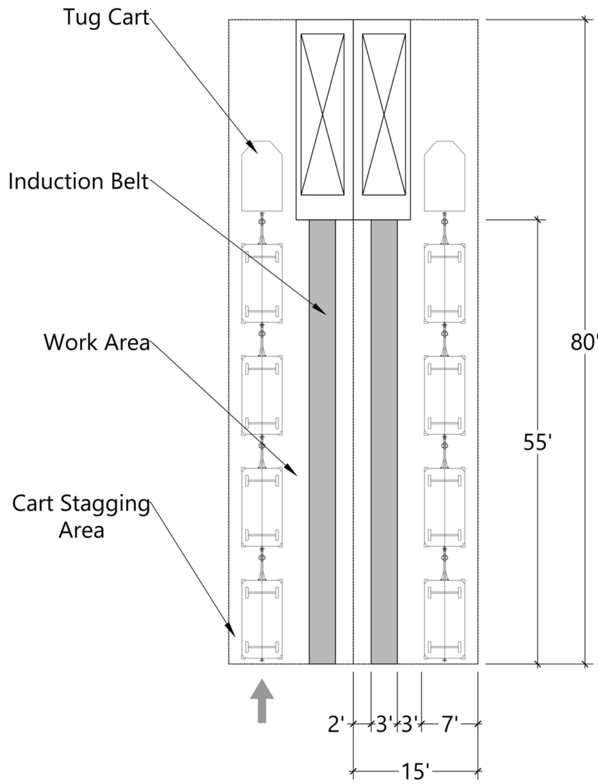
	UNITS	OPERATING PARAMETER
Number of Inbound Piers per Claim Device	each	1
Area per Pier	sq ft	1,200

SOURCES: Benchmarking studies of comparable airports, Ricondo & Associates, Inc. June 2019.

The offload zone includes the following components:

- **Offload Conveyor**. Conveyor equipment is used to transport bags from the baggage carts to the baggage claim device. Conveyor length can vary to accommodate different numbers of carts.
- **Cart Parking**. This area is typically the width of a tug road (approximately 10 to 12 feet wide) and is required for carts to park and bags to be unloaded; carts usually park parallel with the induction belt.
- **Work Area**. Space where bag agents unload bags onto the induction belt, located directly between cart staging and the belt, with a typical clearance of 3 feet.

EXHIBIT 4-29 INBOUND BAGGAGE SPACE TEMPLATE



SOURCE: Airport Cooperative Research Program, Report 25: *Air Passenger Terminal Planning and Design, Volume 1: Guidebook*, 2010 (critical dimensions).

4.5.2.3 BAGGAGE CLAIM

Baggage claim requirements include the linear feet of presentation frontage at the carousels and associated retrieval areas. The number of devices is dependent on the building configuration and the size of aircraft being served. Baggage claim requirements are based on the peak accumulation of terminating passengers that have checked bags. This peak volume of passengers is based on the time required for baggage to travel from the aircraft to the baggage claim device, which is assumed to be 20 minutes based on airline metrics and observations. **Table 4-38** summarizes operating parameters for domestic baggage claim.

TABLE 4-38 DOMESTIC BAGGAGE CLAIM OPERATING PARAMETERS

ASSUMPTION	OPERATING PARAMETER
Load Factor	varies by flight
Passengers with Checked Bags	varies by flight
Typical Claim Device Length	170 ft
Typical Claim Device Area	2,740 sq ft
Area per Passenger	18 sq ft

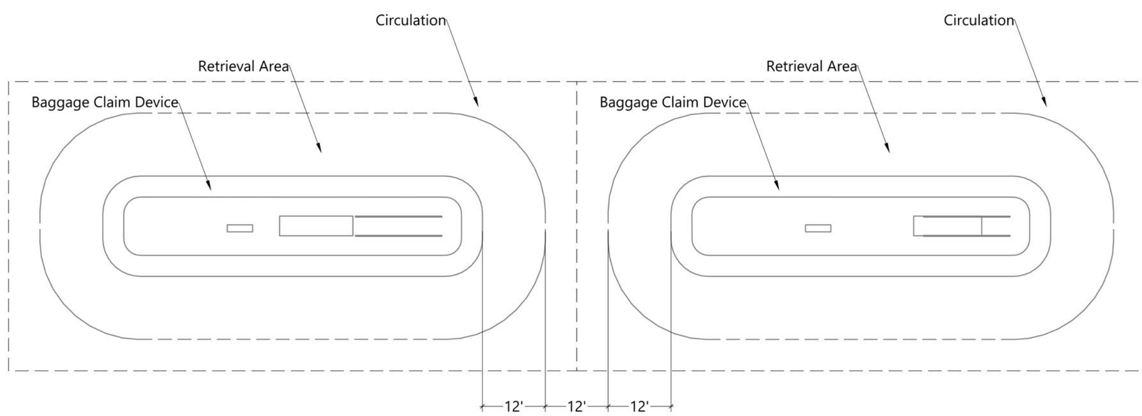
SOURCE: Benchmarking studies of comparable airports, Ricondo & Associates, Inc. June 2019.

No specific requirements are defined for international bag claim because the redevelopment of Concourse E, planning and design of which is underway at the time of this analysis, will include international bag claim balanced to other international arrivals processes and gates.

Requirements for domestic bag claim devices first looked at utilization of existing devices. Requirements for number of new baggage claim units, if needed, were based on a single, indicative unit size to allow for flexibility in future facility configuration and utilization. Final planned baggage claim device size and utilization may vary based on air service characteristics (aircraft size, percentage of terminating passengers), building configuration/constraints, and the number of airlines using a baggage claim area. **Exhibit 4-30** depicts an indicative new baggage claim device for illustrative purposes. Elements of the baggage claim device include:

- **Baggage Claim Device and Retrieval Area**. The area allocated to a single claim device includes the space occupied by the equipment and the minimum recommended clearance between the equipment and adjoining devices, walls, or general circulation corridors. A minimum 12 feet of clearance from the face of the device is required to provide passengers access to and egress from individual devices.
- **Circulation**. A minimum 12-foot circulation corridor between active retrieval areas should be provided for passengers and non-passengers moving between baggage claim devices. This area must be free of any obstructions to allow access to and egress from individual devices.

EXHIBIT 4-30 INDICATIVE DOMESTIC BAGGAGE CLAIM DEVICE SPACE TEMPLATE



SOURCE: Airport Cooperative Research Program, Report 25: *Air Passenger Terminal Planning and Design, Volume 1: Guidebook*, 2010 (critical dimensions); Ricondo & Associates, Inc., June 2019.

Holdrooms

Holdrooms consist of the preboarding areas adjacent to aircraft gates, which are used for passenger seating and standing, airline agent check-in podiums, and boarding/deplaning queuing spaces and aisles. Holdroom requirements are based on the predominant or largest aircraft supported by the holdroom. For this analysis, requirements for existing gates were only evaluated if the size of aircraft changed. **Table 4-39** lists other planning factors that were applied to the respective aircraft seating capacities in order to develop the individual holdroom space requirements to support a new gate. Each new ADG-III gates would require approximately 2,520 square feet.

TABLE 4-39 HOLDROOM PLANNING CRITERIA

PLANNING FACTORS	UNITS	VALUE	SOURCE
Adjoining holdroom credit	percent	0.9	Airport Cooperative Research Program
Agent counter area [1]	square feet	120.0	Airport Cooperative Research Program
Agent counter positions	positions	2.0	Airport Cooperative Research Program
Aisleway [2]	square feet	180.0	Airport Cooperative Research Program
Aisleway	row	1.0	Airport Cooperative Research Program
Holdroom Calculation [3]			
Seated	percentage	60.0	International Air Transport Association
Standing	percentage	20.0	International Air Transport Association
Seated	square feet	18.0	International Air Transport Association
Standing	square feet	12.0	International Air Transport Association
Queuing	square feet	11.0	International Air Transport Association

NOTES:
1 Based on 4 feet wide by 30 feet deep.
2 Based on 6 feet wide and 30 feet deep.
3 Based on 60 percent seated, 20 percent standing, and 30 percent queuing.
SOURCES: Airport Cooperative Research Program, Report 25, *Air Passenger Terminal Planning and Design, Vol. 1, Guidebook, 2010. International Air Transport Association, Airport Development Reference Manual,* 10th ed., May 2019.

4.5.2.4 DEPARTMENT OF HOMELAND SECURITY

As a result of the November 2001 Aviation and Transportation Security Act, the Department of Homeland Security (DHS) maintains in-terminal facilities to conduct airline security screening principally related to the passenger SSCPs, baggage screening areas, and Port of Entry (POE) security. DHS terminal facility requirements are based on the following design guidelines and standards:

- Transportation Security Administration, *Recommended Security Guidelines for Airport Planning, Design and Construction*, June 15, 2006.
- Transportation Security Administration, *Checkpoint Requirements and Planning Guide (CRPG)*, December 17, 2018.
- U.S. Customs and Border Protection, Airport Technical Design Standards, November 2018.

The Transportation Security Administration (TSA) is responsible for enforcing and regulating passenger and baggage screening at the Airport. Facility templates and guidelines published by DHS were referenced to develop space requirements for accommodating equipment as well as passenger queuing and support areas. Although the TSA has direct responsibility for determining the size and configuration of the passenger SSCPs and baggage screening facilities at the Airport, the agency typically collaborates with airport management to plan locations and passenger screening programs.

Passenger Screening Checkpoint

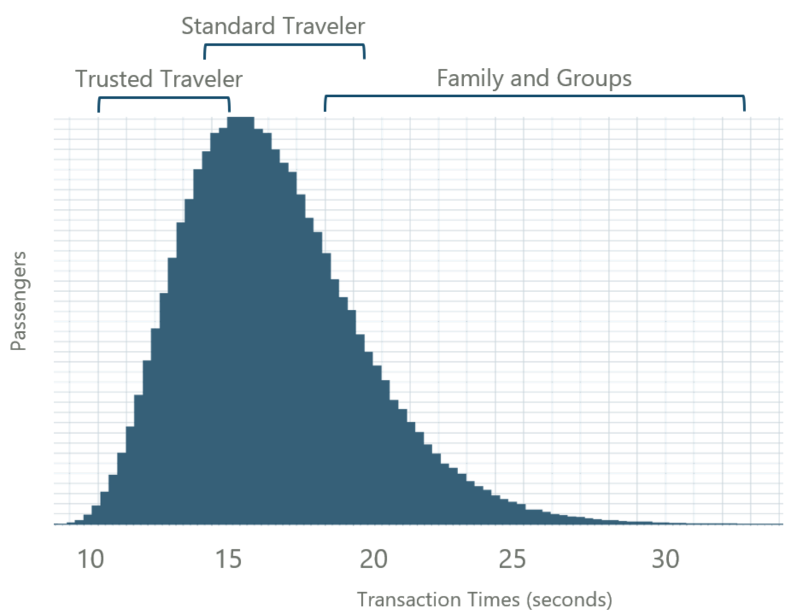
Unit requirements for SSCPs were based on TSA goals for wait time and expected passenger processing rates. Currently, the Airport operates standard/legacy screening, the Trusted Traveler Program (Pre✓®), and CLEAR®

screening lanes. DHS offers the Trusted Traveler Program to enhance security and system efficiency while improving the passenger experience.

Future processing rates and program utilization percentages are unknown, as screening technology and passenger eligibility for these programs continues to evolve. To simplify processing variables and provide a realistic assessment of lane and area requirements over time, an average throughput rate was adopted to represent a blended rate for advanced technologies, Pre✓®, family, oversized carry-on, and Americans with Disabilities Act passengers. This methodology allows for the randomization of processing times for individual passengers and Trusted Traveler Program distributions, resulting in a blended average throughput rate of a collective SSCP based on TSA goals/objectives and observed performance of each lane type. **Exhibit 4-31** illustrates the distribution for security screening processing rates. **Table 4-40** presents the assumed SSCP operating parameters.

Airport employees and flight crews were assumed to have a nominal impact on checkpoint demand and would utilize Trusted Traveler Program lanes or a supplemental employee lane.

EXHIBIT 4-31 REPRESENTATIVE PROCESSING RATE DISTRIBUTION EXAMPLE



SOURCE: Benchmarking studies of comparable airports, Ricondo & Associates, Inc. June 2019.

TABLE 4-40 PASSENGER SECURITY SCREENING CHECKPOINT OPERATING PARAMETERS

ASSUMPTION	UNITS	OPERATING PARAMETER
Average Throughput Rate	passengers/hour/lane	205
Waiting Time Goal	minutes	10
Queue Capacity	minutes	20
Area per Passenger in Queue	sq ft	10.8

SOURCES: Airport Cooperative Research Program, Report 25: *Air Passenger Terminal Planning and Design, Volume 1: Guidebook*, 2010 (critical dimensions); Ricondo benchmarking from comparable airports, April 2019; Transportation Security Administration, Inc., February 2018 (rates).

Exhibit 4-32 illustrates the space template for the current SSCP configuration. The key metric for SSCP templates is the depth and width of available area per lane. Adequate area and building infrastructure to accommodate new technologies, protocols, and configurations must be considered. TSA is allowing for deployment of Automated Screening Lane, funded by airports. These lanes increase the throughput per lane but are large in both depth and width. The SSCP area should be open, flexible, and capable of incremental expansion. The template module used to derive space requirements for passenger security screening includes:

- **Queue Area and Document Check Podiums**. Each lane includes one ticket and document check podium. While the waiting time goal is 10 minutes, the TSA recommends preserving a queue capacity of 20 minutes to account for delays in opening lanes and surges during peak periods.
- **Security Screening Area**. This area consists of divesting tables, metal detectors, X-ray equipment, advanced imaging technology (AIT) devices, secondary search/examination space, and a recompose area.

The template does not include TSA administrative areas or corollary areas for AIT workstations, technical support space, or common exit circulation corridors beyond the recompose area. The TSA support area requirements are based on the TSA's *Checkpoint Design Guide*, which recommends approximately 150 square feet per screening lane.

Baggage Screening

The Aviation and Transportation Security Act requires that all checked baggage be screened for explosives through Explosives Detection System machines. The TSA recommends locating baggage screening rooms away from critical services, utilities, and distribution systems. An in-line baggage system consists of an integrated conveyor system that provides sufficient bag queuing capacity for on-screen resolution while maintaining high throughput and accurate bag tracking.

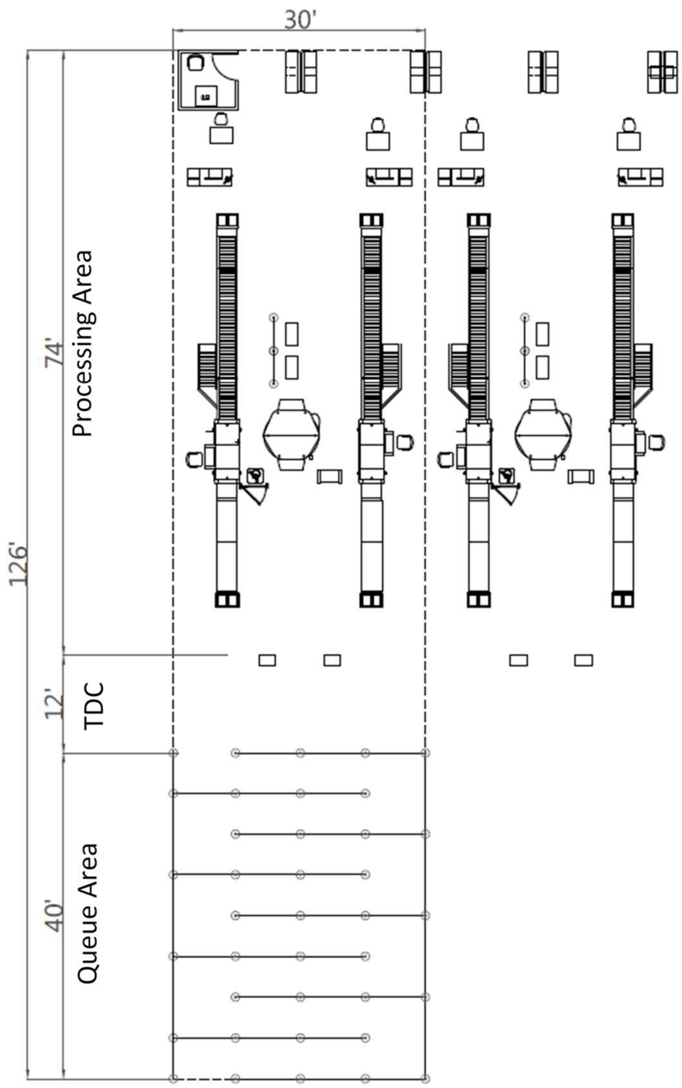
The baggage screening facility requirements were sized for activity using simulation modeling. Equipment requirements are based on surged flows, derived by multiplying the baggage flow by a surge factor. The use of a surge factor captures the intrinsic variance of baggage demand and ensures that equipment requirements are not undersized. **Table 4-41** summarizes the baggage screening facility operating parameters.

TABLE 4-41 CHECKED BAGGAGE SCREENING FACILITY OPERATING PARAMETERS

ASSUMPTION	UNITS	OPERATING PARAMETER
Screening Rate per Device	Bags per Hour	400-680
Number of EDS Devices	Devices	Required Devices +1
Area per EDS Device	Sq Ft	6,500

SOURCE: Transportation Security Administration, *Planning Guidelines and Design Standards for Checked Baggage Inspection Systems* Version 5.0, July 2016.

EXHIBIT 4-32 PASSENGER SECURITY SCREENING CHECKPOINT SPACE TEMPLATE



SOURCE: Transportation Security Administration, *Checkpoint Requirements and Planning Guide (CRPG)*, December 17, 2018

U.S. Customs and Border Protection

All international arriving passengers must be processed at a Port of Entry (POE) prior to entering the United States, whether they are terminating their journey at the Airport or connecting to a domestic flight. The POE at the Airport is a fully independent facility, with CBP administrative offices and facilities, capable of processing both terminating and connecting passengers. CBP requirements are based on current CBP published standards and accepted practices, planned as 400 peak hour passengers to accommodate projected demand. The Airport is currently developing a new international arrivals facility as part of the redevelopment of Concourse E and analysis of international arrivals will not be included in the MPU given the independent planning effort; however, conclusions reached in that project will be summarized or identified in the MPU if they are available before its completion.

4.5.2.5 SUPPORT AND OTHER SPACES

The following information details how requirements were determined for airline and Airport support spaces, as well as for passenger amenities. Support space includes Airport offices and operations areas (relating to the operation and maintenance of the Airport), Airline Ticket Offices (ATOs), Baggage Service Offices (BSOs), and commercial support spaces. Passenger amenities include public restrooms and commercial programs. Requirements were developed from planning factors based on the existing terminal and verified using industry standards. **Table 4-42** summarizes the planning assumptions for each space defined below and do not reflect individual airline or tenant needs.

TABLE 4-42 SUPPORT SPACE OPERATING PARAMETERS

SPACE	VALUE	UNIT	NOTE
Airline Ticket Office	20	square feet	per linear processing
Baggage Service Office	150	square feet	per domestic baggage claim device
Airline Operations and Support	1,150	square feet	per narrowbody equivalent gate
Commercial Program	10	square feet	per 1,000 annual enplaned passengers
Airport Support & Amenities	15,400	square feet	per 5 million enplaned annual passengers
Public Restrooms	750	square feet	per gate
Amenities	3,600	square feet	per 5 million enplaned annual passengers
Building Services	18%	percent	of functional area subtotal
Circulation	48%	percent	of functional area subtotal

SOURCE: Existing Terminal Plans, April 2019; Benchmarking studies of comparable airports, Ricondo & Associates, Inc., June 2019.

Airline support facilities include the following:

- **Airline Ticket Offices**. Requirements were based on ACRP recommendations and were adjusted to reflect an industry trend toward remote offices and other technological advancements.
- **Baggage Service Offices.** ACRP recommendations and other industry standards recommend 150 square feet per domestic baggage claim device, which includes baggage storage and lockers located near the claim devices. Future requirements were increased proportionally with baggage claim growth.
- **Airline Operations and Support.** Based on current lease areas, each gate has approximately 1,400 square feet.

Commercial Program

Requirements were based on the existing ratio of 10 square feet per 10,000 annual enplaned passengers. The planning factor includes food, beverage, specialty retail, services, convenience retail, and duty-free. Support and storage areas for commercial programs were based on the ACRP-recommendation of 10 to 15 percent of the leasable commercial program space.

Airport Support , Sheriff Station and Amenities

The planning factor used to extrapolate Airport Support space, was based on industry benchmarks. Airport support needs were increased proportionally every 5 million annual passengers to reflect incremental facility growth through the 2040 planning horizon.

Public Restrooms

Public restrooms should be distributed throughout the public areas of the terminal, spaced no more than 400 feet apart, providing for a maximum walking distance of 200 feet to a restroom. Each location should include men's and women's restrooms, and a separate family, companion care, or gender-neutral restroom. Restroom assumptions reflect metrics provided in ACRP Report 130.[8] Total restroom requirements were based on 100 square feet per fixture. Future restroom requirements were incrementally increased, based on future gate requirements.

Building Services

Requirements for mechanical, electrical, and plumbing were based on 18 percent of the subtotal of functional terminal areas, based on current areas.

Circulation

Circulation requirements were based on 18 percent of the sub-total of functional areas, based on current areas.

4.5.3 TERMINAL PROGRAM

Table 4-43 summarizes terminal facility requirements. Information gathered through existing conditions and industry metrics was used to extrapolate future requirements for airline offices and lounges, concessions, building services, and circulation areas. The fluid nature of airline gate/facility assignments and the range of activity forecast (baseline forecast and high scenario) will influence facility requirements over the planning horizon. The current terminal has a large amount of unassigned area on Concourse D. This area might be able to be used for some airline and Airport support needs in the future. A 10 percent increase representing Design Configuration Contingency for future years has been added to reflect inefficiency in future programming and unusable space occupied by elements such as columns and shafts.

8 ACRP Report 130, *Guidebook for Airport Terminal Restroom Planning and Design*, 2015.

TABLE 4-43 TERMINAL PROGRAM

			BASELINE FORECAST			HIGH SCENARIO		
FUNCTIONAL AREA	UNITS	EXISTING	PAL 1	PAL 2	PAL 3	PAL 1	PAL 2	PAL 3
Airline Facilities								
Check-in	sq ft	13,884	18,500	19,250	20,750	19,250	20,000	23,000
Baggage Handling System	sq ft	92,397	95,800	100,600	104,600	95,800	101,800	107,400
Domestic Baggage Claim	sq ft	19,468	19,500	19,500	19,500	19,500	19,500	19,500
Airline Support	sq ft	50,516	49,130	50,640	51,360	49,490	51,000	52,440
Holdroom [1]	sq ft	56,392	63,952	66,472	66,472	63,952	66,472	66,472
Airline Club	sq ft	5,002	5,000	5,000	5,000	5,000	5,000	5,000
Department of Homeland Security								
Transportation Security Administration								
Checkpoint Total Area [2]	sq ft	21,647	18,900	22,680	22,680	18,900	22,680	26,460
Checked Baggage Screening	sq ft	22,942	21,600	21,600	27,000	21,600	21,600	27,000
Customs and Border Protection [3]	sq ft	26,000	26,000	26,000	26,000	26,000	26,000	26,000
Other Areas								
Commercial Program	sq ft	57,203	40,000	44,000	54,000	45,000	51,000	69,000
Airport Admin / Support	sq ft	53,769	54,000	54,000	54,000	54,000	54,000	54,000
Restrooms	sq ft	23,908	26,250	27,000	27,000	26,250	27,000	27,000
Building Services	sq ft	85,708	84,840	88,340	92,520	86,020	90,140	97,340
Circulation	sq ft	225,700	223,410	232,630	243,650	226,520	237,380	256,330
Amenities	sq ft	8,149	8,100	8,100	16,200	8,100	16,200	16,200
Sheriff Station	sq ft	9,271	4,300	4,300	4,300	4,300	4,300	4,300
Unassigned	sq ft	56,778						
Design/Configuration Contingency (10%)	sq ft	n/a	75,930	79,010	83,500	76,970	81,410	87,740
TOTAL	**sq ft**	**809,266**	**701,400**	**729,800**	**773,700**	**712,100**	**754,200**	**815,300**

NOTES:
1 Holdroom requirements based on Gating Scenarios 2 and 3.
2 Based on Concourse-specific checkpoints.
3 Placeholder until definition of Concourse E Redevelopment Program is complete.
Numbers are rounded
PAL – Planning Activity Level (PAL1 – 2023; PAL2 – 2028; PAL3 – 2040).
SOURCE: Ricondo & Associates, Inc., June 2019.

The following subsections describe the facility requirements for individual functional areas, based on the planning parameters described in earlier subsections.

4.5.3.1 AIRLINE FACILITIES

Requirements for airline-operated facilities were developed from methodologies consistent with IATA's *Airport Development Reference Manual*, 11th edition [9], and from ACRP Report 25, *Airport Passenger Terminal Planning and Design, Volume 1: Guidebook*.

Check-in

Dynamic modeling was used to generate peak check-in activity for passengers and baggage based on the baseline forecast and high scenario DDFSs and the Airport-specific operational and passenger attributes. Requirements represent the number of units needed to process forecast passenger and baggage demand within the predefined LOS objectives, refer to Section 4.5.1.2, Level-of-Service Framework. Check-in was evaluated using three allocation methods:

1. Full Common Use – Airlines are assigned the number of counters they require during the peak period
2. Limited Common Use – Large airlines have full assignment of positions based on a preferred allocation. Small carriers who do not require positions throughout the day are using common use positions. This is similar to today's operations.
3. No Common Use – All positions are assigned to carriers thought the day as preferential use positions.

Table 4-44 outlines the overall check-in program requirements.

TABLE 4-44 CHECK-IN REQUIREMENTS

FUNCTIONAL AREA	UNITS	EXISTING	BASELINE FORECAST			HIGH SCENARIO		
			PAL 1	PAL 2	PAL 3	PAL 1	PAL 2	PAL 3
Baggage Acceptance Points (Full Common Use)	each	74	55	55	65	55	61	72
Baggage Acceptance Points (Limited Common Use)	each	74	74	77	83	77	80	92
Baggage Acceptance Points (No Common Use)	each	74	89	98	106	95	98	133
Total Passenger Processing Area[1/]	sq ft	13,880	18,500	19,250	20,750	19,250	20,000	23,000
ATO space [1]	sq ft	7,042	8,880	9,240	9,960	9,240	9,600	11,040

NOTES: Numbers are rounded.
1 Area requirements based on Limited Common Use allocation
2 PAL – Planning Activity Level (PAL1 – 2023; PAL2 – 2028; PAL3 – 2040).
SOURCE: Ricondo & Associates, Inc., June 2019.

[9] International Air Transport Association, *Airport Development Reference Manual*, 11th ed., April 2019.

Baggage Handling System

The BHS comprises outbound and incoming baggage systems. The outbound system is comprised of baggage screening and make up devices. The inbound system includes area offload piers which feed the claim devices. Both include some provision for drive area. Other drive areas are covered, unenclosed areas which are used by tugs and other service vehicles under the building. **Table 4-45** summarizes the BHS requirements.

TABLE 4-45 BAGGAGE HANDLING SYSTEM REQUIREMENTS

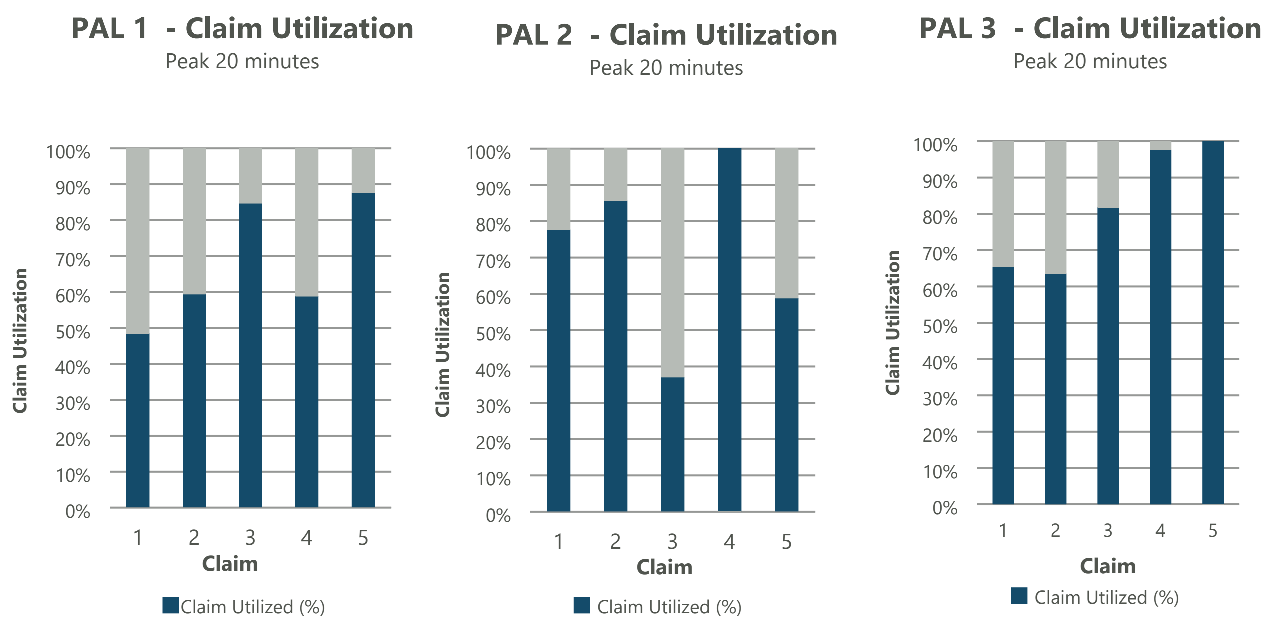
			BASELINE FORECAST			HIGH SCENARIO		
	UNITS	EXISTING	PAL 1	PAL 2	PAL 3	PAL 1	PAL 2	PAL 3
Peak Flights in Make-up		26	26	28	30	26	29	32
Outbound Carts Required	each	78	81	93	103	81	96	110
Outbound Baggage Handling Area	sq ft	29,002	32,400	37,200	41,200	32,400	38,400	44,000
Inbound Offload Devices	each	5	5	5	5	5	5	5
Inbound Baggage Handling Area	sq ft	24,832	24,800	24,800	24,800	24,800	24,800	24,800
Other Drive Area	sq ft	38,563	38,600	38,600	38,600	38,600	38,600	38,600
Bag Service Offices	sq ft	900	750	750	750	750	750	750

NOTES: Numbers are rounded.
1 PAL – Planning Activity Level (PAL1 – 2023; PAL2 – 2028; PAL3 – 2040).
SOURCE: Ricondo & Associates, Inc., June 2019.

Domestic Baggage Claim

Exhibit 4-33 shows the forecast peak 20-minute bag claim utilization for each of the five baggage claim areas. Baggage claim requirements are outlined in **Table 4-46**. The bag claim analysis indicates that existing claim units are adequate to meet forecast demand over the planning horizon based on the utilization of the claim units and projected occupancy of the claim area. However, by approximately 2040, two of the five claim units will be fully utilized to accommodate the DDFSs (baseline forecast and high scenario), suggesting that additional claim units may be required shortly after 2040 (PAL 3).

EXHIBIT 4-33 DOMESTIC BAGGAGE CLAIM UTILIZATION



SOURCE: Ricondo & Associates, Inc., June 2019.

TABLE 4-46 BAGGAGE CLAIM REQUIREMENTS

			BASELINE FORECAST			HIGH SCENARIO		
	UNITS	EXISTING	PAL 1	PAL 2	PAL 3	PAL 1	PAL 2	PAL 3
Rolling 20-minute Operations	Operations	N/A	8	8	9	8	8	9
Rolling 20-minute Passengers	Passengers	N/A	550	560	740	660	570	760
Baggage Claim Devices	Units	5	5	5	5	5	5	5
Baggage Claim Area	Square Feet	19,468	19,500	19,500	19,500	19,500	19,500	19,500

NOTES:
1 Numbers are rounded
2 PAL – Planning Activity Level (PAL1 – 2023; PAL2 – 2028; PAL3 – 2040).
SOURCE: Ricondo & Associates, Inc., June 2019.

It is important to recognize that the baggage claim requirements were based on current passenger baggage-check characteristics, which are highly dependent on airline practices related to checked-bag fees. Changes in these fees by individual or multiple airlines could significantly affect future demand for baggage facilities and should be monitored closely. Utilization for Bag claim is similar for both the baseline forecast and high scenario.

Holdrooms

The requirements for holdrooms were based on the gate requirements, presented in Section 4.4.1, Aircraft Gate Requirements. The space requirements for a narrowbody holdroom based on IATA planning guidelines is shown in **Table 4-47**.

TABLE 4-47 HOLDROOM REQUIREMENTS

			BASELINE FORECAST			HIGH SCENARIO		
	UNITS	EXISTING	PAL 1	PAL 2	PAL 3	PAL 1	PAL 2	PAL 3
Gating Scenario 1								
Gates	each	32	35	36	38	35	37	42
Holdrooms	sq ft	56,392	63,950	66,470	71,510	79,070	84,110	96,710
Gating Scenario 2								
Gates	each	32	35	36	36	35	36	36
Holdrooms	sq ft	56,392	63,592	66,472	66,472	63,592	66,472	66,472
Gating Scenario 3								
Gates	each	32	35	36	36	35	36	36
Holdrooms	sq ft	56,392	63,952	66,472	66,472	63,952	66,472	66,472

NOTES:
1 Numbers are rounded
2 PAL – Planning Activity Level (PAL1 – 2023; PAL2 – 2028; PAL3 – 2040).
SOURCE: Ricondo & Associates, Inc., June 2019.

Airline Support

Airline support areas include, without limitation, ATOs, BSOs, and other operational space not listed on previous tables. Support space requirements are directly proportional to the requirements of the associated functional facility. The requirements listed in **Table 4-48** are aggregated and do not reflect individual airline needs.

TABLE 4-48 AIRLINE SUPPORT AREA REQUIREMENTS

			BASELINE FORECAST			HIGH SCENARIO		
	UNITS	EXISTING	PAL 1	PAL 2	PAL 3	PAL 1	PAL 2	PAL 3
Club/Lounge	sq ft	5,002	5,000	5,000	5,000	5,000	5,000	5,000
Operations and Support	sq ft	36,876	40,250	41,400	41,400	40,250	41,400	41,400

NOTES:
1 Numbers are rounded
2 PAL – Planning Activity Level (PAL1 – 2023; PAL2 – 2028; PAL3 – 2040).
SOURCE: Ricondo & Associates, Inc., June 2019.

4.5.3.2 DEPARTMENT OF HOMELAND SECURITY FACILITIES

Requirements for the DHS security facilities were based on DHS-published facility templates and guidelines, as well as specific operating parameters outlined below.

Transportation Security Administration – Security Screening

Space requirements necessary to accommodate TSA equipment, support facilities, passenger processing, and queueing areas are listed in **Table 4-49**, reflecting both existing units and future requirements. Checkpoint requirements were analyzed using two different allocations. First was continuing the concourse-specific checkpoint locations with no abilities to balance demand between the checkpoints. This is how the airport currently operates. The second was to consider the requirements based on a single consolidated checkpoint. In this case, all passengers would be processed through a single location with access to all gates. This allows TSA to operate more efficiently because it allows a balancing of the demand for each concourse. All passengers using the future Concourse E gates are planned to use existing Concourse D security screening checkpoint because of the limited operations planned on new gates Concourse E.

TABLE 4-49 PASSENGER SECURITY SCREENING REQUIREMENTS

			BASELINE FORECAST			HIGH SCENARIO		
	UNITS	EXISTING	PAL 1	PAL 2	PAL 3	PAL 1	PAL 2	PAL 3
Concourse C Total Checkpoint								
Checkpoint Lanes	lanes	5	5	6	6	5	6	7
Total Passenger Processing Area	sq ft	10,481	9,450	11,340	11,340	9,450	11,340	13,230
Concourse D Total Checkpoint								
Checkpoint Lanes	lanes	6	5	6	6	5	6	7
Total Passenger Processing Area	sq ft	11,166	9,450	11,340	11,340	9,450	11,340	13,230
Consolidated Total Checkpoint Area								
Checkpoint Lanes	lanes	n/a	9	9	11	9	9	11
Total Passenger Processing Area	sq ft	n/a	17,010	17,010	20,790	17,010	17,010	20,790

NOTES:
Numbers are rounded
PAL – Planning Activity Level (PAL1 – 2023; PAL2 – 2028; PAL3 – 2040).
SOURCE: Ricondo & Associates, Inc., June 2019.

Transportation Security Administration – Checked Baggage Screening

The use of a surge factor is recommended by the TSA Planning Guidelines and Design Standards Version 6.0, September 29, 2017, for Checked Baggage Inspection Systems to capture the intrinsic variance of baggage demand and ensure that equipment requirements are not undersized. **Table 4-50** summarizes the baggage screening facility requirements.

TABLE 4-50 CHECKED BAGGAGE SECURITY SCREENING REQUIREMENTS

			BASELINE FORECAST			HIGH SCENARIO		
	UNITS	EXISTING	PAL 1	PAL 2	PAL 3	PAL 1	PAL 2	PAL 3
Checked Baggage Screening Devices	each	4	3	3	4	3	3	4
Processing Area	square Feet	21,781	16,200	16,200	21,600	16,200	16,200	21,600

NOTE:
1 Numbers are rounded
2 PAL – Planning Activity Level (PAL1 – 2023; PAL2 – 2028; PAL3 – 2040).
SOURCE: Ricondo & Associates, Inc., June 2019.

U.S. Customs and Border Protection

The Airport is currently developing a new international arrivals facility as part of the redevelopment of Concourse E and analysis of international arrivals is not included in the master plan update given the independent planning effort; however, conclusions reached in that project will be summarized or identified in the master plan update if they are available before its completion. The terminal space program includes an allowance of 26,000 square feet for U.S. Customs and Border Protection facilities (based on the size of the existing FIS).

Support and Other Areas

Support and other area requirements are based on factors such as annual passengers or gates, discussed in Section 4.5.2.5, Support and Other Spaces. **Table 4-51** summarizes the support and other terminal area requirements.

TABLE 4-51 SUPPORT AND OTHER AREA REQUIREMENTS

			BASELINE FORECAST			HIGH SCENARIO		
FUNCTIONAL AREA	UNITS	EXISTING	PAL 1	PAL 2	PAL 3	PAL 1	PAL 2	PAL 3
Commercial Program	sq ft	57,203	40,000	44,000	54,000	45,000	51,000	69,000
Airport Admin / Support	sq ft	53,769	54,000	54,000	54,000	54,000	54,000	54,000
Restrooms	sq ft	23,908	26,250	27,000	27,000	26,250	27,000	27,000
Building Services	sq ft	85,708	84,840	88,340	92,520	86,020	90,140	97,340
Circulation	sq ft	225,700	223,410	232,630	243,650	226,520	237,380	256,330
Amenities	sq ft	8,149	8,100	8,100	16,200	8,100	16,200	16,200
Sheriff Station	sq ft	4,286	4,300	4,300	4,300	4,300	4,300	4,300

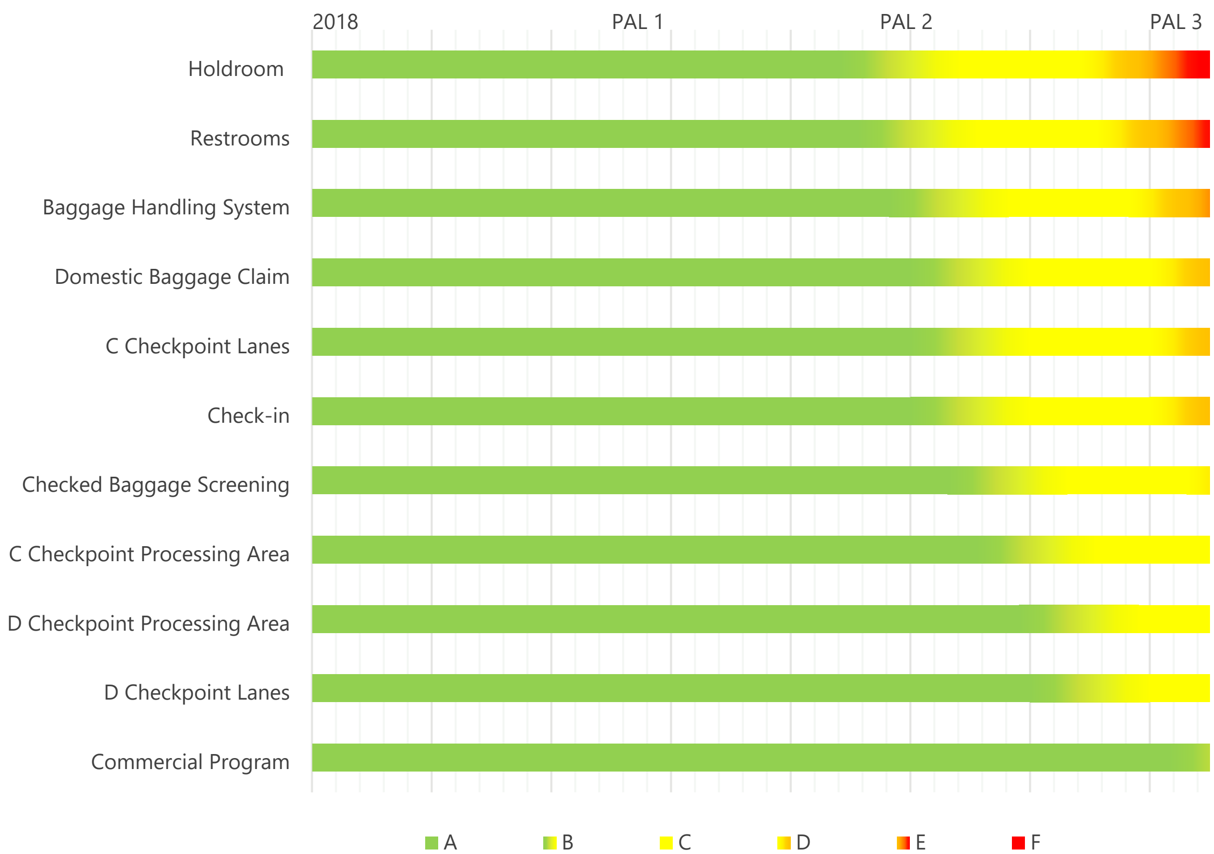
NOTES:
1 Numbers are rounded
2 PAL – Planning Activity Level (PAL1 – 2023; PAL2 – 2028; PAL3 – 2040).
SOURCE: Ricondo & Associates, Inc. June 2019.

4.5.4 TERMINAL GAP ANALYSIS

Exhibit 4-34 shows the projected level of service for each functional process through the planning period for the baseline forecast. The chart is organized with the functions which reach the lowest level of service earliest shown on the top. With the addition of the required new gates, additional hold room area will be needed. The outbound baggage system is constrained due to bypass and drive lane dimensional restrictions. Additional bag make-up space will be need within the planning horizon. The Concourse C security screening checkpoint will require one additional lane by PAL 1 and two additional lanes by PAL 3. The current check-in area has limited depth; therefore, the area per position is less than the industry standard of 250 square feet. Airlines are using other locations in the terminal for some of their ATO/administrative functions. Changes in allocation, operation, and improved processing time through the use of technology could lessen the need for additional check-in space. An additional EDS device might be needed by PAL 3 unless future machines have improved throughput rates. Current baggage claim will be sufficient thought the planning period for all forecast horizons.

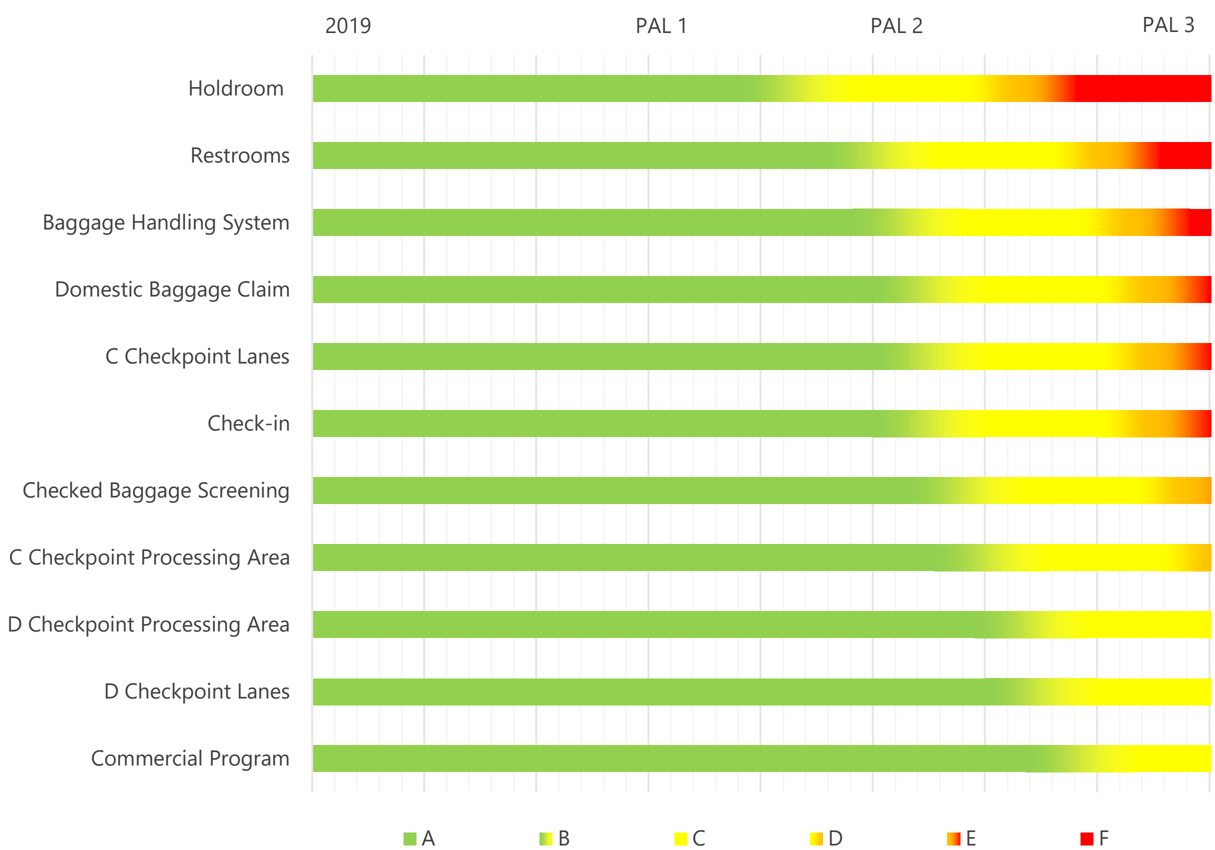
Exhibit 4-35 shows the projected level of service for each functional process through the planning period for the high scenario forecast. The needs for the high scenario forecast are similar to the baseline forecast with the exception of a need for an additional lane security screening checkpoint lane on Concourse D by PAL 3. The holdroom requirement is based on Gating Scenario 2 and 3. Operational efficiencies and technology improvements for check-in may not be sufficient to avoid the need for additional check in positions.

EXHIBIT 4-34 BASELINE FORECAST TERMINAL LOS STOPLIGHT CHART



NOTES:
1 Holdroom requirements based on Gating Scenarios 2 and 3.
2 PAL – Planning Activity Level (PAL1 – 2023; PAL2 – 2028; PAL3 – 2040).
3 Levels of Service (A though F) defined in International Air Transport Association, *Airport Development Reference Manual, 9th ed.*, January 2004.
SOURCE: Ricondo & Associates, Inc., June 2019.

EXHIBIT 4-35 HIGH SCENARIO FORECAST TERMINAL LOS STOPLIGHT CHART



NOTES:
1 Holdroom requirements based on Gating Scenarios 2 and 3.
2 PAL – Planning Activity Level (PAL1 – 2023; PAL2 – 2028; PAL3 – 2040).
3 Levels of Service (A though F) defined in International Air Transport Association, *Airport Development Reference Manual, 9th ed.*, January 2004.
SOURCE: Ricondo & Associates, Inc., June 2019.

4.6 LANDSIDE ACCESS ROADWAY AND CURBSIDE FACILITIES

This subsection describes the landside facility requirements developed as part of the Master Plan Update. Requirements were developed for the following landside elements:

- Airport roadways
- Curbside roadways

A combination of spreadsheet-based mathematical modeling and simulation modeling was used to identify existing facility demands and future requirements for the peak terminal departure hour and the peak terminal arrival hour. The spreadsheet-static analysis allows for an initial determination of preliminary facility requirements before full simulation analysis. The simulation analysis, which requires more detailed coding and data input, provides a more comprehensive analysis of the full curbside and roadway circulation system, allowing a more dynamic and detailed assessment of weaving and merging conditions, upstream and downstream capacity constraints, queue and bottleneck assessments, and vehicle and pedestrian interaction, allowing the evaluation of different scenarios and the production of detailed measures of effectiveness (MOEs). Both, static and dynamic methodologies are used in parallel for a comprehensive assessment of the roadway system.

Facility demands and requirements were developed for existing (2018), and future year (2023, 2028, and 2040) conditions under both the baseline forecast and high scenarios. Annual and peak hour passenger and aircraft operations forecasts were used in the calculation of roadway and curbside requirements. These forecast scenarios are presented in Section 3, Aviation Activity Forecasts.

4.6.1 EXISTING CONDITIONS AND DETERMINATION OF PEAK HOURS

4.6.1.1 PEAK HOURS

The primary Airport roadway system and curbside facilities are planned to accommodate demand during peak hour conditions. To determine the hours of peak landside activity at the Airport, automatic traffic recorder (ATR) counts collected as part of the October 23-30, 2018 survey were reviewed; specifically, the ATRs located at beginning of the departures and arrivals curbside roadways at the Airport. Counts at these locations indicate when traffic entering the Airport is peaking. As shown on **Exhibit 4-36**, Airport roadway traffic is heaviest during two primary peak periods. Based on these observations, the period from 7:30 a.m. to 11:30 a.m. was identified as the potential curbside morning peak period, and from 3:00 p.m. to 8:00 p.m. was identified as the potential curbside afternoon peak period. Additional data collection counts and observations were made during these identified peak periods:

- Curbside vehicle dwell duration
- Curbside number of passengers loading and unloading per vehicle
- Vehicle mode classification
- ATR counts
- Intersection turning movement counts

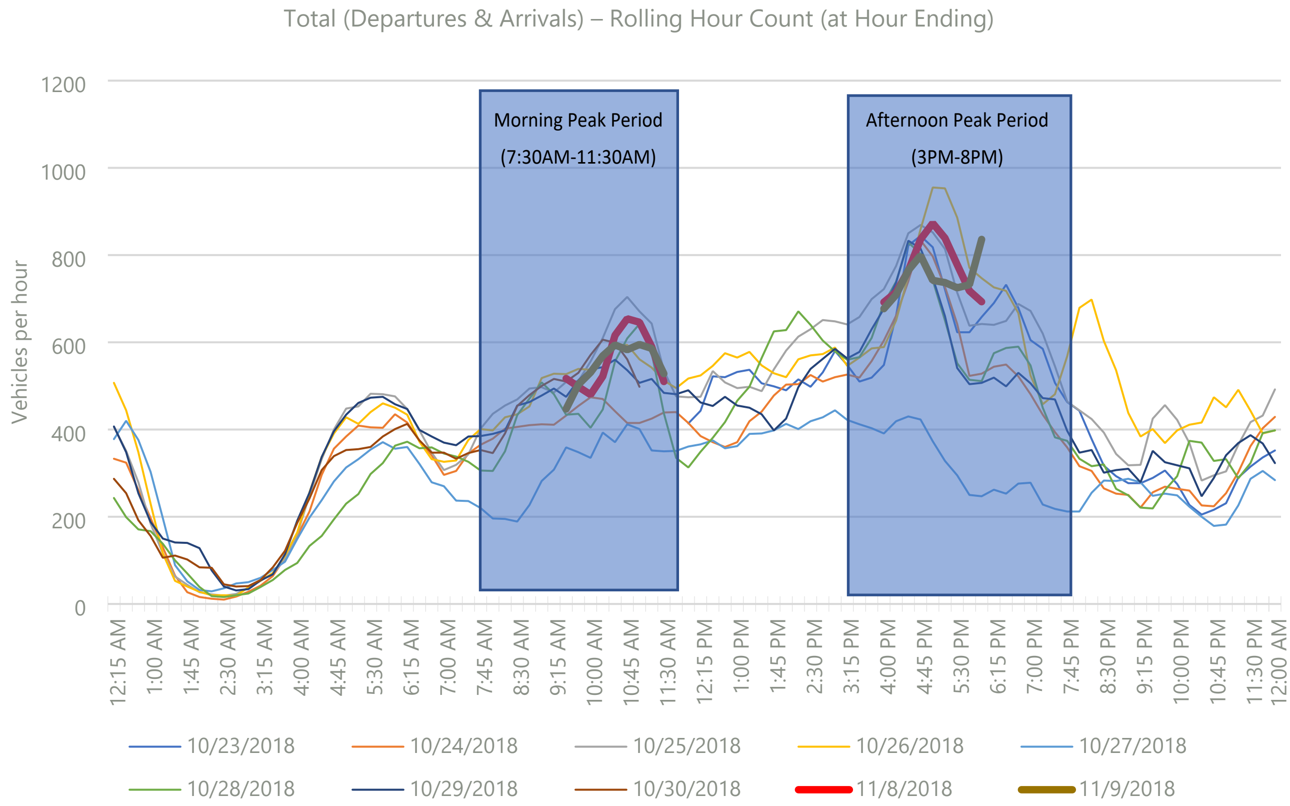
Morning Peak Hour

As shown on Exhibit 4-36, the additional November 8, 2018 vehicle mode classification counts identified the (Morning Peak Hour) from 9:45 a.m. to 10:45 a.m. with 654 vehicles across all Airport curbsides. During the Morning Peak Hour, there were 328 vehicles on the two arrivals curbsides and 326 vehicles on the single departures curbside.

Afternoon Peak Hour

As shown on Exhibit 4-36, the additional November 8, 2018 vehicle mode classification counts identified the (Afternoon Peak Hour) from 4:00 p.m. to 5:00 p.m. with 873 vehicles across all Airport curbsides. During the Afternoon Peak Hour, there were 442 vehicles on the two arrivals curbsides and 431 vehicles on the single departures curbside.

EXHIBIT 4-36 CURBSIDE TRAFFIC VOLUMES (7-DAY COUNT AND ADDITIONAL PEAK PERIOD COUNTS)



SOURCE: TranSMART Technologies, Inc. October 2018; Ricondo & Associates, Inc., April 2019.

Peak Hour Vehicle Classification

During the identified peak hours above, the vehicle mode split taken from the peak day, November 8, 2018, resulted in vehicle classification as presented in **Table 4-52**. Private vehicles account for approximately 70 percent of all vehicles crossing the Terminal Roadways, while TNCs account for 11 to 13 percent for total vehicles entering the Terminal Roadways.

TABLE 4-52 PEAK HOUR VEHICLE CLASSIFICATION DATA AT TERMINAL CURBSIDES

VEHICLE CLASS	MORNING PEAK HOUR (9:45-10:45 AM)						AFTERNOON PEAK HOUR (4:00-5:00 PM)					
	DEPARTURES ROADWAY		ARRIVALS ROADWAY[1]		TERMINAL TOTAL		DEPARTURES ROADWAY		ARRIVALS ROADWAY[1]		TERMINAL TOTAL	
	# OF VEHICLES	% OF TOTAL	# OF VEHICLES	% OF TOTAL	# OF VEHICLES	% OF TOTAL	# OF VEHICLES	% OF TOTAL	# OF VEHICLES	% OF TOTAL	# OF VEHICLES	% OF TOTAL
Private Vehicles	223	68.4%	236	72.0%	459	70.2%	257	59.6%	359	81.2%	616	70.6%
Taxicabs	5	1.5%	12	3.7%	17	2.6%	11	2.6%	7	1.6%	18	2.1%
TNCs	55	16.9%	20	6.1%	75	11.5%	118	27.4%	2	0.5%	120	13.7%
Hotel/Motel Shuttle	8	2.5%	6	1.8%	14	2.1%	4	0.9%	17	3.8%	21	2.4%
Off-Airport Parking Shuttle	22	6.7%	24	7.3%	46	7.0%	18	4.2%	27	6.1%	45	5.2%
Super Saver Parking (Lot A/B) Shuttle	3	0.9%	4	1.2%	7	1.1%	6	1.4%	7	1.6%	13	1.5%
International Terminal Parking Shuttle	0	0.0%	2	0.6%	2	0.3%	0	0.0%	0	0.0%	0	0.0%
Amtrak/Rail Station	5	1.5%	0	0.0%	5	0.8%	0	0.0%	1	0.2%	1	0.1%
Employee Parking Shuttle	0	0.0%	1	0.3%	1	0.2%	0	0.0%	0	0.0%	0	0.0%
Go-Rite Transportation	1	0.3%	0	0.0%	1	0.2%	7	1.6%	5	1.1%	12	1.4%
Other Shuttle	2	0.6%	1	0.3%	3	0.5%	2	0.5%	0	0.0%	2	0.2%
Limousines	0	0.0%	6	1.8%	6	0.9%	7	1.6%	2	0.5%	9	1.0%
Charter Buses	0	0.0%	3	0.9%	3	0.5%	0	0.0%	3	0.7%	3	0.3%
City Buses	0	0.0%	12	3.7%	12	1.8%	0	0.0%	12	2.7%	12	1.4%
Police, Tow Trucks, Delivery, etc.	2	0.6%	1	0.3%	3	0.5%	1	0.2%	0	0.0%	1	0.1%
Total	**326**	**100.0%**	**328**	**100.0%**	**654**	**100.0%**	**431**	**100.0%**	**442**	**100.0%**	**873**	**100.0%**

NOTE:
1 Arrivals Roadway Vehicle counts consist of both Arrivals Inner Roadway and Arrivals Outer Roadway
SOURCE: TranSMART Technologies, Inc. November 2018, Ricondo & Associates, Inc., November 2020.

4.6.1.2 DEVELOPMENT OF BALANCED ROADWAY NETWORK

A traffic generation and assignment model was developed to replicate existing roadway traffic at the Airport and used to create a balanced roadway network for both the Morning and Afternoon Peak Hours. This process included the following:

- **Trip Generation**. Total ground transportation trips accessing the Airport roadway system and curbsides were classified by vehicle mode (e.g., private vehicles, taxicabs, limousines, etc.) based on the vehicle classification survey information described in Section 2, Inventory of Existing Conditions.
- **Trip Assignment**. Each vehicle mode using the Airport has unique circulation patterns as described in Section 2, Inventory of Existing Conditions. For example, a private vehicle picking up passengers may enter the Airport, travel along the arrivals curbside looking for their passenger(s) and stop at the curbside or recirculate around the terminal loop roadway. During this step of the modeling process, the trips generated by the Airport's various vehicle modes are assigned to the roadway network based on each mode's unique travel path.
- **Balanced Roadway Network**. Prior to conducting the operational analysis, a balanced traffic roadway network needed to be developed that resembled actual Airport traffic conditions. This involved balancing the Morning and Afternoon Peak Hour traffic data to ensure that the total number of vehicles entering the Airport equals the total number of vehicles exiting the Airport. Consequently, the traffic volumes on key roadway links were adjusted in the network but monitored to assure they were within five percent of actual volumes. The existing roadway network is depicted on **Exhibit 4-37** along with the balanced Morning and Afternoon Peak Hour volumes. In 2018, March was the peak month for passenger activity at the Airport with a total of 690,383 total passengers. Passenger activity in November 2018 during the data collection was significantly lower, with a total of 560,827 passengers. To factor the traffic volumes to account for the peak month, a 1.23 peak month conversion factor was applied to the November traffic volumes to account for the difference between November and the peak month (March). Once the traffic volumes on the roadway network were balanced for the Morning and Afternoon Peak Hours, the seasonally adjusted traffic volumes were used as existing (2018) conditions in the models described below.

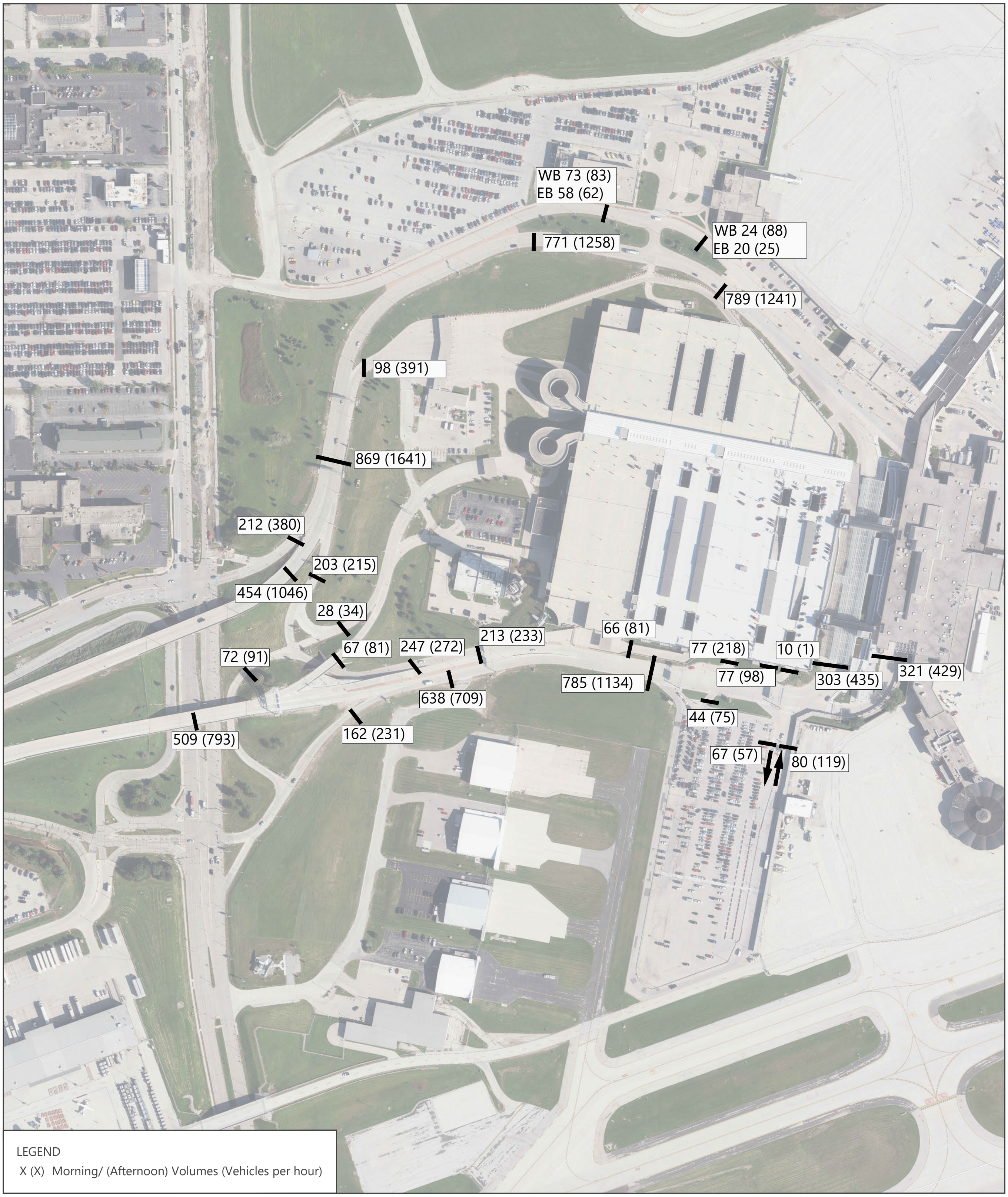
4.6.2 FUTURE YEAR GROWTH

Future traffic volumes were based on the latest O&D passenger forecast developed as part of the Master Plan Update. Further explanation of the development of each forecast is presented in Section 3, Aviation Activity Forecasts. **Table 4-53** depicts the O&D passenger forecast, and corresponding growth of existing passenger volumes under both the baseline forecast and high scenario.

TABLE 4-53 O&D PASSENGER FORECAST, BY SCENARIO

	BASELINE FORECAST		HIGH SCENARIO	
YEAR	O&D PASSENGERS	GROWTH RATE	O&D PASSENGERS	GROWTH RATE
2018	3,496,951	-	3,496,951	-
2023	3,785,839	8.3%	4,008,112	14.6%
2028	4,188,894	19.8%	4,514,263	29.1%
2040	5,171,516	47.9%	5,883,898	68.3%

SOURCE: Milwaukee Mitchell International Airport, November 2018 (historical); Ricondo & Associates., April 2019 (forecast).



SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH 0 400 ft.

EXHIBIT 4-37

BALANCED ROADWAY VOLUMES
2018

Drawing: P:\project-chicago\mke\mke master plan update\master plan project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\On-Airport Roadway Study Area_2022-03-11.dwgLayout: Balanced Roadway Volumes 2018 Plotted: Apr 7, 2022, 10:37AM

All single-occupancy vehicle traffic (i.e., private vehicles, taxicabs, limousines) was assumed to increase at the same rate as O&D passenger growth reflected in Table 4-53. Multiple-occupancy vehicle traffic (e.g., shuttles, shared ride vehicles, buses) was assumed to increase at exactly half the rate of O&D passengers, because multiple-occupancy vehicles can handle additional growth with existing vehicles before introducing new vehicles to the fleet.

4.6.3 CAPACITY ANALYSIS AND REQUIREMENT FOR ON-AIRPORT ROADWAYS

This subsection describes the approach and results of both the spreadsheet-based mathematical modeling and the dynamic traffic simulation modeling used to analyze Airport access and circulation roadways and determine their future requirements. Spreadsheet-based models provide facility requirements for an "unconstrained" approach, in which vehicles are not impeded by upstream congestion or other physical features that may restrict and meter downstream flows. This mathematical approach does not consider roadway upstream or downstream traffic congestion or capacity constraints. Regardless of the above limitations, the static, spreadsheet-based methodology provides valuable information regarding the unconstrained, full-demand levels of service (LOS) for each roadway segment in the network. On the other hand, traffic simulation provides a more in-dept and holistic understanding of the overall roadway network operation as an interconnected system considering the impacts of upstream and downstream congestion creating either "metering" traffic conditions or queues that spill over into other connected roadway segments.

4.6.3.1 ON-AIRPORT ROADWAY SPREADSHEET-BASED ANALYSIS AND ROADWAY REQUIREMENTS

A spreadsheet-based model representing the physical layout of the on-Airport roadway system components that accommodate ground transportation was developed. This model accurately depicts key on-Airport roadways pertaining to Airport entry/exit, access to parking facilities, and rental car facilities. The on-Airport roadway links included in the analysis are depicted on **Exhibit 4-38**.

To determine on-Airport roadway requirements, traffic volumes representing the Morning and Afternoon Peak Hours described above were compared with the capacity of individual roadway segments comprising the roadway system. The capacities of roadway segments were determined based on the characteristics of each segment, including free flow speed and the number of travel lanes. To assess the number of lanes required on the Airport roadway system to accommodate forecast vehicle traffic, the maximum flow rates presented in **Table 4-54** were used. Table 4-54 presents the maximum number of vehicles that the roadway could accommodate to provide a minimum level of service (LOS). LOS reflects the operating performance of a roadway, measured quantitatively and reported on a scale of "A" to "F." LOS A represents the optimal operating condition, characterized by uninterrupted free flow operations. At the other end of the scale, LOS F represents the worst operating condition, characterized by severe roadway congestion and delay.

Link Designation	Location	Link Designation	Location
A	Airport Spur EB	O	Cell Phone Lot/Surface Parking Exit
B	S Howell Ave Exit to Airport Spur EB-Terminal & Surface Lot	S	Airport Spur Outbound Leaving Curb
C	S Howell Ave Exit to Parking Structure & Rental Car Return	T-EB	E Joseph M Hutsteiner Dr. Towards Service Area (EB)
D	Hourly Parking and Rental Car from Terminal Recirculation & Howell Ave	T-WB	E Joseph M Hutsteiner Dr. Towards Service Area (WB)
E	Airport Spur EB to Daily Parking	U-EB	E Joseph M Hutsteiner Dr. Before International Terminal Ent/Exit (EB)
F	Airport Spur EB to Hourly/RAC Parking Before Merge	U-WB	E Joseph M Hutsteiner Dr. Before International Terminal Ent/Exit (WB)
G	Airport Spur EB to Terminal & Surface Lot Before Merge	V	Airport Spur Outbound after International Terminal Ent/Exit
H	Airport Spur Approach to Curb After Merge	W	Parking Structure Exit
I	Hourly Parking Entrance	X	Airport Spur Outbound after Parking Structure Exit
J	Rental Car Entrance 1	Y	Airport Spur Outbound Split Towards Parking and Terminal Recirculation
K	Rental Car Entrance 2	Z	Airport Spur Outbound Split Towards Howell Ave
L	Limo and Ground Transportation Entrance	AA	Recirculation to Daily Parking
M	TNC Hold Lot	BB	Airport Sput Outbound Split Towards I-94
N	Cell Phone Lot/Surface Parking Entrance		

SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH 0 400 ft.

EXHIBIT 4-38

ON-AIRPORT ROADWAY LINKS

Drawing: P:\project-chicago\mke\mke master plan update\master plan project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\On-Airport Roadway Study Area_2022-03-11.dwgLayout: Airport Links_2 Plotted: Mar 11, 2022, 10:06AM

TABLE 4-54 ROADWAY LEVELS OF SERVICE AND MAXIMUM FLOW RATES

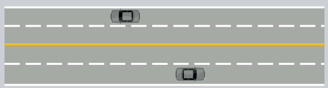
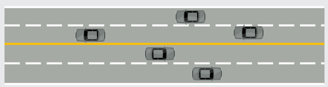
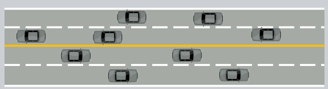
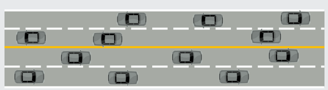
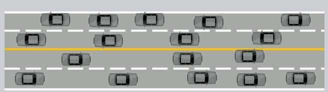
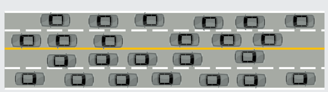
TYPICAL ROADWAY CLASSIFICATIONS [2]	MAXIMUM FREE FLOW SPEED (MPH)[2]	MAXIMUM FLOW RATES (VEHICLES/HOUR/LANE) AT INDICATED LEVELS OF SERVICE[1]				
		A	B	C	D	E
Airport Access Highway	60	630	1,030	1,460	1,880	2,090
	55	520	850	1,220	1,580	1,800
Entry/Exit Roadway	50	450	730	1,050	1,390	1,620
	45	400	660	950	1,260	1,530
Terminal Loop Roadway	40	370	600	860	1,130	1,410
	35	340	540	790	1,030	1,290
Terminal Access Roadway	30	310	480	700	930	1,170
	25	250	400	600	800	1,010
Ramps (25 mph or less)	15	250	400	600	800	1,010

NOTES:
MPH = Miles per hour
1 Flow rates account for heavy vehicles and the effects of unfamiliar drivers.
2 The roadway classifications and associated speeds represent typical ranges that vary by airport.
SOURCES: Ricondo & Associates, Inc., based on information presented in (a) Transportation Research Board, National Research Council, *Highway Capacity Manual*, Exhibit 21-2, "LOS Criteria for Multilane Highways," December 2000, and (b) Airport Cooperative Research Program, ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations*, Table 4-1, "Levels of Service for Airport Terminal Area Access and Circulation Roadways," July 2010.

Definitions and graphical representations of LOS A through F are depicted in **Exhibit 4-39**. LOS C is generally considered to be a desirable operating condition for the design of new facilities; however, LOS D conditions may be acceptable at some airports during peak periods of the typical busy day of the peak season (e.g., the design-day analyzed for this study). The decision of whether to plan for LOS C or LOS D conditions is a policy decision; planning for LOS C conditions typically requires more substantial improvements, and expedited implementation of those improvements as they are triggered sooner by increasing activity and resulting congestion. **Exhibit 4-40** presents an example of the timing of roadway link improvements when planning for LOS C as compared to LOS D conditions.

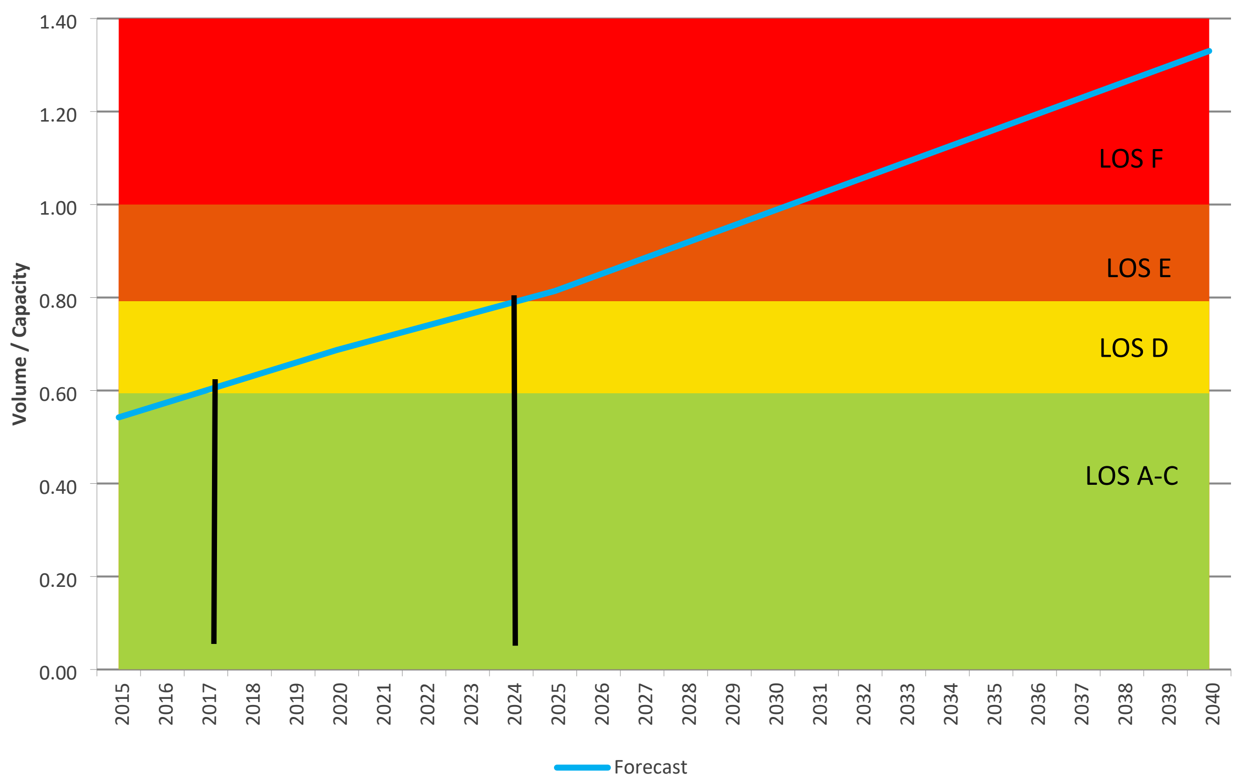
As shown for the sample forecast scenario, an improvement would need to be in place by 2017 if planning for LOS C while that same improvement would be delayed by approximately seven years (to 2024) should LOS D be deemed acceptable.

EXHIBIT 4-39 LEVEL OF SERVICE DEFINITIONS FOR AIRPORT TERMINAL AREA ROADWAYS

LOS	VISUAL REPRESENTATION	DESCRIPTION OF TRAFFIC CONDITIONS
A		LOS A represents operations where free-flow speeds prevail. The ability of each driver to maneuver within the traffic stream, change lanes, merge, or weave is almost completely unimpeded by other vehicles because of low traffic densities. The effects of transient blockages or incidents are easily absorbed at this level of service.
B		LOS represents conditions in which free-flow speeds are maintained. The ability of each driver to maneuver within the traffic stream, change lanes, or weave is only slightly restricted by the presence of other vehicles. The general physical and psychological comfort of drivers is still high. The effects of minor incidents and point breakdowns are still easily absorbed.
C		LOS C represents traffic flow with speeds at or near the free-flow speeds of the roadway. Freedom of maneuver within the traffic stream is noticeably restricted and lane changes may require more care and vigilance on the part of the driver because of high traffic densities. Minor blockages or incidents may still be absorbed, but the local deterioration in service will be substantial. Queues may be expected to form behind any significant blockage.
D		LOS D represents the level at which speeds begin to decline slightly with increasing flows, and density begins to increase somewhat more quickly. Freedom to maneuver within the traffic stream is more noticeably limited, and the driver experiences reduced physical and psychological comfort. Even minor blockages or incidents can be expected to quickly create queues because the traffic stream has little space to absorb disruptions.
E		LOS E represents operations at or near capacity. Operations at this level are volatile because there are virtually no usable gaps in the traffic stream. Vehicles are closely spaced, leaving little room to maneuver. Any disruption of traffic stream, such as vehicles entering from a ramp or a vehicle changing lanes, can disrupt upstream traffic flows. At capacity, the traffic stream has no ability to absorb even the most minor disruptions, and any incident can be expected to produce serious breakdown with extensive queueing. Maneuverability with the traffic stream is extremally limited and the level of physical and psychological comfort afforded the driver is poor.
F		LOS F represents breakdowns in vehicular flow. Such conditions generally exist within queues forming behind bottleneck points. Bottlenecks occur as a result of (1) traffic accidents, (2) typical traffic congestion areas, such as lane drops, weaving segments, or merges, (3) parking maneuvers, or (4) traffic conditions when the projected hourly flow exceeds the estimated capacity of the roadway segment.

SOURCE: Ricondo and Associates, Inc. based on definitions included in the Highway Capacity Manual (HCM) sixth edition, Transportation Research Board (TRB) of the National Academies of Sciences, Engineering, and Medicine in the United States, December 2000.

EXHIBIT 4-40 EXAMPLE OF TIMING OF IMPROVEMENT IMPLEMENTATION – LOS C VERSUS LOS D



SOURCE: Ricondo & Associates, Inc., based on information presented in (a) Transportation Research Board, National Research Council, *Highway Capacity Manual*, Exhibit 21-2, "LOS Criteria for Multilane Highways", December 2000, and (b) Airport Cooperative Research Program, ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations*, Table 4-1, "Levels of Service for Airport Terminal Area Access and Circulation Roadways", July 2010.

Existing (2018) Conditions

The roadway demand/capacity analysis for existing (2018) conditions is presented in **Table 4-55**. It was calculated that all on-Airport roadway links were operating at LOS B or better under existing (2018) conditions. A summary of the on-Airport roadway demand/capacity analysis for the Morning and Afternoon Peak Hours is graphically depicted on **Exhibit 4-41**.

TABLE 4-55 ON-AIRPORT ROADWAY DEMAND/CAPACITY – EXISTING (2018) CONDITIONS

LINK DESIGNATION	LOCATION	ROADWAY CLASSIFICATION	LINK SPEED (MPH)	NUMBER OF LANES	LINK CAPACITY (VPH)	MORNING PEAK HOUR 2018		AFTERNOON PEAK HOUR 2018	
						VOLUME (VPH)	LOS	VOLUME (VPH)	LOS
A	Airport Spur EB	Entry/Exit Roadway	35	2	2,580	509	A	793	B
B	South Howell Avenue Exit to Airport Spur EB-Terminal and Surface Lot	Ramp	25	1	1,010	162	A	231	A
C	South Howell Avenue Exit to Parking Structure and Rental Car Return	Ramp	15	1	1,010	72	A	91	A
D	Hourly Parking and Rental Car from Terminal Recirculation and Howell Avenue	Terminal Access Roadway	15	1	1,010	247	A	272	B
E	Airport Spur (EB) to Daily Parking	Terminal Access Roadway	25	1	1,010	67	A	81	A
F	Airport Spur (EB) to Hourly/RAC Parking Before Merge	Terminal Access Roadway	25	1	1,010	213	A	233	A
G	Airport Spur (EB) to Terminal & Surface Lot Before Merge	Terminal Access Roadway	25	2	2,020	638	B	709	B
H	Airport Spur Approach to Curb After Merge	Terminal Access Roadway	25	4	4,040	785	A	1,134	B
I	Hourly Parking Entrance	Terminal Access Roadway	15	2	2,020	66	A	81	A
J	Rental Car Entrance 1	Terminal Access Roadway	15	1	1,010	77	A	218	A
K	Rental Car Entrance 2	Terminal Access Roadway	15	1	1,010	77	A	98	A
L	Limo and Ground Transportation Entrance	Terminal Access Roadway	15	1	1,010	10	A	1	A
M	TNC Staging Lot Exit	Terminal Access Roadway	15	1	1,010	44	A	75	A
N	Cell Phone Lot/Surface Parking Entrance	Terminal Access Roadway	15	1	1,010	67	A	57	A
O	Cell Phone Lot/Surface Parking Exit	Terminal Access Roadway	15	1	1,010	80	A	119	A
S	Airport Spur Outbound Leaving Curb	Terminal Loop Roadway	15	3	3,030	789	B	1,241	C
T-EB	E Joseph M Hutsteiner Drive Towards Service Area (EB)	Terminal Loop Roadway	30	1	1,170	20	A	25	A
T-WB	E Joseph M Hutsteiner Drive Leaving Service Area (WB)	Terminal Loop Roadway	30	1	1,170	24	A	88	A
U-EB	E Joseph M Hutsteiner Drive Before International Arrivals Building Entrance/Exit (EB)	Terminal Loop Roadway	30	1	1,170	58	A	62	A
U-WB	E Joseph M Hutsteiner Drive After International Arrivals Building Entrance/Exit (WB)	Terminal Loop Roadway	30	1	1,170	73	A	83	A
V	Airport Spur Outbound after International Arrivals Building Entrance/Exit	Terminal Loop Roadway	15	3	3,030	771	B	1,258	C
W	Parking Structure Exit	Terminal Loop Roadway	25	2	2,020	98	A	391	A
X	Airport Spur Outbound after Parking Structure Exit	Terminal Loop Roadway	25	5	5,050	869	A	1,641	B
Y	Airport Spur Outbound Split Towards Parking and Terminal Recirculation	Terminal Loop Roadway	15	1	1,010	203	A	215	A
Z	Airport Spur Outbound Split Towards Howell Avenue	Entry/Exit Roadway	25	2	2,020	212	A	380	A
AA	Recirculation to Daily Parking	Terminal Loop Roadway	15	1	1,010	28	A	34	A
BB	Airport Spur Outbound Split Toward I-94	Entry/Exit Roadway	50	2	3,240	454	A	1,046	B

NOTES:
EB = Eastbound
WB = Westbound
TNC = Transportation Network Company
RAC = Rental Car Center
MPH = Miles per hour
VPH = Vehicles per hour
LOS = Level of Service

SOURCES: TranSMART Technologies, Inc., November 2018; ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations*, Table 4-1, "Levels of Service for Airport Terminal Area Access and Circulation Roadways," July 2010, Ricondo & Associates, Inc., October 2020.

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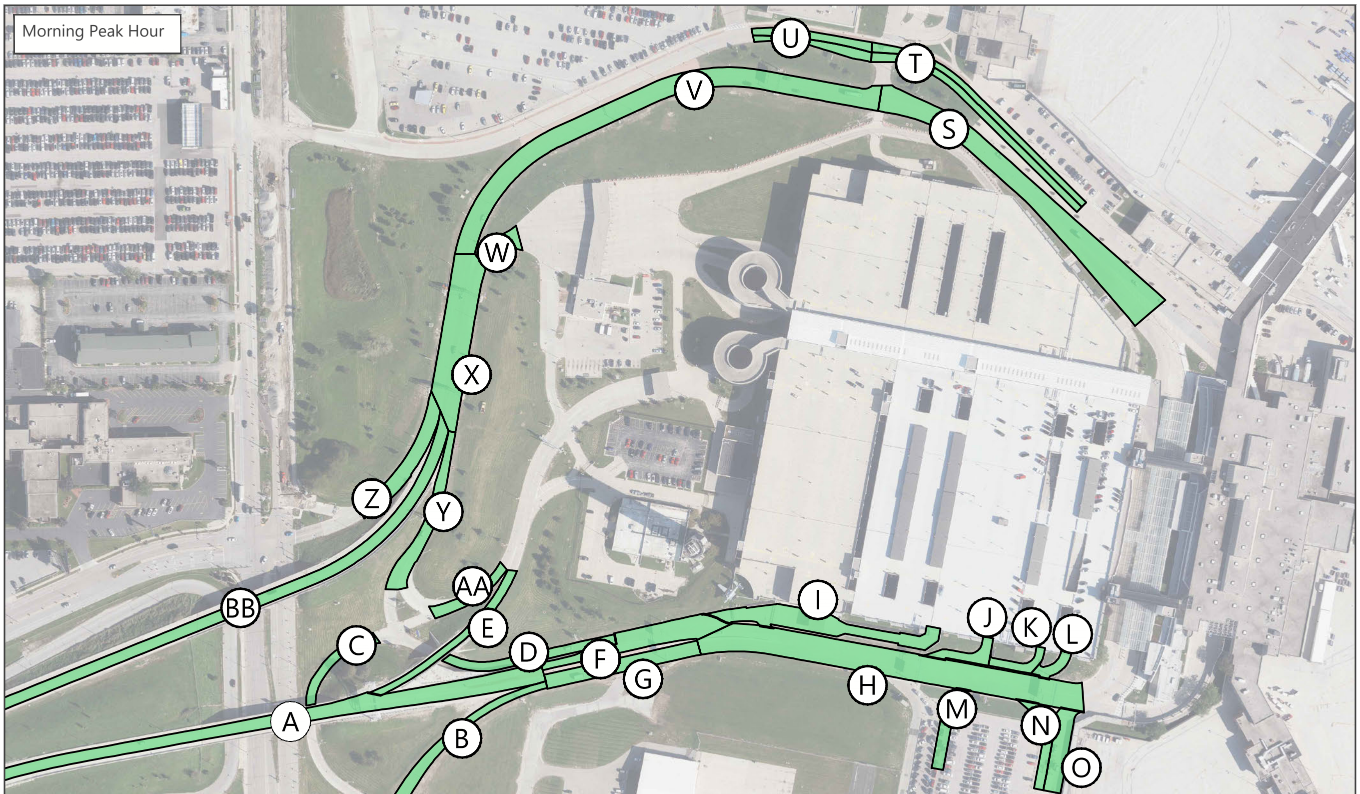

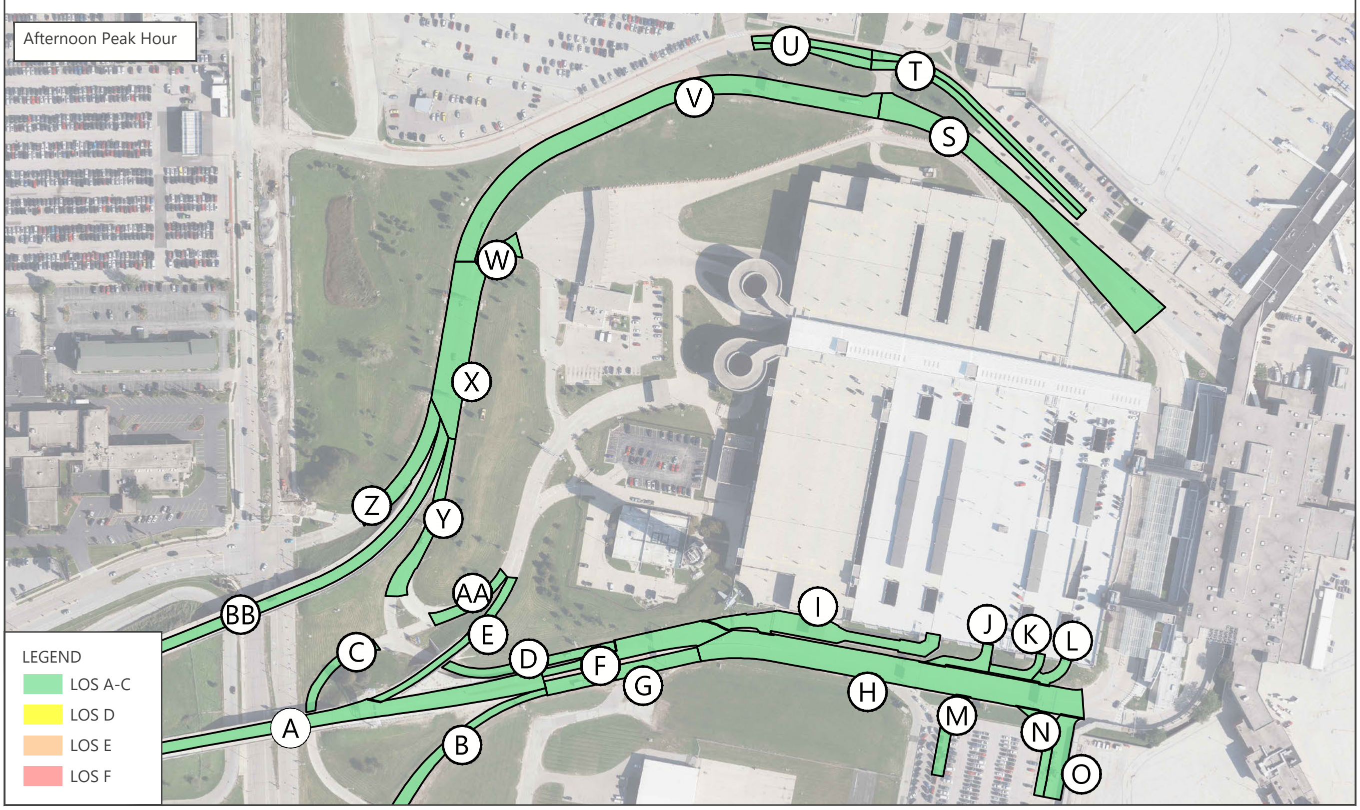

SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH 0 400 ft.

EXHIBIT 4-41

ON-AIRPORT ROADWAY DEMAND/CAPACITY SUMMARY
EXISTING CONDITIONS - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\On-Airport Roadway Study Area_2022-03-11.dwgLayout: Existing Plotted: Mar 29, 2022, 10:36AM

Future Years – Baseline Forecast

Existing (2018) on-Airport roadway traffic volumes were grown proportionally to future year O&D passenger volumes (2023, 2028, and 2040) from the baseline forecast summarized in Table 4-53. The results of the on-Airport roadway analysis, under the baseline forecast, are presented in **Table 4-56**. As shown, a total of three links were forecast to be operating at LOS D or worse by 2040 under the baseline forecast, all in the Afternoon Peak Hour. A summary of the results under the baseline forecast for the Morning and Afternoon Peak Hours, for future years 2023, 2028, and 2040, is graphically depicted on **Exhibit 4-42** through **Exhibit 4-44**. The links anticipated to operate at LOS D or worse by 2040 under the Afternoon Peak Hour were:

- Link G: Airport Spur (Eastbound) to Terminal and Surface Lot Before Merge
- Link S: Airport Spur Outbound Leaving Curb
- Link V: Airport Spur Outbound after International Arrivals Building Entrance/Exit

For the three links forecast to operate at LOS D or worse, further analyses were conducted to determine the number of additional lanes required to maintain LOS D or better and the number of additional lanes required to achieve LOS C or better conditions. If after adding one lane was not enough to meet the desired LOS, a second or third lane will be identified, and when such lanes will be needed. For the evaluated roadway links, the maximum number of additional lanes needed to obtain LOS C over the 2040 planning horizon was one additional lanes on (Link G, Link S and Link V). **Table 4-57** presents the year by which and additional lane is needed to maintain the desired LOS D and LOS C conditions during the Afternoon Peak Hour. The analysis did not identify any Morning Peak Hour LOS deficiencies.

TABLE 4-56 ON-AIRPORT ROADWAY DEMAND/CAPACITY RESULTS – BASELINE FORECAST

LINK DESIGNATION	LOCATION	ROADWAY CLASSIFICATION	LINK SPEED (MPH)	NUMBER OF LANES	LINK CAPACITY (VPH)	MORNING PEAK HOUR 2023		MORNING PEAK HOUR 2028		MORNING PEAK HOUR 2040		AFTERNOON PEAK HOUR 2023		AFTERNOON PEAK HOUR 2028		AFTERNOON PEAK HOUR 2040	
						VOLUME (VPH)	LOS	VOLUME (VPH)	LOS	VOLUME (VPH)	LOS	VOLUME (VPH)	LOS	VOLUME (VPH)	LOS	VOLUME (VPH)	LOS
A	Airport Spur (EB)	Entry/Exit Roadway	35	2	2,580	695	B	770	B	949	B	1,087	C	770	C	949	C
B	South Howell Avenue Exit to Airport Spur (EB)-Terminal and Surface Lot	Ramp	25	1	1,010	198	A	216	A	256	B	286	B	310	B	370	B
C	South Howell Avenue Exit to Parking Structure and Rental Car Return	Ramp	15	1	1,010	96	A	106	A	131	A	121	A	134	A	166	A
D	Hourly Parking and Rental Car from Terminal Recirculation and Howell Avenue	Terminal Access Roadway	15	1	1,010	269	B	269	B	269	B	144	A	144	A	144	A
E	Airport Spur (EB) to Daily Parking	Terminal Access Roadway	25	1	1,010	109	A	121	A	149	A	108	A	119	A	147	A
F	Airport Spur (EB) to Hourly/RAC Parking Before Merge	Terminal Access Roadway	25	1	1,010	277	B	306	B	373	B	397	B	438	C	536	C
G	Airport Spur (EB) to Terminal and Surface Lot Before Merge	Terminal Access Roadway	25	2	2,020	830	C	917	C	1,119	C	1,192	C	1,313	D	1,607	E
H	Airport Spur Approach to Curb After Merge	Terminal Access Roadway	25	4	4,040	1,019	B	1,124	B	1,372	B	1,481	B	1,631	C	1,995	C
I	Hourly Parking Entrance	Terminal Access Roadway	15	2	2,020	88	A	97	A	120	A	108	A	119	A	147	A
J	Rental Car Entrance 1	Terminal Access Roadway	15	1	1,010	66	A	73	A	90	A	211	A	233	A	288	B
K	Rental Car Entrance 2	Terminal Access Roadway	15	1	1,010	66	A	73	A	90	A	211	A	233	A	288	B
L	Limo and Ground Transportation Entrance	Terminal Access Roadway	15	1	1,010	86	A	96	A	118	A	1	A	1	A	2	A
M	TNC Staging Lot Exit	Terminal Access Roadway	15	1	1,010	59	A	65	A	80	A	100	A	111	A	137	A
N	Cell Phone Lot/Surface Parking Entrance	Terminal Access Roadway	15	1	1,010	89	A	99	A	122	A	76	A	84	A	104	A
O	Cell Phone Lot/Surface Parking Exit	Terminal Access Roadway	15	1	1,010	104	A	114	A	139	A	155	A	169	A	207	A
S	Airport Spur Outbound Leaving Curb	Terminal Loop Roadway	15	3	3,030	1,025	B	1,130	B	1,380	C	1,624	C	1,789	C	2,190	D
T-EB	East Joseph M Hutsteiner Drive Towards Service Area (EB)	Terminal Loop Roadway	30	1	1,170	88	A	95	A	115	A	298	A	321	B	388	B
T-WB	East Joseph M Hutsteiner Drive Leaving Service Area (WB)	Terminal Loop Roadway	30	1	1,170	122	A	132	A	157	A	143	A	152	A	182	A
U-EB	East Joseph M Hutsteiner Drive Before International Terminal Entrance/Exit (EB)	Terminal Loop Roadway	30	1	1,170	171	A	190	A	232	A	82	A	91	A	113	A
U-WB	East Joseph M Hutsteiner Drive After International Terminal Entrance/Exit (WB)	Terminal Loop Roadway	30	1	1,170	74	A	82	A	99	A	105	A	113	A	136	A
V	Airport Spur Outbound after International Arrivals Building Entrance/Exit	Terminal Loop Roadway	15	3	3,030	1,005	B	1,107	B	1,353	C	1,651	C	1,818	D	2,229	D
W	Parking Structure Exit	Terminal Loop Roadway	25	2	2,020	269	A	292	A	354	A	521	B	577	B	712	B
X	Airport Spur Outbound after Parking Structure Exit	Terminal Loop Roadway	25	5	5,050	1,135	A	1,251	B	1,531	B	2,161	C	2,383	C	2,926	C
Y	Airport Spur Outbound Split Towards Parking and Terminal Recirculation	Terminal Loop Roadway	15	1	1,010	271	B	299	B	370	B	287	B	317	B	391	B
Z	Airport Spur Outbound Split Towards Howell Avenue	Entry/Exit Roadway	25	2	2,020	269	A	292	A	354	A	485	A	529	B	641	B
AA	Recirculation to Daily Parking	Terminal Loop Roadway	15	1	1,010	37	A	41	A	51	A	45	A	50	A	62	A
BB	Airport Spur Outbound Split Towards I-94	Entry/Exit Roadway	50	2	3,240	603	A	668	A	822	A	1,427	B	1,580	C	1,949	C

LEGEND:

Level of Service D

Level of Service E

NOTES:

EB = Eastbound
TNC = Transportation Network Company
MPH = Miles per hour
LOS = Level of Service
WB = Westbound
RAC = Rental Car Center
VPH = Vehicles per hour

SOURCES: TranSMART Technologies, Inc., November 2018; ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations*, Table 4-1, "Levels of Service for Airport Terminal Area Access and Circulation Roadways," July 2010, Ricondo & Associates, Inc., November 2020.

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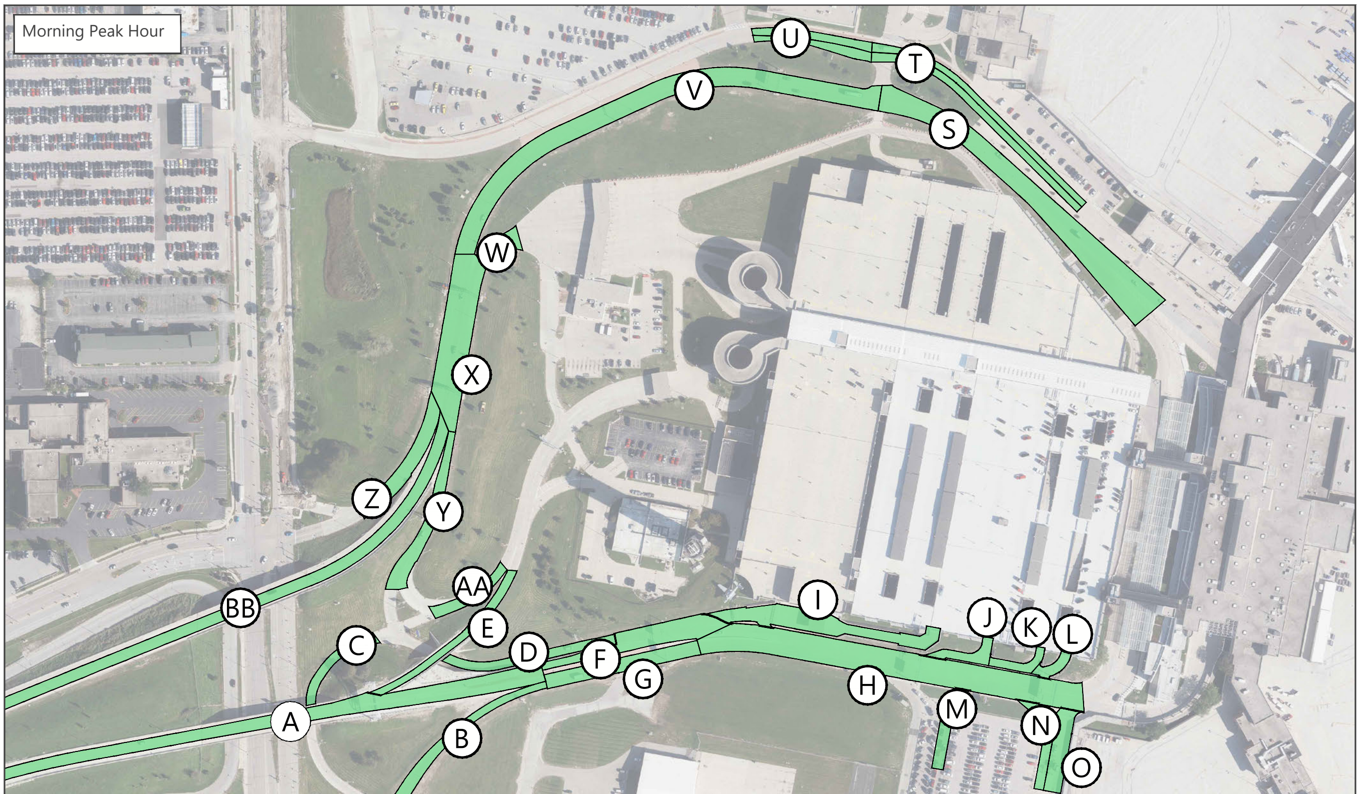
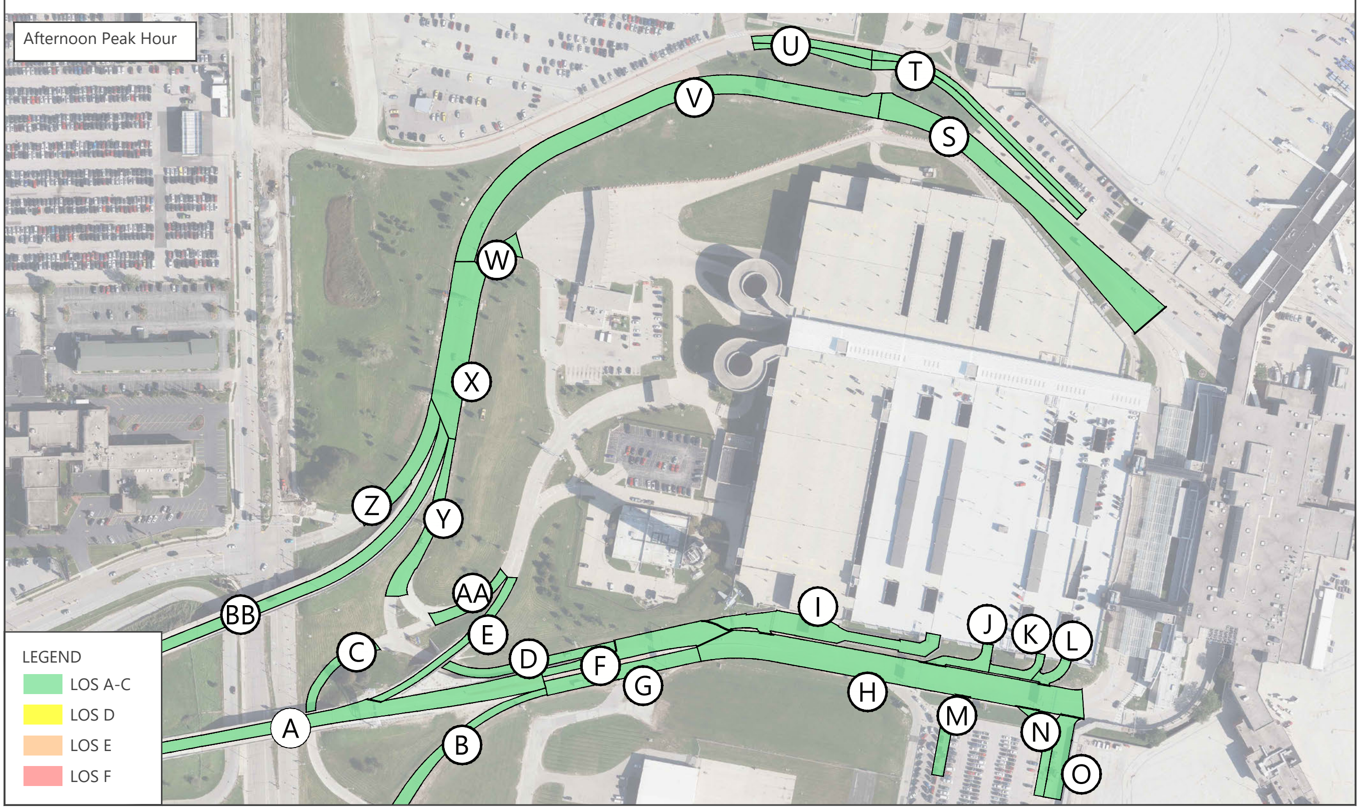




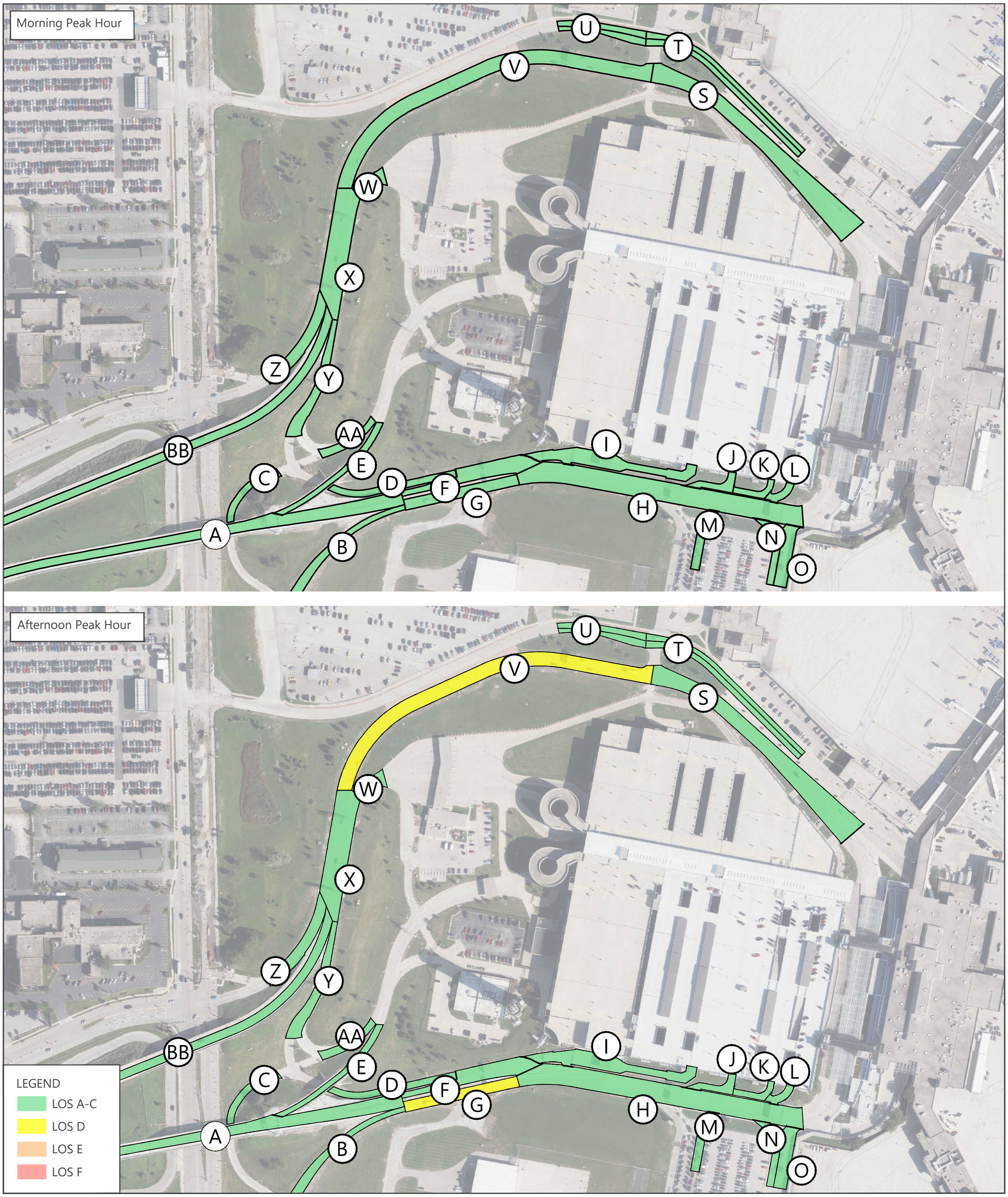
SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH 0 400 ft.

EXHIBIT 4-42

ON-AIRPORT ROADWAY DEMAND/CAPACITY SUMMARY
BASELINE SCENARIO 2023 - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\On-Airport Roadway Study Area_2022-03-11.dwgLayout: Baseline 2023 Plotted: Mar 29, 2022, 10:37AM



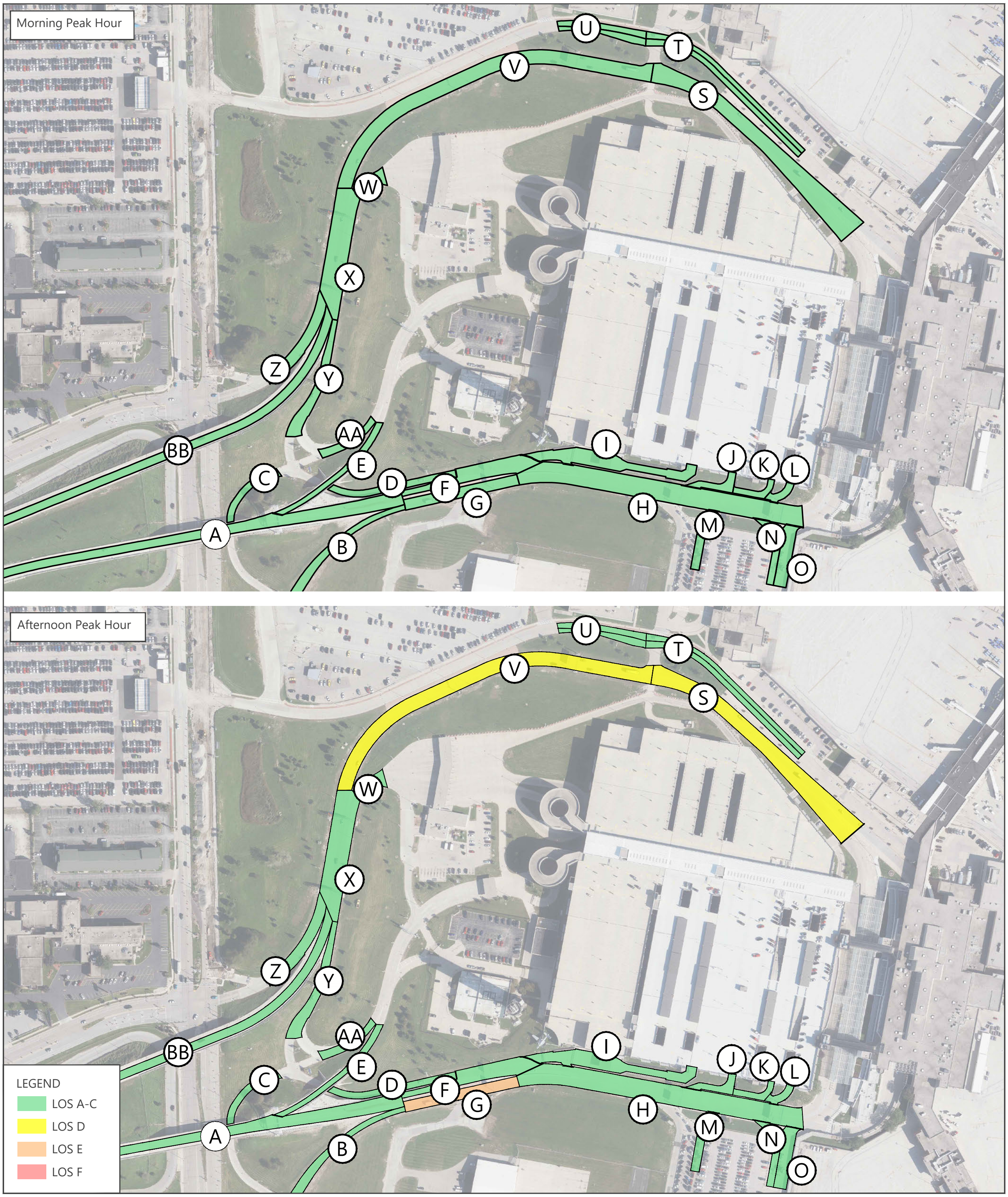
SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH
0 400 ft.

EXHIBIT 4-43

ON-AIRPORT ROADWAY DEMAND/CAPACITY SUMMARY
BASELINE SCENARIO 2028 - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\On-Airport Roadway Study Area_2022-03-11.dwgLayout: Baseline 2028 Plotted: Mar 29, 2022, 10:40AM



SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH 0 400 ft.

EXHIBIT 4-44

ON-AIRPORT ROADWAY DEMAND/CAPACITY SUMMARY
BASELINE FORECAST 2040 - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\On-Airport Roadway Study Area_2022-03-11.dwgLayout: Baseline 2040 Plotted: Mar 29, 2022, 10:41AM

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TABLE 4-57 ON-AIRPORT ROADWAY LANE REQUIREMENTS – BASELINE FORECAST

					ADDITIONAL LANES			2023		2028		2040	
LINK DESIGNATION	DESCRIPTION	ADDITIONAL LANE REQUIRED WHEN LINK VOLUME EXCEEDS (VPH)	LOS CRITERIA	EXISTING LANES	FIRST IMPROVEMENT (ADD A LANE)	SECOND IMPROVEMENT (ADD 2ND LANE)	THIRD IMPROVEMENT (ADD 3RD LANE)	AFTERNOON VOLUME (VPH)	LOS	AFTERNOON VOLUME (VPH)	LOS	AFTERNOON VOLUME (VPH)	LOS
G	Airport Spur (EB) to Terminal and Surface Lot Before Merge	1,600	LOS D	2	Before 2040	-	-	1,192	C	1,313	D	1,607	D → C
		1,200	LOS C	2	Before 2028	-	-	1,192	C	1,313	D → C	1,607	D → C
S	Airport Spur Outbound Leaving Curb	2,400	LOS D	3	-	-	-	1,624	C	1,789	C	2,190	D
		1,800	LOS C	3	Before 2040	-	-	1,624	C	1,789	C	2,190	D → C
V	Airport Spur Outbound after International Arrivals Building Entrance/Exit	2,400	LOS D	3	-	-	-	1,651	C	1,818	D	2,229	D
		1,800	LOS C	3	Before 2028	-	-	1,651	C	1,818	D → C	2,229	D → C

LEGEND:

One Additional Lane Added

NOTES:
EB = Eastbound
LOS = Level of Service
VPH = Vehicles per hour
D → C = represented the LOS before and after the lane improvement is added
SOURCES: TranSMART Technologies, Inc. November 2018; ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations*, Table 4-1, "Levels of Service for Airport Terminal Area Access and Circulation Roadways," July 2010, Ricondo & Associates, Inc., November 2020.

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Future Years – High Scenario

Similar to the baseline forecast, existing (2018) volumes were grown proportionally to future year (2023, 2028, and 2040) levels based on the high scenario O&D passenger activity reflected in Table 3.6-2. The results of the future year on-Airport roadway analysis, under the high scenario, are presented in **Table 4-58**. A total of seven links were forecast to operate at LOS D or worse by 2040 under the high scenario. One of these, Link G, was estimated to operate at LOS D in the Afternoon Peak Hour by 2023. A summary of the results under the high scenario for the Morning and Afternoon Peak Hours is graphically depicted on **Exhibit 4-45** through **Exhibit 4-47**. The links anticipated to operate at an unacceptable LOS are:

- Link A: Inbound Airport Spur
- Link F: Airport Spur EB to Hourly/RAC Parking Before Merge
- Link G: Airport Spur (EB) to Terminal and Surface Lot Before Merge
- Link S: Airport Spur Outbound Leaving Curb
- Link V: Airport Spur Outbound after International Arrivals Building Entrance/Exit
- Link X: Airport Spur Outbound after Parking Structure Exit
- Link BB: Airport Spur Outbound Toward I-94

For the seven links forecast to operate at LOS D or worse, further analyses were conducted to determine the number of additional lanes that would be required to maintain LOS D or better and the number of additional lanes required to achieve LOS C or better conditions. If after adding one lane was not enough to meet the desired LOS, a second or third lane will be identified, and when such lanes will be needed. For the evaluated roadway links, the maximum number of additional lanes needed to obtain LOS C over the 2040 planning horizon was two additional lanes on (Link G, Link S and Link V). **Table 4-59** presents the year by which and additional lane is needed to maintain the desired LOS D and LOS C conditions during the Afternoon Peak Hour. Only Link G required an additional lane during the Morning Peak Hour period.

On-Airport Roadway Static Spreadsheet Analysis Summary

Table 4-60 presents the required number of additional lanes, by year, under the baseline forecast and high scenario required to obtain LOS D and LOS C conditions, based on the capacity analysis using the static spreadsheet-based methodology. This methodology allows for a conservative, planning-level analysis. The requirements defined in this section, should be also considered in the context of the more detailed and comprehensive analysis conducted using the VISSIM[10] microsimulation analysis, which is described in the following sections.

[10] VISSIM is a multi-modal traffic flow simulation software used to model the airport terminal roadway network, analyzing traffic under constraints that include lane configuration and traffic composition.

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TABLE 4-58 ON-AIRPORT ROADWAY DEMAND/CAPACITY RESULTS – HIGH SCENARIO

						MORNING PEAK HOUR						AFTERNOON PEAK HOUR					
						2023		2028		2040		2023		2028		2040	
LINK DESIGNATION	LOCATION	ROADWAY CLASSIFICATION	LINK SPEED (MPH)	NUMBER OF LANES	LINK CAPACITY	VOLUME (VPH)	LOS	VOLUME (VPH)	LOS	VOLUME (VPH)	LOS	VOLUME (VPH)	LOS	VOLUME (VPH)	LOS	VOLUME (VPH)	LOS
A	Airport Spur (EB)	Entry/Exit Roadway	35	2	2,580	736	B	828	B	1,078	B	1,151	C	1,295	C	1,688	D
B	South Howell Avenue Exit to Airport Spur (EB) - Terminal and Surface Lot	Ramp	25	1	1,010	206	A	228	A	281	B	299	B	328	B	410	C
C	South Howell Avenue Exit to Parking Structure and Rental Car Return	Ramp	15	1	1,010	102	A	114	A	149	A	128	A	145	A	188	A
D	Hourly Parking and Rental Car from Terminal Recirculation and Howell Avenue	Terminal Access Roadway	15	1	1,010	269	B	269	B	269	B	144	A	144	A	144	A
E	Airport Spur (EB) to Daily Parking	Terminal Access Roadway	25	1	1,010	116	A	130	A	170	A	114	A	129	A	168	A
F	Airport Spur (EB) to Hourly/RAC Parking Before Merge	Terminal Access Roadway	25	1	1,010	292	B	327	B	421	C	419	C	469	C	605	D
G	Airport Spur (EB) to Terminal and Surface Lot Before Merge	Terminal Access Roadway	25	2	2,020	876	C	982	C	1,263	D	1,256	D	1,408	D	1,815	E
H	Airport Spur Approach to Curb After Merge	Terminal Access Roadway	25	4	4,040	1,075	B	1,205	B	1,547	B	1,561	B	1,748	C	2,252	C
I	Hourly Parking Entrance	Terminal Access Roadway	15	2	2,020	93	A	105	A	137	A	114	A	129	A	168	A
J	Rental Car Entrance 1	Terminal Access Roadway	15	1	1,010	70	A	79	A	103	A	223	A	251	B	328	B
K	Rental Car Entrance 2	Terminal Access Roadway	15	1	1,010	70	A	79	A	103	A	223	A	251	B	328	B
L	Limo and Ground Transportation Entrance	Terminal Access Roadway	15	1	1,010	92	A	103	A	135	A	1	A	2	A	2	A
M	TNC Staging Lot Exit	Terminal Access Roadway	15	1	1,010	62	A	70	A	91	A	106	A	119	A	155	A
N	Cell Phone Lot/Surface Parking Entrance	Terminal Access Roadway	15	1	1,010	95	A	106	A	139	A	80	A	91	A	118	A
O	Cell Phone Lot/Surface Parking Exit	Terminal Access Roadway	15	1	1,010	110	A	122	A	157	A	163	A	181	A	233	A
S	Airport Spur Outbound Leaving Curb	Terminal Loop Roadway	15	3	3,030	1,080	B	1,211	C	1,555	C	1,712	C	1,918	D	2,474	E
T-EB	East Joseph M Hutsteiner Drive Towards Service Area (EB)	Terminal Loop Roadway	30	1	1,170	93	A	100	A	128	A	311	B	341	B	430	B
T-WB	East Joseph M Hutsteiner Drive Leaving Service Area (WB)	Terminal Loop Roadway	30	1	1,170	126	A	140	A	174	A	148	A	161	A	200	A
U-EB	East Joseph M Hutsteiner Drive Before International Terminal Entrance/Exit (EB)	Terminal Loop Roadway	30	1	1,170	180	A	204	A	262	A	88	A	98	A	128	A
U-WB	East Joseph M Hutsteiner Drive After International Terminal Entrance/Exit (WB)	Terminal Loop Roadway	30	1	1,170	77	A	88	A	111	A	110	A	119	A	151	A
V	Airport Spur Outbound after International Terminal Entrance/Exit	Terminal Loop Roadway	15	3	3,030	1,059	B	1,186	B	1,526	C	1,741	C	1,951	D	2,521	E
W	Parking Structure Exit	Terminal Loop Roadway	25	2	2,020	281	A	311	A	394	A	552	B	621	B	810	C
X	Airport Spur Outbound after Parking Structure Exit	Terminal Loop Roadway	25	5	5,050	1,197	A	1,342	B	1,729	B	2,282	C	2,559	C	3,314	D
Y	Airport Spur Outbound Split Towards Parking and Terminal Recirculation	Terminal Loop Roadway	15	1	1,010	286	B	323	B	420	C	303	B	342	B	445	C
Z	Airport Spur Outbound Split Towards Howell Avenue	Entry/Exit Roadway	25	2	2,020	281	A	311	A	394	A	508	B	565	B	716	B
AA	Recirculation to Daily Parking	Terminal Loop Roadway	15	1	1,010	40	A	44	A	58	A	48	A	54	A	70	A
BB	Airport Spur Outbound Split Towards I-94	Entry/Exit Roadway	50	2	3,240	639	A	718	A	936	B	1,512	C	1,701	C	2,218	D

LEGEND:

Level of Service D

Level of Service E

NOTES:
EB = Eastbound
WB = Westbound
TNC = Transportation Network Company
RAC = Rental Car Center
MPH = Miles per hour
VPH = Vehicles per hour
LOS = Level of Service

SOURCES: TranSMART Technologies, Inc., November 2018; ACRP Report 40, Airport Curbside and Terminal Area Roadway Operations, Table 4-1, "Levels of Service for Airport Terminal Area Access and Circulation Roadways," July 2010; Ricondo & Associates, Inc., November 2020.

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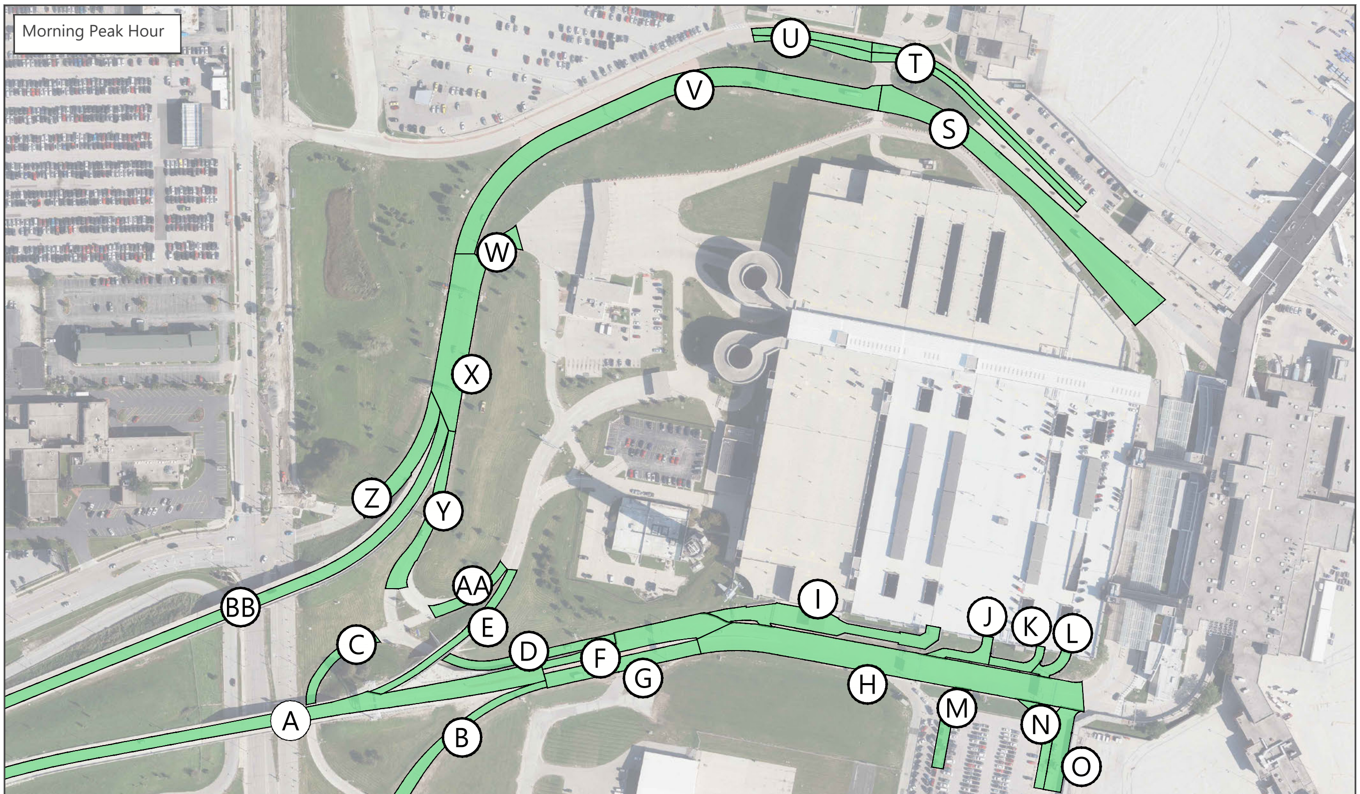
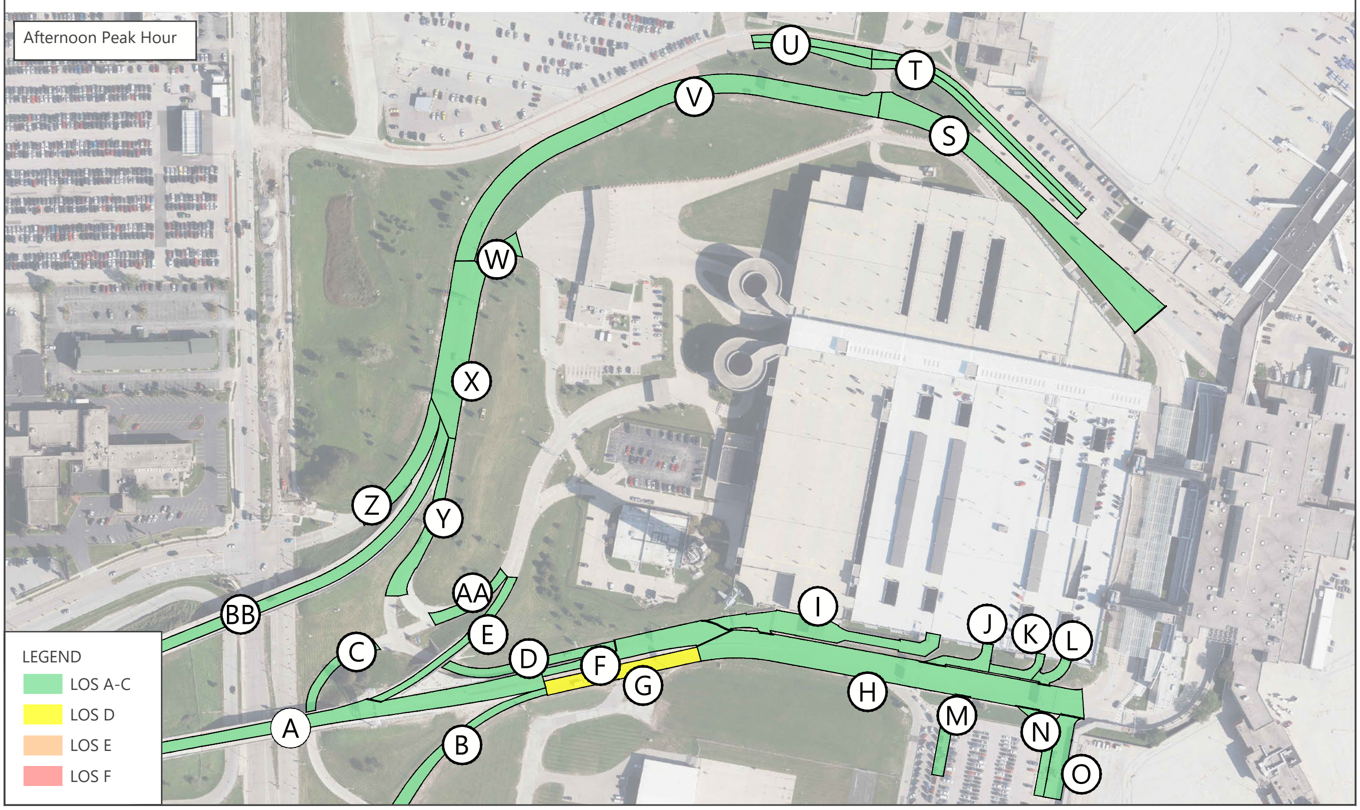




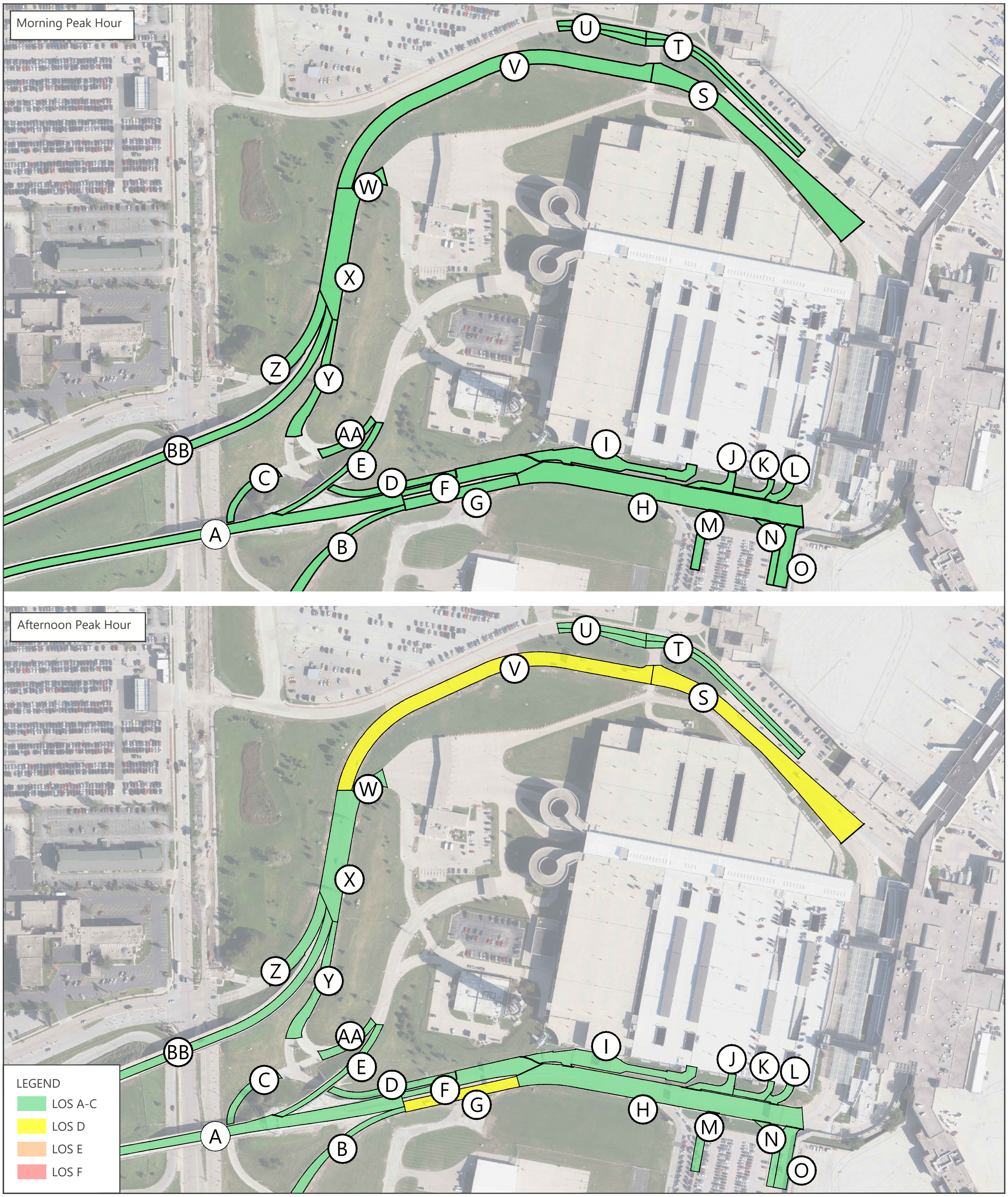
SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH 0 400 ft.

EXHIBIT 4-45

ON-AIRPORT ROADWAY DEMAND/CAPACITY SUMMARY
HIGH SCENARIO 2023 - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\On-Airport Roadway Study Area_2022-03-11.dwgLayout: High 2023 Plotted: Mar 29, 2022, 10:41AM



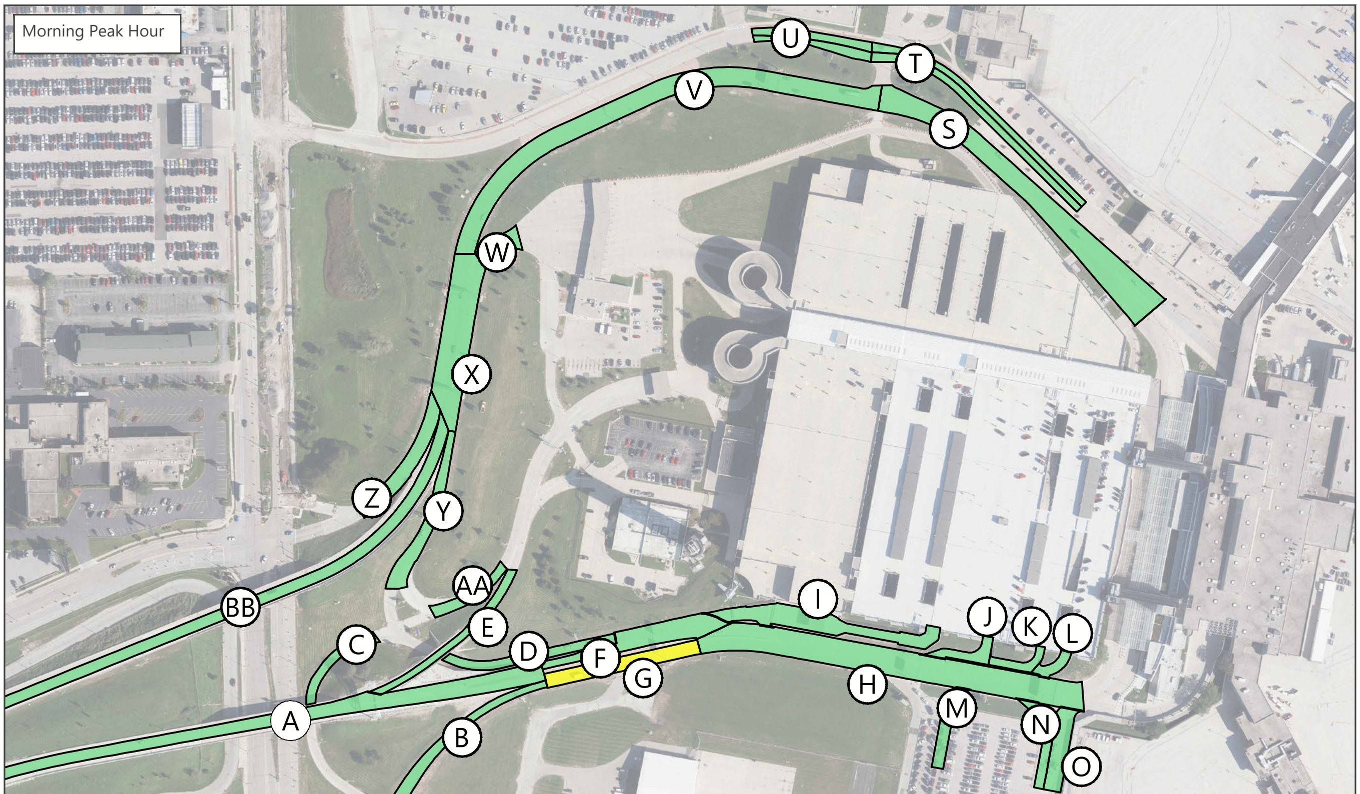
SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

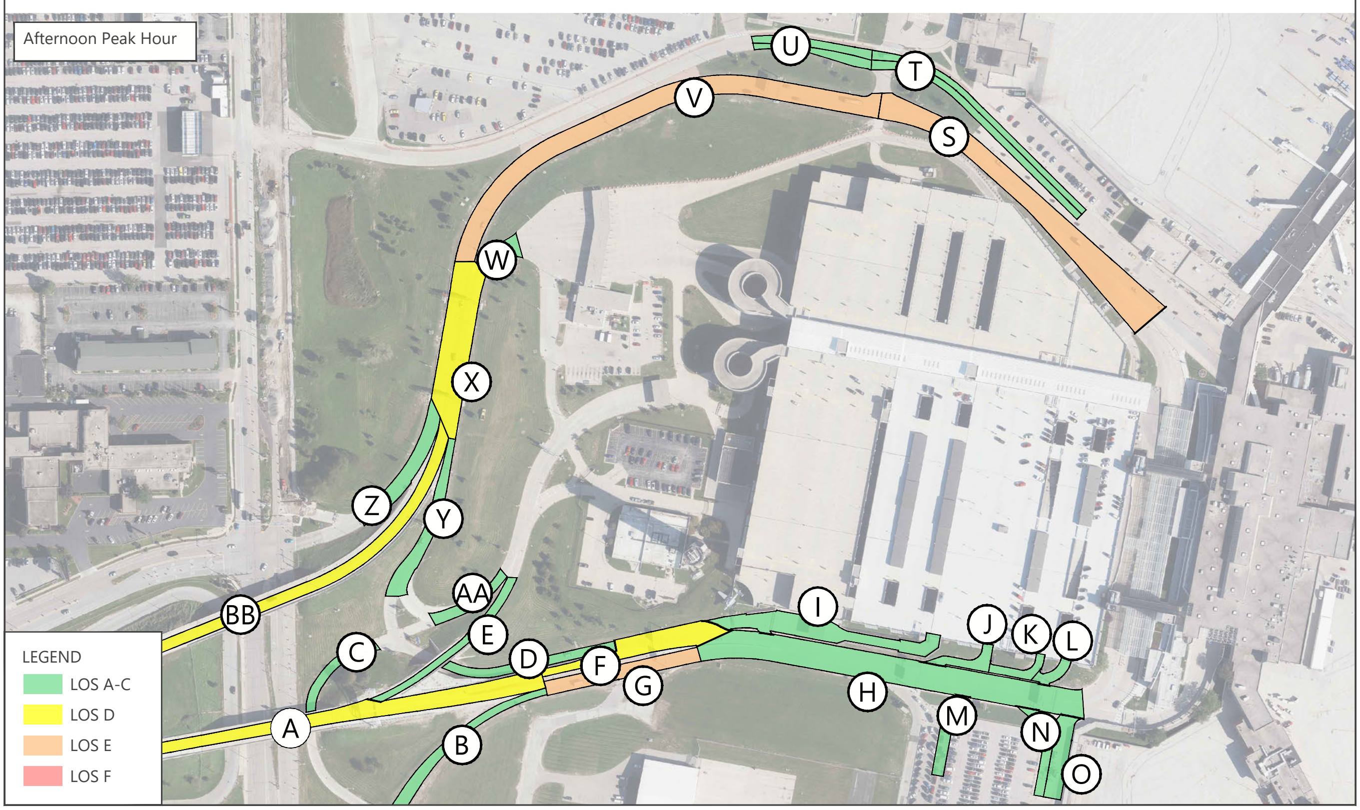
NORTH 0 400 ft.

EXHIBIT 4-46

ON-AIRPORT ROADWAY DEMAND/CAPACITY SUMMARY
HIGH SCENARIO 2028 - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\On-Airport Roadway Study Area_2022-03-11.dwgLayout: High 2028 Plotted: Mar 29, 2022, 10:42AM





SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH 0 400 ft.

EXHIBIT 4-47

ON-AIRPORT ROADWAY DEMAND/CAPACITY SUMMARY
HIGH SCENARIO 2040 - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\On-Airport Roadway Study Area_2022-03-11.dwgLayout: High 2040 Plotted: Mar 29, 2022, 10:42AM

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TABLE 4-59 ON-AIRPORT ROADWAY LANE REQUIREMENTS – HIGH SCENARIO

LINK DESIGNATION	DESCRIPTION	ADDITIONAL LANE REQUIRED WHEN LINK VOLUME EXCEEDS (VPH)	LOS CRITERIA	EXISTING LANES	ADDITIONAL LANES: FIRST IMPROVEMENT (ADD A LANE)	ADDITIONAL LANES: SECOND IMPROVEMENT ADD 2ND LANE)	ADDITIONAL LANES: THIRD IMPROVEMENT (ADD 3RD LANE)	2040: MORNING VOLUME (VPH)	2040: LOS	2023: AFTERNOON VOLUME (VPH)	2023: LOS	2028: AFTERNOON VOLUME (VPH)	2028: LOS	2040: AFTERNOON VOLUME (VPH)	2040: LOS
A	Airport Spur EB Inbound	2,060	LOS D	2	-	-	-	-	-	1,151	C	1,295	C	1,688	D
		1,580	LOS C	2	Before 2040	-	-	-	-	1,151	C	1,295	C	1,688	D → C
F	Airport Spur (EB) to Hourly/RAC Parking Before Merge	800	LOS D	1	-	-	-	-	-	419	C	469	C	605	D
		600	LOS C	1	Before 2040	-	-	-	-	419	C	469	C	605	D → B
G	Airport Spur (EB) to Terminal and Surface Lot Before Merge	1,600	LOS D	2	Before 2040	-	-	1,263	D	1,256	D	1,408	D	1,815	E → D
		1,200	LOS C	2	Before 2023	Before 2040	-	1,263	D → C	1,256	D → C	1,408	D → C	1,815	E → C
S	Airport Spur Outbound Leaving Curb	2,400	LOS D	3	Before 2040	-	-	-	-	1,712	C	1,918	D	2,474	E → D
		1,800	LOS C	3	Before 2028	Before 2040	-	-	-	1,712	C	1,918	D → C	2,474	E → C
V	Airport Spur Outbound after International Arrivals Building Entrance/Exit	2,400	LOS D	3	Before 2040	-	-	-	-	1,741	C	1,951	D	2,521	E → D
		1,800	LOS C	3	Before 2028	Before 2040	-	-	-	1,741	C	1,951	D → C	2,521	E → C
X	Airport Spur Outbound after Parking Structure Exit	4,000	LOS D	5	-	-	-	-	-	2,282	C	2,559	C	3,314	D
		3,000	LOS C	5	Before 2040	-	-	-	-	2,282	C	2,559	C	3,314	D → C
BB	Airport Spur Outbound Split Towards I-94	2,780	LOS D	2	-	-	-	-	-	1,512	C	1,701	C	2,218	D
		2,100	LOS C	2	Before 2040	-	-	-	-	1,512	C	1,701	C	2,218	D → C

LEGEND

One Additional Lane Added

2nd Additional Lane Added

NOTES:
EB = Eastbound
LOS = Level of Service
VPH = Vehicles per hour
D → C = represented the LOS before and after the lane improvement is added
SOURCES: TranSMART Technologies, Inc., November 2018; ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations*, Table 4-1, "Levels of Service for Airport Terminal Area Access and Circulation Roadways," July 2010; Ricondo & Associates, Inc., November 2020,

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TABLE 4-60 ON-AIRPORT ROADWAY LANE REQUIREMENTS – SUMMARY

YEAR ADDITIONAL LANES ARE NEEDED	ADDITIONAL LANES REQUIRED FOR LOS D			ADDITIONAL LANES REQUIRED FOR LOS C		
	2023	2028	2040	2023	2028	2040
Baseline Forecast	-	-	G	-	G, V	G, S, V
High Scenario	-	-	G, S, V	G	G, S, V	A, F, ***G***^{2}, ***S***^{2}, **V**^{2}, X, BB

NOTES:
1 # represents year first new lane is needed
2 (**#**^{2}) represents year a second lane is needed. (#) represents name of roadway segment; bolding indicates segment requires additional lane; superscript indicates the addition of second lane (in addition to lane additions required to meet baseline forecast activity).
SOURCE: Ricondo & Associates, Inc. November 2020.

4.6.3.2 ON-AIRPORT ROADWAY SIMULATION ANALYSIS AND RESULTS

The calibrated VISSIM simulation models were used to develop baseline and future models for each of the traffic condition scenarios described above. These models were run multiple times with different random seeds[11] to introduce variability in the results. Results from all runs were compiled, averaged, and summarized for the key measures of effectiveness (MOE) including average speed (mph), average throughput (vehicles per hour), and average density (vehicles per mile per lane).

A full description of the simulation analysis background, model development and calibration are described in Section 4.6.3.4, Simulation Based Modeling - VISSIM.

Table 4-61 and **Table 4-62** summarize the results for the Morning and Afternoon Peak Hours for the 2018, 2023, 2028, and 2040, baseline forecast and high scenarios. As shown in these tables, most roadway segments operate at adequate conditions with no significant congestion throughout the period of analysis; however, there are a few exceptions. During the Morning Peak Hour, in the future scenarios beyond 2023, and especially under the high scenario, Segments S (Airport Spur outbound roadway leaving the curbsides) and Segment V (Airport Spur outbound segment downstream of International Arrivals Building Entrance/Exit) show signs of slight congestion with density values ranging between 35 to 53 vehicles per mile per lane. While conditions became slightly more constrained, the operating speed remains above 16 mph and those segments are able to process the entire demand volume for the peak period, which means that no queue is generated at these locations. During the Afternoon Peak Hour, these two previously described segments (S and V) show higher levels of congestion in 2028 and 2040, however never reaching conditions of severe congestion and maintaining operating speeds of nearly or above 16 mph. In addition, Segments D (access to Hourly Parking and Rental Car from Terminal recirculation and Howell Avenue), H (Airport Spur approach to curb after merge), W (Parking Structure Exit), X (Airport Spur outbound segment downstream of parking structure exit) and Y (Airport Spur Outbound Split Towards Parking and Terminal Recirculation) show some signs of slight congestion in 2040.

Overall, the simulation modeling results show that the existing roadway network, without any additional lanes added, performs better than the static spreadsheet analysis and has sufficient capacity to adequately handle the

[11] VISSIM is a stochastic simulation model. Stochastic is defined as having a random probability distribution or pattern that may be analyzed statistically but cannot be predicted precisely. Stochastic functions are utilized in VISSIM to account for day to day variability of traffic conditions. In practical terms, the user introduces this variability in the model by entering a "seed number", which triggers the random process in the simulation. Each "seed number" will result in slightly different results in VISSIM.

future demand for the baseline forecast. The high scenario shows some areas of deterioration in the operation, however, even when some segments would reach borderline density levels and show moderate congestion in future years, the operating speed and throughput volumes would remain stable and not be significantly impacted by the increase in density. Based on simulation results, while some additional capacity could improve the operation and increase the useful life of the access and circulation system, particularly under the high scenario, congestion and vehicle speeds are consistent with performance at similar airports. The cost and operational disruption associated with lane addition are not justified in light of the performance of the terminal roadway system as dynamically modeled.

4.6.3.3 CURBSIDE REQUIREMENTS

The balanced Morning and Afternoon Peak Hour traffic volumes described in Section 4.6.1.2, Development of Balanced Roadway Network, were also used to estimate the number of vehicles, by vehicle mode, accessing the terminal curbsides. This information was then used to develop a separate curbside demand and requirements model to estimate the linear requirements[12] for terminal curbsides during both the Morning and Afternoon Peak Hours for curbside traffic.

Approach

As described in previous sections, a combination of spreadsheet-based mathematical modeling and dynamic stochastic simulation modeling was used to identify existing facility demands and future curbside requirements for the peak terminal departure hour (Morning Peak Hour) and the peak terminal arrival hour (Afternoon Peak Hour). The following section describes in more detail the spreadsheet-based static methodology.

This curbside mathematical approach model does not take into account curbside pedestrian crossings, or any type of curbside management used to regulate the operation. This is an important consideration given that both the arrivals and departures roadways at MKE have several designated pedestrian crossings, which are stop-controlled. This could have a significant impact on the capacity of the curb, especially for through traffic as all vehicles are required to stop at pedestrian crossings even when no pedestrians are actively crossing the road.

The curbside demand and requirements spreadsheet model use the volume of vehicles at the curbside during the Morning and Afternoon Peak Hours, combined with average dwell times by vehicle mode, to estimate the number of vehicles requiring curbside frontage during the peak hours. To account for fluctuating arrival rates during the peak hour, the model applies a statistical "surge" factor based on a Poisson distribution to estimate the length of curbside required during the peak hour. The estimated space requirements are then multiplied by the average length of one vehicle (including a buffer to represent the empty space between two parked vehicles and lost spaces resulting from parking inefficiencies) to determine the demand for curbside frontage in linear feet.

[12] Curbside requirements were obtained based on the existing conditions at the time of the analysis and the projected traffic demand. At the time of the analysis, MKE did not have dedicated ADA loading zones allocated at curbsides, however, accessible loading/unloading zones were added to the curbs more recently. ADA guidance calls for the provision of at least one ADA-compliant passenger loading zone in every continuous 100 linear feet of loading zone space. Although ADA-compliant loading zones are recommended, these zones are typically not policed in a manner that precludes use by other modes. The impact on curbside requirements due to considerations for ADA loading/unloading spaces is historically absorbed within the overall determination of curbfront requirements, without exclusive allocation to dedicated zones. Should MKE decide to increase the number of ADA-compliant passenger loading zones and restrict those areas from use by non-ADA users, the curbfront requirements may Increase in the future.

TABLE 4-61 LINK DENSITY ANALYSIS FROM SIMULATION MODEL FOR AIRPORT ROADWAYS - BASELINE FORECAST

		MORNING PEAK 2018			MORNING PEAK 2023			MORNING PEAK 2028			MORNING PEAK 2040			AFTERNOON PEAK 2018			AFTERNOON PEAK 2023			AFTERNOON PEAK 2028			AFTERNOON PEAK 2040		
LINK DESIGNATION	LOCATION	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)
A	Airport Spur EB	495	38.9	7.0	585	38.8	8.3	650	38.7	9.2	806	38.6	11.4	776	38.6	11.0	962	38.5	13.7	1,063	38.4	15.2	1,324	38.1	19.0
B	S Howell Ave. Exit to Airport Spur EB-Terminal & Surface Lot	157	26.5	5.9	200	26.4	7.6	222	26.4	8.4	265	26.4	10.1	222	26.4	8.4	279	26.4	10.6	308	26.4	11.7	368	26.3	14.0
C	S Howell Ave. Exit to Parking Structure & Rental Car Return	77	26.5	2.9	98	26.4	3.7	107	26.4	4.1	128	26.3	4.9	107	26.3	4.0	133	26.3	5.1	146	26.2	5.6	172	26.2	6.6
D	Hourly Parking and Rental Car from Terminal Recirculation & Howell Ave.	273	18.4	14.8	338	18.3	18.4	382	18.3	20.9	459	18.0	25.5	407	18.0	22.6	503	17.8	28.3	535	17.8	30.2	665	17.5	38.0
E	Airport Spur EB to Daily Parking	59	39.1	1.8	70	39.0	2.1	77	39.0	2.3	95	39.0	2.9	92	39.0	2.8	114	38.9	3.4	122	38.9	3.7	153	38.8	4.6
F	Airport Spur EB to Hourly/RAC Parking Before Merge	90	38.4	2.4	106	38.3	2.8	117	38.3	3.1	147	38.1	3.9	140	38.2	3.7	174	38.1	4.6	195	38.1	5.1	238	37.9	6.3
G	Airport Spur EB to Terminal & Surface Lot Before Merge	494	32.9	8.8	598	32.6	10.6	668	32.5	11.7	816	32.3	14.4	752	32.5	13.5	935	32.2	16.7	1,035	32.1	18.4	1,276	31.6	23.0
H	Airport Spur Approach to Curb After Merge	675	23.0	14.0	820	22.8	17.0	924	22.7	19.0	1,123	22.5	23.0	1,027	22.6	21.5	1,275	22.1	27.2	1,393	22.1	29.5	1,723	20.1	40.9
I	Hourly Parking Entrance	57	13.5	3.3	69	13.4	4.0	77	13.5	4.4	96	13.5	5.5	88	13.4	5.0	112	13.4	6.3	122	13.4	6.9	150	13.4	8.5
J	Rental Car Entrance 1	89	18.1	5.0	111	18.0	6.2	123	18.1	6.8	149	18.1	8.3	136	18.0	7.5	168	18.1	9.3	188	18.1	10.4	227	18.0	12.6
K	Rental Car Entrance 2	58	16.5	3.6	71	16.5	4.3	79	16.5	4.8	96	16.5	5.9	90	16.5	5.5	109	16.4	6.7	121	16.4	7.4	146	16.4	8.9
L	Limo and Ground Transportation Entrance	9	16.6	0.5	10	16.6	0.6	11	16.5	0.7	15	16.4	0.9	15	16.5	0.9	18	16.4	1.1	20	16.5	1.2	23	16.5	1.4
M	TNC Staging Lot Exit	41	18.0	2.3	55	17.9	3.1	61	17.7	3.5	76	17.5	4.3	70	17.5	4.0	95	17.5	5.5	108	17.5	6.2	130	16.6	7.9
N	Cell Phone Lot/Surface Parking Entrance	62	10.1	8.7	73	10.0	10.2	83	9.8	11.7	105	9.5	15.1	100	9.6	14.3	120	9.5	17.4	134	9.3	19.5	166	8.9	24.9
S	Airport Spur Outbound Leaving Curb	800	17.7	23.7	986	17.6	29.1	1,106	17.5	33.0	1,346	17.2	40.6	1,301	17.3	40.3	1,577	17.0	48.9	1,685	16.9	51.7	1,903	16.4	59.5
T-EB	E Joseph M Hutsteiner Dr. Towards Service Area (EB)	17	23.8	0.7	17	25.1	0.7	23	24.2	0.9	29	24.3	1.2	20	23.2	0.8	25	24.8	1.1	23	25.1	1.0	36	24.1	1.5
T-WB	E Joseph M Hutsteiner Dr. Leaving Service Area (WB)		20.4	1.2	30	20.5	1.5	33	20.4	1.6	37	20.3	1.8	26	20.4	1.3	31	20.4	1.5	34	20.4	1.7	39	20.3	1.9
U-EB	E Joseph M Hutsteiner Dr. Before International Terminal Ent/Exit (EB)	26	24.0	1.4	27	24.2	1.5	37	24.2	2.0	44	24.0	2.3	28	22.7	1.5	32	22.7	1.8	28	22.7	1.6	46	22.7	2.5
U-WB	E Joseph M Hutsteiner Dr. After International Terminal Ent/Exit (WB)	55	19.1	2.9	68	19.0	3.6	75	18.9	4.0	92	18.9	4.9	79	18.9	4.2	98	18.8	5.2	108	18.8	5.8	127	18.7	6.8
V	Airport Spur Outbound after International Terminal Ent/Exit	762	17.2	27.1	940	17.1	33.4	1,056	17.0	38.0	1,280	16.7	47.1	1,228	16.7	46.5	1,484	16.5	56.2	1,577	16.5	59.2	1,785	16.0	69.6
W	Parking Structure Exit	97	19.8	4.7	130	19.7	6.3	144	19.7	7.1	178	19.6	8.8	384	19.3	18.4	526	19.0	24.4	581	18.9	27.0	719	18.7	32.3
X	Airport Spur Outbound after Parking Structure Exit	874	18.4	13.8	1,094	18.4	17.1	1,221	18.4	19.2	1,484	18.2	23.5	1,636	18.4	25.5	2,039	18.2	31.7	2,188	18.1	33.9	2,537	17.9	39.6
Y	Airport Spur Outbound Split Towards Parking and Terminal Recirculation	218	17.2	12.7	269	16.8	16.0	307	16.7	18.4	370	16.3	22.8	335	16.5	20.3	414	16.0	26.0	439	15.9	27.6	553	14.6	38.1
Z	Airport Spur Outbound Split Towards Howell Ave.	237	18.6	7.4	299	18.5	9.4	329	18.6	10.0	401	18.4	12.1	415	18.7	12.3	535	18.5	15.8	583	18.6	17.0	664	18.4	19.2
AA	Recirculation to Daily Parking	24	21.9	1.1	30	21.1	1.4	32	21.4	1.5	42	21.1	2.0	36	20.9	1.7	48	21.0	2.3	55	21.0	2.6	66	20.8	3.2
BB	Airport Spur Outbound Split Towards I-94	430	27.1	9.9	539	27.1	12.2	600	27.0	13.6	733	26.8	16.7	905	26.9	19.4	1,113	26.8	23.9	1,191	26.8	25.6	1,348	26.6	29.0

LEGEND:

Not Congested | Slightly Congested | Congested | Severely Congested

NOTES:
VPH = Vehicles per Hour
MPH = Miles per Hour
VPMPL = Vehicles per Mile Per Lane
Density Criteria: 0-35 Not Congested (Green), 35.1-60 Slightly Congested (Yellow), 60.1-90 Congested (Orange), >90 Severely Congested (Red).
Links in This Table Are Characterized by Uninterrupted, Free Flow Traffic. Link O is Included in the Static Results Table but is Omitted Here Because It Is Stop Controlled.
SOURCES: TranSMART Technologies, Inc. November 2018; Ricondo & Associates, Inc. October 2020.

TABLE 4-62 LINK DENSITY ANALYSIS FROM SIMULATION MODEL FOR AIRPORT ROADWAYS – HIGH SCENARIO

		MORNING PEAK 2018			MORNING PEAK 2023			MORNING PEAK 2028			MORNING PEAK 2040			AFTERNOON PEAK 2018			AFTERNOON PEAK 2023			AFTERNOON PEAK 2028			AFTERNOON PEAK 2040		
LINK DESIGNATION	LOCATION	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)	VOLUME (VPH)	SPEED (MPH)	DENSITY (VPMPL)
A	Airport Spur EB	495	38.9	7.0	618	38.8	8.8	693	38.7	9.8	912	38.5	13.1	776	38.6	11.0	1,015	38.4	14.4	1,140	38.3	16.2	1,489	37.7	21.6
B	S Howell Ave. Exit to Airport Spur EB-Terminal & Surface Lot	157	26.5	5.9	211	26.4	8.0	234	26.4	8.9	294	26.4	11.1	222	26.4	8.4	291	26.4	11.0	322	26.3	12.2	407	26.2	15.6
C	S Howell Ave. Exit to Parking Structure & Rental Car Return	77	26.5	2.9	101	26.4	3.8	113	26.4	4.3	141	26.3	5.4	107	26.3	4.0	140	26.3	5.3	152	26.2	5.8	195	26.2	7.5
D	Hourly Parking and Rental Car from Terminal Recirculation & Howell Ave.	273	18.4	14.8	359	18.3	19.6	394	18.2	21.7	503	17.8	28.3	407	18.0	22.6	516	17.8	29.0	581	17.6	33.0	726	17.4	41.6
E	Airport Spur EB to Daily Parking	59	39.1	1.8	74	39.0	2.2	82	39.0	2.4	106	38.9	3.2	92	39.0	2.8	120	38.9	3.6	135	38.9	4.1	170	38.8	5.1
F	Airport Spur EB to Hourly/RAC Parking Before Merge	90	38.4	2.4	111	38.4	2.9	126	38.3	3.3	166	38.0	4.4	140	38.2	3.7	186	38.0	4.9	206	38.0	5.4	270	37.9	7.2
G	Airport Spur EB to Terminal & Surface Lot Before Merge	494	32.9	8.8	631	32.5	11.2	707	32.5	12.4	919	32.2	16.2	752	32.5	13.5	983	32.2	17.5	1,101	32.0	19.7	1,431	27.6	31.8
H	Airport Spur Approach to Curb After Merge	675	23.0	14.0	869	22.7	17.9	965	22.7	19.9	1,252	22.3	26.3	1,027	22.6	21.5	1,325	22.2	28.0	1,490	21.9	31.8	1,905	16.8	60.7
I	Hourly Parking Entrance	57	13.5	3.3	73	13.4	4.2	83	13.4	4.8	109	13.4	6.3	88	13.4	5.0	119	13.4	6.7	130	13.4	7.4	171	13.3	9.7
J	Rental Car Entrance 1	89	18.1	5.0	116	18.1	6.4	130	18.1	7.2	167	18.0	9.3	136	18.0	7.5	177	18.0	9.8	197	18.0	11.0	256	18.1	14.2
K	Rental Car Entrance 2	58	16.5	3.6	76	16.5	4.6	85	16.5	5.2	106	16.5	6.5	90	16.5	5.5	116	16.4	7.1	129	16.4	7.9	165	16.4	10.1
L	Limo and Ground Transportation Entrance	9	16.6	0.5	11	16.5	0.7	13	16.5	0.8	17	16.4	1.1	15	16.5	0.9	20	16.5	1.2	21	16.5	1.3	29	16.5	1.8
M	TNC Staging Lot Exit	41	18.0	2.3	58	17.8	3.3	64	17.6	3.7	85	17.7	4.8	70	17.5	4.0	100	17.2	5.8	112	17.2	6.6	151	13.7	13.1
N	Cell Phone Lot/Surface Parking Entrance	62	10.1	8.7	77	10.0	10.8	91	9.6	13.0	115	9.6	16.4	100	9.6	14.3	125	9.4	18.1	139	9.1	20.5	187	8.2	29.3
S	Airport Spur Outbound Leaving Curb	800	17.7	23.7	1,043	17.5	31.0	1,158	17.4	34.5	1,510	17.0	46.3	1,301	17.3	40.3	1,627	16.9	50.2	1,754	16.8	54.3	2,000	16.3	62.9
T-EB	E Joseph M Hutsteiner Dr. Towards Service Area (EB)	17	23.8	0.7	22	24.2	0.9	20	25.6	0.8	22	26.2	0.9	20	23.2	0.8	26	24.6	1.1	31	24.4	1.3	30	26.0	1.2
T-WB	E Joseph M Hutsteiner Dr. Leaving Service Area (WB)	25	20.4	1.2	31	20.4	1.5	34	20.4	1.7	41	20.3	2.0	26	20.4	1.3	33	20.4	1.6	35	20.3	1.7	43	20.3	2.1
U-EB	E Joseph M Hutsteiner Dr. Before International Terminal Ent/Exit (EB)	26	24.0	1.4	35	24.1	1.8	31	24.2	1.6	30	23.9	1.6	28	22.7	1.5	35	22.7	1.9	38	22.4	2.1	33	22.0	1.8
U-WB	E Joseph M Hutsteiner Dr. After International Terminal Ent/Exit (WB)	55	19.1	2.9	71	19.0	3.7	80	19.0	4.2	104	18.9	5.5	79	18.9	4.2	105	18.7	5.6	112	18.7	6.0	137	18.7	7.3
V	Airport Spur Outbound after International Terminal Ent/Exit	762	17.2	27.1	994	17.0	35.6	1,099	16.9	39.7	1,417	16.6	53.1	1,228	16.7	46.5	1,527	16.5	57.9	1,644	16.3	62.6	1,931	15.9	73.1
W	Parking Structure Exit	97	19.8	4.7	137	19.7	6.7	153	19.7	7.3	202	19.5	10.0	384	19.3	18.4	555	19.0	25.7	622	18.8	28.2	808	18.5	36.1
X	Airport Spur Outbound after Parking Structure Exit	874	18.4	13.8	1,151	18.4	18.1	1,274	18.3	20.1	1,650	18.2	26.3	1,636	18.4	25.5	2,113	18.2	33.0	2,300	18.1	35.6	2,709	17.8	42.3
Y	Airport Spur Outbound Split Towards Parking and Terminal Recirculation	218	17.2	12.7	282	17.0	16.7	311	16.7	18.6	404	16.1	25.1	335	16.5	20.3	420	16.1	26.2	478	15.7	30.4	598	14.3	42.0
Z	Airport Spur Outbound Split Towards Howell Ave.	237	18.6	7.4	316	18.5	9.8	344	18.5	10.4	437	18.4	13.2	415	18.7	12.3	551	18.6	16.3	604	18.5	17.7	702	18.3	20.4
AA	Recirculation to Daily Parking	24	21.9	1.1	29	21.4	1.4	34	21.3	1.6	48	21.0	2.3	36	20.9	1.7	50	20.9	2.4	56	20.9	2.7	76	20.7	3.7
BB	Airport Spur Outbound Split Towards I-94	430	27.1	9.9	567	27.0	12.9	634	27.0	14.4	829	26.8	18.8	905	26.9	19.4	1,165	26.7	25.0	1,243	26.7	26.7	1,437	26.7	30.8

LEGEND:

Not Congested | Slightly Congested | Congested | Severely Congested

NOTES:
VPH = Vehicles per Hour
MPH = Miles per Hour
VPMPL = Vehicles per Mile Per Lane
Density Criteria: 0-35 Not Congested (Green), 35.1-60 Slightly Congested (Yellow), 60.1-90 Congested (Orange), >90 Severely Congested (Red).
Links in This Table Are Characterized by Uninterrupted, Free Flow Traffic. Link O is Included in the Static Results Table but is Omitted Here Because It Is Stop Controlled.
SOURCES: TranSMART Technologies, Inc. November 2018; Ricondo & Associates, Inc. October 2020.

Curbside frontage demand is a theoretical measurement of the peak accumulation of vehicles waiting at the curbside if they were aligned in a single linear queue. For existing conditions, a "utilization" factor can be derived, representing the calculated ratio of curbside demand in linear feet divided by existing curbside length. The utilization factor provides an indication of the amount of double and triple parking that would result for a given curbside demand, and the LOS associated with a given utilization rate recognizes that vehicles do not park uniformly along the curbside.

The curbside utilization factor reflects the amount of congestion at the curbside and the resulting LOS. For example, a very low utilization factor indicates that vehicles are easily accommodated along the inner curbside lane without the need to double park. This utilization factor equates to an excellent LOS (i.e., LOS A). Conversely, a very high utilization factor equates to double and triple parking along the entire curbside, restricting vehicle movements and resulting in a poor LOS.

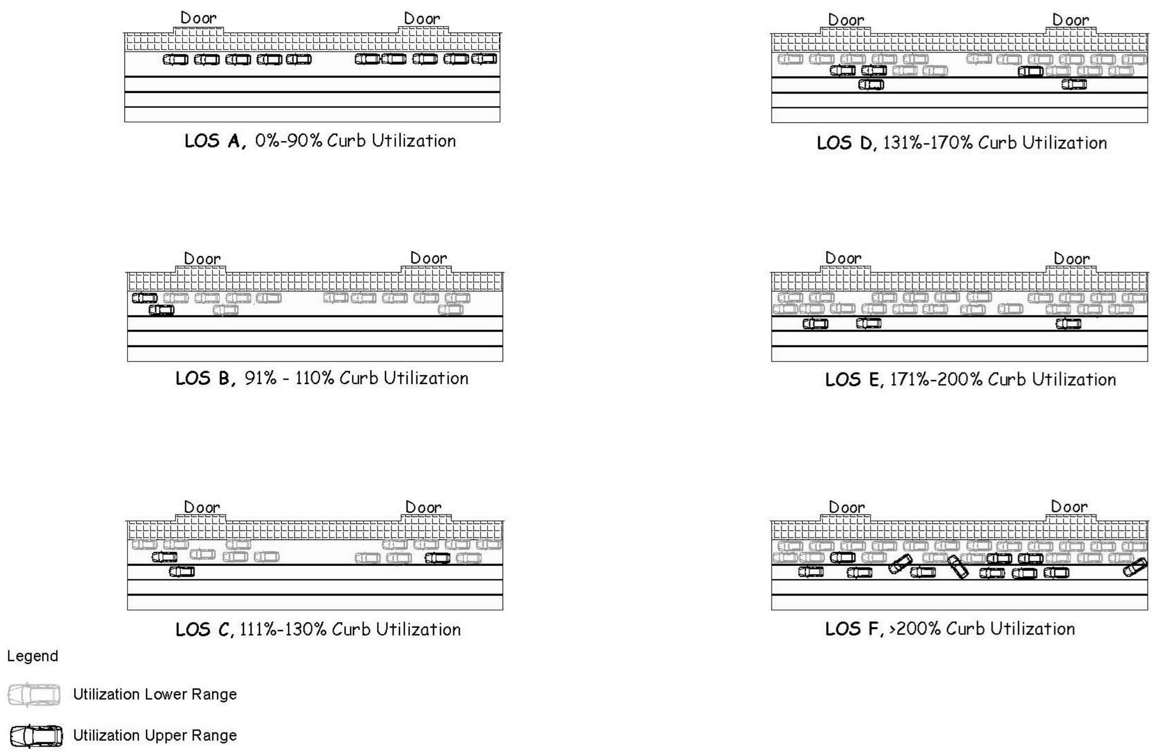
In this analysis, private vehicle curbsides were analyzed based on the assumption that passenger loading/unloading would occur in the lane directly adjacent to the curbside if available, with an allowance for activity in the adjacent lane (i.e., multiple-lane loading). Conversely, curbsides serving commercial vehicles were analyzed based on the assumption that passenger loading/unloading would occur in the lane directly adjacent to the curbside only (i.e., single-lane loading). **Table 4-63** presents the LOS for various curbside utilization rates for passenger loading/unloading. **Exhibit 4-48** provides a graphical representation of levels of service for multiple-lane loading curbside utilization.

TABLE 4-63 CURBSIDE UTILIZATION AND LEVEL OF SERVICE

LEVEL OF SERVICE	CURBSIDE UTILIZATION SINGLE-LANE LOADING	CURBSIDE UTILIZATION MULTIPLE-LANE LOADING	DESCRIPTION
A	0% - 70%	0% - 90%	Excellent: Drivers experience no interference from pedestrians or other motorists
B	71% - 85%	91% - 110%	Very Good: Relatively free flow conditions with limited double parking
C	86% - 100%	111% - 130%	Good: Double parking near doors is common with some intermittent triple parking
D	101% - 115%	131% - 170%	Fair: Vehicle maneuverability restricted due to frequent double/triple parking
E	116% - 130%	171% - 200%	Poor: Significant delays and queues; double/triple parking throughout curbside
F	> 131%	> 201%	Failure: Motorists unable to access/depart curbside; significant queuing along entry road

SOURCE: Ricondo & Associates., April 2019, based on information published in Airport Cooperative Research Program, ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations,* July 2010.

EXHIBIT 4-48 CURBSIDE LEVEL OF SERVICE AND UTILIZATION RANGES, MULTIPLE-LANE LOADING



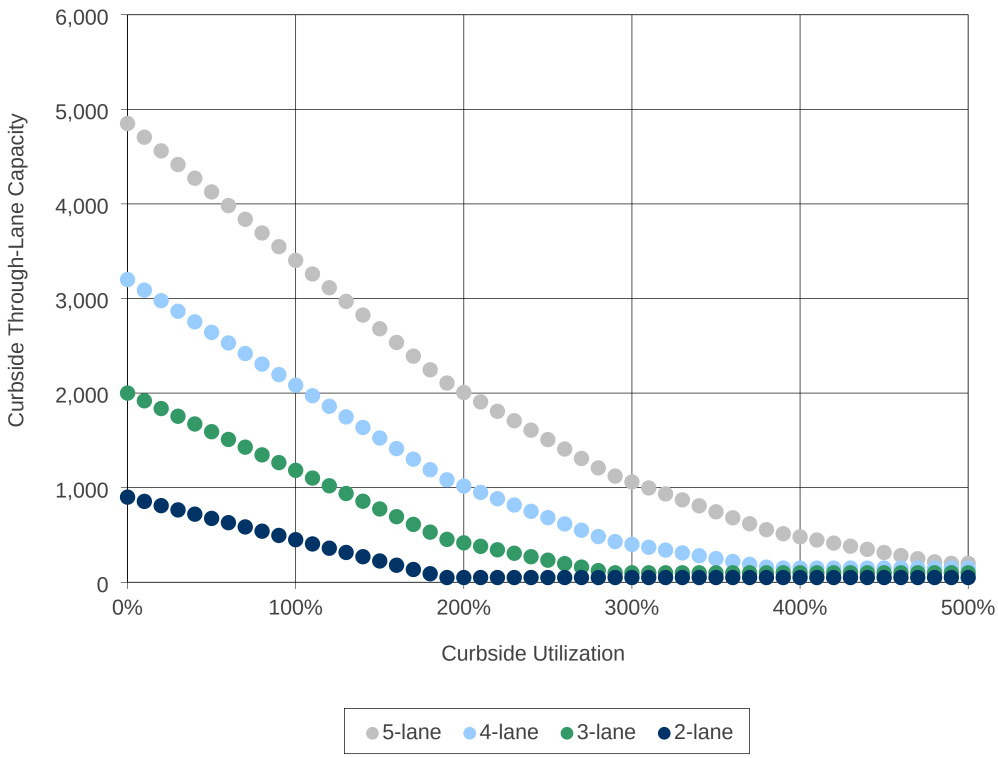
SOURCE: Airport Cooperative Research Program, ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations*, July 2010.

Curbsides with multiple-lane loading/unloading are not considered to be operating at a poor LOS when all available curbside length is being used (100 percent utilization). When a single lane is fully utilized, parked vehicles are still able to depart and access the curbside and are not generally blocked by vehicles in a second parking lane. For curbsides with multiple-lane loading/unloading, double or triple parking, or queuing along 100 percent of both the loading lane and the adjacent travel lane constitutes a failed LOS (i.e., 201 percent utilization, or LOS F).

LOS C is generally a desirable condition during peak activity periods at major airports for most days of the year. LOS D conditions may be acceptable during peak seasonal periods. As with the on-Airport roadway link analysis, a decision to attain LOS C or better along the curbsides will require greater curbside lengths (attaining a higher level-of-service may require greater capital investment). For comparison purposes, curbside requirements needed to obtain LOS C and LOS D are presented.

In addition to analyzing the curbside requirement, the spreadsheet-based curbside model was used to evaluate the throughput capacity of the curbside section of the curbside's bypass lanes. It also demonstrates the effect that congestion from stopped vehicles has on the ability to process vehicles through the curbside lanes. The throughput of the bypass lanes at MKE were analyzed using a dynamic capacity scale that varies as a function of the amount of congestion along the curbside frontage. This implies that the curbside throughput capacity values change as a function of the curbside parking utilization and the number of available through lanes. **Exhibit 4-49** illustrates the estimated curbside roadway throughput capacity as a function of the number of lanes, curbside utilization, effects of friction from stopped and maneuvering vehicles. As shown, curbside roadway throughput capacity decreases as curbside utilization increases.

EXHIBIT 4-49 CURBSIDE UTILIZATIONS EFFECT ON CURBSIDE THROUGH-LANE CAPACITY



SOURCE: Ricondo & Associates, Inc., based on information published by the Transportation Research Board, Special Report 215, *Measuring Airport Landside Capacity*, 1987, and Federal Aviation Administration in Advisory Circular 150/5360-13, *Planning and Design Guidelines for Airport Terminal Facilities*, 1994.

Existing (2018) Conditions

Using Existing 2018 data collection results (vehicle mode volume/dwell/length), the Morning and Afternoon Peak Hour curbside requirements were computed and compared with the existing length of curb. This resulted in a utilization factor and LOS for all curbside facilities (e.g., Departures Roadway, Arrivals Inner Roadway and Arrivals Outer Roadway). Optimal length of curb needed to satisfy both LOS C and LOS D conditions were calculated, along with the resulting surplus/deficit of curb length needed to obtain these LOS C and LOS D requirements. Finally, the throughput roadway capacity and resulting through-lane LOS were determined for each curbside section. These results for Existing (2018) plus future years (baseline forecast) are presented in **Table 4-64.**

The existing (2018) conditions, both the departures and arrivals roadways, experienced LOS C or better during both the Morning and Afternoon Peak Hours.

Future Years – Baseline Forecast and High Scenario

The existing (2018) Morning and Afternoon Peak Hour traffic volumes were grown based on the different growth factors directly proportional to the O&D passenger activity presented in Table 4-53. Additionally, as described above in Section 4.6.2, Future Year Growth, single occupancy vehicles such as private vehicles, taxicabs, TNCs and limousines were increased proportionally to O&D passengers, while multi-party or commercial vehicles were assumed to increase at half the O&D passenger growth rate.

The future baseline forecast requirements are presented in Table 4-64, and the Future High Scenario are presented in **Table 4-65**. Similar calculations are presented in each table comparing the Existing (2018) values to the future values for required length of curbside, curbside utilization, required length for LOS C and LOS D, projected surplus/(deficit), through-lane capacity and roadway LOS.

In the Baseline forecast analysis, all curbsides experience LOS C or better during the Morning Peak Hour. During the Afternoon Peak Hour, the Departures Roadway experiences LOS D by the 2023 period but remains at LOS D through 2040. On the Arrivals Inner Roadway, only the 2040 Afternoon Peak Hour experiences LOS D. On the Arrivals Outer Roadway, only the 2040 Afternoon Peak experiences LOS D.

In the high scenario spreadsheet analysis, only the Departures Roadway experiences LOS D during the 2040 Morning Peak Hour. During the Afternoon Peak Hour, the Departures Roadway begins at LOS D during the 2023 period and congestion increases to LOS E by 2040. The Arrivals Inner Roadway begins to experience LOS D utilization by 2028 and congestion increases to LOS E in 2040, which also produces roadway throughput LOS F constraints by 2040. The Arrivals Outer Roadway experiences LOS C or better through the 2023 period and is computed to operate at LOS D in the 2028 and 2040 Afternoon Peak Hour.

TABLE 4-64 CURBSIDE REQUIREMENTS SUMMARY – EXISTING CONDITIONS AND BASELINE FORECAST

		EXISTING		BASELINE FORECAST					
		2018		MORNING PEAK			AFTERNOON PEAK		
	UNITS	MORNING PEAK	AFTERNOON PEAK	2023	2028	2040	2023	2028	2040
Departures Roadway (Available Length: 525 Feet) – Multiple-Lane Loading									
Curbside Parking Demand	vehicles/hour	340	427	338	371	451	453	499	612
Required Curb Length	feet	535	685	560	585	635	710	735	835
Curbside Utilization (LOS)	percent	102% (B)	130% (C)	107% (B)	111% (C)	121% (C)	135% (D)	140% (D)	159% (D)
Required Total Curb Length for LOS C	feet	412	527	431	450	488	546	565	642
Required Total Curb Length for LOS D	feet	315	403	329	344	374	418	432	491
Surplus/(Deficit) for LOS C	feet	113	(2)	94	75	37	(21)	(40)	(117)
Surplus/(Deficit) for LOS D	feet	210	122	196	181	151	107	93	34
Throughput of Curbside Traffic									
Total Lanes (including parking lanes)	#	4	4	4	4	4	4	4	4
Total Roadway Demand	vehicles/hour	395	528	415	457	557	560	618	757
Throughput Roadway Capacity	vehicles/hour	2,083	1,748	2,083	1,972	1,860	1,748	1,748	1,525
Roadway Throughput LOS	LOS	A	A	A	A	A	A	A	A
Arrivals Inner Roadway (Available Length 700 feet) – Multiple-Lane Loading									
Curbside Parking Demand	vehicles/hour	261	433	283	313	375	469	519	641
Required Curb Length	feet	325	500	350	375	450	525	600	7,225
Curbside Utilization (LOS)	percent	71% (A)	109% (B)	76% (A)	82% (A)	98% (B)	114% (C)	130% (C)	158% (D)
Required Total Curb Length for LOS C	feet	250	385	269	288	346	404	462	558
Required Total Curb Length for LOS D	feet	191	294	206	221	265	309	353	426
Surplus/(Deficit) for LOS C	feet	210	75	191	172	114	56	(2)	(98)
Surplus/(Deficit) for LOS D	feet	269	166	254	239	195	151	107	34
Throughput of Curbside Traffic									
Total Number of Lanes (including parking lanes)	#	3	3	3	3	3	3	3	3
Total Roadway Demand	vehicles/hour	291	444	314	347	428	479	530	653
Throughput Roadway Capacity	vehicles/hour	1,428	1,183	1,428	1,347	1,265	1,102	938	775
Roadway Throughput LOS	LOS	A	A	A	A	A	A	A	D
Arrivals Outer Roadway (Available Length 540 feet) – Single-Lane Loading									
Curbside Parking Demand	vehicles/hour	71	78	69	75	85	78	82	90
Required Curb Length	feet	410	480	375	435	435	480	515	540
Curbside Utilization (LOS)	percent	80% (B)	93% (C)	73% (B)	84% (B)	84% (B)	93% (C)	100% (C)	105% (D)
Required Total Curb Length for LOS C	feet	410	480	375	435	435	480	515	540
Required Total Curb Length for LOS D	feet	357	417	326	378	378	417	448	470
Surplus/(Deficit) for LOS C	feet	105	35	140	80	80	35	0	(25)
Surplus/(Deficit) for LOS D	feet	158	98	189	137	137	98	67	45
Throughput of Curbside Traffic									
Total Number of Lanes (including parking lanes)	#	3	3	3	3	3	3	3	3
Total Roadway Demand	vehicles/hour	71	78	69	75	85	78	82	90
Throughput Roadway Capacity	vehicles/hour	1,592	1,510	1,592	1,510	1,510	1,510	1,428	1,428
Roadway Throughput LOS	LOS	A	A	A	A	A	A	A	A

LEGEND:

Level of Service D

SOURCES: TranSMART Technologies, Inc. November 2018; Ricondo & Associates, Inc. April 2019.

TABLE 4-65 CURBSIDE REQUIREMENTS SUMMARY – EXISTING CONDITIONS AND HIGH SCENARIO

		EXISTING		HIGH SCENARIO					
		2018		MORNING PEAK			AFTERNOON PEAK		
	UNITS	MORNING PEAK	AFTERNOON PEAK	2023	2028	2040	2023	2028	2040
Departures Roadway (Available Length: 525 Feet) – Multiple-Lane Loading									
Curbside Parking Demand	vehicles/hour	340	427	374	419	535	478	536	691
Required Curb Length	feet	535	685	610	660	760	710	785	920
Curbside Utilization (LOS)	percent	102% (B)	130% (C)	116% (C)	126% (C)	145% (D)	135% (D)	150% (D)	175%(E)
Required Total Curb Length for LOS C	feet	412	527	469	508	585	546	604	708
Required Total Curb Length for LOS D	feet	315	403	359	388	47	418	462	541
Surplus/(Deficit) for LOS C	feet	113	(2)	56	17	(60)	(21)	(79)	(183)
Surplus/(Deficit) for LOS D	feet	210	122	166	137	78	107	63	(16)
Throughput of Curbside Traffic									
Total Lanes (including parking lanes)	#	4	4	4	4	4	4	4	4
Total Roadway Demand	vehicles/hour	395	528	437	490	627	591	663	854
Throughput Roadway Capacity	vehicles/hour	2,083	1,748	1,972	1,860	1,637	1,748	1,637	1,302
Roadway Throughput LOS	LOS	A	A	A	A	A	A	A	B
Arrivals Inner Roadway (Available Length 700 feet) – Multiple-Lane Loading									
Curbside Parking Demand	vehicles/hour	261	433	299	337	439	497	559	729
Required Curb Length	feet	325	500	350	400	500	575	625	800
Curbside Utilization (LOS)	percent	71% (A)	109% (B)	76% (A)	87% (A)	109% (B)	125% (C)	136% (D)	174% (E)
Required Total Curb Length for LOS C	feet	250	385	269	308	385	442	481	615
Required Total Curb Length for LOS D	feet	191	294	206	235	294	338	368	471
Surplus/(Deficit) for LOS C	feet	210	75	191	152	75	18	(21)	(155)
Surplus/(Deficit) for LOS D	feet	269	166	254	225	166	122	92	(11)
Throughput of Curbside Traffic									
Total Number of Lanes (including parking lanes)	#	3	3	3	3	3	3	3	3
Total Roadway Demand	vehicles/hour	291	444	332	373	486	507	570	741
Throughput Roadway Capacity	vehicles/hour	1,428	1,183	1,428	1,347	1,183	1,020	938	612
Roadway Throughput LOS	LOS	A	A	A	A	A	A	A	F
Arrivals Outer Roadway (Available Length 540 feet) – Single-Lane Loading									
Curbside Parking Demand	vehicles/hour	71	79	71	77	91	79	83	91
Required Curb Length	feet	410	480	375	435	495	480	540	540
Curbside Utilization (LOS)	percent	80% (B)	93% (C)	73% (B)	84% (B)	96% (C)	93% (C)	105% (D)	105% (D)
Required Total Curb Length for LOS C	feet	410	480	375	435	495	480	540	540
Required Total Curb Length for LOS D	feet	357	417	326	378	430	417	470	470
Surplus/(Deficit) for LOS C	feet	105	35	140	80	20	35	(25)	(25)
Surplus/(Deficit) for LOS D	feet	158	98	189	137	85	98	45	45
Throughput of Curbside Traffic									
Total Number of Lanes (including parking lanes)	#	3	3	3	3	3	3	3	3
Total Roadway Demand	vehicles/hour	71	79	71	77	91	79	83	91
Throughput Roadway Capacity	vehicles/hour	1,428	1,265	1,428	1,347	1,265	1,265	1,183	1,183
Roadway Throughput LOS	LOS	A	A	A	A	A	A	A	A

LEGEND:

Level of Service D | Level of Service E | Level of Service F

SOURCES: TranSMART Technologies, Inc. November 2018; Ricondo & Associates, Inc. April 2019.

4.6.3.4 SIMULATION BASED MODELING – VISSIM

The simulation process used to evaluate existing baseline (2018) and future year (2023, 2028, and 2040) curbside and roadways requirements at the Airport is described below.

Background

The spreadsheet-based analyses described previously in Section 4.6.3.1, On-Airport Roadway Spreadsheet-based Analysis and Roadway Requirements, represent roadway demands that would be expected under an "unconstrained" condition, where each zone of the curbside is somewhat independently analyzed without much concern for upstream or downstream congestion or bottlenecks that could otherwise impede traffic flow. The VISSIM micro-simulation methodology is used to analyze a larger and more complex airport roadway network representing the full existing Airport landside network and can analyze future roadways and curbside operations under a variety of scenarios. Compared to traditional spreadsheet modeling, micro-simulation analysis of curbside operations offers several distinct advantages. These include the ability to model the interaction of vehicles within a complex and congested curbside environment; the flexibility to test new facility enhancements; the ability to clearly articulate the impacts of new facilities and operations on traffic; and the ability to analyze operations over a variety of future demand levels and operational scenarios.

In addition, the MKE curbside roadways present singularities that could not be accurately represented with the spreadsheet models. These include the several pedestrian crossings along the inner, middle, and outer curbside lanes, which are by themselves a source of capacity reduction for the vehicle throughput. Furthermore, the stop-controlled operation (due to stop signs present at each pedestrian crossing) adds another significant constraint to the curb capacity as all vehicles are required to stop at each pedestrian crossing regardless of the presence of pedestrians. This type of interaction can be captured with the VISSIM modeling and not by the spreadsheet tool, and as a result, simulation tends to show worse conditions than those identified in the spreadsheet analysis. Finally, the spreadsheet model considers only average vehicle dwell times for curbside drop-offs or pick-ups, while simulation uses a complete time distribution based on empirical data collected in the field. These are the main factors that explain some of the differences between the methodologies. In general, once a simulation model has been calibrated, it allows for a more realistic and in-depth evaluation of the existing and future operation of the curbside roadways. While the spreadsheet analysis serves as a preliminary high-level, unconstrained evaluation, ultimately, the full understanding of the curbside operational issues and the assessment of potential improvements is done using the simulation tool.

The VISSIM simulation outputs were correlated with the curbside LOS thresholds set forth in Table 4-63 to provide a basis for converting simulation output results into a quantifiable representation of curbside operations and requirements. This VISSIM methodology also allows for analysis of curbside LOS on a minute-by-minute basis for any area within the model, providing detailed information on peaking characteristics and allowing an understanding of how effective the existing curbsides can handle various traffic levels.

Simulation Model Development and Calibration

VISSIM models for the on-airport roadways and curbside networks which represent the Morning and Afternoon Peak Hours were developed for the analysis of existing (2018) and future year (2023, 2028, and 2040). The models were also developed for both baseline forecast and the high scenario. The steps involved in developing the model and simulating demand can generally be summarized as follows:

- **Develop Existing Conditions Model.** The first step was developing a VISSIM model of the terminal area, depicting the physical roadway network and characteristics. The model was created to scale from an aerial survey of the roadway system depicting roadway lanes and other physical features. Key physical characteristics, including lane width, design speed, and horizontal curvature, among other features, were incorporated into the model. The location and configuration of vehicle curbside parking areas were assigned within the model, with varying levels of desirability depending upon the relative proximity of each area to doorways, baggage check-in locations, and other facilities.

- **Define Existing Vehicle Characteristics and Trip Assignments.** The spreadsheet-based vehicle trip generation and assignment model described in Section 4.6.1.2, Development of Balanced Roadway Network, was used to define the types of vehicles (vehicle modes) accessing the Airport roadway system, the total traffic volumes associated with each mode, and the associated travel paths used by each vehicle. These individual trip assignments were coded into the model for each vehicle mode, representing every destination along the travel path. For example, a complex travel path may consist of a vehicle entering the Airport roadway system, followed by a stop at the terminal Departures Roadway to drop-off passengers and baggage, and then the driver proceeds to park in the Daily Garage. Various characteristics were defined for each vehicle mode, including average dwell times, driver aggressiveness/familiarity characteristics, and curbside stopping locations. Additionally, pedestrians on the terminal curbside crosswalks were estimated based on commercial vehicle activity on the Arrivals Outer Roadway, and rental car/parking garage activity for the arrivals passengers. It is assumed that the pedestrian sky bridges are used for the majority of the parking garage-to-departing passenger movements but some of the arrivals passengers in the baggage claim building will elect to use the crosswalks to the parking garage rather than the sky bridges.
- **Load Volumes and Perform Simulation of Data Collection Conditions.** Traffic volumes representing observed levels during the data collection day were loaded in to the VISSIM model. The simulation model was observed to confirm that it was performing as expected, which included reviewing quantitative results as well as observing visual output. A key component of the calibration process consisted of comparing roadway traffic volume output from the model with observed roadway traffic volumes at the same locations to confirm that the model was generating the accurate traffic volumes. The visual output of the model was also reviewed and compared with field observations to confirm that modeled and actual congestion points were at the same locations, and that the levels of vehicle queuing were of similar magnitudes under modeled and observed results.
- **Analyze Existing (2018) and Future Year (2023, 2028, and 2040) Conditions.** Observed traffic volumes for the existing year (2018) and future years for the Baseline Forecast and High Scenario were used to conduct an operational analysis using the VISSIM model. A curbside analysis was based on a quantitative review of the number of stopped vehicles relative to available curbside length. In addition, the simulation animation was reviewed to determine whether the traffic flow was impacted by significant curbside/roadway congestion or queuing.

Simulation Results

The results of the VISSIM simulation analysis for the existing (2018) and future year (2023, 2028, and 2040) curbside and roadway systems are described in this subsection. The future years are based on Morning and Afternoon Peak Hour volumes under the baseline forecast and high scenario. At the end of the section, simulation results are compared with previously described spreadsheet results for final reconciliation and interpretation of outcomes from both methodologies.

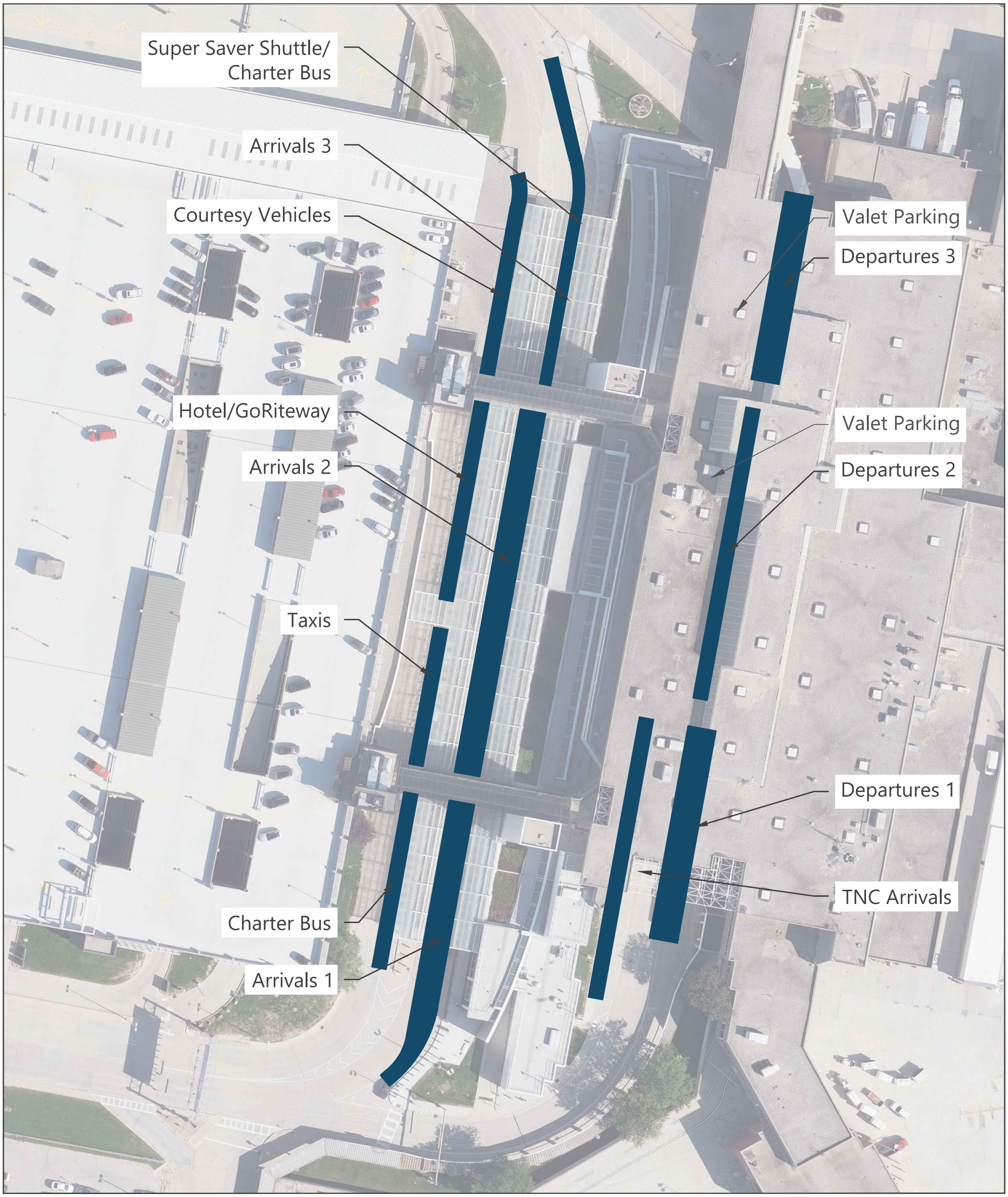
The curbside LOS was based on an average of five simulation runs for each condition analyzed. The minute-by-minute frequency of vehicles stopping in each curbside zone was extracted from the simulations to determine the average curbside utilization for each zone of the terminal curbsides. The terminal departures curbside area was divided into four zones, and the arrivals curbside area was divided into seven zones on the arrivals inner and outer roadways. For the purpose of the analysis, the curbside system at MKE was divided in 11 curbside study areas or zones as depicted in **Exhibit 4-50** based on vehicle mode allocation and curbside functions. The Departures Roadway activity is divided into the unloading of vehicles in three distinct zones on the right-hand side of the roadway, representing the double wide drop off lane at the beginning of the curb, the narrower section in the middle of the curbside with only one unloading lane and the final section of the curb which widens back out to a double wide drop-off lane at the end. The TNC pick-up section of the curbside on the left-hand side adjacent to the baggage claim hall is also a part of the Departures Roadway represented in this exhibit. The center section of the left-side of the roadway was also modeled to represent the underutilized Valet section of the curbside, as well as the GoRiteway shuttle parking at the end of the left-side of the Departures Roadway, but because of low activity, these sections are not summarized in Exhibit 4-47. The Arrivals Inner Roadway curbside was subdivided into two zones for private vehicles loading along the first three sections of the curbside and the Super Saver Shuttle staging on the last section of the Arrivals Inner Roadway, followed by the Charter Bus Pick-up area. The Arrivals Outer Roadway was divided into four sections representing the Charter/Bus area, Taxi loading, Hotel/GoRiteway Shuttles, and the Off-Airport Parking Courtesy Vehicles.

Exhibit 4-51 through **Exhibit 4-57** depict the LOS for all 11 zones for the Existing through 2040 conditions for the Morning and Afternoon Peak Hours, for both the baseline forecast and the high scenario. In these exhibits, LOS is depicted in colors ranging from green for LOS A through C, yellow for LOS D, orange for LOS E, and red for LOS F. Overall, the LOS "E" can be interpreted as the curbside system reaching capacity for that particular facility, while LOS "F" would indicate failing conditions where the curbside facility does not have sufficient capacity to handle the projected demand thus generating congestion, stop-and-go operation, blockage of vehicles that are unable to exit the curb or reach the pick-up or drop-off spot, or generating queues that could spill over into the terminal approach roadways.

Key findings from the simulation results indicate most sections of the Departures Roadway and Arrivals Inner Roadway operate beyond capacity or will reach capacity as soon as 2023 for the Afternoon Peak Hour operation. For the Morning Peak Hour, the Departures Roadway reaches capacity in 2028 while the Arrivals Inner Roadway reaches failing conditions in 2040. The outer curbside operates adequately for all commercial vehicle modes and only the Hotel/GoRiteway area reaches capacity in 2040 for the High Scenario. Average curbside utilization for each curbside zone and resulting LOS for each of the loading areas are summarized in **Table 4-66** for all the curbside areas.

It is important to note that the assessment of the simulation results as well as the observation of the operation through the VISSIM visual animation showed that the main operational issues associated with the poor LOS for the Departures Roadway and Arrivals Inner Roadway in the Afternoon Peak Hour operation were mainly related to the following factors:

- Stop-controlled pedestrian crossings: this type of operation imposes significant constraints to the through capacity of the curbside system. As traffic continues to increase in future scenarios, this type of constraint becomes even more predominant and exacerbates congestion and queuing for the inner curbs.
- Valet Parking on left lane of Departures Roadway: while demand for valet parking is generally low, the space reserved for this parking product extends several hundred feet effectively reducing the cross-section of the curb to three lanes and creating a "choking" point when demand increases in the future.
- High dwell times for both private and commercial vehicle modes. Some of the dwell times collected from the field show distributions significantly higher than industry standards, which may reflect a lack of enforcement in periods of minimal congestion. This results in vehicles dwelling on the curbsides for extended periods of time and impacting capacity.



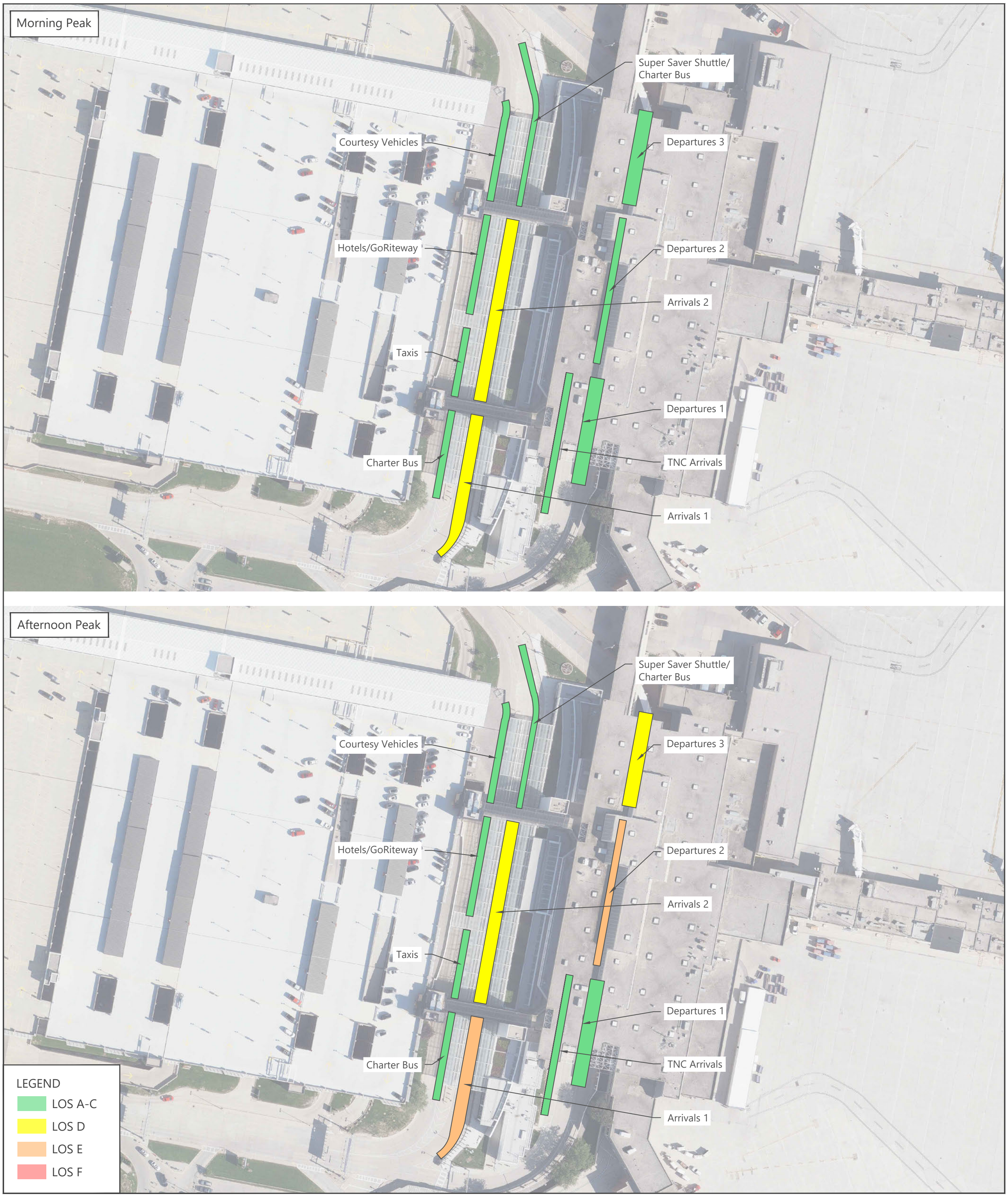
SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH 0 100 ft.

EXHIBIT 4-50

VISSIM SIMULATION
CURBSIDE STUDY AREAS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\Curbside Vissim LOS_2022-03-11.dwgLayout: Allocations Plotted: Mar 29, 2022, 10:43AM

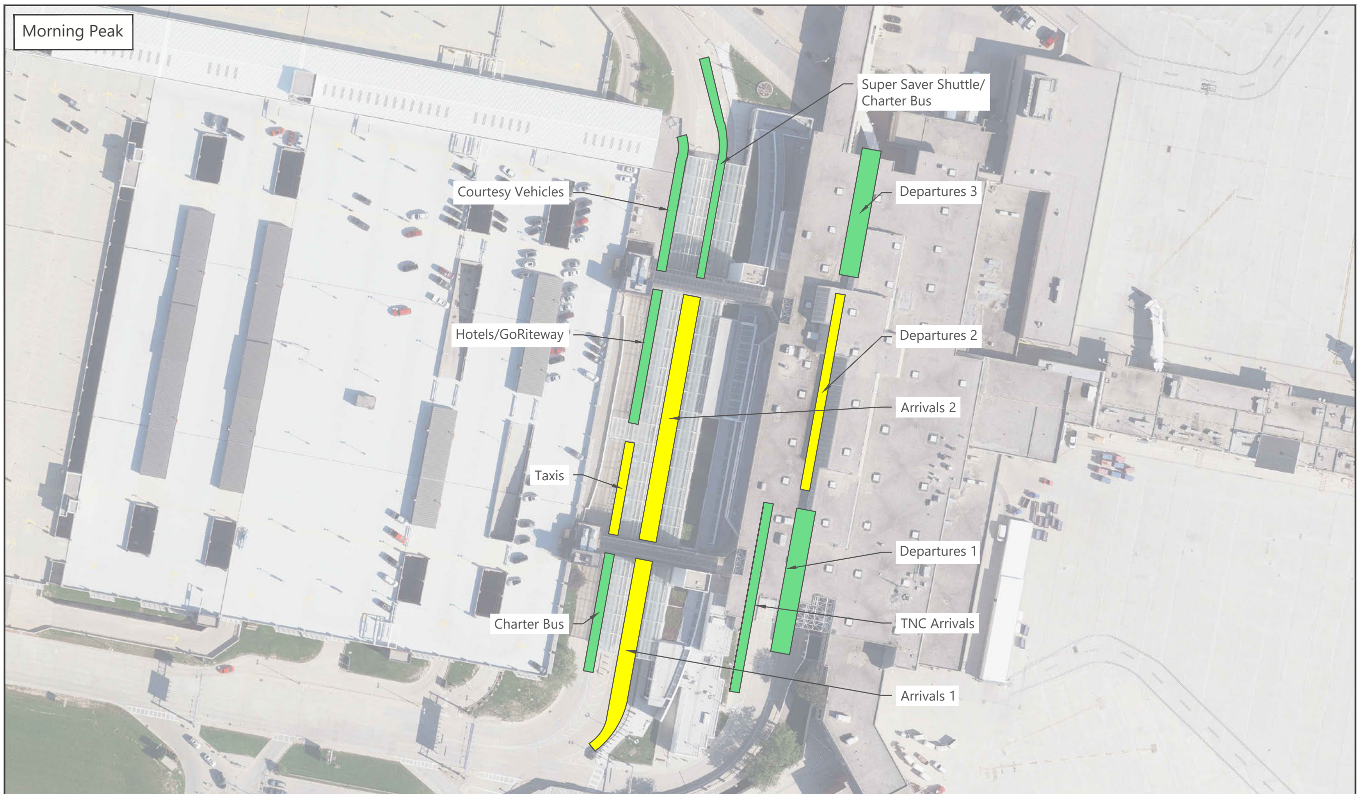


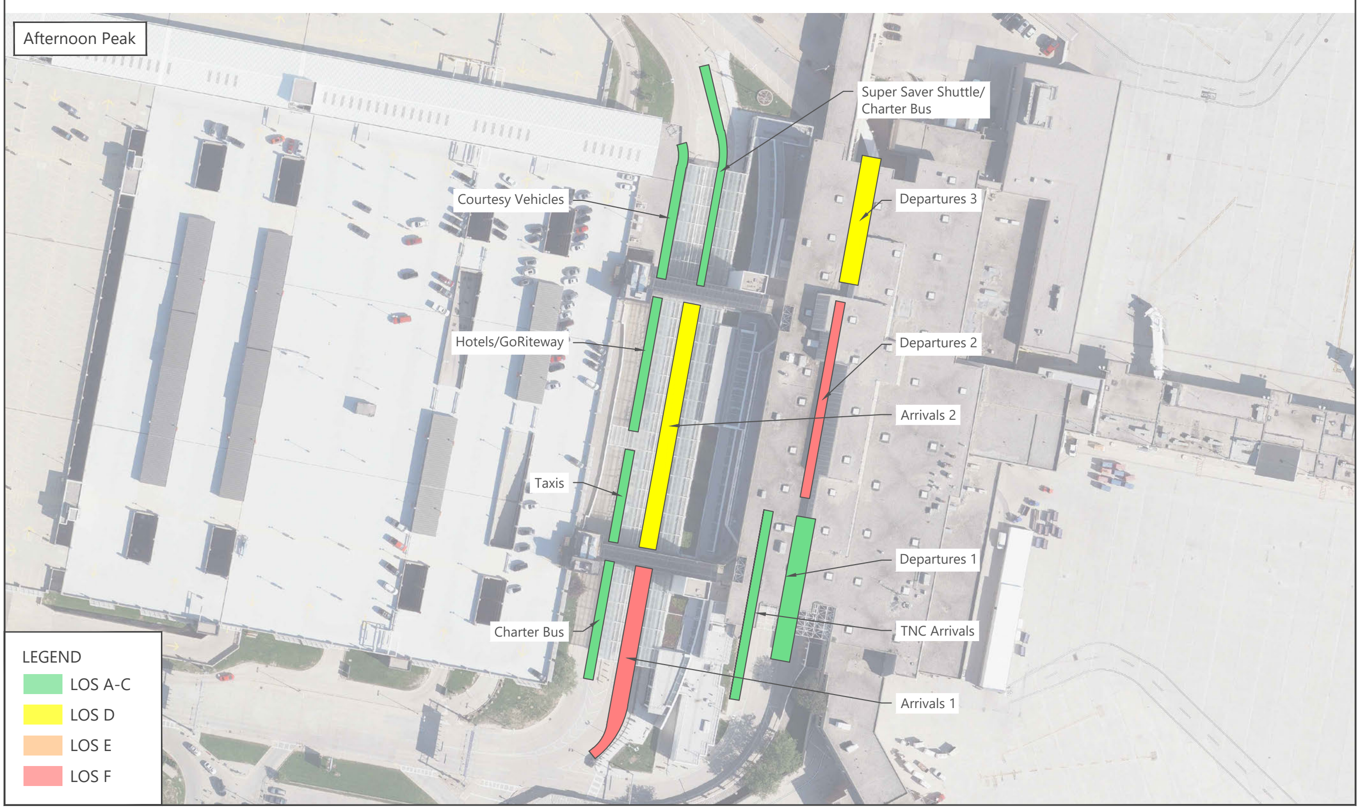
SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale); Ricondo & Associates, Inc., September 2020 (analysis).

EXHIBIT 4-51

VISSIM SIMULATION RESULTS
EXISTING CONDITIONS - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\Curbside Vissim LOS_2022-03-11.dwgLayout: Existing Conditions Plotted: Mar 29, 2022, 10:44AM





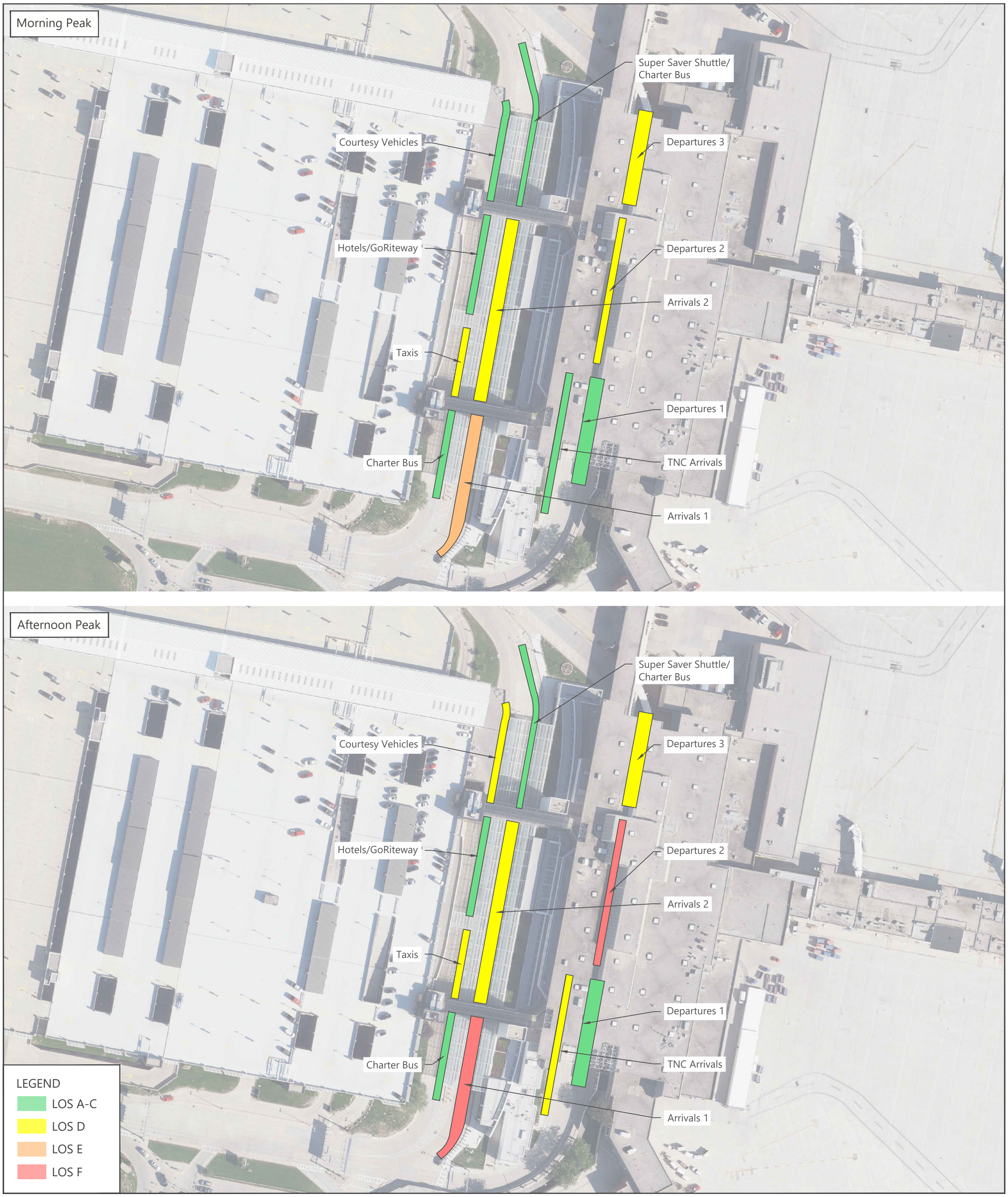
SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH 0 200 ft.

EXHIBIT 4-52

VISSIM SIMULATION RESULTS
BASELINE SCENARIO 2023 - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\Curbside Vissim LOS_2022-03-11.dwgLayout: Baseline VISSIM 2023 Plotted: Mar 29, 2022, 10:44AM



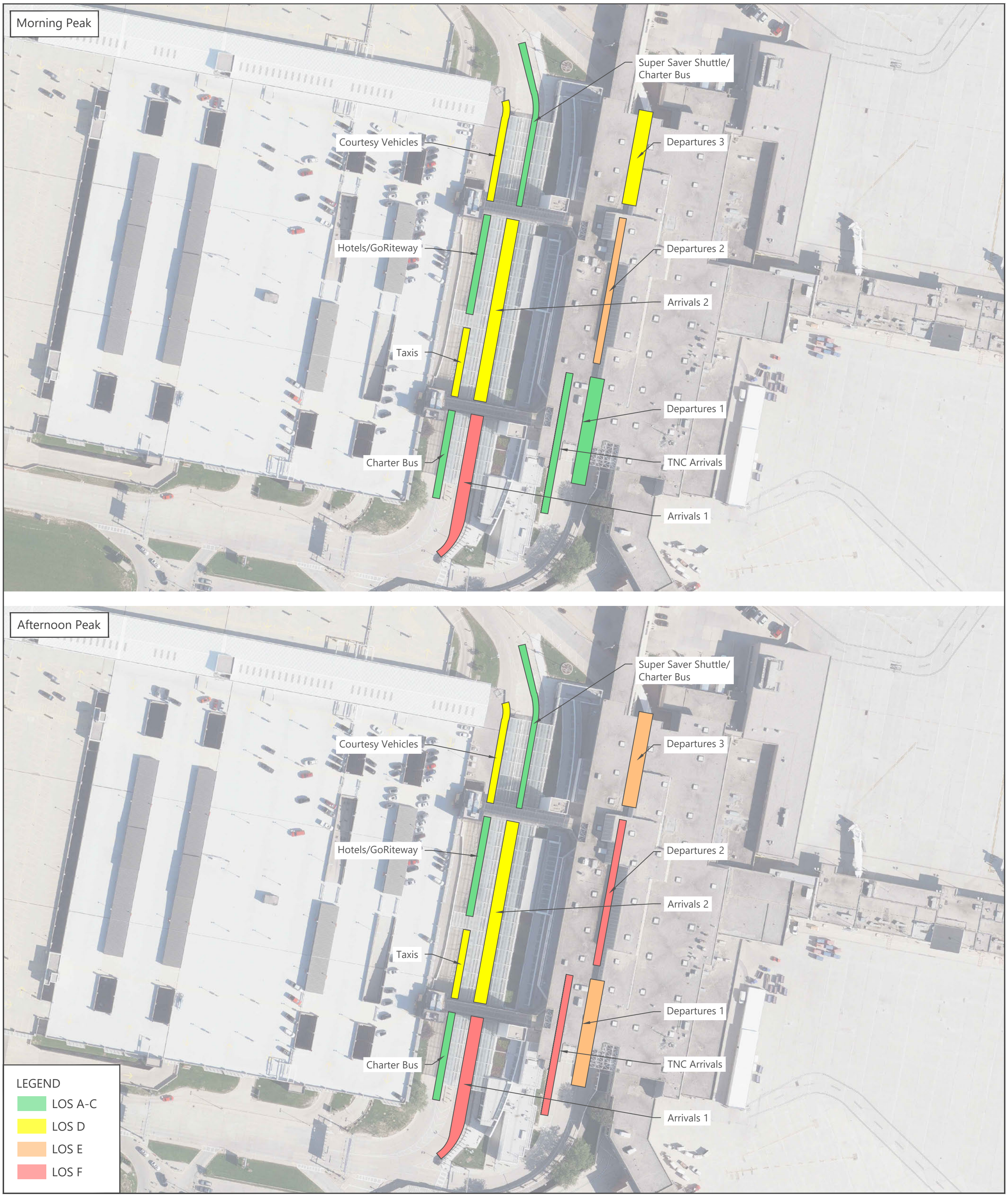
SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH 0 200 ft.

EXHIBIT 4-53

VISSIM SIMULATION RESULTS
BASELINE SCENARIO 2028 - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\Curbside Vissim LOS_2022-03-11.dwgLayout: Baseline VISSIM 2028 Plotted: Mar 29, 2022, 10:45AM



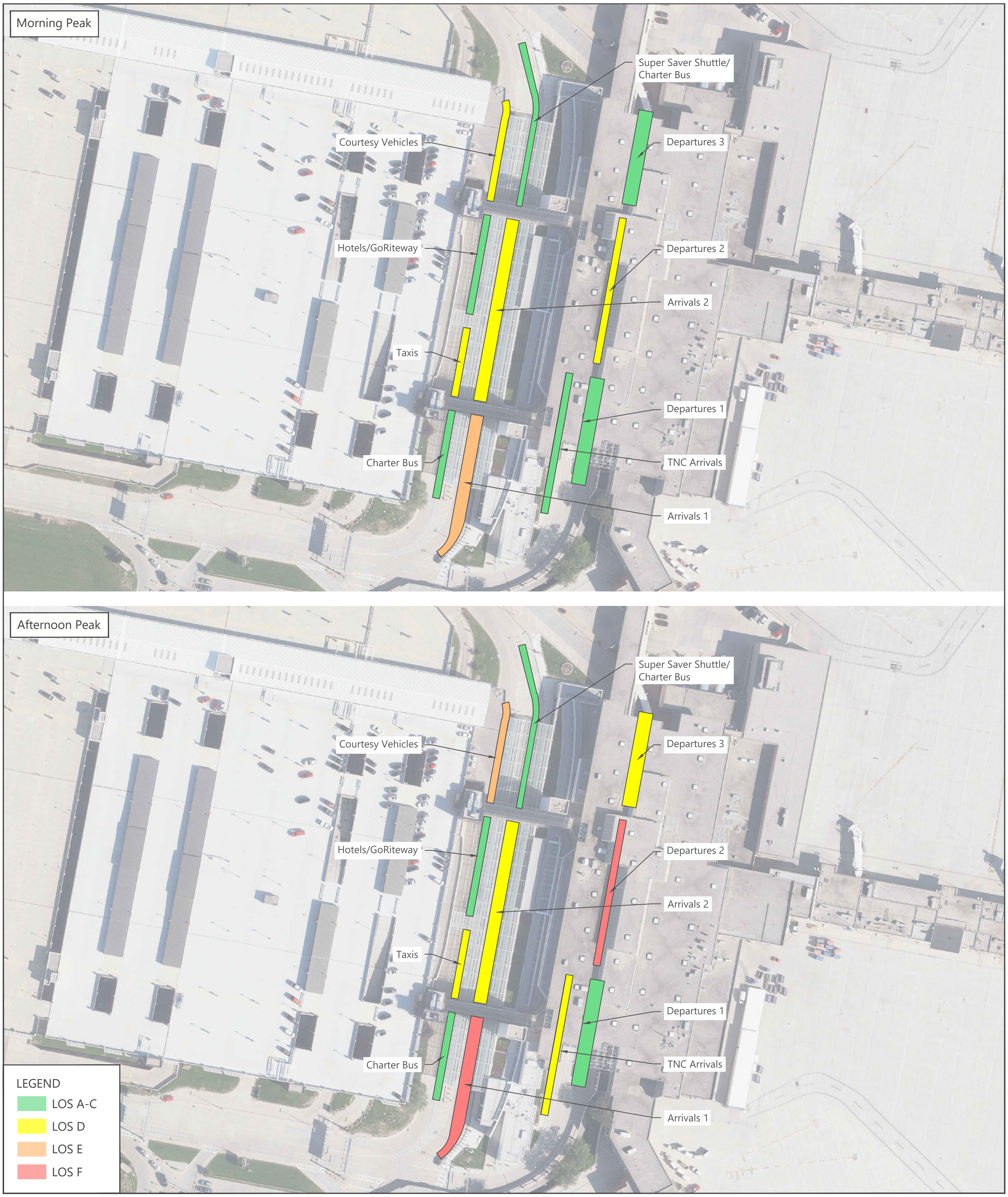
SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH 0 200 ft.

EXHIBIT 4-54

VISSIM SIMULATION RESULTS
BASELINE SCENARIO 2040 - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\Curbside Vissim LOS_2022-03-11.dwgLayout: Baseline VISSIM 2040 Plotted: Mar 29, 2022, 10:45AM



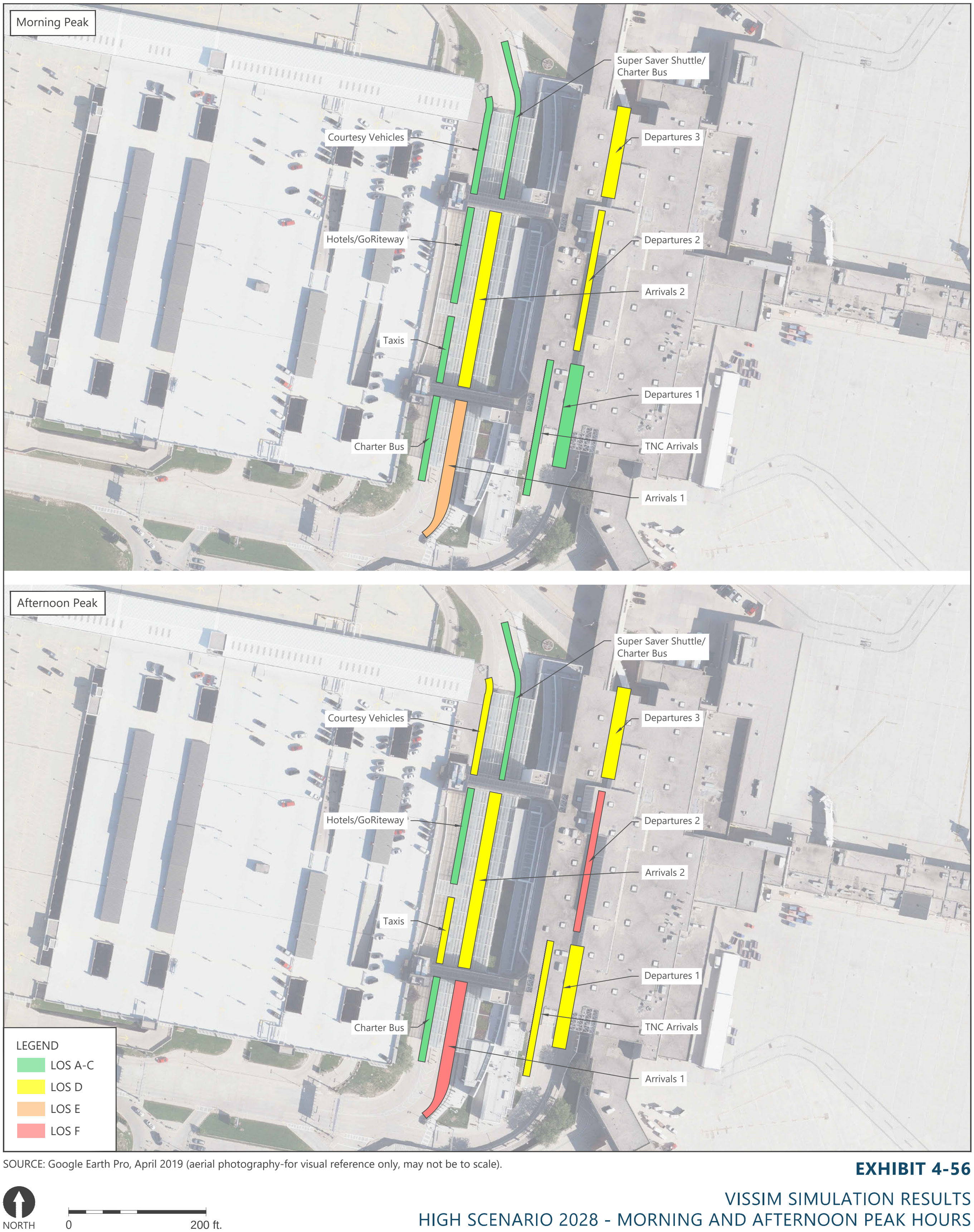
SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH 0 200 ft.

EXHIBIT 4-55

VISSIM SIMULATION RESULTS
HIGH SCENARIO 2023 - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\Curbside Vissim LOS_2022-03-11.dwgLayout: High VISSIM 2023 Plotted: Mar 29, 2022, 10:46AM

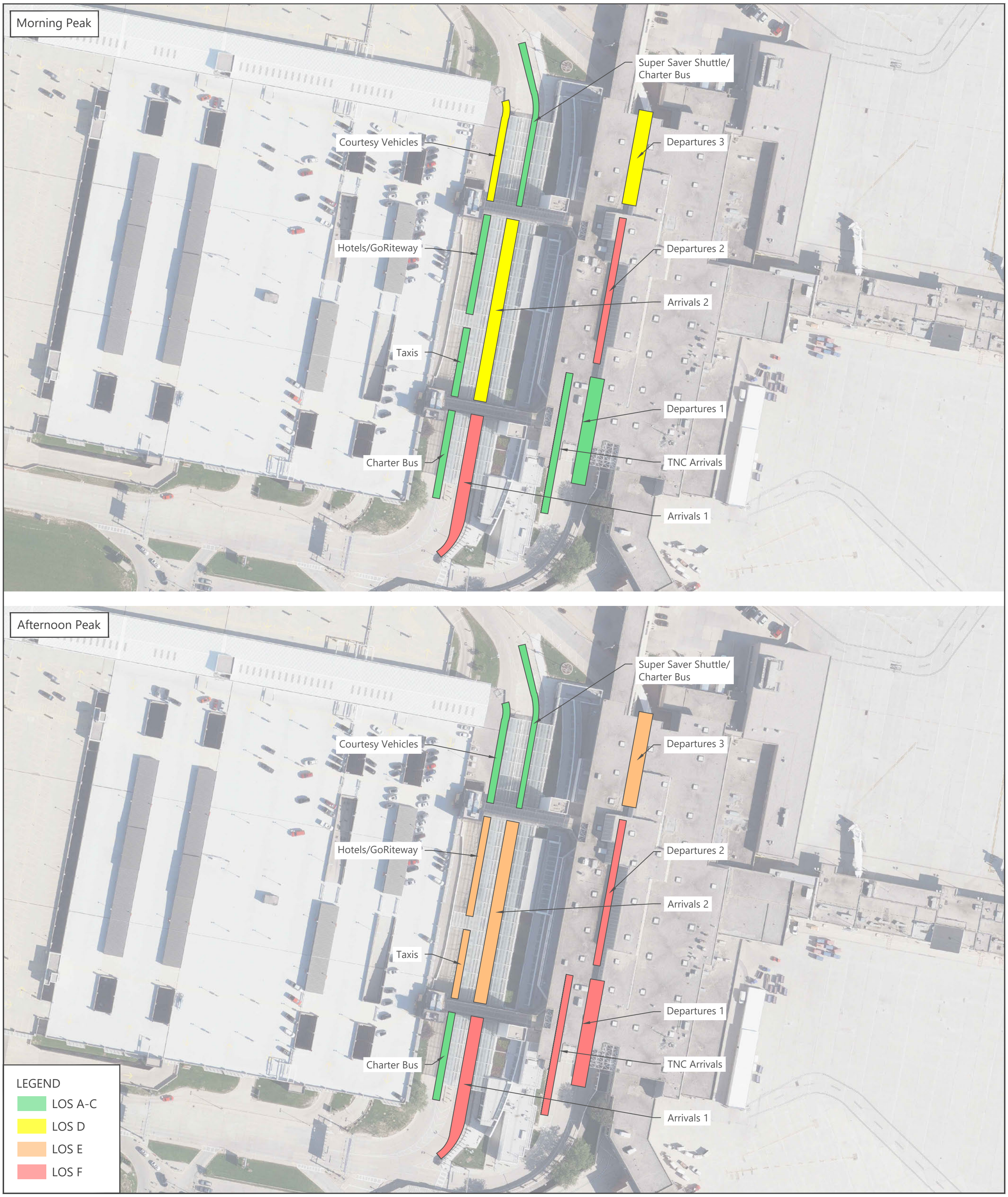


SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

EXHIBIT 4-56

VISSIM SIMULATION RESULTS
HIGH SCENARIO 2028 - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\Curbside Vissim LOS_2022-03-11.dwgLayout: High VISSIM 2028 Plotted: Mar 29, 2022, 10:46AM



SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale).

NORTH 0 200 ft.

EXHIBIT 4-57

VISSIM SIMULATION RESULTS
HIGH SCENARIO 2040 - MORNING AND AFTERNOON PEAK HOURS

Drawing: P:\Project-Chicago\MKE\MKE Master Plan Update\Master Plan Project 2018\03 - Inventory of Existing Conditions\3.10 - Ground Access and Curbfront\CAD\Curbside Vissim LOS_2022-03-11.dwgLayout: High VISSIM 2040 Plotted: Mar 29, 2022, 10:46AM

TABLE 4-66 VISSIM CURBSIDE LEVEL OF SERVICE

SCENARIO	YEAR (PEAK PERIOD)	DEPARTURES ROADWAY				ARRIVALS INNER ROADWAY			ARRIVALS OUTER ROADWAY			
		DEPARTURES 1	DEPARTURES 2	DEPARTURES 3	TNC ARRIVALS	ARRIVALS POV 1	ARRIVALS POV 2	SUPER SAVER SHUTTLE	BUSES/ CHARTERS	TAXIS	HOTEL/ GORITEWAY	COURTESY SHUTTLES
Existing	2018 (Morning)	A	B	B	A	D	D	A	A	A	A	A
Baseline Forecast	2023 (Morning)	A	D	C	A	D	D	A	A	D	A	C
Baseline Forecast	2028 (Morning)	A	D	D	B	E	D	A	A	D	A	C
Baseline Forecast	2040 (Morning)	B	E	D	B	F	D	A	A	D	B	D
Existing	2018 (Afternoon)	A	E	D	B	E	D	A	A	A	A	A
Baseline Forecast	2023 (Afternoon)	B	F	D	C	F	D	A	A	C	B	D
Baseline Forecast	2028 (Afternoon)	C	F	D	D	F	D	A	A	D	B	D
Baseline Forecast	2040 (Afternoon)	E	F	E	F	F	D	A	A	D	B	D
Existing	2018 (Morning)	A	B	B	A	D	D	A	A	A	A	A
High Scenario	2023 (Morning)	A	D	C	A	E	D	A	A	D	B	D
High Scenario	2028 (Morning)	A	D	D	B	E	D	A	A	C	A	C
High Scenario	2040 (Morning)	B	F	D	C	F	D	A	A	C	B	D
Existing	2018 (Afternoon)	A	E	D	B	E	D	A	A	A	A	A
High Scenario	2023 (Afternoon)	C	F	D	D	F	D	A	A	D	C	E
High Scenario	2028 (Afternoon)	D	F	D	D	F	D	A	A	D	B	D
High Scenario	2040 (Afternoon)	F	F	E	F	F	E	A	C	E	E	C

LEGEND:

Level of Service D | Level of Service E | Level of Service F

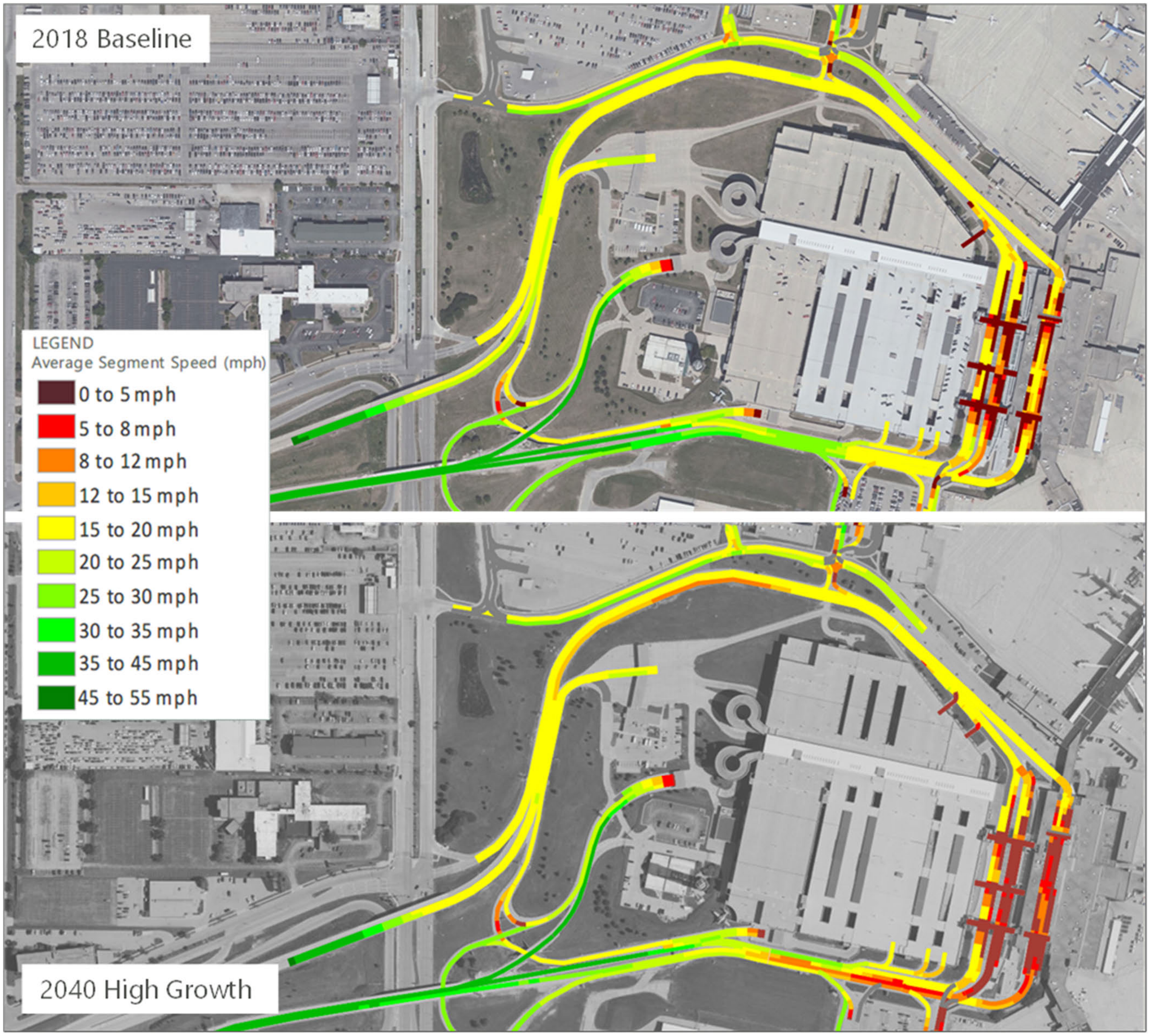
SOURCE: Ricondo & Associates, Inc. September 2020.

In general, all these factors could be managed to achieve better operation and improve the curbside LOS without significant capital investment.

In addition to the curbside LOS based on occupancy, VISSIM allows the collection of different measures of effectiveness (MOE) including average speed in miles per hour (mph) for the entire simulation period. This MOE is recorded for every roadway segment and sub-segment and for every vehicle type and every time step of the simulation (tenth of a second). As result, a speed heatmap can be generated which represent the average segment speeds for all areas covered by the VISSIM model. Areas of congestions are typically represented by the lowest ranges of speeds in these graphics. Results of the speed heatmap analysis are presented in **Exhibit 4-58**, which depict the average segment speeds for the 2018 Baseline Afternoon Peak Hour and the 2040 High Scenario

Afternoon Peak Hour. In general, the curbside segments approach capacity more consistently in the Afternoon Peak Hour over the planning horizon.

EXHIBIT 4-58 VISSIM SIMULATION RESULTS – SPEED HEATMAP – EXISTING CONDITIONS AND 2040 (HIGH GROWTH SCENARIO) AFTERNOON PEAK HOUR



SOURCE: Ricondo & Associates, Inc. September 2020.

The assessment of these speed heatmaps shows that for the 2018 baseline conditions, while some areas of the Arrivals Inner Roadway are congested during the Afternoon Peak Hour, traffic continues to flow without generating any significant queuing on the terminal approach roadways. In general, the Arrivals Inner Roadway shows more congestion (more "red") than the Departures Roadway. No significant signs of congestion or operational issues are seen on the Arrivals Outer Roadway. In the 2040 high scenario for the Afternoon Peak Hour, moderate to high curbside congestion is observed which begins to generate queuing that spills over into the terminal approach roadway.

Comparison between Simulation and Spreadsheet Results and Explanation of Differences

Table 4-67 summarizes curbside results by vehicle mode from VISSIM and from the static spreadsheet tool. In this table, those results that significantly differ (two or more LOS degrees between methodologies) have been highlighted. As shown, there are several places where results between these two methodologies do not match, which is expected. However, these differences need to be addressed and ultimately reconciled to determine the results to be used in the recommendation for improvements.

As explained previously, the static spreadsheet methodology has several limitations and is unable to capture some of the complexities associated with the MKE curbside system. Specially the pedestrian interaction, pedestrian crossings, stop signs at pedestrian crossings, differences between average dwell time and empirical dwell time distribution, and some of the nuances associated with the valet parking and TNC pick-up using the left lane of the Departures Roadway. All these factors contribute to limit the applicability of the spreadsheet analysis. In general, Table 4-67 shows more congestion in the VISSIM results for most of the curbside zones where private vehicles, TNC, or taxis are the predominant users of the curb. For these facilities, the impact of the pedestrian crossings and the stop signs are the main factors that results in significantly more congestion in the simulation model results. On the other hand, some of the commercial vehicle zones show the opposite, with more congestion in the spreadsheet model results. This is explained by the ability of the VISSIM model to simulate a more realistic operation in which commercial vehicles will cooperate with each other in ways that facilitate the operation and result in some additional capacity for the overall curbside system. For instance, if a shuttle is standing in a spot for too long and a new shuttle is approaching with no other space available at the curb, the shuttle that is dwelling would make room and/or leave so the new shuttle can use the space.

Based on this understanding, the VISSIM simulation results are recognized as the more reliable source for the understanding of curbside operational issues and the development of potential future improvements.

4.7 TAXICAB/GROUND TRANSPORTATION STAGING AREA

4.7.1 TAXICAB STAGING AREA

The taxicab staging area requirements are based on the total number of taxicabs entering the Arrivals Outer Roadway area for passenger pick-up during the data collection survey in November 2018. It is assumed all taxicabs on the Arrivals curbside are being dispatched from the taxicab staging lot.

4.7.1.1 APPROACH

To ensure that facilities are adequately sized, it is important to understand the seasonal, daily, and hourly peaking characteristics of taxicab activity. Available data from the vehicle classification counts conducted were utilized as the basis of peak hour taxicab demand. Taxicab data was collected on both the departures roadway and arrivals roadways in 15-minute increments. Given the focus on taxicab staging, only the peak hour traffic going to the arrivals curbside was utilized.

TABLE 4-67 VISSIM AND STATIC MODELING LEVEL OF SERVICE COMPARISON BY VEHICLE MODE

		DEPARTURES ROADWAY				ARRIVALS INNER ROADWAY						ARRIVALS OUTER ROADWAY					
		DEPARTURES AVERAGE		TNC ARRIVALS		ARRIVALS AVERAGE		SUPER SAVER SHUTTLE		BUSES/ CHARTERS		TAXIS		HOTEL/ GORITEWAY		COURTESY SHUTTLES	
SCENARIO	YEAR (PEAK PERIOD)	VISSIM	STATIC	VISSIM	STATIC	VISSIM	STATIC	VISSIM	STATIC	VISSIM	STATIC	VISSIM	STATIC	VISSIM	STATIC	VISSIM	STATIC
Existing	2018 (Morning)	B	B	A	A	**D**	**A**	A	B	A	A	A	C	A	A	**A**	**C**
Baseline Forecast	2023 (Morning)	C	B	A	A	**D**	**A**	A	A	A	A	D	C	A	A	**C**	**A**
Baseline Forecast	2028 (Morning)	C	C	B	A	**D**	**A**	A	A	A	A	D	D	A	A	C	C
Baseline Forecast	2040 (Morning)	D	C	B	A	**E**	**B**	A	B	A	A	D	D	B	A	D	C
Existing	2018 (Afternoon)	D	C	B	A	**D**	**B**	**A**	**D**	A	A	A	A	**A**	**F**	**A**	**E**
Baseline Forecast	2023 (Afternoon)	D	D	C	A	**E**	**C**	A	B	A	A	C	A	**B**	**F**	D	C
Baseline Forecast	2028 (Afternoon)	E	D	D	A	**E**	**C**	**A**	**D**	A	A	**D**	**A**	**B**	**F**	D	C
Baseline Forecast	2040 (Afternoon)	**F**	**D**	**F**	**A**	E	D	**A**	**D**	A	A	**D**	**A**	**B**	**F**	D	C
Existing	2018 (Morning)	B	B	A	A	**D**	**A**	A	B	A	A	**A**	**C**	A	A	A	C
High Scenario	2023 (Morning)	C	C	A	A	**D**	**A**	A	A	A	A	D	C	B	A	**D**	**A**
High Scenario	2028 (Morning)	D	C	B	A	**E**	**A**	A	A	A	A	C	D	A	A	C	C
High Scenario	2040 (Morning)	D	D	**C**	**A**	**E**	**B**	A	B	A	A	**C**	**F**	B	C	D	C
Existing	2018 (Afternoon)	D	C	B	A	**D**	**B**	**A**	**D**	A	A	A	A	**A**	**F**	**A**	**E**
High Scenario	2023 (Afternoon)	E	D	**D**	**A**	**E**	**C**	A	B	A	A	**D**	**A**	**C**	**F**	**E**	**C**
High Scenario	2028 (Afternoon)	E	D	**D**	**A**	E	D	**A**	**D**	A	A	**D**	**A**	**B**	**F**	D	C
High Scenario	2040 (Afternoon)	F	E	**F**	**A**	F	E	**A**	**D**	**C**	**A**	**E**	**A**	E	F	C	C

LEGEND:

Level of Service D | Level of Service E | Level of Service F

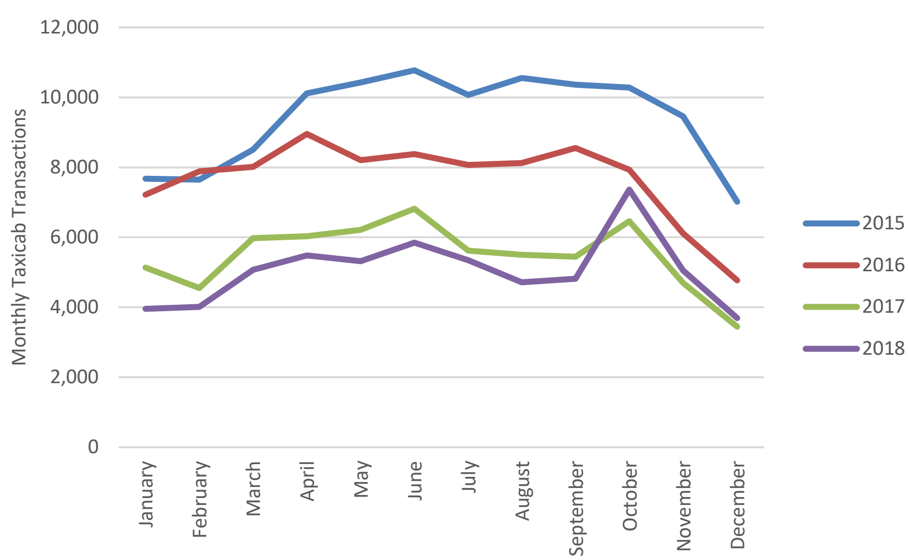
NOTE:
BOLD TEXT indicates two-degree LOS change or more
SOURCE: Ricondo & Associates, Inc. September 2020.

The collected taxicab data from the curbside classification counts only represents a small sample of data, requiring a review of data summarizing monthly taxicab pick-up trips available in the Airport's ground transportation reports to validate its reasonableness and applicability. Monthly data was processed using daily factors and hourly factors from similar airports to confirm the validity of the sample data gathered in November 2018, representing the existing peak hour demand at the Airport.

Since the introduction of TNCs in 2015, the number of taxicab transactions have been decreasing year-over-year. Monthly taxicab trip data from January 2015 to December 2018 was obtained and summarized on **Exhibit 4-59**. These statistics indicate that taxicabs in calendar year 2018 are below the values from all previous years, and November 2018 is 45 percent lower than October 2018, which is the peak month for 2018. Therefore, November counts were adjusted upward by 45 percent to account for the possibility of higher taxicab volumes in October as the annual existing peak. Additionally, the day of the week factor for peak hour taxicab demand was considered. Using multiple days of comparative data at other airports, Mondays are determined to typically be the busiest days for taxicabs at airports. The comparison of the Thursday peak hour to the Monday peak hour indicated that there are 34 percent higher volumes on a Monday than a Thursday. Accordingly, November 2018 peak hour data was increased by 45 percent to represent the peak month (converting from November to October) and further increased by 35 percent to convert Thursday (non-peak) to Monday peak hours.

The resulting factored volumes were summarized into rolling 45-minute, 60-minute, and 75-minute curbside demand periods. This approach is considered to be conservative for facilities planning purposes given that (a) all taxicabs are required to process through the Taxicab staging lot before accessing the curbside to pick-up arriving passengers and (b) an assumption was made that no additional taxicabs backfill those emptied spaces as taxicabs are dispatched to the curb during the peak period.

EXHIBIT 4-59 MONTHLY TAXICAB TRANSACTIONS



SOURCE: Milwaukee Mitchell International Airport, April 2019.

4.7.1.2 EXISTING (2018) CONDITIONS

The base 2018 demand are shown in **Table 4-68**, as 13, 18 and 19 taxicabs for the rolling peak 45-minute, 60-minute and 75-minute periods, respectively. To determine our 2018 existing requirement, the monthly and daily conversion factors were applied to determine the 2018 existing peak requirement per 45-minute, 60-minute and 75-minutre time periods, which resulted in 26, 36 and 38 taxicabs per period, respectively.

Note that the current size of the taxicab staging lot located on E. Hutsteiner Drive near Howell Avenue is currently configured to accommodate 101 taxicabs aligned in a more conventional parking lot configuration with parking spaces around the perimeter and in the center of the lot. This layout differs from most taxicab staging lots which are typically more space efficient in their parking configuration, utilizing linear rows of taxicabs parked “nose to tail”. However, the existing taxicab staging lot has a capacity of almost 3 times the peak 75-minute taxicab requirement. Therefore, the lot is considered to be oversized and ultimately can be decreased in size.

TABLE 4-68 TAXICAB CONVERSION FACTORS

	NOVEMBER 8TH, 2018					NOVEMBER 2018 (5,053 TAXIS/MO) TO OCTOBER 2018 (7,372 TAXIS/MO) CONVERSION	THURSDAY PEAK HOUR (188) TO MONDAY PEAK HOUR (252)	RESULTING 2018 REQUIREMENT PEAK HOUR VOLUME
	8:45-9:00 AM	9:00-9:15 AM	9:15-9:30 AM	9:30-9:45 AM	9:45-10:00 AM			
Taxicabs on Arrivals Curbside	6	5	2	5	1			
45-minute Demand	13							26
60-minute Demand	18					45% Increase	34% Increase	36
75-minute Demand	19							38

SOURCES: TranSMART Technologies, Inc. November 2018 (data); Ricondo & Associates, Inc. June 2019 (analysis).

4.7.1.3 FUTURE YEAR TAXICAB STAGING REQUIREMENTS

The growth in demand for taxicabs was assumed to be directly related to the increase in O&D passenger activity based on the baseline forecast. However, taxicabs are currently experiencing a decline in market share due to the growth of TNCs. Therefore, three growth scenarios are forecast for taxicabs based on work outlined in Section 4.14, Landside Access Strategy. These growth scenarios include Baseline TNC Scenario, High TNC Growth Scenario, and Low TNC Growth Scenario, during which all taxicabs were forecast to lose varying market share to TNCs, year-over year, while O&D passenger activity grows according to the baseline forecast. The Baseline TNC Scenario has taxicabs losing 5 percent of its market share annually to TNCs. The High TNC Growth Scenario, similar to the Baseline TNC Scenario, is also expected to lose 5 percent of its market share annually to TNCs. Finally, the Low Growth Scenario only loses 1.5 percent market share annually to TNCs. The results of the Existing 2018 taxicab requirements and three TNC growth scenarios are presented in **Table 4-69** and show the highest growth in taxicabs in the Low TNC Growth Scenario, which will have a Monday morning peak 75-minute volume of 41 taxicabs. This resulting volume utilizes only 40 percent of the existing taxicab staging lot. A suitably sized taxicab staging lot should accommodate the peak curbside 75-minute demand for taxicabs, with the ability to supply more as additional taxicabs are free to enter the staging lot and backfill the emptied spaces throughout the peak period. Therefore, the maximum size of the taxi staging lot is 41 spaces.

TABLE 4-69 THREE TAXICAB FUTURE STAGING REQUIREMENT SCENARIOS

PERIOD OF ACTIVITY	PEAK PERIOD	2018 DEMAND	BASELINE TNC SCENARIO			LOW TNC SCENARIO			HIGH TNC SCENARIO		
			2023	2028	2040	2023	2028	2040	2023	2028	2040
45-minute	08:45 - 09:30	26	22	19	13	27	27	28	24	23	20
60-minute	08:45 - 09:45	36	31	26	18	37	38	39	33	32	27
75-minute	08:45 - 10:00	38	32	28	19	39	40	41	35	33	29
SURPLUS/(DEFICIT) IN A 101-SPACE TAXICAB STAGING LOT											
PERIOD OF ACTIVITY	PEAK PERIOD	2018 CAPACITY	BASELINE TNC SCENARIO			LOW TNC SCENARIO			HIGH TNC SCENARIO		
			2020	2025	2040	2020	2025	2040	2020	2025	2040
45-minute	08:45 - 09:30	75	79	82	88	74	74	73	77	78	81
60-minute	08:45 - 09:45	65	70	75	83	64	63	62	68	69	74
75-minute	08:45 - 10:00	63	69	73	82	62	61	60	66	68	72

SOURCES: TranSMART Technologies, Inc. November 2018 (data); Ricondo & Associates, Inc. June 2019 (analysis).

4.7.2 COMMERCIAL VEHICLE STAGING REQUIREMENTS

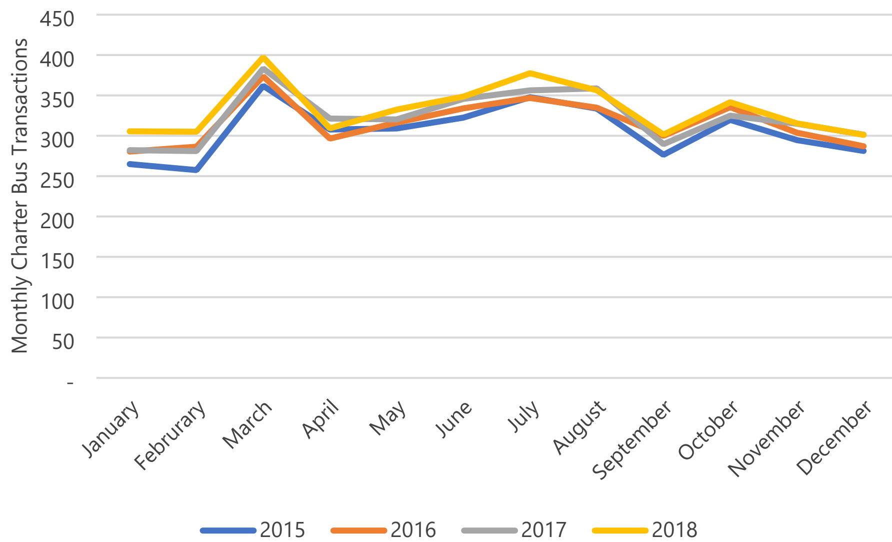
The commercial vehicle staging area requirements are based on the total number of charter buses recorded entering the Arrivals Inner and Outer Roadways during the data collection survey in November 2018. It is assumed these vehicles are being held in the bus staging area located along the perimeter of the Surface Parking area, just south of the terminal curbsides.

4.7.2.1 APPROACH

To ensure that facilities are adequately sized, it is important to understand the seasonal, daily, and hourly peaking characteristics of charter bus activity. Available data from the vehicle classification counts were utilized as the basis of peak hour charter bus demand. Charter bus data was collected on the arrival's curbs in 15-minute increments. Because there are two designated charter bus curbside areas; one on the beginning of the Arrivals Outer Roadway and the second on the end of the Arrivals Inner Roadway, it was assumed that all users reported to the Bus Staging Area prior to parking on the terminal curbsides.

Charter bus data from the curbside classification counts only represents a small sample of data, therefore the monthly charter bus transactions were obtained from the Airport ground transportation reports. The monthly data was used to factor the number of observed peak period charter bus trips to represent peak month levels. Monthly charter bus trip data from January 2015 to December 2018 was obtained and is summarized in **Exhibit 4-60**. Charter bus activity is relatively constant year-to-year, meaning it is less susceptible to market share loss associated with the growth in TNCs. However, the busiest month for charter bus activity is March each year; therefore, a 25% growth factor was applied to the observed November 2018 data to adjust it to represent the peak month of March 2018 for this analysis.

EXHIBIT 4-60 MONTHLY CHARTER BUS TRANSACTIONS



SOURCE: Milwaukee Mitchell International Airport, June 2019.

4.7.2.2 EXISTING (2018) CONDITIONS

Base 2018 demand from the November 2018 counts is shown in **Table 4-70**, as 7, 8 and 12 charter buses for the rolling peak 45-minute, 60-minute and 75-minute periods, respectively. To determine 2018 existing requirement, the monthly conversion factor (increase by 25 percent) was applied to determine the 2018 existing peak requirement per 45-minute, 60-minute and 75-minute time periods, which resulted in 9, 11 and 16 charter buses per period, respectively.

The current size of the Bus Staging Area, outside the perimeter of the Surface Parking Lot and configured for linear bus parking, is approximately 400 feet long and has the capacity to accommodate nine coach-sized charter buses simultaneously.

TABLE 4-70 CHARTER BUS CONVERSION FACTORS

	NOVEMBER 9TH, 2018					NOVEMBER 2018 (315 CHARTERS/MO) TO MARCH 2018 (397 CHARTERS/MO) CONVERSION	RESULTING 2018 REQUIREMENT PEAK HOUR VOLUME
	9:30-9:45 AM	9:45-10:00 AM	10:00-10:15 AM	10:15-10:30 AM	10:30-10:45 AM		
Charter Buses on Curb	4	2	1	1	4		
45-minute Demand	7						9
60-minute demand	8					25% Increase	11
75-minute Demand	12						16

SOURCES: TranSMART Technologies, Inc. November 2018 (data); Ricondo & Associates, Inc. June 2019 (analysis).

4.7.2.3 FUTURE YEAR CHARTER BUS STAGING REQUIREMENTS

The growth in demand for charter bus activity was assumed to correlate with the increase in O&D passenger activity based on the baseline forecast. Although charter bus activity is minimally affected by TNCs gaining market share on other ground transportation modes, three growth scenarios for charter buses were explored, relating to the work outlined in Section 4.14, Landside Access Strategy. The Baseline TNC Scenario has charter buses losing 2 percent of market share annually to TNCs. The High TNC Growth Scenario is expected to lose 3 percent of market share annually to TNCs. Finally, the TNC Low Growth Scenario is predicted to lose only 1.5 percent market share annually to TNCs.

The results of the Existing 2018 requirements and three TNC Growth Scenarios are presented in **Table 4-71**, showing the highest growth in charter buses in the Low TNC Growth Scenario, which is projected to have a peak 75-minute volume of 17 charter buses. This is nearly double the simultaneous capacity of the bus staging area, but not all spaces are expected to be utilized at the same time. Using a similar method as the curbside analysis based on volume, dwell time and vehicle length, it is projected that 17 charter buses per hour with a dwell time of 20 minutes and requiring 45 feet per bus would need nine staging positions, or roughly 405 feet. The current facilities are adequate to handle 2040 peak charter bus staging demand. If charter bus staging either increases in volume, or the dwell time per vehicle increases, there could there be potential capacity issues in the existing bus staging area.

TABLE 4-71 THREE CHARTER BUS FUTURE STAGING REQUIREMENT SCENARIOS

PERIOD OF ACTIVITY	PEAK PERIOD	2018 DEMAND	BASELINE TNC SCENARIO			LOW TNC SCENARIO			HIGH TNC SCENARIO		
			2023	2028	2040	2023	2028	2040	2023	2028	2040
45-minute	09:15 - 10:00	9	9	9	9	10	10	10	9	8	7
60-minute	09:15 - 10:15	11	11	11	11	12	12	12	11	10	9
75-minute	09:15 - 10:30	16	16	16	16	17	17	17	15	15	13

SOURCES: TranSMART Technologies, Inc. November 2018 (data); Ricondo & Associates, Inc. June 2019 (analysis).

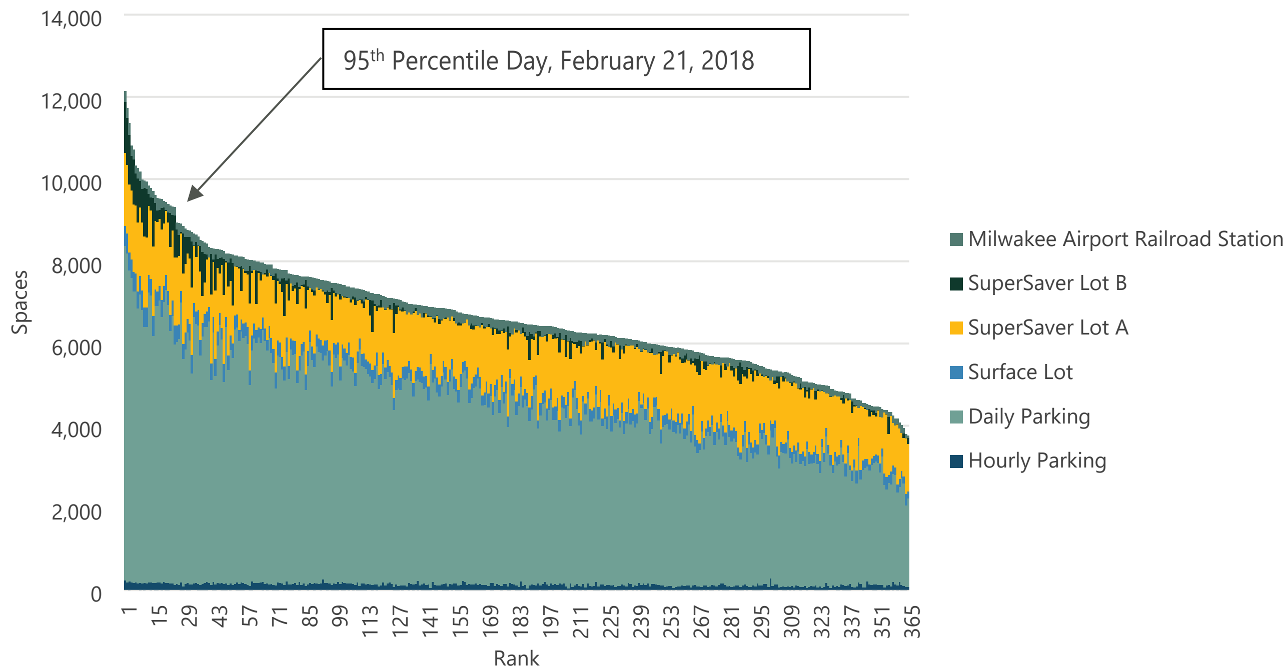
4.8 PUBLIC AND EMPLOYEE PARKING FACILITIES

4.8.1 PUBLIC PARKING DEMAND/CAPACITY AND REQUIREMENTS

4.8.1.1 PUBLIC PARKING DEMAND

Existing public parking demand was determined using actual daily occupancy data from the Airports parking access and revenue control (PARC) system for twelve consecutive months (January through December 2018). The base year (2018) public parking demand was estimated by identifying the peak hour daily parking occupancy on the “parking design day” or 95th percentile day of parking activity, as depicted in **Exhibit 4-61**. The design day is represented not by the busiest day of the year, but by a representative typical busy day that falls on the 95th percentile day of parking activity. 2018 estimated public parking demand, by parking product, is depicted in **Table 4-72**. The base year (2018) public parking demand was projected under the baseline forecast and high scenario to determine the future requirements for the 2023, 2028, and 2040 planning horizons. Off-airport parking demand was not included in the analysis due to a lack of reliable data and it was assumed that the on- and off-airport parking market shares will remain constant throughout the planning horizons.

EXHIBIT 4-61 2018 DESCENDING ORDER PEAK HOUR DAILY PARKING OCCUPANCY



SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

TABLE 4-72 2018 PUBLIC PARKING DEMAND

PUBLIC PARKING FACILITY	CAPACITY (SPACES)	ESTIMATED PARKING DESIGN DAY OCCUPANCY RATE	ESTIMATED DEMAND (2018)	SERVICE FACTOR[1]	REQUIREMENT (SPACES)
Hourly Parking	444	43%	192	10%	211
Daily Parking	7,719	89%	6,863	10%	7,549
Surface Lot	528	65%	343	5%	360
SuperSaver Lot A	1,726	95%	1,634	5%	1,716
SuperSaver Lot B	1,201	18%	220	5%	231
Milwaukee Airport Railroad Station	300	90%	271	5%	285
Total	**11,918**		**9,523**		**10,352**

NOTE:
1 The service factor is a buffer that accounts for the increasing difficulty in locating an available parking spot as facility occupancy approaches capacity.
SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

4.8.1.2 ESTIMATED PUBLIC PARKING REQUIREMENTS

Parking demand was estimated without capacity considerations and demonstrates the demand for parking spaces in each parking facility, regardless of the number of available spaces. This estimate assumes that parking demand will increase in proportion to the forecast growth in annual originating passengers at the Airport, after adjusting for future propensity to park, which reflects the reduction in parking activity over time resulting from passengers utilizing access modes other than private vehicles to travel to the Airport. Current trends and future projections indicate a decrease in parking demand due to reduction in vehicle ownership and innovations in transportation modes (e.g., autonomous vehicles). It is assumed that the percentage of originating passengers who will park at the Airport will decrease 0.25 percent per year throughout the forecast horizon, based on historic trends of parkers per enplanements over recent years.

The public parking requirements represent the minimum number of spaces needed to accommodate parking demand, while providing a service factor, which represents an additional buffer of spaces to account for the increasing difficulty of finding an available parking spot as usage approaches capacity (i.e., the time spent searching for the last available space). For purposes of converting space "demand" to space "requirements," a 10 percent service factor was added to the calculated demand for the Public Parking Garages (Hourly Parking, Daily Parking), and a five percent service factor was applied to the space demand for the surface lots (Surface Lot, SuperSaver Lots A and B, and the Milwaukee Airport Railroad Station).

As shown in **Table 4-73**, future public parking demand was grown at a rate proportional to the forecast growth of originating enplaned passengers, reduced by the future propensity to park described above.

TABLE 4-73 ANNUAL PUBLIC PARKING DEMAND ADJUSTED FOR CUSTOMER PROPENSITY TO PARK

	ACTUAL (2018)	FORECAST (BASELINE FORECAST)		
		2023	2028	2040
Originating passengers	3,497,000	3,786,000	4,189,000	5,171,000
Growth of originating passengers	N/A	8.3%	10.6%	23.5%
Propensity to park adjustment	1	0.99	0.98	0.95
Adjusted originating passengers[1]	3,497,000	3,739,000	4,085,000	4,895,000
Growth of adjusted originating passengers	N/A	6.9%	9.3%	19.8%

NOTE:
1 The originating passenger forecast is adjusted downward to reflect a reduced propensity to park in the future.
SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

The estimated baseline forecast parking requirements are summarized in **Table 4-74**, and the high scenario parking requirements are summarized in **Table 4-75**. Requirements were compared to existing capacity in each facility to identify surpluses or deficiencies. When combining all public parking facilities, there is a deficit in 2040 of 2,571 spaces under the baseline forecast, and a deficit of 4,567 space under the high scenario. **Exhibit 4-62** through **Exhibit 4-67** depicts space requirements by parking product for the baseline and high forecast scenarios. As shown, demand in the Daily Parking Garage and SuperSaver Lot B will exceed capacity in 2023, and in the Milwaukee Airport Railroad Station by 2028. Demand will exceed capacity Airport-wide by 2028.

TABLE 4-74 PUBLIC PARKING DESIGN DAY REQUIREMENTS - BASELINE FORECAST

PARKING PRODUCT	EXISTING (SPACES)		2018	2023	2028	2040
Hourly Parking	444	Requirement	211	221	247	296
		Surplus/(Deficit)	233	223	197	148
Daily Parking	7,719	Requirement	7,549	7,915	8,820	10,566
		Surplus/(Deficit)	170	(196)	(1,101)	(2,847)
Surface Lot	528	Requirement	360	378	421	504
		Surplus/(Deficit)	168	150	107	24
SuperSaver Lot A	1,726	Requirement	1,716	1,799	2,004	2,401
		Surplus/(Deficit)	10	(73)	(278)	(675)
SuperSaver Lot B	1,201	Requirement	231	242	270	323
		Surplus/(Deficit)	970	959	931	878
Milwaukee Airport Railroad Station	300	Requirement	285	298	332	398
		Surplus/(Deficit)	15	2	(32)	(98)
Total	**11,918**	**Requirement**	**10,352**	**10,854**	**12,094**	**14,489**
		Surplus/(Deficit)	**1,566**	**1,064**	**(176)**	**(2,571)**

SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

TABLE 4-75 PUBLIC PARKING DESIGN DAY REQUIREMENTS - HIGH SCENARIO

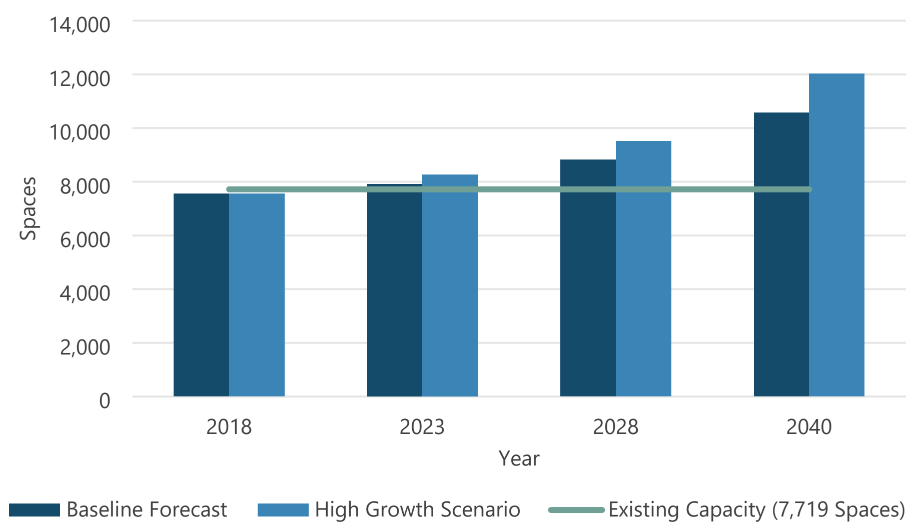
PARKING PRODUCT	EXISTING (SPACES)		2018	2023	2028	2040
Hourly Parking	444	Requirement	211	231	266	336
		Surplus/(Deficit)	233	213	178	108
Daily Parking	7,719	Requirement	7,549	8,269	9,505	12,022
		Surplus/(Deficit)	170	(550)	(1,786)	(4,303)
Surface Lot	528	Requirement	360	394	453	574
		Surplus/(Deficit)	168	134	75	(46)
SuperSaver Lot A	1,726	Requirement	1,716	1,879	2,160	2,732
		Surplus/(Deficit)	10	(153)	(434)	(1,006)
SuperSaver Lot B	1,201	Requirement	231	253	291	368
		Surplus/(Deficit)	970	948	910	833
Milwaukee Airport Railroad Station	300	Requirement	285	312	358	453
		Surplus/(Deficit)	15	(12)	(58)	(153)
Total	**11,918**	**Requirement**	**10,352**	**11,339**	**13,033**	**16,485**
		Surplus/(Deficit)	**1,566**	**579**	**(1,115)**	**(4,567)**

SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

EXHIBIT 4-62 PUBLIC PARKING HOURLY PARKING REQUIREMENTS

SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

EXHIBIT 4-63 PUBLIC PARKING DAILY PARKING REQUIREMENTS

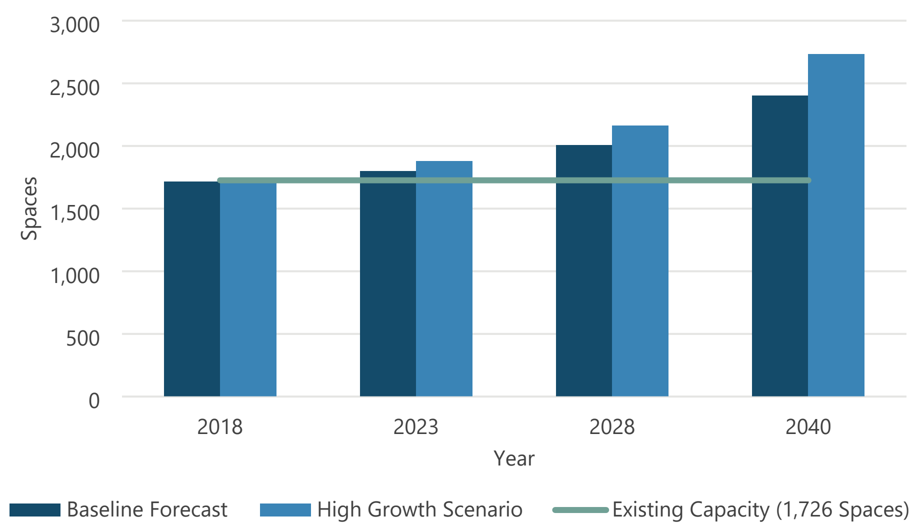


SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

EXHIBIT 4-64 PUBLIC PARKING SURFACE LOT REQUIREMENTS

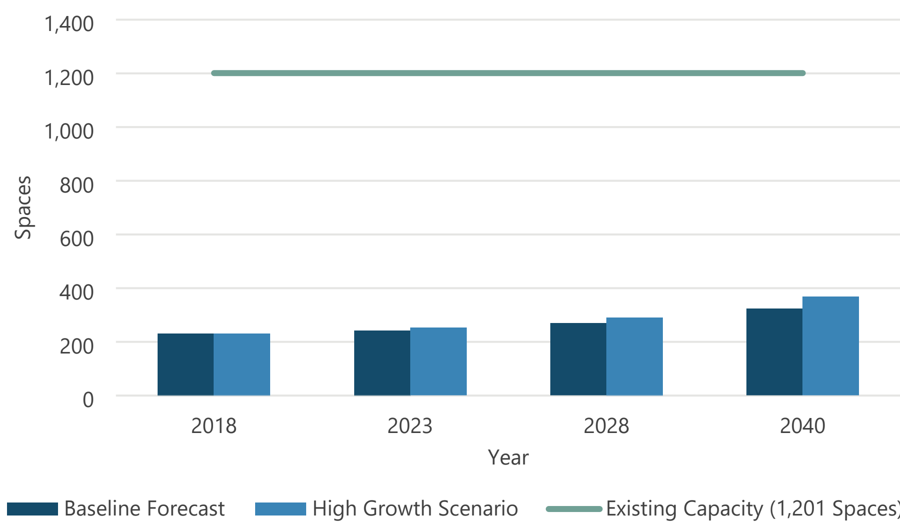
SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

EXHIBIT 4-65 PUBLIC PARKING SUPERSAVER LOT A REQUIREMENTS



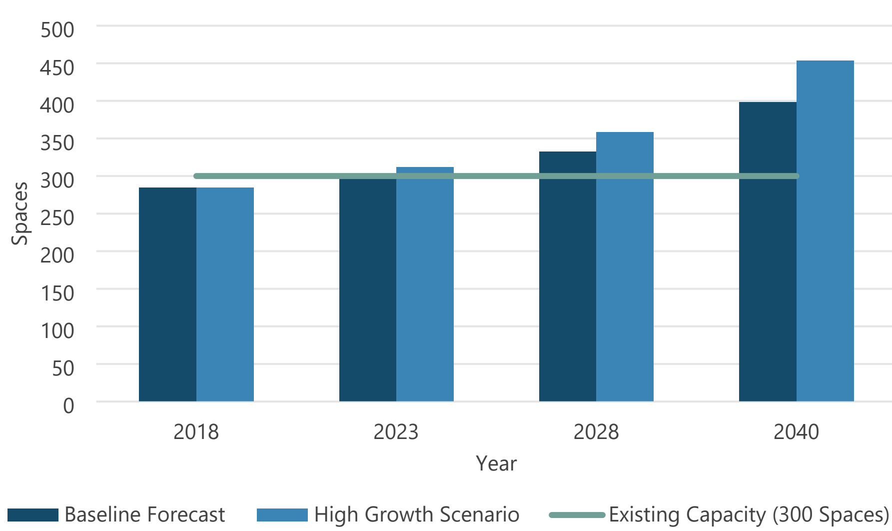
SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

EXHIBIT 4-66 PUBLIC PARKING SUPERSAVER LOT B REQUIREMENTS



SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

EXHIBIT 4-67 PUBLIC PARKING MILWAUKEE AIRPORT RAILROAD STATION REQUIREMENTS



SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

4.8.2 PUBLIC PARKING REVENUE

4.8.2.1 METHODOLOGY AND APPROACH

A model was developed to project annual parking revenues for all on-Airport public parking products. The model was based on the average day of the peak month of the year for total revenue; in this case, March 2018.

March 2018 parking duration data, by product category, was used to build the model. The Airport's PARC system reports total exits (transactions) and audited revenues by month, for every parking facility. The PARC system also generates duration summary documents that report transaction data by duration category (0 to 30 minutes, 31 to 60 minutes, and 61 to 90 minutes, 1-2 days, 2-3 days, etc.). Parking duration generally corresponds with the incremental increases in parking fees. These duration summaries are unofficial and less accurate than the monthly transaction and revenue reports. Also, duration categories vary slightly among parking facilities. The time increments beyond the point at which the maximum daily rate is first levied are measured in days, rather than hours or minutes. As a result, only the relative distribution reflected in the duration summaries were used and applied to the total volumes from the transaction reports for this analysis.

Parking space demand is determined by estimating how frequently, on average, a parking space turns over from one parker to the next. Turnover rates are based on the midpoint of time in each reported transaction duration increment and include a small allowance for time spent in circulation and in the parking process.

The average length of stay within each duration category is calibrated on a product-level basis using the overall average length of stay for the peak month. The demand for spaces is equal to transactions during the average busy day by duration category, divided by the turnover rate for that category. Once a facility is effectively full, which includes the service factors, parkers are diverted to other parking facilities with available spaces by Airport staff, or, if all facilities are at capacity, diverted off-Airport or to another access mode not monitored by the PARC system. The model was calibrated by comparing estimated demand for long-term spaces to the average number of daily maximum occupancy and overnight parkers by parking product. The model results were found to be within five percent of observed counts and average length of stay, which was considered adequate for these analyses. These calibrated parameters for the parking revenue design day are assumed to be constant for purposes of estimating future demand. Similar to the parking demand analysis, off-airport parking was not considered in the revenue analysis, and it was assumed that the on- and off-airport parking market shares will remain constant throughout the planning horizons.

Annualization factors were then computed on a product-specific basis using a ratio of March 2018 to annual transaction and revenue data to replicate 2018 revenue. Future-year annualization factors are projected to be consistent with the base year. **Table 4-76** shows the annualization factors used to convert modeled results for future-year estimates of activity on the average busy day in March 2018 into annual transactions and revenue.

TABLE 4-76 ANNUALIZATION FACTOR BY PARKING PRODUCT

YEAR	PARKING PRODUCT					
	HOURLY PARKING	DAILY PARKING	SURFACE LOT	SUPERSAVER LOT A	SUPERSAVER LOT B	MILWAUKEE AIRPORT RAILROAD STATION
Percent of Annual Transactions Occurring During Peak Month						
2018	8.40%	10.39%	8.52%	8.89%	33.6%	8.10%
Percent of Annual Revenue Generated During Peak Month						
2018	5.40%	12.13%	12.09%	9.88%	34.86%	8.34%

SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

4.8.2.2 PUBLIC PARKING REVENUE PROJECTION

The parking revenues under the baseline forecast and high scenario were modeled assuming no rate changes and no new parking products are introduced through the planning horizon. The resulting revenue projections are reflected in **Table 4-77** and **Table 4-78** and on **Exhibit 4-68** and **Exhibit 4-69**. Total projected annual revenue equals $38.6 million in 2040 under the baseline forecast, and $39.0 million in the high scenario. Further revenue could be realized by adding additional on-Airport capacity, however, as capacity in each of the parking products is reached, revenues level out as customers use other modes of transportation to access the Airport or park at off-Airport privately-operated parking locations.

TABLE 4-77 PROJECTED PUBLIC PARKING REVENUE - BASELINE FORECAST

	2018	2023	2028	2040
Hourly Parking	$2,481,000	$2,821,000	$4,530,000	$5,489,000
Daily Parking	$22,435,000	$24,058,000	$25,271,000	$25,271,000
Surface Lot	$1,625,000	$1,832,000	$1,901,000	$1,896,000
Super Saver Lot A	$4,091,000	$4,091,000	$4,135,000	$4,214,000
Super Saver Lot B	$549,000	$587,000	$660,000	$753,000
Milwaukee Airport Railroad Station	$576,000	$646,000	$822,000	$978,000
Total	**$31,757,000**	**$34,035,000**	**$37,319,000**	**$38,601,000**

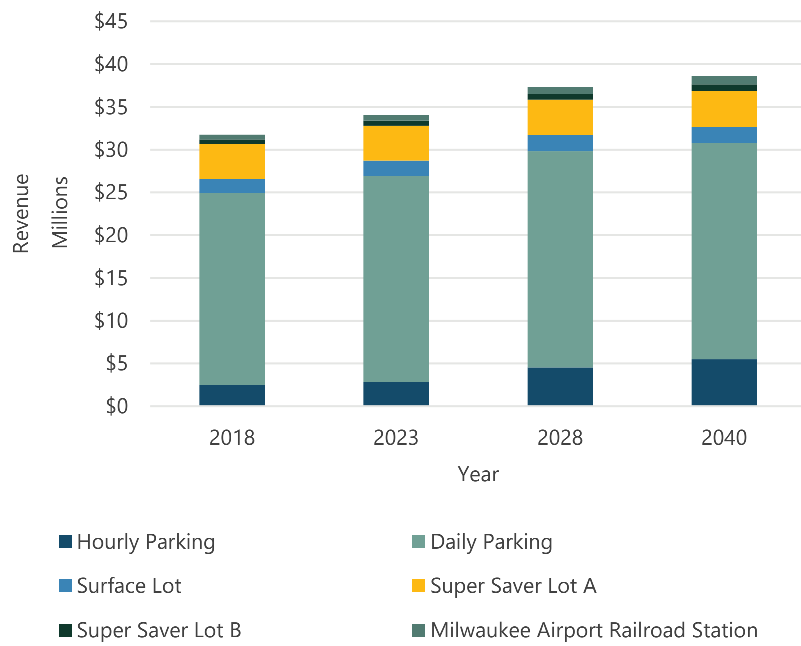
SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

TABLE 4-78 PROJECTED PUBLIC PARKING REVENUE - HIGH SCENARIO

	2018	2023	2028	2040
Hourly Parking	$2,481,000	$3,484,000	$5,008,000	$6,147,000
Daily Parking	$22,435,000	$25,271,000	$25,271,000	$25,271,000
Surface Lot	$1,625,000	$1,889,000	$1,896,000	$1,896,000
Super Saver Lot A	$4,091,000	$4,096,000	$4,227,000	$4,091,000
Super Saver Lot B	$549,000	$625,000	$763,000	$753,000
Milwaukee Airport Railroad Station	$576,000	$783,000	$948,000	$855,000
Total	**$31,757,000**	**$36,148,000**	**$38,113,000**	**$39,013,000**

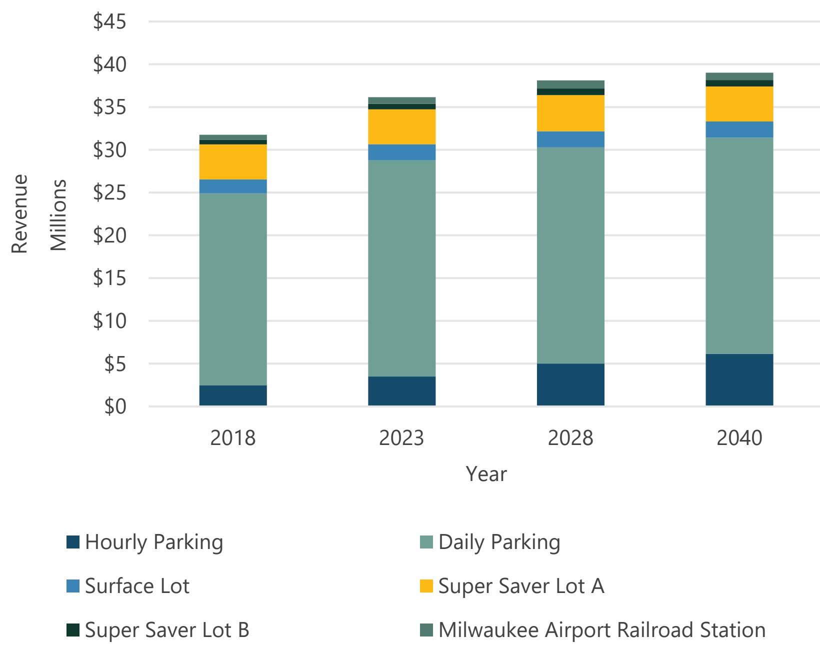
SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

EXHIBIT 4-68 PROJECTED PUBLIC PARKING REVENUE - BASELINE FORECAST



SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

EXHIBIT 4-69 PROJECTED PUBLIC PARKING REVENUE - HIGH SCENARIO



SOURCES: Milwaukee Mitchell International Airport, February 2019; Ricondo & Associates, Inc., March 2019.

4.8.3 EMPLOYEE PARKING DEMAND/CAPACITY AND REQUIREMENTS

4.8.3.1 METHODOLOGY AND APPROACH

As discussed in Section 2.5.7, Public and Employee Parking, employee parking lot entry and exit data were collected using camera counters on Thursday, November 8, 2018 from 6:30 a.m. to 7:00 p.m., and on Friday, November 9, 2018 from 6:30 a.m. to 7:00 p.m. Parking demand over the course of the day was estimated by adding entry volumes and subtracting exit volumes from the accumulation counts. An adjustment factor was applied to account for the change in occupancy from the overnight count provided by the Milwaukee County Sheriff's department, and the start of the camera counts. The overnight count was reported to be approximately 275 vehicles which, when compared to the peak hour of 434 vehicles, reflected an increase of 159 vehicles from the lowest to the highest occupancy counts. The peak hour was observed to occur at 11:00 a.m. on Thursday, November 8, resulting from the overlap of the morning and afternoon employee shifts.

Future parking requirements were estimated by assuming that existing volumes will increase in proportion to the average of the forecast growth of O&D enplaned passengers and growth of aircraft operations as defined in the baseline forecast and high scenario. An average of the O&D enplaned passengers and aircraft operations forecasts growth rates was used to reflect slower anticipated growth in employees at the Airport, as compared to passenger growth.

4.8.3.2 FORECAST EMPLOYEE PARKING DEMAND AND REQUIREMENTS

The resulting employee parking requirements, under the baseline forecast and high scenario, are shown in **Table 4-79** and **Table 4-80**, and on **Exhibit 4-70**. As shown, under both the baseline forecast and the high scenario, employee parking does not reach capacity through the planning horizon. No service factor (buffer) was added to the employee parking demand figures, because employee parking demands are relatively constant, and the peak accumulation of capacity occurs during a brief period when vehicles are entering and exiting the lot during the peak mid-day shift change. Apart from those few minutes, the employee parking lot has spaces available.

TABLE 4-79 EMPLOYEE PARKING REQUIREMENTS - BASELINE FORECAST

SPACES	2018	2023	2028	2040
Capacity	878	878	878	878
Requirement	434	458	497	596
Surplus/(Deficit)	444	420	381	282

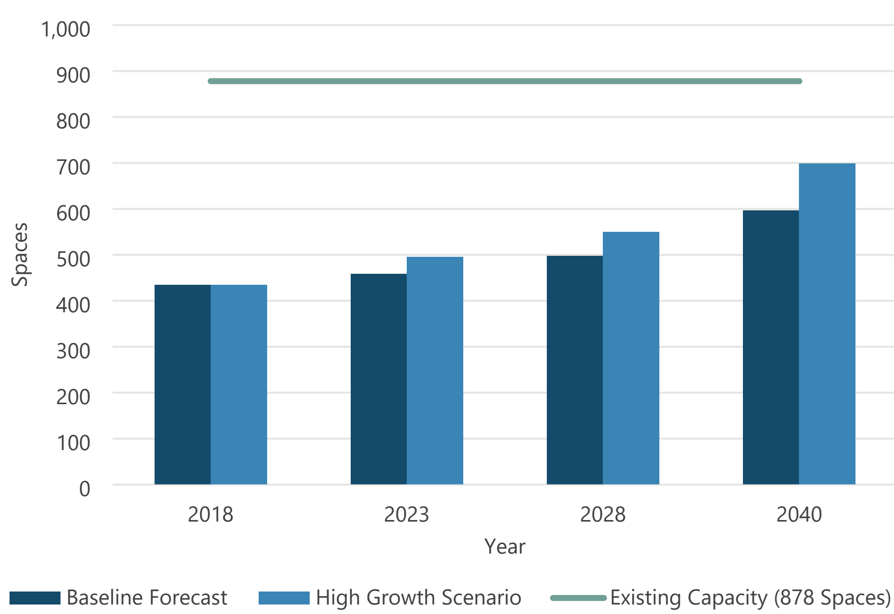
SOURCES: TranSmart Inc., March 2019 (data); Milwaukee County Sheriff's Department, March 2019; Ricondo & Associates, Inc., March 2019 (analysis).

TABLE 4-80 EMPLOYEE PARKING REQUIREMENTS - HIGH SCENARIO

SPACES	2018	2023	2028	2040
Capacity	878	878	878	878
Requirement	434	496	550	698
Surplus/(Deficit)	444	382	328	180

SOURCES: TranSmart Inc., March 2019 (data); Milwaukee County Sheriff's Department, March 2019; Ricondo & Associates, Inc., March 2019 (analysis).

EXHIBIT 4-70 EMPLOYEE PARKING REQUIREMENTS



SOURCES: TranSmart Inc., March 2019 (data) ; Milwaukee County Sheriff's Department, March 2019; Ricondo & Associates, Inc., March 2019 (analysis).

4.9 RENTAL CAR FACILITIES

Specific requirements for each of the following rental car facility components are presented in this section:

- Customer Service Area
- Ready/Return Vehicle Area
- Vehicle Storage Area
- Quick Turnaround Area
  - fueling positions
  - wash bays
  - vehicle light maintenance bays
  - vehicle stacking spaces

4.9.1 METHODOLOGY

Facility requirements for defined planning horizons were developed based on forecast O&D passenger growth (under both the baseline forecast and high scenario) presented in Section 3, Aviation Activity Forecasts. The planning period consisted of the base year (2018) and three planning horizon years - 2023, 2028, and 2040.

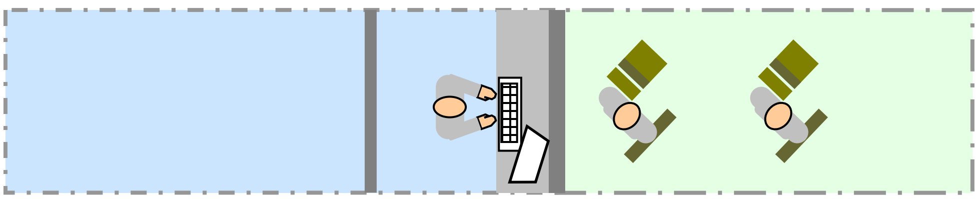
The space requirements methodology uses industry standard airport rental car facility utilization rates for transactions during a defined planning hour and was additionally informed by Ricondo's experience planning other airport rental car facilities. Hourly transaction information was requested directly from the eight on-Airport rental car companies. Five of the eight companies provided the requested data, which covered hourly transactions for 365 days, over the latest timeframe available (August 2017 through July 2018). Hourly transaction information for the rental car companies that did not provide any data was extrapolated using MKE market share information received from the Airport, and the hourly transaction information received from the five companies that did respond. Separate rental and return hours were calculated by taking the total rentals and, separately, total returns falling within the 15th busiest hour identified for each company individually and then totaled to represent a rental planning hour and a return planning hour.

In addition to hourly transaction information, a questionnaire requesting the size, configuration, and use of existing rental car facilities, was sent to each on-Airport rental car company in September 2018. Again, only five of the eight on-Airport companies representing less than half (47 percent) of the total rental car market share at MKE returned a completed questionnaire. Although hourly transactions can be extrapolated as noted above, the rental car operator's facilities vary considerably, from both an airport-to-airport perspective and a company-to-company perspective, in the way they are sized, utilized, and staffed. The same process used to extrapolate market share should not be used to extrapolate all existing (2018) facilities given the low response rate and therefore, existing conditions are included below for only those on-airport facilities that could be inspected or that were documented through Airport records (customer service and rental/return areas). The 2018 facility requirements summarized in this section are derived through the calculation of facility needs, by component, based on the conservative assumptions outlined below.

4.9.2 CUSTOMER SERVICE AREA

The customer service area is used to process arriving rental car customers. The number of required counter positions is the primary factor that determines the space requirement. **Exhibit 4-71** depicts an example of a customer service area counter layout with associated area measurements.

EXHIBIT 4-71 EXAMPLE CUSTOMER SERVICE AREA COUNTER SIZING



SOURCE: Ricondo & Associates, Inc., March 2019.

As described above, a conservative approach was taken in the development of the facility requirements due to the limited survey response by rental car companies (responses representing less than half [47 percent] of the total rental car market share at MKE). For example, as this approach pertains to the customer service area, Ricondo understands that some rental car companies at MKE provide premium or preferred service where rental car customers would deplane an aircraft, walk directly out to their respective rental car area in the garage, would have limited interaction with any rental car team member, pick up their car and depart the Airport. Since this type of service varies significantly by rental car brand, the most conservative assumption was made that all customers utilize the counters when renting a vehicle.

During the rental planning hour, there were 313 total rental car transactions. Based on Ricondo's experience at similar airports with rental car customer business/leisure splits similar to the MKE market, it was assumed that a typical rental car counter transaction takes approximately eight minutes, translating to 7.5 transactions per hour. **Exhibit 4-72** depicts the baseline forecast customer service counter requirements for the current planning year (2018) and each planning horizon, as well as the existing customer service area space. Similarly, **Exhibit 4-73** depicts the high scenario customer service counter requirements for the same planning horizons and the existing space.

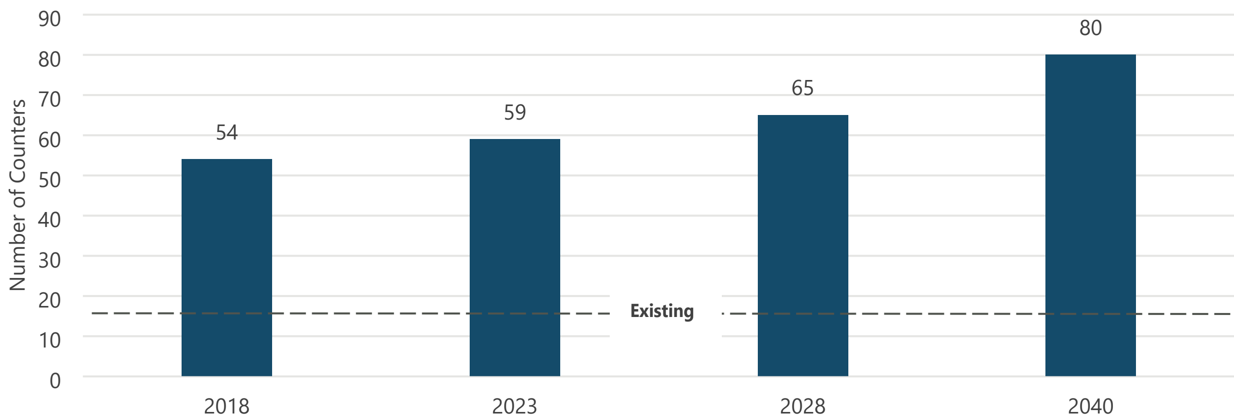
4.9.3 READY AND RETURN VEHICLE AREA

Vehicles are picked up and returned by customers in the ready and return areas. Ready vehicles are parked in a 90-degree configuration, like the layout of a conventional public parking lot. Return vehicles are parked in a nose-to-tail configuration.

Rental car companies require a sufficient supply of ready spaces and vehicles to accommodate anticipated demand during the next hour's expected transactions. Companies also desire the availability of additional ready spaces in anticipation of unplanned operational challenges (e.g., flight delays). When flights are delayed, affected customers are added to the next hour's planned rentals, potentially creating a shortfall of available vehicles.

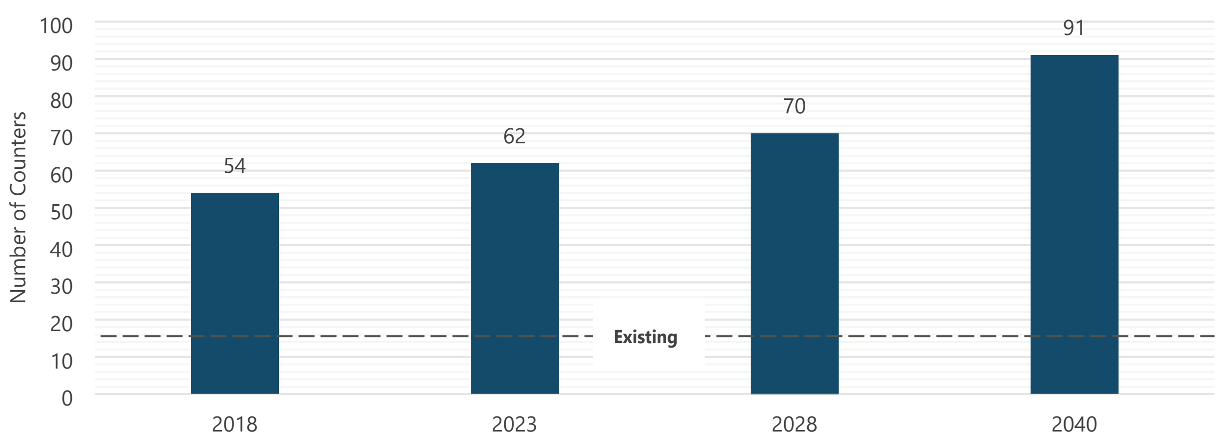
The key utilization rate—or hours of available parking capacity—used to determine rental and return space requirements was based on the planning hour number of rentals (313) and the planning hour number of returns (342). Based on rental car company preferences, facility requirements for rental/return vehicle space were based on an average requirement of 2 hours of rental space capacity and 1.5 hours of return capacity.

EXHIBIT 4-72 CUSTOMER SERVICE COUNTER FACILITY REQUIREMENTS – BASELINE FORECAST



SOURCES: Milwaukee Mitchell International Airport Geographic Information System Property and Space Layer Data – November 2018; Mead & Hunt/Ricondo site visit, January 2019; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019.

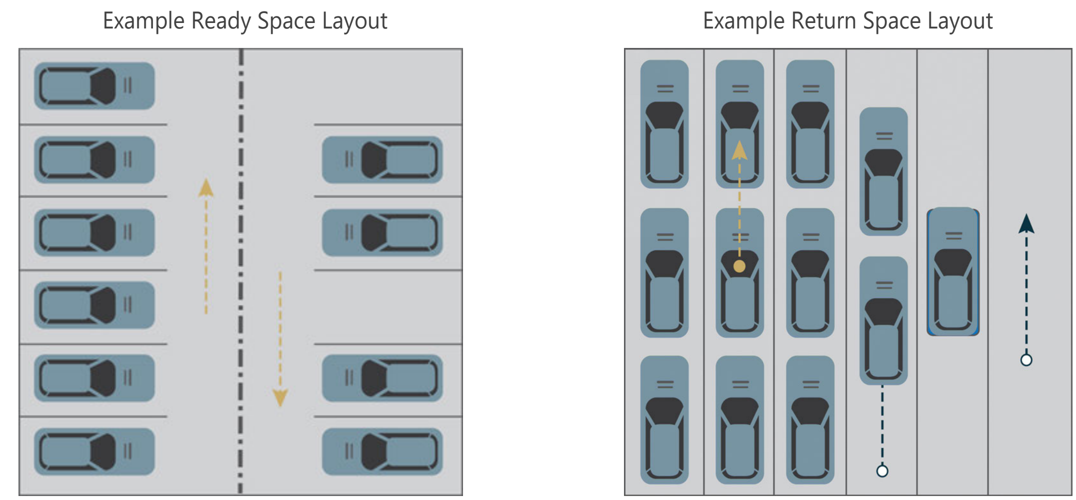
EXHIBIT 4-73 CUSTOMER SERVICE COUNTER FACILITY REQUIREMENTS – HIGH SCENARIO



SOURCES: Milwaukee Mitchell International Airport Geographic Information System Property and Space Layer Data – November 2018; Mead & Hunt/Ricondo site visit, January 2019; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019.

Exhibit 4-74 depicts example layouts and area measurements for ready space and return space. **Exhibit 4-75** presents the baseline forecast ready and return requirements for the current planning year (2018) and each planning horizon year (2023, 2028 and 2040). The forecast requirements under the high scenario are depicted in **Exhibit 4-76**. Existing rental and return facilities encompass approximately 261,200 square feet (including circulation), which equates to approximately 712 aggregate rental and return spaces, spanning portions of the first and second levels of the existing parking structure. This estimation of spaces is based on an average area (square feet) per space, irrespective of whether it is a rental space or a return space.

EXHIBIT 4-74 EXAMPLE RENTAL AND RETURN SPACE LAYOUTS

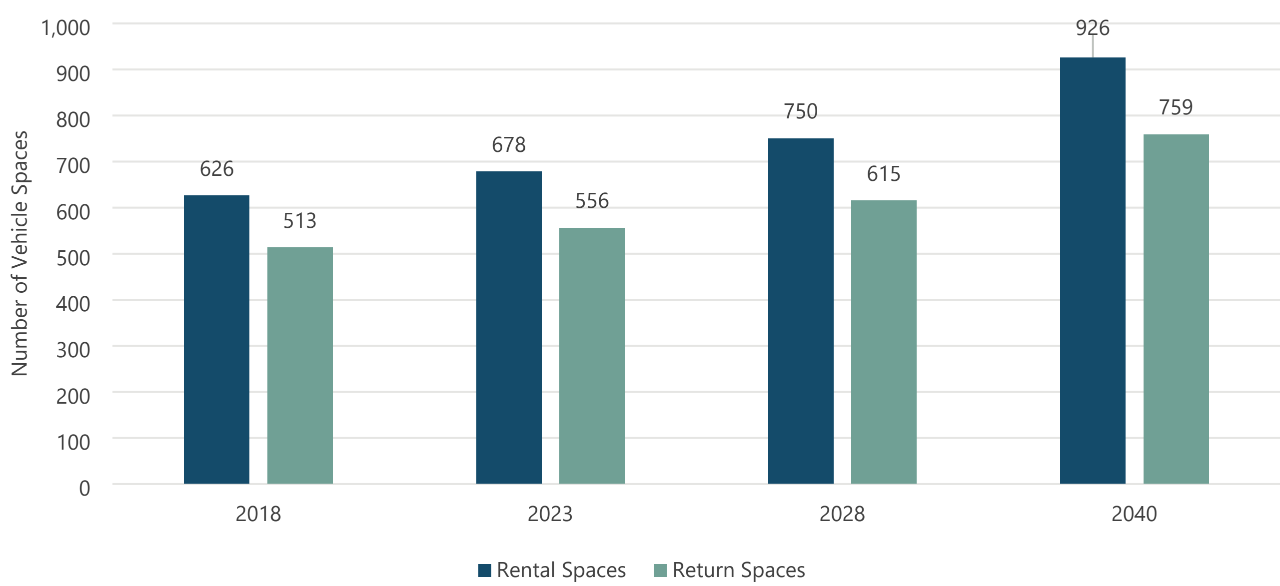


98 vehicles/acre
444 square feet per space, including drive lanes

206 vehicles/acre
211 square feet per space

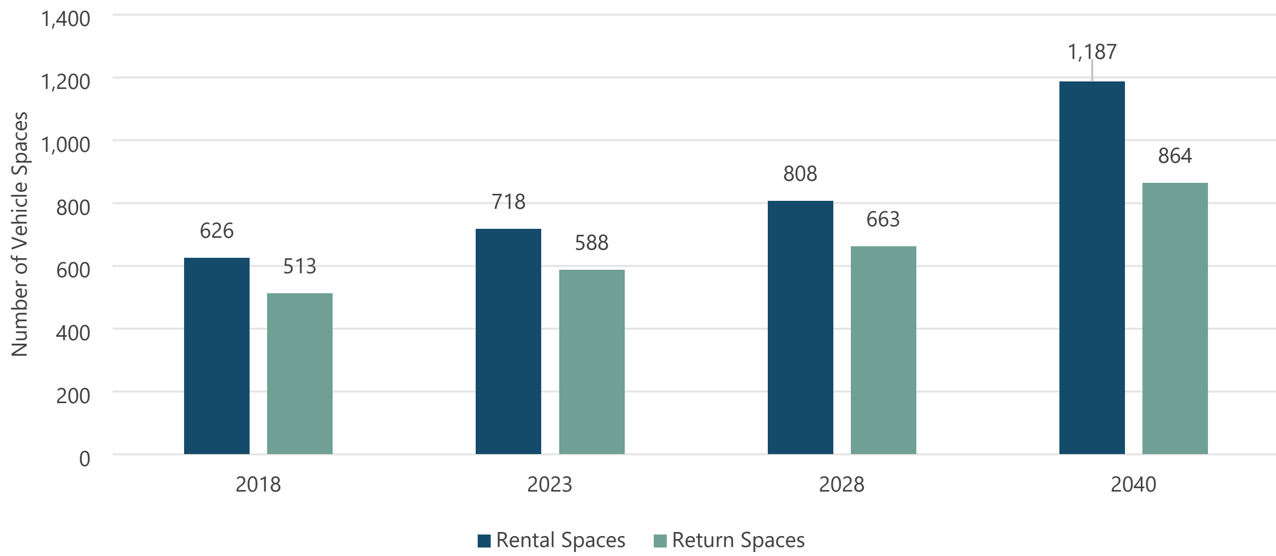
SOURCE: Ricondo & Associates, Inc., Example Rental and Return Space Layout, March 2019.

EXHIBIT 4-75 RENTAL CAR RENTAL AND RETURN REQUIREMENTS – BASELINE FORECAST



NOTES:
1 2018 requirements are calculated based on planning hour demand (rental and return), providing 2 hours of rental capacity and 1.5 hours of return capacity.
2 Although a split between rental and return spaces is not available the existing aggregate number of rental and returns spaces is approximately 712 spaces.
SOURCE: Ricondo & Associates, Inc., Example Rental and Return Space Layout, March 2019.

EXHIBIT 4-76 RENTAL CAR RENTAL AND RETURN REQUIREMENTS – HIGH SCENARIO



NOTES:
1 2018 requirements are calculated based on planning hour demand (rental and return), providing 2 hours of rental capacity and 1.5 hours of return capacity.
2 Although a split between rental and return spaces is not available the existing aggregate number of rental and returns spaces is 712 spaces.
SOURCE: Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019.

4.9.4 QUICK TURNAROUND AREA

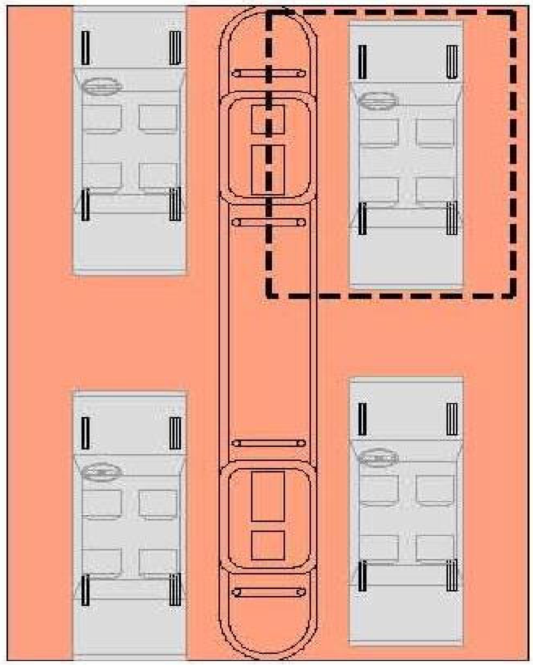
The Quick Turnaround Area (QTA) is designed to accommodate vehicle support functions, including fueling, vacuuming, washing, and maintenance. Airport rental car company QTAs are currently accommodated at off-site locations near the Airport. Traditionally, QTA's are configured similar to full-service gas stations, with double fuel dispensers installed on raised concrete islands. Each island is equipped so that vehicles can be vacuumed, and fluids checked while fueling is in process. Once the service is completed, vehicles are driven forward through an automated vehicle wash bay. Parking (stacking/staging) lanes are provided for queuing vehicles at each stage of the process.

QTA facilities for on-Airport rental car operators are currently located off-Airport, generally dispersed in proximity to the Airport. Because these facilities are not located on leased airport property, specific information about QTA facilities is limited to what is gathered from survey responses. Accordingly, a requirement for 2018 based on current activity levels is developed but no comparison is made to existing (2018) facilities.

4.9.4.1 FUELING POSITIONS

The number of fueling nozzles required to accommodate future demand was based on the number of vehicles that can be fueled in the return planning hour. The utilization rate, or number of vehicles that were processed per hour per nozzle, was calculated by dividing the number of return transactions in the return planning hour by the number of fuel nozzles. "Processing" includes vehicle fueling, vehicle inspections, vehicle vacuuming, and accompanying documentation (e.g., requests for mirror fix, windshield wiper replacement, etc.). **Exhibit 4-77** depicts an example of a fueling position layout and associated area measurements.

EXHIBIT 4-77 EXAMPLE FUELING POSITION LAYOUT

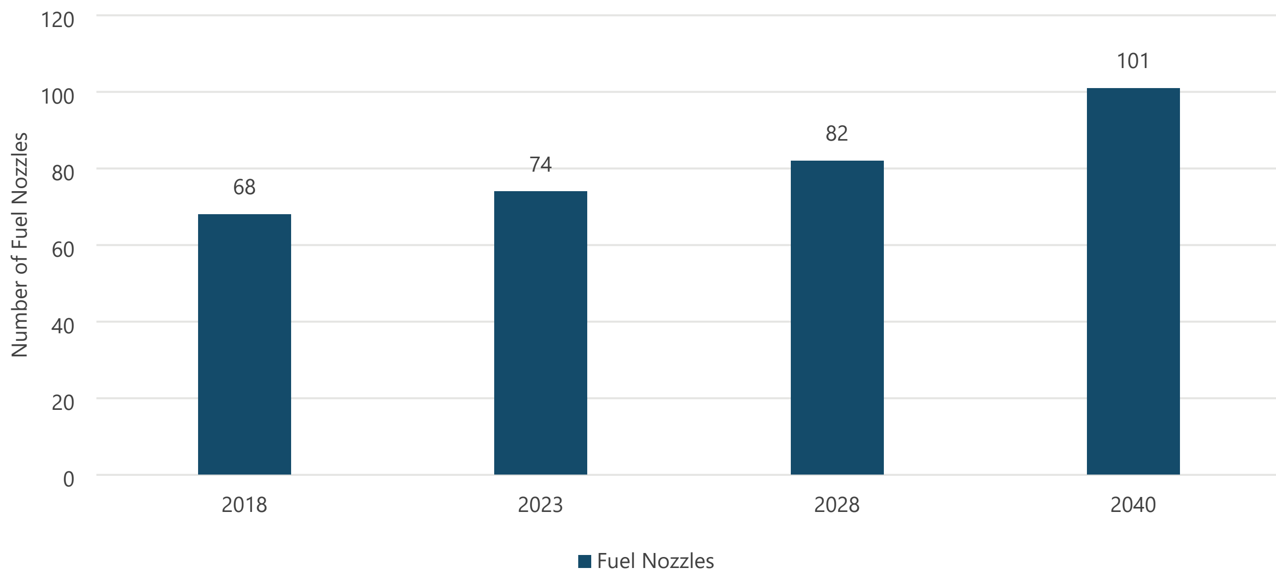


Indicates One Fuel Position (18 sq ft x 20 sq ft = 360 sq ft)

SOURCE: Ricondo & Associates, Inc., March 2019.

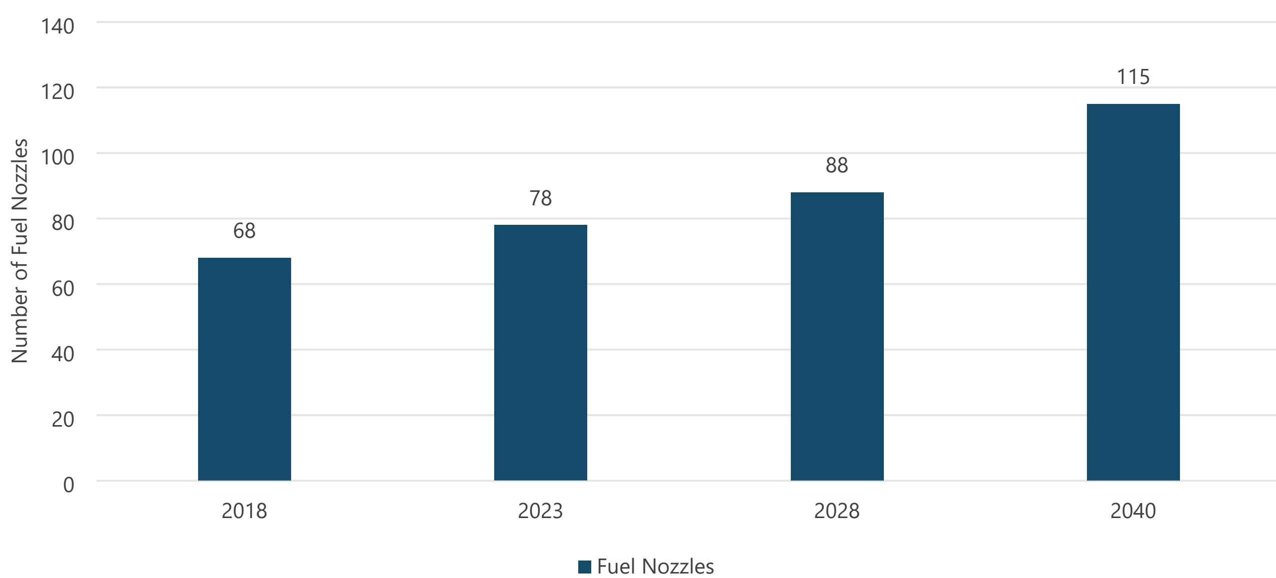
The utilization rate used for this analysis was five vehicles per hour per fueling nozzle or 12 minutes per vehicle per fueling nozzle. Using this utilization rate, 101 fuel nozzles will be required in 2040 under the baseline forecast, as shown in **Exhibit 4-78**, and 115 will be required under the high scenario, as shown on **Exhibit 4-79**.

EXHIBIT 4-78 FUELING NOZZLE REQUIREMENTS – BASELINE FORECAST



SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

EXHIBIT 4-79 FUELING NOZZLE REQUIREMENTS – HIGH SCENARIO



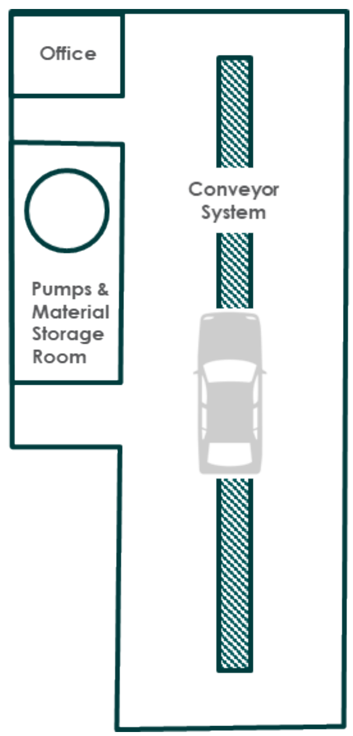
SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

4.9.4.2 WASH BAYS

The number of wash bays required to accommodate future demand was based on the number of vehicles that can be washed within the return planning hour. The utilization rate, or number of vehicles that can be processed per hour per wash bay, was calculated by dividing the number of return transactions in the return planning hour by the number of wash bays available.

The utilization rate determined was calculated to be 30 vehicles per hour, or one vehicle per two minutes. This generates a requirement of 19 wash bays in 2040 under the high scenario. **Exhibit 4-80** depicts an example of a typical wash bay layout and associated area measurements. **Exhibit 4-81** depicts the baseline forecast wash bay requirements for existing demand and for the current planning year and each planning horizon. **Exhibit 4-82** depicts the high scenario wash bay requirements for existing demand and for the current planning year and each planning horizon.

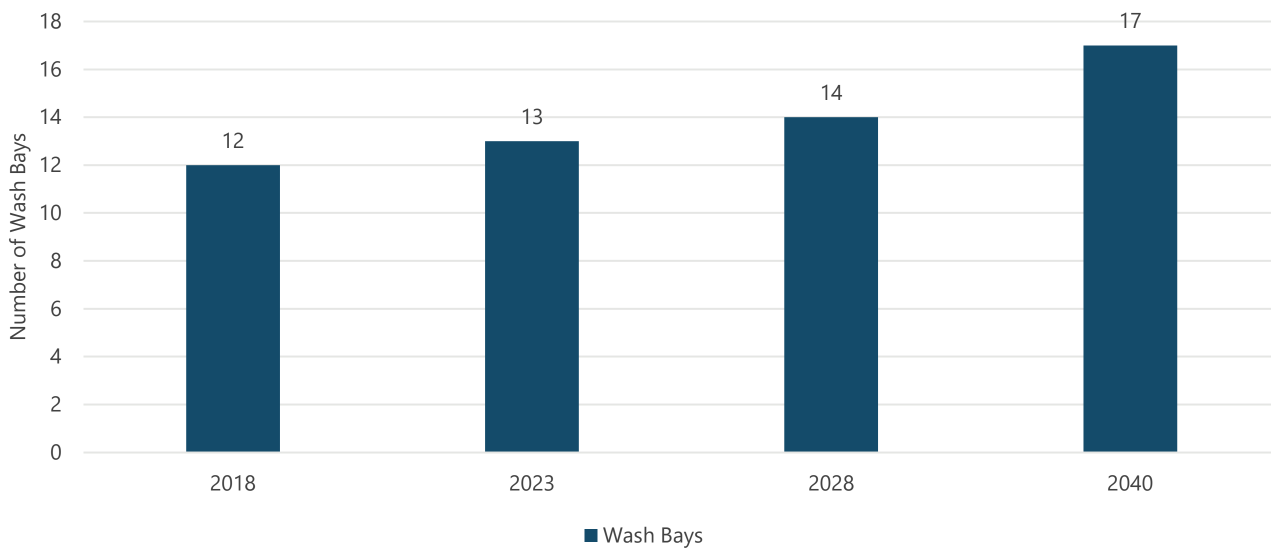
EXHIBIT 4-80 EXAMPLE WASH BAY LAYOUT



Single wash bay - 22 sq ft x 75 sq ft =1,650 sq ft
(Dimensions reflect entire area including office, conveyor area, pump room and circulation)

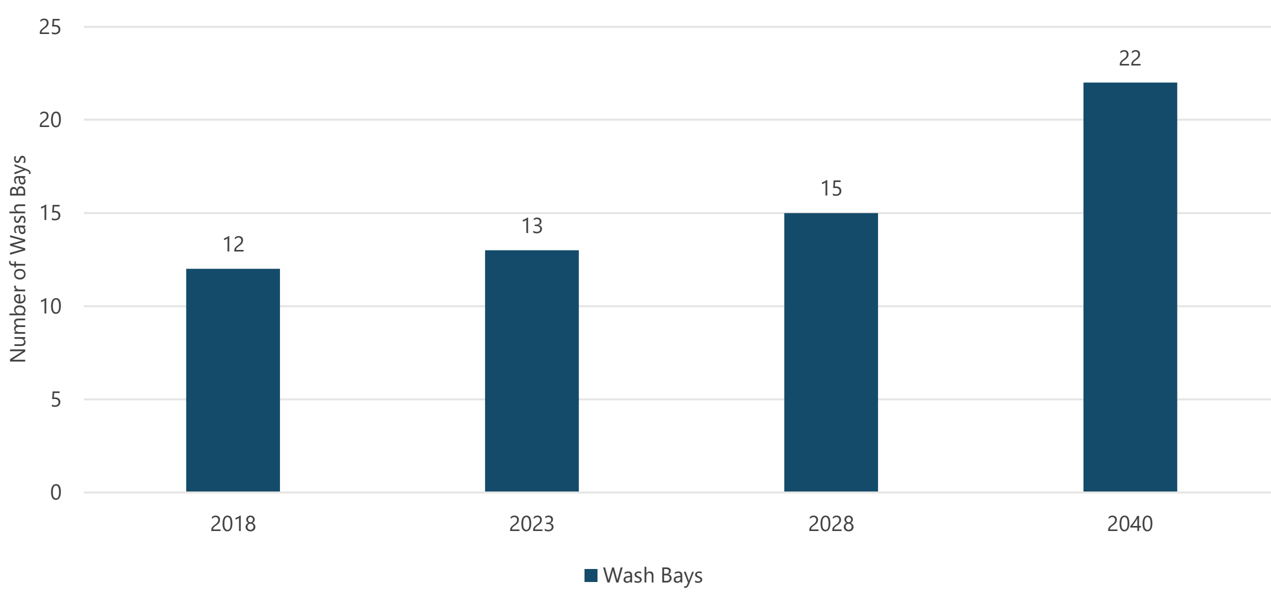
SOURCE: Ricondo & Associates, Inc., Example Fuel Position Layout, March 2019.

EXHIBIT 4-81 WASH BAY REQUIREMENTS – BASELINE FORECAST



SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

EXHIBIT 4-82 WASH BAY REQUIREMENTS – HIGH SCENARIO



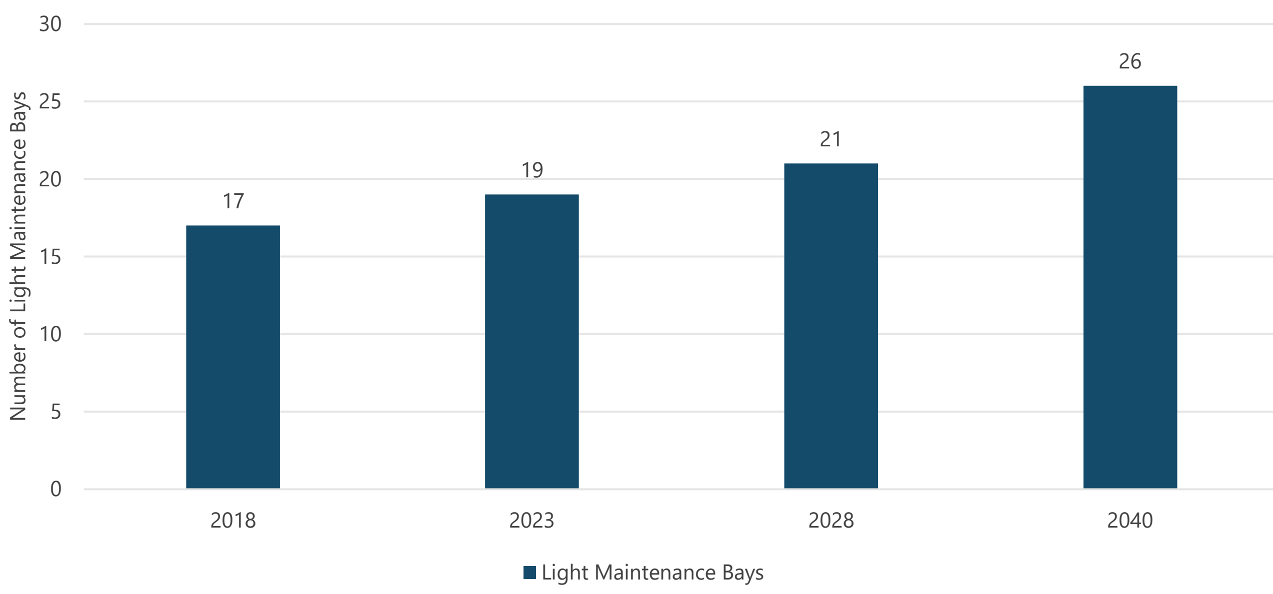
SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

4.9.4.3 VEHICLE LIGHT MAINTENANCE BAYS

Vehicle maintenance facilities and functions, including vehicle lifts, parts storage, tool lockers, vehicle records storage, administrative support, and employee break areas and locker areas, are traditionally located adjacent to the wash bays. The light maintenance bays are used to change oil, align wheels, and/or make minor parts replacements (e.g., interior, head, or taillights). Through conversations with rental car industry representatives in March 2018, approximately 5 to 8 percent of returned vehicles require normal preventive maintenance (e.g., oil change/tire rotation) at a given time. These industry representatives have also stated that approximately 2 to 3 percent of vehicles are returned with body damage requiring repairs, and 1 to 2 percent of vehicles require "non-preventative" maintenance (e.g., new brakes, radiator repair, etc.). Generally, body damage and non-preventative maintenance are performed off-site.

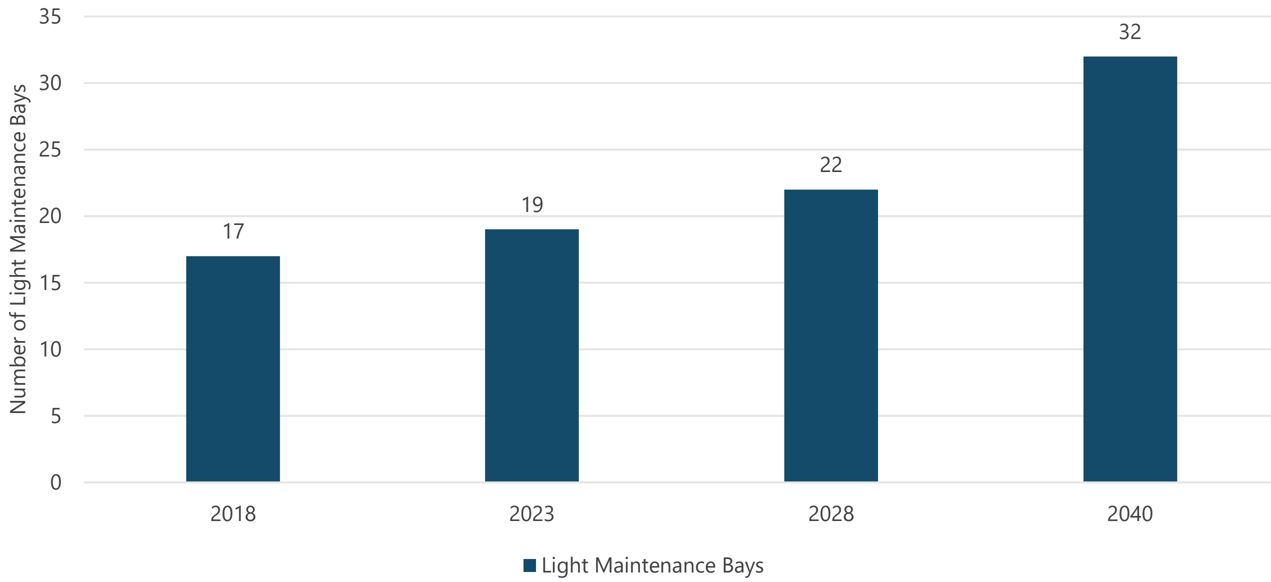
The number of vehicle light maintenance bays required for 2018 year assumed that five percent of the total vehicle returns during the planning hour would require on-site light maintenance in the return planning hour. Maintenance bay requirements for future planning horizon years were based on the forecast growth rate of O&D passengers at the Airport through the planning horizons. **Exhibit 4-83** depicts the baseline forecast requirements for light maintenance bays for the current planning year and each planning horizon. The high scenario requirements are shown on **Exhibit 4-84**.

EXHIBIT 4-83 LIGHT MAINTENANCE BAY REQUIREMENTS – BASELINE FORECAST



SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

EXHIBIT 4-84 LIGHT MAINTENANCE BAY REQUIREMENTS – HIGH SCENARIO

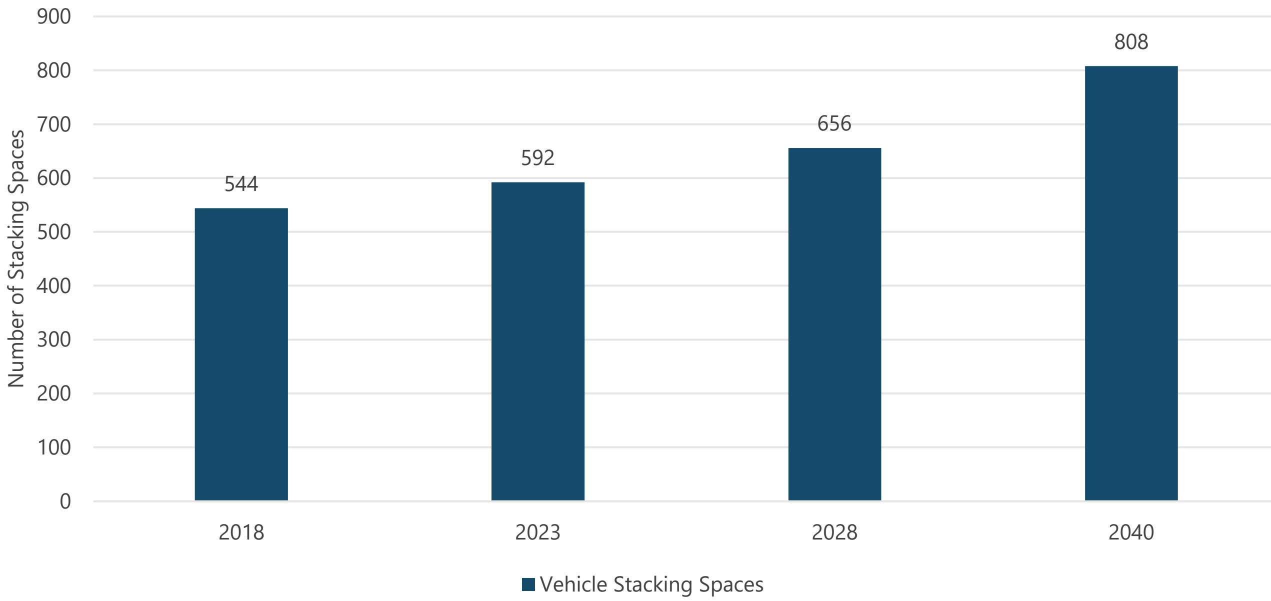


SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

4.9.4.4 VEHICLE STACKING SPACES

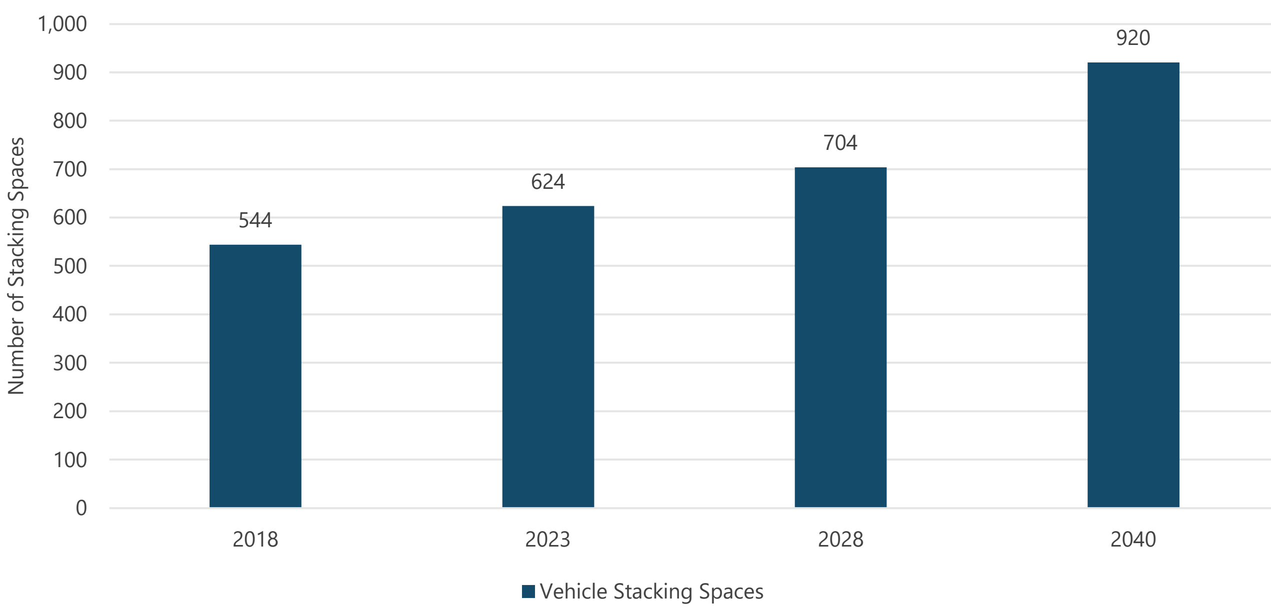
Overflow parking areas are provided for the staging of clean vehicles for peak rental periods and for the return of rented vehicles. The utilization rate used to size the stacking area is based on the number of required fuel nozzles. Returned vehicles are positioned in the stacking areas prior to being serviced at fueling positions. In some cases, clean vehicles can be stored in this area prior to being placed back in the rental areas. It was assumed that each fuel nozzle correlates to eight vehicle stacking spaces per hour. This is based on Ricondo's experience and understanding of similar airport rental car facilities. **Exhibit 4-85** depicts the baseline forecast requirements for vehicle stacking spaces for the current planning year and for each planning horizon. The high scenario vehicle stacking requirements are shown on **Exhibit 4-86**.

EXHIBIT 4-85 VEHICLE STACKING SPACE REQUIREMENTS – BASELINE FORECAST



SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

EXHIBIT 4-86 VEHICLE STACKING SPACE REQUIREMENTS – HIGH SCENARIO



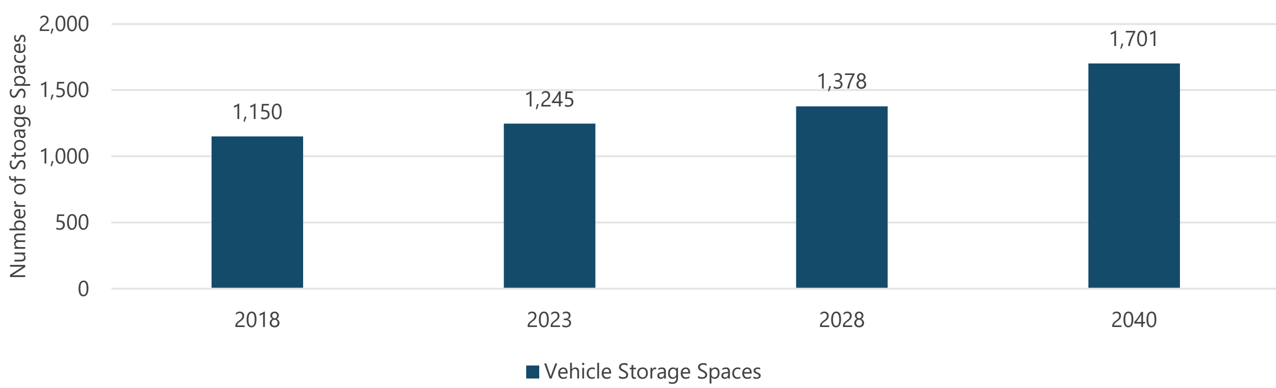
SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

4.9.4.5 VEHICLE STORAGE AREA

Rental car vehicle storage is currently accommodated at various off-site facilities locations near the Airport. Rental car operators at airports similar to MKE have traditionally utilized both on- and off-airport land to accommodate their vehicle storage needs. Vehicle storage requirements are based on the number of spaces needed to store rental vehicles that are not rented or not occupying a rental, return, or a stacking/staging space. It is assumed that rental, return or stacking/staging spaces are not used to store vehicles.

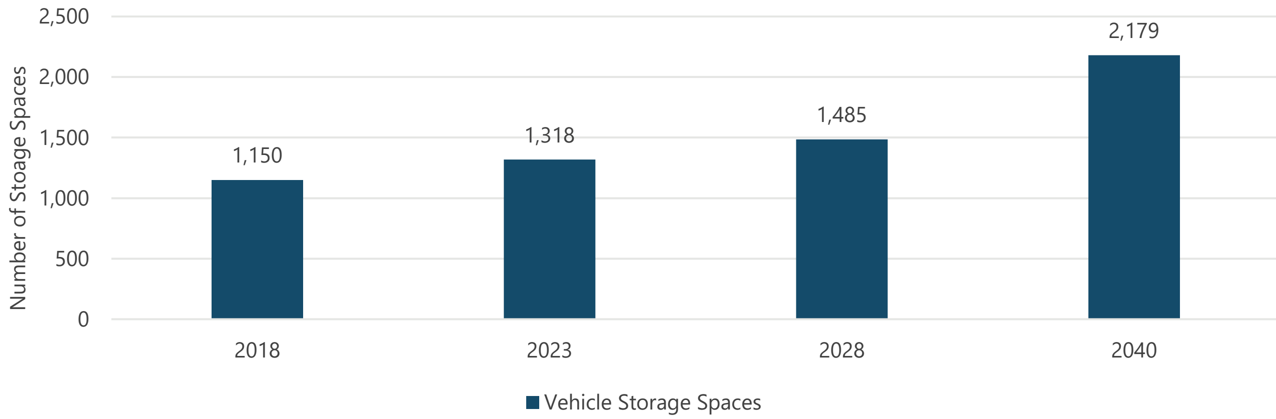
Information necessary to calculate storage requirements (i.e., peak average accumulation during peak seasons) was not provided by the rental car companies. Based on Ricondo's experience with similar airport rental car facilities and operations, an alternative method was used to develop rental car storage requirements. It was assumed that existing vehicle storage adequately accommodates the current activity by MKE rental car operators. The 2018 rental car storage capacity was derived based on a combination of information provided by the completed rental car questionnaire surveys and an aerial image count of the spaces of those companies that did not complete a rental car questionnaire. The vehicle storage requirements for each future planning horizon year are increased at the same percentage growth rate as the O&D passenger forecast. **Exhibit 4-87** depicts the baseline forecast requirements for vehicle storage spaces for 2018 and for each planning horizon. The high scenario requirements are presented on **Exhibit 4-88**.

EXHIBIT 4-87 RENTAL CAR VEHICLE STORAGE REQUIREMENTS – BASELINE FORECAST



SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

EXHIBIT 4-88 RENTAL CAR VEHICLE STORAGE REQUIREMENTS – HIGH SCENARIO

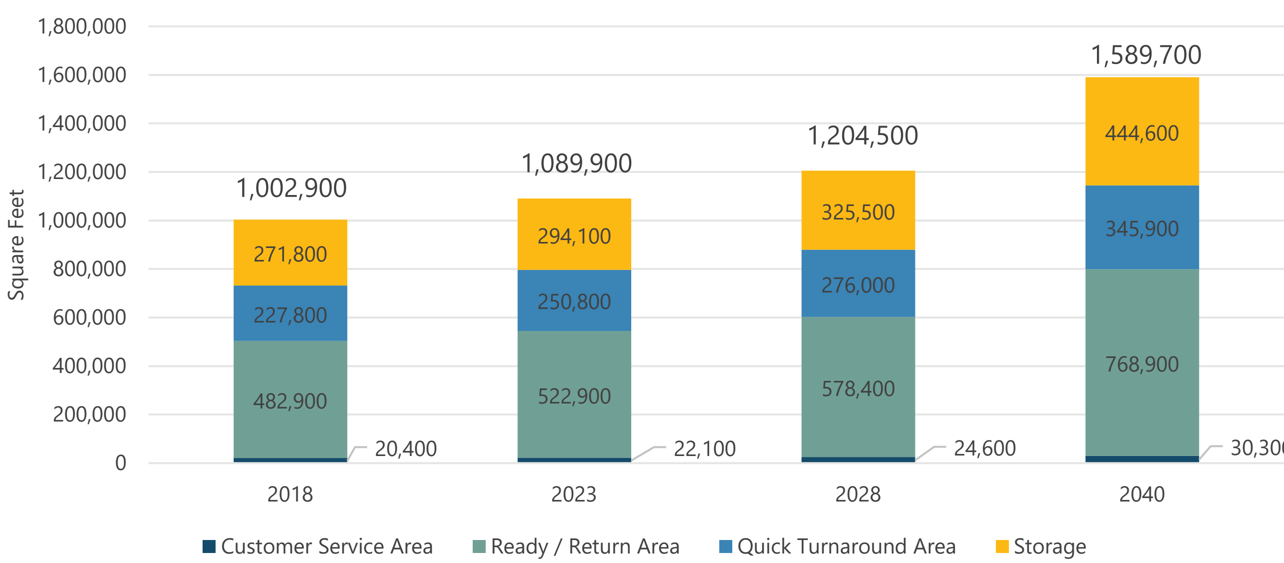


SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

4.9.5 RENTAL CAR FACILITY REQUIREMENTS SUMMARY

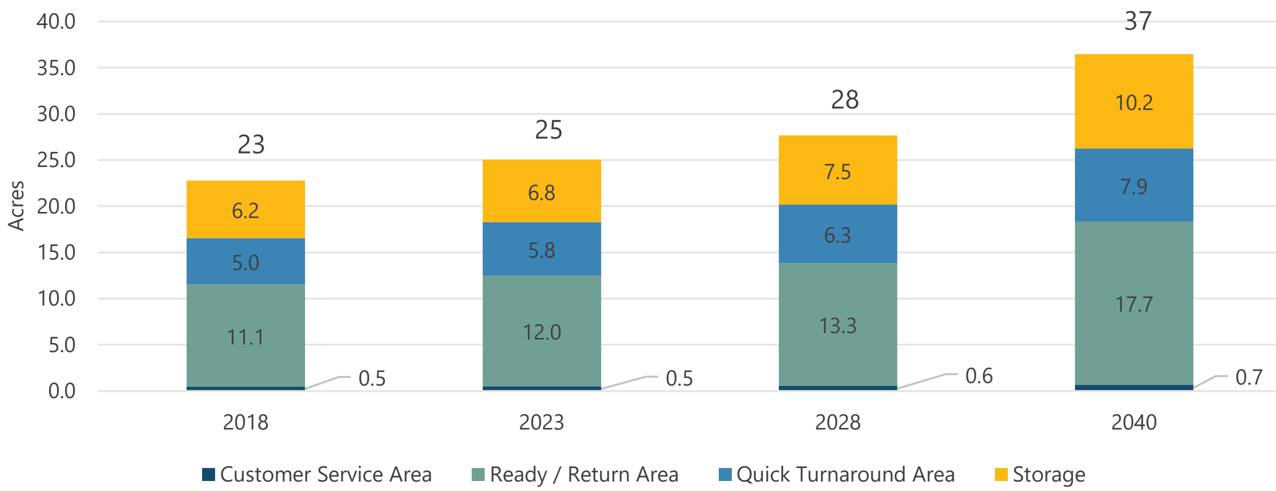
The baseline forecast facility requirements for each of the primary rental car facility components (Customer Service Areas, Rental and Return Areas, Quick Turnaround Areas, and Vehicle Storage) including circulation are presented on **Exhibit 4-89**, **Exhibit 4-90** and in **Table 4-81.** The high scenario facility requirements for the primary rental car facility components are shown on **Exhibit 4-91** and **Exhibit 4-92** and in **Table 4-82**.

EXHIBIT 4-89 RENTAL CAR FACILITY REQUIREMENTS SUMMARY (SQUARE FEET) – BASELINE FORECAST



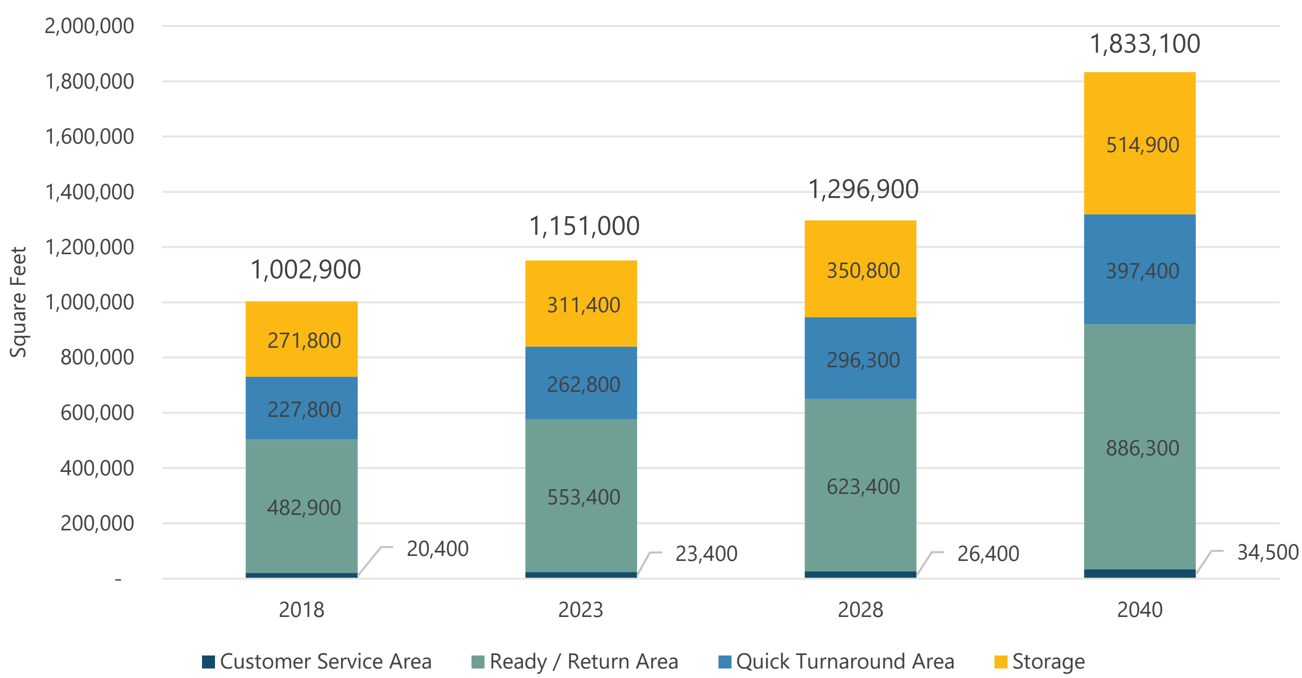
NOTE: No summary is provided for existing (2018) facilities given that information on all existing rental car components is not comprehensively available.
SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

EXHIBIT 4-90 RENTAL CAR FACILITY REQUIREMENTS SUMMARY (ACRES) – BASELINE FORECAST



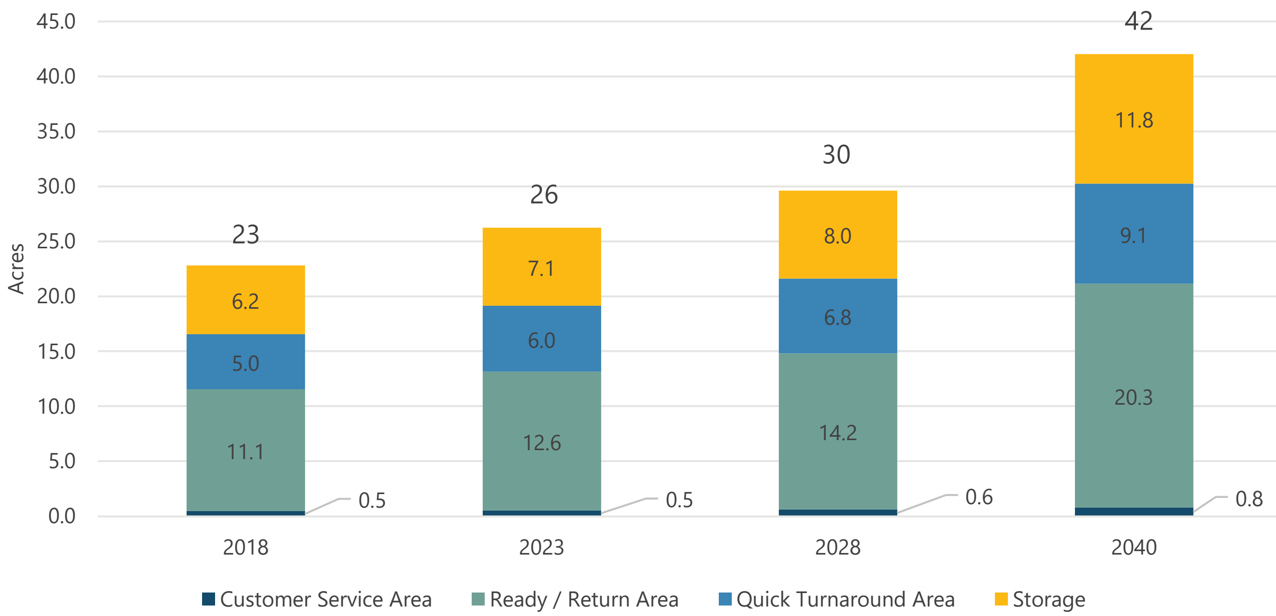
NOTE: No summary is provided for existing (2018) facilities given that information on all existing rental car components is not comprehensively available.
SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

EXHIBIT 4-91 RENTAL CAR FACILITY REQUIREMENTS SUMMARY (SQUARE FEET) – HIGH SCENARIO



NOTE: No summary is provided for existing (2018) facilities given that information on all existing rental car components is not comprehensively available.
SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

EXHIBIT 4-92 RENTAL CAR FACILITY REQUIREMENTS SUMMARY (ACRES) – HIGH SCENARIO



NOTE: No summary is provided for existing (2018) facilities given that information on all existing rental car components is not comprehensively available.
SOURCES: Ricondo & Associates, Inc., MKE Rental Car Industry Questionnaire, September 2018; Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019; Google Earth Pro, 2019.

TABLE 4-81 RENTAL CAR FACILITY REQUIREMENTS SUMMARY – BASELINE FORECAST

COMPONENT	2018			2023			2028			2040		
	QUANTITY	UNIT AREA (SQ FT)	TOTAL AREA (SQ FT)	QUANTITY	AREA (SQ FT)	TOTAL AREA (SQ FT)	QUANTITY	AREA (SQ FT)	TOTAL AREA (SQ FT)	QUANTITY	AREA (SQ FT)	TOTAL AREA (SQ FT)
Customer Service Area												
Regular Customer Service Positions	54	290	15,700	59	290	17,000	65	290	18,900	80	290	23,300
Circulation	30%		4,700	30%		5,100	30%		5,700	30%		7,000
Total Customer Service Area			20,400			22,100			24,600			30,300
Rental/Return Area												
Rental Spaces	626	444	278,000	678	444	301,000	750	444	333,000	926	444	454,900
Return Spaces	513	211	108,300	556	211	117,300	615	211	129,700	759	211	160,200
Circulation	25%		96,600	25%		104,600	25%		115,700	25%		153,800
Total Rental / Return Spaces	1,139		482,900	1,234		522,900	1,365		578,400	1,685		768,900
Vehicle Storage Spaces	1,150	189	217,400	1,245	189	235,300	1,378	189	260,400	1,701	189	355,700
Circulation	25%		54,400	25%		58,800	25%		65,100	25%		88,900
Total Vehicle Storage			271,800			294,100			325,500			444,600
Quick Turnaround Area												
Fueling Positions	68	360	24,600	74	360	26,700	82	360	29,500	101	360	36,400
Wash Bays	12	1,650	19,800	13	1,650	21,500	14	1,650	22,500	17	1,650	30,800
Light Maintenance Bays	17	720	12,200	19	720	13,700	21	720	15,100	26	720	18,700
Stacking Spaces	544	200	108,800	592	200	118,400	656	200	131,200	808	200	161,600
Administrative Area (SF)	8,800		8,800	9,527		9,500	10,541		10,500	14,400		14,400
Employee Parking	32	250	8,000	43	250	10,800	48	250	12,000	59	250	14,800
Circulation	25%		45,600	25%		50,200	25%		55,200	25%		69,200
Total QTA			227,800			250,800			276,000			345,900
Total Area Required	**1,002,900 sq ft (23 acres)**			**1,089,900 sq ft (25 acres)**			**1,204,500 sq ft (28 acres)**			**1,589,700 sq ft (37 acres)**		

SOURCE: Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019.

TABLE 4-82 RENTAL CAR FACILITY REQUIREMENTS SUMMARY – HIGH SCENARIO

COMPONENT	2018			2023			2028			2040		
	QUANTITY	UNIT AREA (SQ FT)	TOTAL AREA (SQ FT)	QUANTITY	AREA (SQ FT)	TOTAL AREA (SQ FT)	QUANTITY	AREA (SQ FT)	TOTAL AREA (SQ FT)	QUANTITY	AREA (SQ FT)	TOTAL AREA (SQ FT)
Customer Service Area												
Regular Customer Service Positions	54	290	15,700	62	290	18,000	70	290	20,300	91	290	26,500
Circulation	30%		4,700	30%		5,400	30%		6,100	30%		8,000
Total Customer Service Area			20,400			23,400			26,400			34,500
Rental/Return Area												
Rental Spaces	626	444	278,000	718	444	318,600	808	444	358,900	1,187	444	526,800
Return Spaces	513	211	108,300	588	211	124,100	663	211	139,800	864	211	182,200
Circulation	25%		96,600	25%		110,700	25%		124,700	25%		177,300
Total Rental / Return Spaces	1,139		482,900	1,306		553,400	1,471		623,400	2,050		886,300
Vehicle Storage Spaces	1,150	189	217,400	1,318	189	249,100	1,485	189	280,600	2,179	189	411,900
Circulation	25%		54,400	25%		62,300	25%		70,200	25%		103,000
Total Vehicle Storage			271,800			311,400			350,800			514,900
Quick Turnaround Area												
Fueling Positions	68	360	24,600	78	360	28,200	88	360	31,800	115	360	41,500
Wash Bays	12	1,650	19,800	13	1,650	21,600	15	1,650	24,300	22	1,650	35,700
Light Maintenance Bays	17	720	12,200	19	720	14,000	22	720	15,800	32	720	23,200
Stacking Spaces	544	200	108,800	624	200	124,800	704	200	140,800	920	200	184,000
Administrative Area (SF)	8,800		8,800	10,100		10,100	11,400		11,400	16,700		16,700
Employee Parking	32	250	8,000	46	250	11,500	52	250	12,900	67	250	16,800
Circulation	25%		43,600	25%		52,600	25%		59,300	25%		79,500
Total QTA			227,800			262,800			296,300			397,400
Total Area Required	**1,002,900 sq ft (23 acres)**			**1,151,000 sq ft (26 acres)**			**1,296,900 sq ft (30 acres)**			**1,833,100 sq ft (42 acres)**		

SOURCE: Ricondo & Associates, Inc., Rental Car Facility Planning Model, March 2019.

4.10 CARGO FACILITIES

This section documents the existing and future air cargo facility requirements based on characteristics for each cargo carrier type. Cargo carriers are defined by three different transport business models: integrated, all-cargo, and passenger (belly cargo). Integrated carriers own and operate the entire door-to-door transportation service (e.g., FedEx and UPS). All-cargo carriers provide only airport-to-airport cargo transportation, and contract with other companies to deliver from the airport to the customer. The belly cargo carrier group comprises passenger airlines that carry cargo in the belly compartment.

Airport cargo planning industry standards were used to analyze the forecast for the annual cargo tonnage and operations to determine facility requirements for cargo operations at MKE. Facility requirements were quantified for each of the four main components that entail a cargo facility, with a range reflecting the base forecast and the high scenario for cargo operations:

- Size of future dedicated air cargo buildings or warehouses
- Future air cargo apron size and ground service equipment (GSE) requirements
- Future air cargo storage and support facilities
- Air cargo vehicular access and circulation

4.10.1 AIR CARGO STANDARDS FOR FACILITY PLANNING

Historically, the conventional industry standard used to plan cargo facilities was one ton of annual cargo moved per square foot of warehouse. However, this calculation did not account for differences in the functions and efficiencies of different cargo carrier types. Since integrated carriers are generally more efficient because of their use of automation and containers, these carriers process cargo at a higher rate than belly cargo carriers. Belly cargo carriers using narrowbody aircraft are not equipped to handle containers or even some pallets, and therefore, cannot process heavier freight. All-cargo carriers can process cargo with more efficient equipment, labor resources, and warehouse space than the individual belly cargo carriers, sometimes contracting out on-airport handling duties to transport cargo away from the passenger terminal.

Planning standards and design guidelines were limited for air cargo facilities, especially with the evolving cargo market and operators, such as Amazon. The Transportation Research Board (TRB) of the National Academy of Sciences sponsored the Airport Cooperative Research Program (ACRP) *Report 143: Guidebook for Air Cargo Facility Planning & Development* (ACRP 143) in an effort to standardize metrics and assist airport planners in this area. ACRP 143 was completed in 2015 and modified in October 2016. The guidebook provides general procedures and standards for the planning and development of airport air cargo buildings, apron areas, and support facilities. The TRB's ACRP 143 addressed several deficiencies in current planning practices for on-airport cargo operations:

- Many air cargo facilities were outdated.
- Many facilities no longer meet demand.
- Facilities lacked technology to accommodate changes to the handling systems and security requirements.

The updated general standards to size cargo facilities are now based on throughput tonnage and total cargo aircraft operations. These standards can also be adjusted to reflect local requirements and conditions, including current and future requirements at MKE.

ACRP 143 assigns ratios of annual tonnage per square foot of space to determine the space requirements of four primary cargo facility areas: the aircraft parking ramp, GSE storage area, processing warehouses, and landside access for the movement and storage of cargo vehicles:

- **Aircraft Parking Ramp**. Dedicated parking areas for cargo aircraft near air cargo warehouses. The parking positions, or hardstands, should be sized and spaced to accommodate peak day demand. Belly cargo transported by passenger aircraft does not require dedicated cargo ramp because air cargo is tugged or trucked to the passenger ramp area, or apron, near the terminal.
- **GSE Storage Area**. Space accommodating equipment used to service aircraft, support operations, and transport cargo between aircraft and the warehouse. Cargo GSE typically includes:
  - unit load devices
  - dolly trailers for towing unit load devices
  - portable air stairs
  - tugs
  - belt loaders
  - “K” loaders for loading cargo onto aircraft
  - forklifts, pallets, and maintenance vehicles

  GSE is typically stored adjacent to cargo warehouses and on the aircraft parking ramp, filling the areas between hardstand positions. The GSE Area must contain sufficient space to allow equipment to maneuver from the aircraft to the warehouse, and to be stored when not in use.
- **Air Cargo Warehouse**. Facility where cargo is handled, screened, processed, sorted, and stored. Typically, one side of the warehouse faces the aircraft parking ramp (airside), and the opposite side (landside) faces truck loading docks. Air cargo warehouses may also contain the cargo operator’s office and administration space, either on the ground level or a mezzanine level within the building.
- **Landside Area**. Includes cargo employee parking areas, loading docks, maneuvering areas, and private vehicle lots for employees and customers. Truck lots may be adjacent to warehouses or in separate designated areas. Movements by truck on the Landside Area include travel on access roadways. Landside facilities should be designed to facilitate uninterrupted truck access and should not interfere with passenger terminal traffic or other aviation activities.

Annual Tonnage Per Area Ratio

Under ACRP 143, existing and future facility space requirements for the four primary cargo areas are based on Annual Tonnage Per Area Ratio (TAR), which equals the total annual tons of freight per square foot of warehouse, apron, or GSE space. The typical TAR ratio ranges from 0.2 to 3.0 tons per square foot at airports across the country. Although a higher TAR could mean a facility is operating at or over capacity, it typically indicates a more efficient cargo facility and layout with an automated sorting system. A lower TAR value typically represents lower efficiency. A facility’s TAR is affected by several factors, including:

- The degree of mechanization and automation
- Warehouse technology

- Building layout
- Distance from airside facilities to the warehouse and landside facilities
- The type(s) of cargo handled (e.g., international, domestic, refrigerated, etc.)
- Packaging type (pallets or containers)

The ACRP 143 TAR varies for each primary cargo area based on the air cargo carrier type. Integrated carriers, all-cargo, and passenger/belly cargo carriers each have different space requirements based on the type of aircraft used, different freight handled, packaging type, and the use of automation technology. **Table 4-83** shows the TAR ratios for annual ton per square footage utilization that ACRP 143 recommends for warehouses, aircraft ramps, and GSE storage area, by carrier type.

TABLE 4-83 ACRP 143 TONNAGE AREA RATIOS (ANNUAL TONS PER SQUARE FOOT)

PRIMARY CARGO AREA		TAR RATIO BY CARGO CARRIER TYPE		
		INTEGRATED	ALL-CARGO	BELLY
Aircraft Ramp	ACRP 143 Recommendation[2]	0.40	0.40	N/A[1]
	Industry Range	0.20 to 0.80	0.20 to 0.80	
GSE Storage Area	ACRP 143 Recommendation[2]	0.57	1.11	0.36
	Industry Range	0.29 to 1.15	0.55 to 2.22	0.18 to 0.71
Warehouse	ACRP 143 Recommendation[2]	0.92	0.81	0.64
	Industry Range	0.46 to 1.84	0.41 to 1.63	0.32 to 1.28

NOTES:
1 Belly cargo aircraft ramp space is not presented since cargo carried on passenger aircraft is typically tugged to the aircraft parked on the passenger terminal ramp.
2 Default ratios based on ACRP 03-24 Research.
SOURCE: ACRP *Report 143: Guidebook for Air Cargo Facility Planning & Development*, Modified October 2016.

ACRP 143 recommends that landside cargo requirements be based on warehouse size. For warehouses under 50,000 square feet, ACRP 143 proposes 1.8 square feet of landside space for every 1.0 square foot of warehouse space. For warehouses over 50,000 square feet, the ratio is 1.7 square feet of landside space per 1.0 square foot of warehouse.

The TARs presented in Table 4-83 will be used as a starting point for planning the cargo facilities at MKE. Space requirements can vary substantially, depending on the individual cargo carriers using facilities and each carrier's specific processing technologies and facility layouts.

Peak Hour Apron Analysis

The ACRP 143 annual tonnage model does not account for the role of flight schedules in apron availability and recommends a second method for determining cargo aircraft apron area: sizing the apron based on the maximum number of aircraft occupying the cargo apron at one time. This method is referred to as "peak hour analysis". ACRP 143 recognizes the peak hour analysis method as a more accurate planning tool but requires the use of a detailed fleet mix and operations schedule and forecast.

The Design Day Flight Schedule (DDFS) was developed as part of the Forecasts and provides detailed aircraft fleet mix for future operations at MKE including cargo aircraft. The design day is the average busy day at MKE. From the

DDFS, the peak hour of cargo operations may be determined. The peak hour for operations is the hour when the most cargo aircraft are simultaneously on the apron during the design day. Specific aircraft models are provided in the DDFS, and hardstand – or aircraft parking space – dimensions may be determined using the DDFS. An aggregate apron requirement may be derived from analyzing the cargo fleet mix during the peak hour of the DDFS. This is referred to as the peak hour apron analysis.

4.10.2 AIR CARGO FACILITY AND FORECAST REVIEW

This section reviews the existing inventory for the on-Airport cargo facilities by carrier type at MKE. This inventory was used to determine the existing TAR values for each cargo area, which were compared to the ACRP 143 recommended TARs to identify existing deficiencies.

4.10.2.1 AIR CARGO FACILITY REVIEW

A review of cargo facility areas helped determine the TAR used for cargo planning at MKE. The review included tenant interviews and research into the four facility areas and had the following objectives:

- Gather qualitative information on facility deficiencies for which cargo planning metrics may not account.
- Quantify the level of cargo operations by carrier type.
- Determine if existing facilities can accommodate future demand as opposed to improving existing or constructing new facilities.
- Determine if improvements to existing facilities could accommodate future demand (through internal facilities, automation, sorting technology improvements, capacity infill, etc.), as opposed to constructing new facilities. However, a cargo operator's perspective on automation or other technological improvements does not represent a commitment to implementation of those improvements.
- Calculate the square footage required for the aircraft parking ramp, GSE storage area, warehouse, and landside areas to compare existing use ratios (TARs) to industry-standard TARs to determine the efficiency of current facilities.

United Parcel Service (UPS)

UPS is an integrated carrier that leases two separate areas in the MKE Air Freight Building (facility number 3-02), totaling 18,300 square feet with 11 tractor bays. UPS staff indicated an immediate need for restroom facilities and office space in addition to a container sorting facility and for additional staffing and equipment to conduct operations. These needs can be attributed to UPS facilities being non-contiguous and located at opposite ends of the MKE Air Freight Building. The lack of office space and bathrooms on one side of the facility forces staff to cross the building for these functions, and also impacts operational efficiency. The UPS national planning team has discussed expanding operations at other regional airports to accommodate future demand in the region, unless facilities at MKE can be improved in the short term, particularly through consolidation and technological improvements.

UPS apron space totals more than 145,000 square feet, including aircraft parking and GSE storage for UPS aircraft and feeder aircraft operated by the all-cargo carrier Freight Runners Express, described in a following subsection. Interviews with UPS staff indicated that aircraft ramp space is at capacity when the daily MD-11 and regional feeders (Beechcraft 99) occupy the apron at the same time. Overflow feeder aircraft may be parked on the deice ramp when not in use, located between the cargo ramp and Taxiway A. UPS indicated the ramp currently has parking capacity for eight feeder aircraft, with a need for 12.

Staff indicated that landside area and access are not an immediate concern but did mention the building's existing design for smaller trucks makes maneuvering tight at times for trucks, especially the larger, 53-foot trailers in use today.

FedEx

FedEx, an integrated carrier, leases 86,400 square feet in the Cargo Carriers Building (facility number 3-01, at Cargo West). FedEx narrowbody and widebody aircraft park on an apron covering over 227,000 square feet, which includes hardstand and GSE storage areas. An additional 183,500 square feet of landside area is used for truck docking and circulation. FedEx aircraft that currently fly into MKE on a regular basis include the Boeing 757F, 767F, 777F, and MD-11F, depending on season and demand.

DHL

DHL is an all-cargo carrier that operates a daily narrowbody 737F from Cincinnati that primarily transports Amazon deliveries in the region. The staff, during interviews, indicated that the growth rate for DHL is strong but not significant enough to increase the daily flights into MKE or up-gauge to a larger aircraft at this time. Staff indicated the existing warehouse accommodations are adequate for the planning horizon. The aircraft ramp, however, is only able to accommodate a 767-200, and not a 767-300; should DHL consider up-gauging aircraft, more ramp space may be needed.

Freight Runners Express

Freight Runners Express is an all-cargo, third-party operator that is contracted to provide feeder service for UPS. Freight Runners Express leases six hangars located on the Northeast Apron that are used for storing aircraft, maintenance and office facilities; however, no cargo operations occur on the Northeast Apron. An interview with Freight Runners Express staff indicated immediate need for office space, plus maintenance and storage hangar space. If routes or tonnage continue to increase, Freight Runners Express will require additional ramp space, hangars, employee parking, and offices. Since no cargo operations occur on the Northeast Apron, these needs are addressed in the General Aviation requirements section.

Freight Runners Express loads and offloads on the UPS apron at Cargo West, and processes cargo through the UPS facilities. Interviews with Freight Runners staff indicated there is an immediate need for additional apron space at Cargo West. Freight Runners does not have dedicated apron space and shares the UPS apron. This apron becomes congested at peak times, at which time Freight Runners Express aircraft may move off this apron and onto the deice apron.

CSA Air

CSA Air is an all-cargo carrier that services the Upper Midwest, and sometimes operates as the subsidiary of Mountain Air Cargo out of MKE. CSA is a feeder cargo carrier for FedEx with a fleet of Cessna 208 Caravans (C208). The CSA Air fleet of C208 aircraft utilize a section of the FedEx apron that is approximately 60,000 square feet with six hardstand positions. All CSA freight is processed through FedEx.

United States Postal Service (USPS)

The USPS sort facility is approximately 28,500 square feet and located on the Corporate Ramp, east of the Cargo West facilities and south of the Passenger Terminal. Mail freight is transported from the belly cargo carriers to Cargo West. There, mail freight is separated from the other belly cargo freight by third-party handlers described in the following section (along with the space requirements), and then moved to the USPS facility for resorting. In 2018, 38 percent of passenger (belly) cargo at MKE (1,111 tons) was USPS mail freight.

Ground Handlers and Freight Forwarders

Presently, four third-party handlers and freight processors occupy space in the Cargo West facilities. These handlers process freight from the all-cargo carriers and passenger airlines that carry belly cargo:

- Quantem is the ground handler for DHL located in the Cargo Carriers building. Quantem's warehouse facility totals 9,900 square feet.
- Jung Express is located in the Cargo Carriers building and occupies 26,900 square feet. Jung Express is a local courier and freight forwarder for UPS and FedEx, typically for expedited and special deliveries. Jung does not have airside access and does not handle cargo from aircraft, but rather picks up and drops off at the landside loading docks.
- Pilot Air Freight is a home delivery service that provides final mile service by ground for the integrated and belly cargo carriers, primarily UPS, FedEx and Southwest. Pilot Air Freight occupies 7,700 square feet of warehouse space in the MKE Air Freight Building. Pilot Air Freight does not have airside access and does not handle any cargo directly from aircraft.
- Majestic handles passenger belly freight and is located in the MKE Air Freight Building. Belly cargo is transported to and from the passenger terminal to the Majestic facility where it is sorted and then either loaded onto delivery trucks or picked up by the customer on site. Belly cargo includes mail that Majestic will handle from the aircraft and separate. Mail freight is then picked up by USPS trucks and moved to the USPS facility for additional sorting.

Other Cargo West Facilities

Other conversations with MKE staff and cargo tenants revealed additional deficiencies to the Cargo West facilities:

- The apron area is congested during peak hours, with overflow aircraft using the deice apron.
- Cargo Carriers Building (3-01) depth is adequate but the landside area (including truck maneuvering space) is restricted.
- Widebody aircraft tail heights may be an airspace issue when parked on the apron.

4.10.2.2 EXISTING AIR CARGO FACILITY TAR

Table 4-84 shows the existing cargo areas based on the data collected throughout the inventory process, including additional or refined information from staff interviews. To accurately inventory the cargo types and the existing cargo areas, several assumptions were made:

- Freight Runners and CSA Air are exclusive third-party feeder services to FedEx and UPS, respectively. Both feeder carriers use the apron of their integrated carrier, which also process and handles the feeder carrier's freight. Therefore, Freight Runners and CSA Air freight totals are classified as integrated cargo carriers for area inventory and planning purposes.
- Third-party handlers process the remaining all-cargo freight, plus all passenger cargo (belly freight) not handled by the USPS. Third-party handlers do not have dedicated apron space.

- Belly cargo areas were evaluated for GSE needs only. Any belly cargo freight that is processed through the third-party facilities (remaining belly cargo freight not processed by USPS), is classified as all-cargo freight. ACRP 143 provides use ratios for third-party processors that are identical to all-cargo facilities.

These assumptions will not change carrier tonnages for existing carriers or forecasts. Rather, this was done to accurately classify existing cargo facilities and calculate existing use ratios for each facility. TAR values for existing facilities at MKE are shown at the bottom of the Table 4-84. The existing TAR ratios will be considered when applying adjusted TAR to future cargo requirements.

TABLE 4-84 EXISTING CARGO AREA TOTALS AND TAR

BLDG	TENANT	CARRIER TYPE	CARRIER	AIRCRAFT PARKING AREA (SQ FT)	GSE AREA (SQ FT)	WAREHOUSE AREA (SQ FT)	LANDSIDE AREA (SQ FT)
Cargo Carriers	FedEx	Integrated	FedEx	123,500	110,500	86,400	127,000
		All-Cargo/Integrated	CSA Air	60,000	n/a		
	Quantem	All-Cargo	DHL	32,000	22,900	6,900	5,300
	Jung Express	Third-Party Handler	Varies	n/a	n/a	26,900	16,000
MKE Air Freight	UPS	Integrated	UPS	49,000	60,500	18,300	23,900
		All Cargo/Integrated	Freight Runners	33,000	n/a		
	Pilot Air	Third-Party Handler	Varies	n/a	n/a	7,700	10,000
	Majestic	Third-Party Handler	Belly Cargo	n/a	5,000	3,500	8,000
			Total Square Feet[2]	**297,500**	**198,900**	**149,700**	**190,200**
Square Feet Per Carrier[2] Type			Integrated: FedEx	183,500	110,500	86,400	127,000
			Integrated: UPS	82,000	60,500	18,300	23,900
			All-Cargo	32,000	22,900	14,600	15,300
			Belly Cargo[1]	n/a[1]	5,000	3,500	8,000
TAR for Existing Cargo Facilities[3]			Integrated: FedEx	**0.28**	**0.46**	**0.59**	**1.5**
			Integrated: UPS	**0.33**	**0.44**	**1.46**	**1.3**
			All-Cargo	**0.14**	**0.20**	**0.32**	**1.0**
			Belly Cargo	**n/a[1]**	**0.58**	**0.31**	**2.3**

NOTES:
1 Belly cargo carrier aircraft ramp space is not presented because cargo from passenger carriers is typically tugged to the aircraft parked at the passenger terminal ramp.
2 All square footage figures are approximate.
3 Existing TAR calculations by Mead & Hunt.
4 GSE - Ground Service Equipment
5 BLDG - Building
SOURCES: Area calculations based on existing GIS mapping, Mead & Hunt, 2019; Milwaukee Mitchell International Airport, 2018 (lease data); Milwaukee Mitchell International Airport (historical cargo carrier tonnage), October 2018.

4.10.2.3 AIR CARGO FORECAST REVIEW

Future requirements and sizing of aircraft parking aprons, GSE, warehouses and landside facilities are determined by future throughput tonnage, as defined in the Aviation Activity Forecasts (Section 3). General assumptions from the Aviation Activity Forecasts regarding future cargo tonnage and operations include the following:

- Integrated cargo carriers will continue to lead the MKE cargo market in tonnage and operations in the near-term.
- Growth by integrated cargo carriers is expected to slow slightly to align more closely with regional economic growth in the longer timeframe (beyond 10 years).
- All-cargo carriers will experience the highest growth rate through the forecast period, as the e-commerce industry expands and drives an increase in the use of dedicated air freight aircraft operations at MKE.

Table 4-85 summarizes the baseline cargo tonnage forecast for the planning period.

TABLE 4-85 AIR CARGO FORECAST BY CARRIER TYPE (BASELINE FORECAST)

CARRIER TYPE	TONNAGE			
	2018	2023	2028	2040
Integrated	73,923	87,880	102,869	143,277
All-Cargo	8,197	17,335	23,349	34,768
Belly Cargo	2,878	3,206	3,523	4,287
Total[1]	**84,998**	**108,420**	**129,740**	**182,332**

NOTE:
1 Totals may not add due to rounding.
SOURCE: Aviation Activity Forecasts, Table 3.4-4, Ricondo & Associates, Inc., January 2019; Ricondo & Associates, Inc., January 2019.

Cargo operations by aircraft type are shown in **Table 4-86**. Most cargo operations are by turboprop aircraft. Turboprop aircraft are used by the all-cargo feeder operators more frequently. Although turboprop aircraft hold less freight, they distribute most of the freight from the integrated carriers to smaller markets. The cargo fleet mix is expected to shift slightly as narrowbody activity grows at a faster rate than the forecast growth in turboprop activity. Growth in narrowbody activity is consistent with the Boeing World Air Cargo Forecast 2016-2017.

TABLE 4-86 AIR FREIGHT OPERATIONS FORECAST BY AIRCRAFT CATEGORY (BASELINE FORECAST)

AIRCRAFT TYPE	OPERATIONS			
	2018	2023	2028	2040
Piston/Turboprop	9,627	11,275	12,870	16,112
Narrowbody	1,270	1,611	1,839	2,302
Widebody	2,580	3,222	3,677	4,603
Total Air Freight Operations	**13,477**	**16,108**	**18,386**	**23,017**

SOURCE: Aviation Activity Forecasts, Table 3.4-7, Ricondo & Associates, Inc., January 2019.

The DDFS was developed for peak hour operations and enplanements for this Master Plan. The DDFS is referenced throughout Section 4.10, Cargo Facilities, and used to determine peak hour of cargo operations and the cargo fleet mix. The peak hour operations are used to provide the size requirements for the cargo aprons. The fleet mix is used to determine the design aircraft that controls setback and parking hardstand dimensions.

4.10.3 CARGO FACILITY PLANNING: BASELINE FORECAST

Baseline air cargo Base facility requirements were developed using the baseline forecast for annual tonnage and applying tonnage area ratios to determine the required space for the four functional cargo areas. The standard ACRP 143 TARs were used as a guide, and the TAR ratios were compared to the existing ratios in **Table 4-87**.

TABLE 4-87 RATIOS USED FOR CARGO FACILITY REQUIREMENTS

PRIMARY CARGO AREA		CARGO CARRIER TYPE			
		INTEGRATED: FEDEX	INTEGRATED: UPS	ALL-CARGO	BELLY CARGO
Aircraft Ramp[1]	ACRP 143 Recommendation	0.40	0.40	0.40	N/A[2]
	Existing MKE Ratio	0.28	0.33	0.14	
GSE Storage Area	ACRP 143 Recommendation	0.57	0.57	1.11	0.36
	Existing MKE Ratio	0.46	0.44	0.20	0.58
Warehouse	ACRP 143 Recommendation	0.92	0.92	0.81	0.64
	Existing MKE Ratio	0.59	1.46	0.32	0.31
Landside[3]	ACRP 143 Recommendation[3]	1.7	1.7	1.8	1.8
	Existing MKE Ratio	1.5	1.3	1.0	2.3

NOTES:
1 The ACRP 143 annual tonnage model does not account for the role of flight schedules in apron availability. ACRP 143 acknowledges that apron planning is typically more accurate if the aircraft fleet mix is known at the peak hour operations. See Section 4.10.3.1, Peak Hour Air Analysis of Cargo Aircraft Apron, for greater detail about apron requirements based on the DDFS and specific sizing requirements for parked aircraft during the peak hour.
2 Belly cargo carrier aircraft ramp space is not presented since cargo for passenger carriers is typically tugged to the aircraft parked at the passenger terminal ramp.
3 For warehouses less than 50,000 square feet, the ACRP 143 guidelines propose 1.8 square feet of landside space to 1.0 square foot of warehouse. For warehouses over 50,000 square feet the ratio is 1.7 square feet of landside space to 1.0 square foot of warehouse.
SOURCE: ACRP *Report 143: Guidebook for Air Cargo Facility Planning & Development*, Modified October 2016.

Interviews with cargo operators, tenants, and MKE staff provided additional insight into challenges and needs for cargo operators. The TAR for each cargo facility requirement was reviewed and adjusted where appropriate. Adjustments were based on qualitative information from cargo operators and tenants impacted during peak operational periods, MKE staff, observations of existing layouts, and the actual TAR for cargo facilities.

Table 4-87 shows considerable gaps between the ACRP 143 standard ratios and the existing ratios at MKE. This suggests the cargo areas are either being underutilized with low efficiencies, or these facilities are over capacity. The UPS warehouse TAR is greater than the recommended TAR, indicating the warehouse facility is over capacity. This result was supported by interview responses from UPS representatives that indicate existing warehouse facilities at over capacity.

The TAR for the All-Cargo carriers' ramp facilities is also below the ACRP recommended TAR. This variance was also confirmed by interview responses from carriers. Freight Runners Express and UPS who work in conjunction with each other do not have enough ramp space at peak times. For the UPS warehouse, landside, and all-carrier apron needs, the recommendations will highlight immediate requirements.

In the case of FedEx, the gap between the ACRP 143 standard ratios and the existing ratios indicate the facility may be underutilized.

Graduated TAR

For cargo area requirements, the TAR for each carrier and facility type is graduated from existing facility ratios to ACRP 143 standard ratios over the planning period. This methodology assumes that carriers will not invest in measures for technology improvements overnight, but rather improve existing facilities over time during the planning period.

ACRP 143 standard ratios assume a level of technology implementations and layout efficiencies. Using a graduated TAR from the 2018 TAR to the ACRP TAR in 2040 shows the implementation of technology and efficiencies over the planning period for the existing facilities.

For example, applying the ACRP 143 standard TAR to FedEx facilities in the near term assumes that technology will be implemented soon. This results in a near- and mid-term facility surplus for FedEx. This assumption of an investment in technology by a carrier may be an overreaching assumption in the near-term. Therefore, a TAR that matches existing use ratio is applied to short-term requirements, with the TAR shifting to the ACRP-recommended TAR for long-term requirements.

For new cargo facilities, such as those proposed in the high scenario, it is assumed these will be constructed to meet the ACRP 143 recommended TARs. This includes any expansion outside of the existing Cargo West area and is applied to the new cargo operators.

4.10.3.1 PEAK HOUR AIR ANALYSIS OF CARGO AIRCRAFT APRON

As discussed in Standards for Facility Planning above, the ACRP 143 annual tonnage model does not account for the role of flight schedules in apron availability. Instead, the peak hour analysis is used to find requirements for cargo apron area. This analysis derives the square footage required for aircraft parking position dimensions based on wingspan and length dimensions for aircraft on the apron during peak hour. As a result, use of the peak hour analysis requirements will be more accurate than the TAR method. Additionally, interviews with tenants indicate that immediate need for additional cargo apron. Peak hour analysis should validate this requirement.

Cargo aircraft typically operate in the early morning hours, between 4:00 a.m. and 7:00 a.m., and in the evening after 6:00 p.m. Because multiple aircraft are parked and loaded simultaneously, considerable apron space is required. **Table 4-88** shows peak hour activity and hardstand requirements for integrated and all-cargo carriers. The ACRP 143 TAR aircraft parking ramp requirements provided are for comparison. Table 4-88 also summarizes the cargo apron requirements for 2023, 2028, and 2040. The ACRP 143 TAR requirements for apron area are also included for comparison to the peak hour analysis requirements. The ACRP Study recommends using the peak hour analysis to determine the apron requirements, when available.

TABLE 4-88 PEAK HOUR CARGO AIRCRAFT APRON ANALYSIS AND REQUIREMENTS

CARRIER TYPE	PEAK HOUR[1]	AIRCRAFT TYPE[1]	DESIGN CODE[2]	HARDSTAND REQUIREMENTS (SQ FT)[3]	PEAK HOUR AIRCRAFT[1] / SPACE REQUIREMENTS					
					2023		2028		2040	
					PEAK HOUR AIRCRAFT	SPACE REQ. (SQ FT)	PEAK HOUR AIRCRAFT	SPACE REQ. (SQ FT)	PEAK HOUR AIRCRAFT	SPACE REQ. (SQ FT)
Integrated	06:45-07:45 a.m.	B734	C-III	36,100	2	72,200	2	72,200	2	72,200
		B752, A306, B76F	C-IV	51,700	3	155,100	4	206,800	5	258,500
		B77F	C-V	72,000	0	-	0	-	1	72,000
		MD-11	D-IV	58,700	1	58,700	1	58,700	1	58,700
		Total Integrated Apron Requirements:			286,000		337,700		461,400	
		ACRP 143 TAR Apron Requirements[4]:			219,700		257,200		358,200	
All-Cargo	04:30-05:30 p.m.	C208	A-II	5,100	9	45,900	10	51,000	12	61,200
		BE99, E120	B-II	10,100	4	40,400	5	50,500	7	70,700
		Total All-Cargo Apron Requirements:			86,300		101,500		131,900	
		ACRP 143 TAR Apron Requirements[4]:			43,300		58,400		86,900	

NOTES:

1 Peak hour activity and aircraft fleet mix based on DDFS (Ricondo & Associates, Inc., January 2019). Aircraft codes:

- B734: Boeing B737-400
- B752: Boeing B757-200
- A306: Airbus A300-600
- B76F: Boeing 767-300 Freighter
- B77F: Boeing B777 Freighter
- MD-11: McDonnell Douglas MD-11
- C208: Cessna 208 Caravan-1
- BE99: Beechcraft BCH C99
- E120: Embraer EMB 120

2 Design Code: A code signifying the design standards to which an airport area is built based on aircraft characteristics: Airplane Design Group (ADG), a classification of aircraft based on wingspan and tail height, and Aircraft Approach Category (AAC), a grouping of aircraft based on a reference landing (approach) speed.

3 Hardstand dimensions based on aircraft models and design groups as provided in the ACRP 143 Planning Model.

4 ACRP 143 TAR requirements for apron included for comparison to peak hour analysis requirements.

SOURCE: ACRP *Report 143: Guidebook for Air Cargo Facility Planning & Development*, Modified October 2016; Mead & Hunt, 2019.

Apron requirements above considered remain-overnight (RON) positions, which accommodate aircraft that position in the evening and depart in the morning. The RON requirements for all-cargo aircraft match the peak hour, and no integrated aircraft are anticipated for RON in the forecasted DDFS.

4.10.3.2 AIR CARGO FACILITY REQUIREMENTS: BASE SCENARIO

Base scenario facility requirements for the four functional cargo areas are shown in **Table 4-89**. Future area requirements are derived from the future annual tonnages in Table 4-85 and applied to the TAR used for MKE as described in Table 4-87. The exception is the cargo apron requirements, which are derived from the peak hour apron analysis described above.

TABLE 4-89 CARGO FACILITY REQUIREMENTS: BASELINE FORECAST

CARGO FACILITY AREA	CARRIER TYPE	TAR[1]	EXISTING AREA (SQ FT)	FACILITY REQUIREMENTS (SQ FT)			
			2018	2018[4]	2023	2028	2040
Aircraft Ramp[2]	Integrated FedEx	Peak Hour[2]	183,500	166,700	190,700	225,200	307,700
	Integrated UPS	Peak Hour[2]	82,000	83,200	95,300	112,500	153,700
	All-Cargo	Peak Hour[2]	32,000	67,000	86,300	101,500	131,900
		Total	**297,500**	**316,900**	**372,300**	**439,200**	**593,300**
GSE Storage Area	Integrated FedEx	0.46 - 0.57	110,500	110,500	134,500	141,800	179,200
	Integrated UPS	0.44 - 0.57	60,500	60,500	76,200	79,300	98,900
	All-Cargo	0.20 - 0.42	22,900	22,900	23,200	31,200	46,500
	Belly Cargo	0.58	5,000	5,000	5,600	6,100	7,400
		Total	**198,900**	**198,900**	**239,500**	**258,400**	**332,000**
Warehouse	Integrated FedEx	0.59 – 0.92	86,400	86,400	105,200	108,200	111,100
	Integrated UPS	0.92	18,300	32,300	36,500	43,500	61,200
	All-Cargo	0.32 – 0.81	14,600	14,600	17,300	23,300	24,100
	Belly Cargo	0.64	3,500	4,500	5,000	5,500	6,700
		Total	**122,800**	**137,800**	**164,000**	**180,500**	**203,100**
Landside[3]	Integrated FedEx[3]	1.5 - 1.7	127,000	127,000	178,800	183,900	188,900
	Integrated UPS[3]	1.3 – 1.7	23,900	54,900	62,100	74,000	104,000
	All-Cargo[3]	1.4 - 1.8	15,300	20,800	31,100	33,200	43,400
	Belly Cargo[3]	1.8	8,000	8,100	9,000	9,900	12,100
		Total	**174,200**	**210,800**	**281,000**	**301,000**	**348,400**

NOTES:

1 TAR = Annual ton per area ratio. TAR for each facility based on existing facility ratios and this is graduated to standard ratios from ACRP 143 over the planning period to show the implementation of technology and efficiencies over time, where applicable.

2 Peak hour analysis used for apron requirements rather than TAR. Peak hour analysis uses aircraft using the cargo apron at the peak hour of the Design Day Flight Schedule (DDFS). See Section 4.10.3., Peak Hour Air Analysis of Cargo Aircraft Apron, 1 for more information.

3 For warehouses less than 50,000 square feet, the ACRP 143 guidelines propose 1.8 square feet of landside space to 1.0 square foot of warehouse. For warehouses over 50,000 square feet the ratio is 1.7 square feet of landside space to 1.0 square foot of warehouse.

4 Requirements for cargo facilities based on 2018 operations are shown in the 2018 column under requirements.

SOURCE: ACRP *Report 143: Guidebook for Air Cargo Facility Planning & Development*, Modified October 2016; Mead & Hunt, 2019.

Cargo area requirements are directly related to forecasts of annual tonnage. Assuming these forecasts are achieved, the requirements in the Table 4-89 show the following deficiencies for future requirements.

- **UPS warehouse and landside space**: Conversations with tenant staff indicate an immediate need for warehouse and landside area to accommodate circulation and longer trucks. This includes space to process Freight Runners Express cargo as well.
- **Aircraft Ramp**: Another immediate need is additional apron space for the Freight Runners Express/UPS operations. Current apron space allows for one MD-11 aircraft (or A300) and six feeder Beech 99 aircraft, or two MD-11/A300 and no feeder aircraft. If UPS or Freight Runners need to accommodate more operations, these

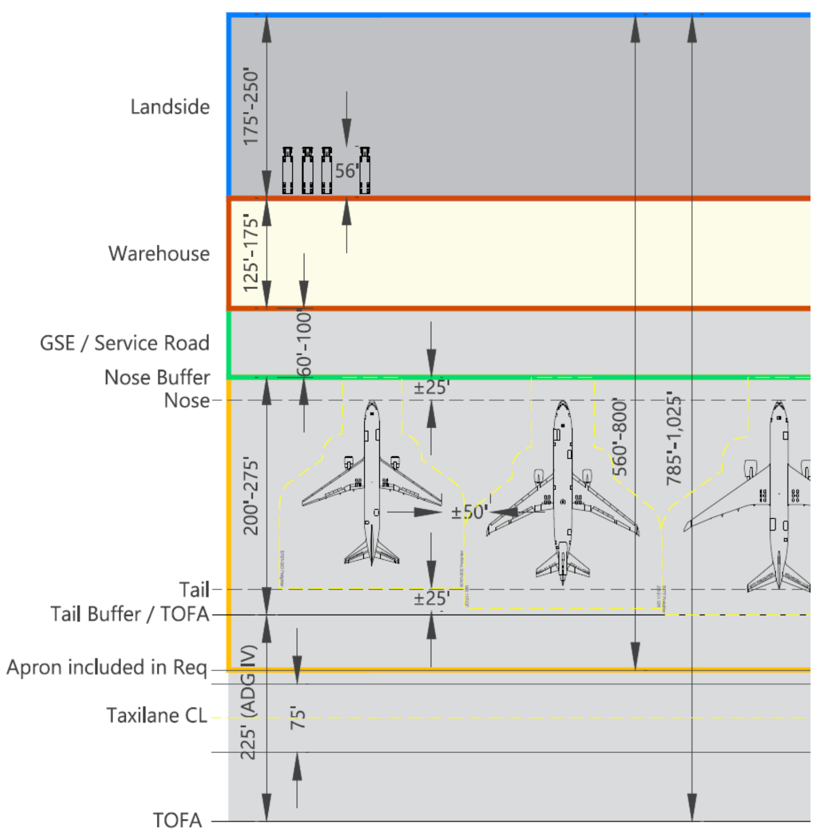
aircraft may park on the deice apron or another area on the West Cargo apron to load/unload freight. This situation occurs during peak operations.

- **GSE Storage Area:** There is adequate area for immediate requirements. Cargo tenants did not indicate that additional GSE space is needed. However, in 2023, GSE requirements will be greater than existing facilities, creating a need for more space.
- **Warehouse:** Requirements show need in the near and midterm (2028) for additional warehouse space, especially for UPS and all-cargo facilities. These are addressed in the tenant recap above and recommendations provided at the end of Section 4.10.5, Cargo Facility Recommendations: Baseline Forecast. However, FedEx warehouse facilities are adequate for the near-term.
- **Landside:** Requirements for landside show immediate need for expanding landside facilities for UPS and all-cargo facilities. While FedEx landside facilities are adequate for the near-term, they will require expansion in 2023.

4.10.4 ANCILLARY CARGO FACILITY REQUIREMENTS

This section describes the methodology used to determine future requirements for cargo areas not planned with the TAR, including cargo area setbacks, taxiways, building heights, and truck maneuvering/access areas. **Exhibit 4-93** shows a conceptual layout for cargo facility areas with recommended dimensions and setbacks.

EXHIBIT 4-93 CONCEPTUAL CARGO FACILITY LAYOUT



SOURCE: Mead & Hunt, Inc., 2019.

4.10.4.1 AIR CARGO PLANNING AIRCRAFT

The FAA Advisory Circular 150/5300-13A, *Airport Design* defines design aircraft (also referred to as cargo planning aircraft) as, "An aircraft with characteristics that determine the application of airport design standards for a specific runway, taxiway, taxilane, apron, or other facility. This aircraft can be a specific aircraft model or a composite of several aircraft using, expected, or intended to use the airport or part of the airport." Therefore, aircraft that regularly operate for cargo carriers at MKE are considered the planning aircraft. **Table 4-90** shows the dimensional specifications of the cargo planning aircraft for both integrated and all-cargo operations that are currently using MKE and are expected to remain the cargo planning aircraft throughout the planning period. Identifying the cargo planning aircraft helps define details for cargo apron planning by determining taxiway and taxilane setbacks for circulation areas as well as pavement design strength. The cargo planning aircraft designations were based on future DDFSs formulated for this Master Plan update.

TABLE 4-90 AIR CARGO PLANNING AIRCRAFT

CARRIER TYPE	AIRCRAFT MODEL[1]	AIRPLANE DESIGN GROUP[2]	WINGSPAN (FEET)	TAIL HEIGHT (FEET)	LENGTH (FEET)	MAXIMUM TAKEOFF WEIGHT (POUNDS)	TDG[3]	TAXILANE OFA[4] (FEET)
Integrated	Boeing 767F	C-IV	156.1	52.9	180.3	412,000	5	225
	MD-11	D-IV	170.5	58.8	202.2	602,500	6	225
	Boeing 777F[5]	C-V	212.6	62.3	209.1	766,800	5	276
All-Cargo	Embraer E120	B-II	64.9	21.4	65.7	26,433	3	115

NOTES:

1 The aircraft models shown are those identified in the Aviation Activity Forecasts Section. The provided dimensions are for freighter models listed above. Aircraft dimensions (wingspan, length, tail height, Maximum Takeoff Weight [MTOW]) may vary based on model types and configurations.
- B76F: Boeing 767-300 Freighter
- MD-11: McDonnell Douglas MD-11
- B77F: Boeing B777 Freighter
- E120: Embraer EMB 120

2 Airplane Design Group: a classification of aircraft based on wingspan and tail height.

3 TDG: Taxiway Design Group. This is based on wheelbase dimensions and used to determine appropriate taxiway/taxilane dimensions and fillets.

4 Taxiway OFA: Taxiway Object Free Area. This is determined by the cargo planning aircraft wingspan, centered on the taxiway centerline, that needs to clear fixed or moveable objects to maneuver. Dimensions provided for taxilane operations.

5 The Boeing 777F is expected to be introduced at MKE after 2023.

SOURCES: Aviation Activity Forecasts, (Ricondo & Associates, Inc., January 2019); FAA Aircraft Characteristics Database, accessed March 21, 2019.

The cargo planning aircraft and DDFS for peak hour operations should be considered prior to apron and taxiway design. For design of a specific carrier's facility (e.g., UPS), the fleet mix for that specific carrier should be considered in addition to the all-cargo, feeder aircraft (e.g., Freight Runners) mix.

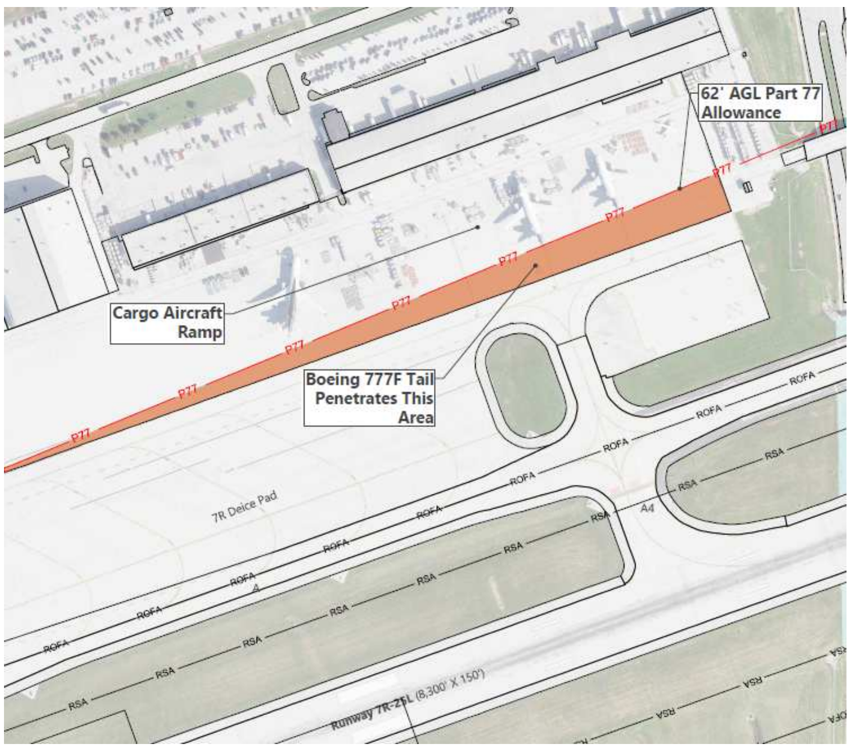
Cargo Aircraft Apron

Current hardstand positions provide approximately 100 feet between the aircraft nose position and the warehouse, with a service road located between. The ACRP 143 recommended a minimum nose-to-structure distance of 55 feet for ADG III through ADG VI aircraft without a nose door. For aircraft equipped with a nose door, the recommended setback is at least 80 feet from structures, although these aircraft types are not in the projected future cargo fleet mix.

The recommended hardstand dimensions (used for total aircraft ramp requirements) include buffer areas for the nose, wings, tail, and room for cargo equipment to maneuver and load/unload freight. The recommended depth of the aircraft ramp, to allow for proper setbacks, freight processing, and aircraft maneuvering is 200 to 275 feet from the front of the aircraft nose position (including the buffer) to the tail buffer, depending on aircraft model.

Analysis shows the largest future cargo aircraft (Boeing 777F, tail height 61 feet above ground level) parked on a section of the FedEx aircraft apron may penetrate Part 77 airspace. This is shown in **Exhibit 4-94** with the existing aircraft and the Part 77 allowable heights. The preliminary analysis shows the tail for the Boeing 777F is close to penetrating the Part 77 transitional surface or may clear it depending on the parking configuration. It is recommended an Obstruction Evaluation/Airport Airspace Analysis be submitted to determine if this tail height is acceptable in this location as that aircraft is anticipated to serve the Airport.

EXHIBIT 4-94 RUNWAY 7R-25L PART 77 TRANSITIONAL SURFACE INFLUENCE



SOURCE: Mead & Hunt, Inc., 2019.

Taxiway/Taxilane Design

The existing pushback area also doubles as the taxilane object free area (OFA), which is the required setback from the taxilane centerline to objects (parked aircraft) for wingtip clearance. The space for aircraft pushback operations from the hardstand to the cargo apron taxilane is included in the aircraft ramp requirements in Table 4-89.

The aircraft ramp requirements do not include the total required circulation area for the cargo taxilane and OFA opposite cargo operations. This OFA dimension for Airplane Design Group IV is 225 feet. Of this, 75 feet is accounted for in the aircraft apron requirements. The additional 150 feet accounts for the taxilane and shoulders plus the 75 feet of OFA opposite the cargo hardstands. A ratio of 0.7 circulation area to 1 aircraft ramp area may be applied to account for circulation area, based on existing conditions. However, this ratio may vary depending on the ultimate cargo facilities layout. A linear facility may not require as much circulation area with a single taxilane. In contrast a double-loaded cargo facility that flanks a central taxilane system is typically designed with dual parallel taxilanes, requiring more circulation area.

Circulation space for cargo aircraft is typically located between the apron and runway. Since setback requirements for tail heights require a considerable separation between cargo facilities and the runway, there is typically adequate area for dual taxilanes or taxilanes in an area that would likely not be occupied by buildings. However, in the case of MKE, this area between the cargo aircraft ramp and the runway is occupied by the deice apron.

The taxilane for the existing cargo apron does not provide proper taxilane OFA clearance to aircraft on the deice apron. When the deice pad is in use, congestion occurs on the cargo ramp taxilanes. Provision of sufficient dimensional clearance and mitigation of congestion in the vicinity of the cargo apron and the deice facility is desirable.

4.10.4.2 SPECIFIC WAREHOUSE REQUIREMENTS

Additional cargo warehouse considerations include the prescribed height, length, width, and setback from parked aircraft. Based on ACRP 143 guidelines, the warehouses should be designed to be 125 to 175 feet deep, with a height that does not penetrate critical airspace surfaces. The typical design height of a warehouse is 20 to 30 feet, and warehouses with vertical storage systems can be up to 40 feet above ground elevation. These warehouse heights are acceptable at the current location and would be clear of Part 77 airspace restrictions.

Generally, each carrier designs and configures their internal warehouse systems. By collaborating with tenants during the planning and design process, MKE will ensure sufficient flexibility and efficiency is built into facilities. This will lead to more effective freight movements and potentially reduce cargo facility footprints.

4.10.4.3 LANDSIDE AND ACCESS REQUIREMENTS

As with most older designs for truck docking, trucks with trailers 53 feet long that use the UPS facility at MKE have difficulty maneuvering and parking to access the dock. Landside facilities should be redesigned to deliver adequate space to improve truck circulation and docking. This need is reflected in immediate landside area requirements for landside facilities.

Cargo operations also require employee parking, which is included in the overall landside requirement. However, this should be separated from trucking operations and loading docks, but within walking distance to the warehouse.

4.10.5 CARGO FACILITY RECOMMENDATIONS: BASELINE FORECAST

Table 4-91 shows the recommended area requirements for the four major cargo facilities at MKE throughout the planning period. This includes the differences from existing facilities.

TABLE 4-91 BASELINE FORECAST CARGO FACILITY REQUIREMENTS

CARGO FACILITY AREA	CARRIER TYPE	EXISTING AREA	IMMEDIATE DEMAND (SQ FT)	FACILITY SPACE REQUIREMENTS (SQ FT)			DIFFERENCE FROM 2018 (SQ FT)		
				2023	2028	2040	2023[4]	2028[4]	2040[4]
Aircraft Ramp[1]	Integrated FedEx[1]	183,500	N/A	190,700	225,200	307,700	(7,200)	(41,700)	(124,200)
	Integrated UPS[1]	82,000	N/A[3]	95,300	112,500	153,700	(13,300)	(30,500)	(71,700)
	All-Cargo[1]	32,000	35,000 [3]	86,300	101,500	131,900	(54,300)	(69,500)	(99,900)
	Total	**297,500**	**35,000**	**372,300**	**439,200**	**593,300**	**(74,800)**	**(141,700)**	**(295,800)**
GSE	Integrated FedEx	110,500	N/A	134,500	141,800	179,200	(24,000)	(31,300)	(68,700)
	Integrated UPS	60,500	N/A	76,200	79,300	98,900	(15,700)	(18,800)	(38,400)
	All-Cargo	22,900	N/A	23,200	31,200	46,500	(300)	(8,300)	(23,600)
	Belly Cargo	5,000	N/A	5,600	6,100	7,400	(600)	(1,100)	(2,400)
	Total	**198,900**	**0**	**239,500**	**258,400**	**332,000**	**(40,600)**	**(59,500)**	**(133,100)**
Ware-house	Integrated FedEx	86,400	N/A	105,200	108,200	111,100	(18,800)	(21,800)	(24,700)
	Integrated UPS	18,300	14,000	36,500	43,500	61,200	(18,200)	(25,200)	(42,900)
	All-Cargo	14,600	N/A	17,300	23,300	24,100	(2,700)	(8,700)	(9,500)
	Belly Cargo	3,500	1,000	5,000	5,500	6,700	(1,500)	(2,000)	(3,200)
	Total	**122,800**	**15,000**	**164,000**	**180,500**	**203,100**	**(41,200)**	**(57,700)**	**(80,300)**
Landside[2]	Integrated FedEx[2]	127,000	N/A	178,800	183,900	188,900	(51,800)	(56,900)	(61,900)
	Integrated UPS[2]	23,900	31,000	62,100	74,000	104,000	(38,200)	(50,100)	(80,100)
	All-Cargo[2]	15,300	5,500	31,100	33,200	43,400	(15,800)	(17,900)	(28,100)
	Belly Cargo[2]	8,000	100	9,000	9,900	12,100	(1,000)	(1,900)	(4,100)
	Total	**174,200**	**36,600**	**281,000**	**301,000**	**348,400**	**(106,800)**	**(126,800)**	**(174,200)**

NOTES:
1 Peak hour analysis used for apron requirements rather than TAR. Peak hour analysis uses aircraft that conduct operations on the cargo apron at the peak hour of the Design Day Flight Schedule (DDFS). See Section 4.10.3.1, Peak Hour Air Analysis of Cargo Aircraft Apron, for more information.
2 For warehouses less than 50,000 square feet, the ACRP 143 guidelines propose 1.8 square feet of landside space to 1.0 square foot of warehouse. For warehouses over 50,000 square feet the ratio is 1.7 square feet of landside space to 1.0 square foot of warehouse.
3 Immediate demand for UPS and All-Cargo apron area reflects need for dedicated area for Freight Runners aircraft (which feeds UPS). Dedicating this area will provide area for a second hardstand position for UPS on the existing apron.
4 (X,XXX) indicates space deficiency at the forecast horizon.
SOURCE: Mead & Hunt, 2019.

4.10.5.1 SPECIFIC CARGO FACILITY RECOMMENDATIONS: BASE SCENARIO

Cargo area base requirements are directly related to forecasts developed for annual tonnage. Assuming the growth in activity aligns with the baseline forecast, the area requirements in Table 4-91 show deficiencies in some areas and surpluses for future requirements. Other requirements based on tenant interviews, setback analysis, and operational flows include:

Aircraft Ramp

- Increase cargo apron ramp space. There is an immediate need for apron space for integrated and all-cargo carriers. The deficiency will increase for near-term (2023) requirements and into the future. This deficiency in apron space was confirmed through interviews with cargo operators.

- Submit an Obstruction Evaluation/Airport Airspace Analysis for the easternmost hardstand position on the FedEx apron to determine if tail height is acceptable in this location. Consider relocating hardstand positions closer to the warehouses and farther from Runway 7R-25L, which would increase separation between parked aircraft and the runway, supporting compliance with Part 77 clearance. This may require relocation of the service road and GSE storage areas.
- Consider opportunities for conversion of the deice pad to a cargo ramp.

GSE Storage Areas

- Prepare GSE storage space for mid-term (2028) cargo development. Short-term (2023) requirements for GSE storage can be met by the designated GSE space in existing facilities. Cargo tenants gave no specific indication of GSE area deficiencies.
- Design GSE storage areas to be located between the aircraft ramp and warehouses, and in between hardstand locations. However, GSE should not limit or interfere with operations on the aircraft ramp.

Warehouses

- Increase warehouse space for UPS and all-cargo carriers. Requirements show need in the near (2023) and mid-term (2028) for additional warehouse space, especially for UPS and all-cargo facilities. FedEx warehouse facilities are adequate for the near-term.
- Consider alternative areas for UPS warehouse facilities consolidation with potential for long-term expansion.
- Consolidate cargo facilities (at Cargo West or another location) to seize the opportunity to maximize the operational efficiency of a cargo complex and configure landside and access facilities for greater efficiency. If the Airport pursues consolidation, investigate relocating non-cargo tenants from the two cargo warehouses and the hangars (facility numbers 3-06 and 3-07) and using this additional space to meet future cargo demand.
- Consider resizing and relocating existing warehouses to increase cargo ramp area and improve circulation for aircraft and service vehicles.

Landside

- Increase area for UPS and all-cargo facilities. Requirements for landside show an immediate need for expanding landside facilities. FedEx landside facilities are adequate for the near-term and will require expansion in 2023. Conversations with UPS identified a need for improved internal circulation and expansion of landside facilities to accommodate larger trucks.
- Redesign the landside facilities to improve truck circulation and docking. The UPS landside/loading dock area is constrained for 53-foot trailers. Relocation or modification of the SuperSaver lot north of Cargo West may provide an opportunity to expand the truck maneuvering and docking area.
- Analyze alternatives to address this scenario should focus on the goal of a consolidated cargo facility that meets the long-term goals listed above. If warehouses are realigned to the north, this would affect landside facilities, West Air Cargo Way, and the SuperSaver Lot.

4.10.6 CARGO FACILITY PLANNING: HIGH SCENARIO

Cargo activity increases under the high scenario are based on these factors: new bi-directional demand from regional manufacturing facilities, additional DHL service to accommodate Amazon and additional FedEx and UPS flights to support expanding e-commerce activity. **Table 4-92** summarizes the high scenario cargo tonnage at MKE with the Baseline forecast and increase in tonnage. As documented in the Aviation Activity Forecasts (Section 3), the high scenario for cargo tonnage and operations reflects the following most prominent factors:

- Integrated carriers (FedEx and UPS) will experience greater increases in annual tonnage than other carrier types due to stronger local and regional e-commerce activity than identified in the Baseline Forecast. The increases will generate additional cargo demand at MKE.
- As e-commerce continues to expand, the all-cargo airlines will experience robust growth rates through the forecast period, which will add more MKE all-cargo aircraft operations.
- Changes anticipated to support supply chain logistics for local and regional manufacturers will stimulate demand for flights to deliver commodity parts and finished goods to markets worldwide.

TABLE 4-92 HIGH GROWTH SCENARIO CARGO DEMAND

	TONNAGE			
CARRIER TYPE	2018	2023	2028	2040
Integrated	73,923	91,456	111,482	168,620
All-Cargo Carriers				
All-Cargo (Regional Manufacturing[1])	-	19,094	35,988	65,208
All-Cargo (DHL/Amazon)	-	18,727	28,261	44,549
Sub-total All-Cargo Carrier	8,197	37,821	64,249	109,757
Belly Cargo	2,878	3,238	3,599	4,529
Total Alternative Demand Tonnage	**84,998**	**132,515**	**179,330**	**282,906**
Baseline Forecast	84,998	108,420	129,740	182,332
Difference	**0**	**24,094**	**49,590**	**100,574**

NOTES:
1 Increased regional manufacturing activities are expected to begin in 2021.
SOURCE: Aviation Activity Forecasts, Table 3.8-7, Ricondo & Associates, Inc., January 2019.

The DDFS for the high scenario forecast does not introduce new aircraft models to the fleet mix.

4.10.6.1 AIR CARGO FACILITY REQUIREMENTS: HIGH GROWTH SCENARIO

Table 4-93 shows the alternative facility requirements for air cargo based on the graduated TARs for MKE. This increase assumes that Amazon and other regional manufacturers will likely be building new ground-up facilities and built for cargo operations. The TAR reflects the fact that these facilities will be highly customized to each carrier's specific needs and will likely integrate extensive technology and systems to enhance efficiency.

TABLE 4-93 CARGO FACILITY REQUIREMENTS: HIGH GROWTH SCENARIO

CARGO FACILITY AREA	CARRIER TYPE	TAR[1]	EXISTING AREA (SQ FT)	FACILITY REQUIREMENTS (SQ FT)			
			2018	2018[4]	2023	2028	2040
Aircraft Ramp[2]	Integrated FedEx	Peak Hour[2]	183,500	166,700	216,100	216,100	384,600
	Integrated UPS	Peak Hour[2]	82,000	83,200	121,600	121,600	216,300
	All-Cargo (Reg Mnfc)	Peak Hour[2]	32,000	67,000	51,200	73,900	87,500
	All-Cargo (DHL/AMZ)	Peak Hour[2]			50,300	58,000	59,700
		Total	**297,500**	**316,900**	**439,200**	**469,600**	**748,100**
GSE Storage Area	Integrated FedEx	0.46 - 0.57	110,500	110,500	127,200	138,500	189,300
	Integrated UPS	0.44 - 0.57	60,500	60,500	74,700	79,400	106,500
	All-Cargo (Reg Mnfc)	1.11	22,900	22,900	17,200	32,400	58,700
	All-Cargo (DHL/AMZ)	1.11			16,900	25,500	40,100
	Belly Cargo	0.58	5,000	5,000	5,600	6,200	7,800
		Total	**198,900**	**198,900**	**241,600**	**282,000**	**402,400**
Warehouse	Integrated FedEx	0.59 – 0.92	86,400	86,400	99,400	105,700	117,300
	Integrated UPS	0.92	18,300	32,300	35,800	43,600	66,000
	All-Cargo (Reg Mnfc)	0.81	14,600	14,600	23,600	44,400	80,500
	All-Cargo (DHL/AMZ)	0.81			23,100	34,900	55,000
	Belly Cargo	0.64	3,500	4,500	5,100	5,600	7,100
		Total	**122,800**	**137,800**	**187,000**	**234,200**	**325,900**
Landside[3]	Integrated FedEx[3]	1.5 - 1.7	127,000	127,000	146,100	167,500	199,400
	Integrated UPS[3]	1.7	23,900	54,900	60,900	74,100	112,200
	All-Cargo (Reg Mnfc)[3]	1.7	15,300	20,800	40,100	75,500	136,900
	All-Cargo (DHL/AMZ)[3]	1.7			39,300	59,300	93,500
	Belly Cargo[3]	2.3 - 1.8	8,000	8,100	11,700	12,800	14,500
		Total	**174,200**	**210,800**	**298,100**	**389,200**	**556,500**

NOTES:

1 TAR = Annual ton per area ratio. TAR for each facility based on existing facility ratios and this is graduated to standard ratios from ACRP 143 over the planning period to show the implementation of technology and efficiencies, where applicable.

2 Peak hour analysis used for apron requirements rather than TAR. Peak hour analysis uses aircraft using the cargo apron at the peak hour of the Design Day Flight Schedule (DDFS). See Section 4.10.3.1, Peak Hour Air Analysis of Cargo Aircraft Apron, for more information.

3 For warehouses less than 50,000 square feet, the ACRP 143 guidelines propose 1.8 square feet of landside space to 1.0 square foot of warehouse. For warehouses over 50,000 square feet the ratio is 1.7 square feet of landside space to 1.0 square foot of warehouse.

4 Requirements for cargo facilities based on 2018 operations are shown in the 2018 column under requirements.

SOURCE: Mead & Hunt, 2019.

Table 4-93 shows the cargo apron requirements for 2023, 2028, and 2040, based on peak hour analysis. The High Growth Scenario in the DDFS was used to determine these area requirements.

4.10.6.2 SPECIFIC CARGO FACILITY RECOMMENDATIONS: HIGH GROWTH SCENARIO

The following cargo requirements are provided to accommodate the High Growth Scenario and growth associated with potential Amazon and regional manufacturer development. These recommendations are in addition to the recommendations provided for the Base Scenario. As with the Base Scenario, these requirements correlate to High Growth Scenario forecasts of annual tonnage and will require reevaluation if activity forecasts change in the future.

- Consider other areas that include airside and landside access on the airport that allow for long-term expansion to accommodate Amazon and regional manufacturer operations.
- Monitor industry growth and additional cargo demand at MKE of the integrated carriers (FedEx and UPS). Growth for each integrated carrier may be accomplished in the West Cargo area, if facilities with efficiencies are implemented.
- Continue to monitor the fluid situation for a regional manufacturer development and communicate with the manufacturer on near- and long-term needs at MKE.

Table 4-94 shows the recommended area requirements for the four major cargo facilities at MKE throughout the planning period for the High Growth Scenario. This includes the differences from existing facilities.

TABLE 4-94 HIGH GROWTH SCENARIO CARGO FACILITY REQUIREMENTS

CARGO FACILITY AREA	CARRIER TYPE	EXISTING AREA	IMMEDIATE DEMAND (SQ FT)	FACILITY SPACE REQUIREMENTS (SQ FT)			DIFFERENCE FROM 2018 (SQ FT) [4]		
				2023	2028	2040	2023	2028	2040
Aircraft Ramp[1]	Integrated FedEx[1]	183,500	N/A	216,100	216,100	384,600	(32,600)	(32,600)	(201,100)
	Integrated UPS[1]	82,000	N/A[3]	121,600	121,600	216,300	(39,600)	(39,600)	(134,300)
	All-Cargo[1]	32,000	35,000 [3]	101,500	131,900	147,200	(69,500)	(99,900)	(115,200)
	Total	**297,500**	**35,000**	**439,200**	**469,600**	**748,100**	**(141,700)**	**(172,100)**	**(450,600)**
GSE	Integrated FedEx	110,500	N/A	127,200	138,500	189,300	(16,700)	(28,000)	(78,800)
	Integrated UPS	60,500	N/A	74,700	79,400	106,500	(14,200)	(18,900)	(46,000)
	All-Cargo	22,900	N/A	34,100	57,900	98,800	(11,200)	(35,000)	(75,900)
	Belly Cargo	5,000	N/A	5,600	6,200	7,800	(600)	(1,200)	(2,800)
	Total	**198,900**	**0**	**241,600**	**282,000**	**402,400**	**(42,700)**	**(83,100)**	**(203,500)**
Ware-house	Integrated FedEx	86,400	N/A	99,400	105,700	117,300	(13,000)	(19,300)	(30,900)
	Integrated UPS	18,300	14,000	35,800	43,600	66,000	(17,500)	(25,300)	(47,700)
	All-Cargo	14,600	N/A	46,700	79,300	135,500	(32,100)	(64,700)	(120,900)
	Belly Cargo	3,500	1,000	5,100	5,600	7,100	(1,600)	(2,100)	(3,600)
	Total	**122,800**	**15,000**	**187,000**	**234,200**	**325,900**	**(64,200)**	**(111,400)**	**(203,100)**
Landside[2]	Integrated FedEx[2]	127,000	N/A	146,100	167,500	199,400	(19,100)	(40,500)	(72,400)
	Integrated UPS[2]	23,900	31,000	60,900	74,100	112,200	(37,000)	(50,200)	(88,300)
	All-Cargo[2]	15,300	5,500	79,400	134,800	230,400	(64,100)	(119,500)	(215,100)
	Belly Cargo[2]	8,000	100	11,700	12,800	14,500	(3,700)	(4,800)	(6,500)
	Total	**174,200**	**36,600**	**298,100**	**389,200**	**556,500**	**(123,900)**	**(215,000)**	**(382,300)**

NOTES:

1 Peak hour analysis used for apron requirements rather than TAR. Peak hour analysis uses aircraft that conduct operations on the cargo apron at the peak hour of the Design Day Flight Schedule (DDFS). See Section 4.10.3.1, Peak Hour Air Analysis of Cargo Aircraft Apron, for more information.

2 For warehouses less than 50,000 square feet, the ACRP 143 guidelines propose 1.8 square feet of landside space to 1.0 square foot of warehouse. For warehouses over 50,000 square feet the ratio is 1.7 square feet of landside space to 1.0 square foot of warehouse.

3 Immediate demand for UPS and All-Cargo apron area reflects need for dedicated area for Freight Runners aircraft (which feeds UPS). Dedicating this area will provide area for a second hardstand position for UPS on the existing apron.

4 (X,XXX) indicates space deficiency at the forecast horizon.

SOURCE: Mead & Hunt, 2019.

4.11 GENERAL AVIATION FACILITIES

General Aviation (GA) includes a wide variety of civil aviation activity, including corporate and business operators, recreational pilots, flight training, agricultural applications, law enforcement, and other government uses. GA facility requirements vary depending on the facility type and levels of activity. The analysis of GA requirements is presented in two subsections. The first presents the primary factors relevant to GA facilities requirements, including the number of forecast GA aircraft operations and based aircraft and a description of existing facility conditions and facilities' deficits determined from tenant interviews. The second presents GA facility requirements by type, organized by airside, hangar, and landside needs. The Airport Cooperative Research Program's *Report 113: Guidebook on General Aviation Facility Planning* (ACRP 113) provides guidance on determining the need for general aviation facilities and is referenced as applicable.

4.11.1 FORECAST REVIEW

This section briefly reviews the GA forecasts presented in Section 3, Aviation Activity Forecasts. Future aircraft operations, based aircraft, and aircraft fleet mix projections directly impact the need for future GA facilities.

Operations

As discussed in Section 3, Aviation Activity Forecasts, rising fuel prices have negatively impacted the number of operations by private pilots. Conversely, business, training, and government operations are less sensitive to fuel costs because these categories operate as businesses or organizations that are often able to either defray cost or generate enough revenue to offset them. As shown in **Table 4-95**, jet aircraft operations are forecast to increase slowly over the 22-year planning period and become a larger share of operations at MKE.

TABLE 4-95 GENERAL AVIATION OPERATIONS FORECAST BY FLEET

	JET		PISTON		TURBINE		OTHER		
YEAR	OPERATIONS	SHARE	OPERATIONS	SHARE	OPERATIONS	SHARE	OPERATIONS	SHARE	TOTAL
2018	15,621	72.8%	2,532	11.8%	3,240	15.1%	86	0.4%	**21,457**
2023	17,258	79.4%	1,676	7.7%	2,394	11.0%	413	1.9%	**21,763**
2028	17,531	79.4%	1,700	7.7%	2,429	11.0%	420	1.9%	**22,080**
2040	18,142	79.4%	1,762	7.7%	2,517	11.0%	435	1.9%	**22,877**
CAGR[1]	*0.75%*	*N/A*	*-1.80%*	*N/A*	*-1.25%*	*N/A*	*8.44%*	*N/A*	*0.32%*

NOTE:
1 CAGR: Compound Annual Growth Rate
SOURCES: Aviation Activity Forecasts, Table 3.5-2 Historical and Forecast General Aviation and Other Air Taxi Fleet Mix. Ricondo & Associates, Inc. January 2019.

GA activity consists of both local and itinerant operations. Local operations take off from one airport and return to the same airport, while itinerant operations fly from one destination to another without returning. Over the past decade, approximately 95 percent of GA activity at MKE consisted of itinerant operations. Itinerant travel is often associated with business operations. Local operations make up the remaining approximate 5 percent at MKE. The approximate distribution between itinerant and local operations is expected to continue, as shown in **Table 4-96**, with business operations expected to remain dominant and largely itinerant.

TABLE 4-96 ITINERANT AND LOCAL GENERAL AVIATION OPERATIONS

YEAR	ITINERANT GA OPERATIONS	ITINERANT SHARE	LOCAL GA OPERATIONS	LOCAL SHARE	TOTAL GA OPERATIONS
2018	20,363	94.9%	1,094	5.1%	21,457
2023	20,653	94.9%	1,110	5.1%	21,763
2028	20,954	94.9%	1,126	5.1%	22,080
2040	21,711	94.9%	1,167	5.1%	22,877

NOTE: Totals may not add due to rounding.
SOURCES: Aviation Activity Forecasts, Table 3.5-1 Historical and Forecast Itinerant and Local General Aviation and Other Air Taxi Operations. Ricondo & Associates, Inc. January 2019.

Based Aircraft

The same trends presented in the Aviation Activity Forecast (Section 3) that are anticipated to affect GA operations have similar impacts on future based aircraft at MKE: the number of piston engine aircraft are forecasted to decrease, while jet and turboprop aircraft will increase. This follows national trends, as recreational flight decreases, and these operations are replaced by business, training, and special operations. **Table 4-97** shows the estimated future GA based aircraft at MKE**.**

TABLE 4-97 GENERAL AVIATION FORECAST OF BASED AIRCRAFT

YEAR	SINGLE-ENGINE PISTON	MULTI-ENGINE PISTON	SINGLE-ENGINE TURBO-PROP	MULTI-ENGINE TURBO-PROP	JET	OTHER	TOTAL
2018	21	3	11	31	19	10	95
2023	19	3	11	31	24	10	98
2028	18	3	12	34	27	10	104
2040	17	3	17	47	34	10	128

SOURCE: Table 3.5-3, Historical and Forecast Based Aircraft, Ricondo & Associates, 2019.

4.11.2 TENANT INTERVIEWS

Ricondo performed informal interviews with staff of Signature Flight Support (Signature), Freight Runners Express, and Avflight to discuss current GA operations at MKE. These discussions help inform GA facility requirements.

Signature is a Fixed Based Operator (FBO), currently, operating under a five-year lease that ends in 2023. MKE leases land to Signature which owns the hangars on this land and leases several buildings, including two large hangars, on the north side of the Airport for based and itinerant aircraft. Because Signature's hangars are occupied at 80 percent capacity, the company has interest in acquiring additional hangar capacity at MKE, either through development or leasing. Some of Signature's hangars also need to be rehabilitated, and one hangar (constructed in 1932) is nearing the end of its useful life.

Signature staff reported that total GA aircraft activity has been in recent decline. The exception to this trend is Signature's business jet aircraft activity, which continues to increase and represents the majority of their clients. Information conveyed through this interview is consistent with local trends as aircraft charter companies such as NetJets and Wheels Up make up a significant share of GA operations. Signature staff indicated that international GA flights operate at MKE and utilize the U.S. Customs facility located at the FBO.

Signature staff also expressed the need for a deice ramp near their facilities due to operating challenges presented by deice operations on the North Ramp. The staff also indicated the need for more parking facilities for GA users. Charter operations for several college and professional sports teams, including the Milwaukee Bucks, Milwaukee Brewers, and Marquette University, who use the Airport during their seasons, have caused surges in demand. During these times, the GA parking lot reaches capacity.

Freight Runners Express is both a cargo operator contracted to provide feeder service for UPS and an aircraft charter operator that leases six hangars. Four of these hangars are on the Northeast Apron and used for maintenance and office facilities. Charter operations occur at the remaining facilities on the west GA apron. As Freight Runner's facilities are divided in two locations on the Airport, this means that aircraft must circulate between facilities as many as five to six times a day. This reduces efficiency and can create congestion. Freight Runners Express does not have dedicated apron space.

Consolidating Freight Runners Express facilities would be ideal in the long term, but immediate needs include additional building space for storage and aircraft maintenance. Often the ability to have several aircraft, such as the Cessna 208 Caravan, in one hangar to conduct maintenance is desirable. This allows tools and personnel to be centralized and requires an overall smaller footprint than storing aircraft in separate locations. Having landside access to their facilities, additional apron space for aircraft loading and unloading and parking for larger aircraft such as the Embraer 120 are also desired.

Finally, Avflight and Whyte Flying also have GA hangars in the northwest and northeast GA areas. Avflight has expressed that, while they recently expanded their facility, the apron space can become congested, and Whyte Flying has also expressed the need for more hangar space. The following section presents the existing facility needs along with the projected increases in aircraft operations and based aircraft from the previous chapter to examine future facility requirements.

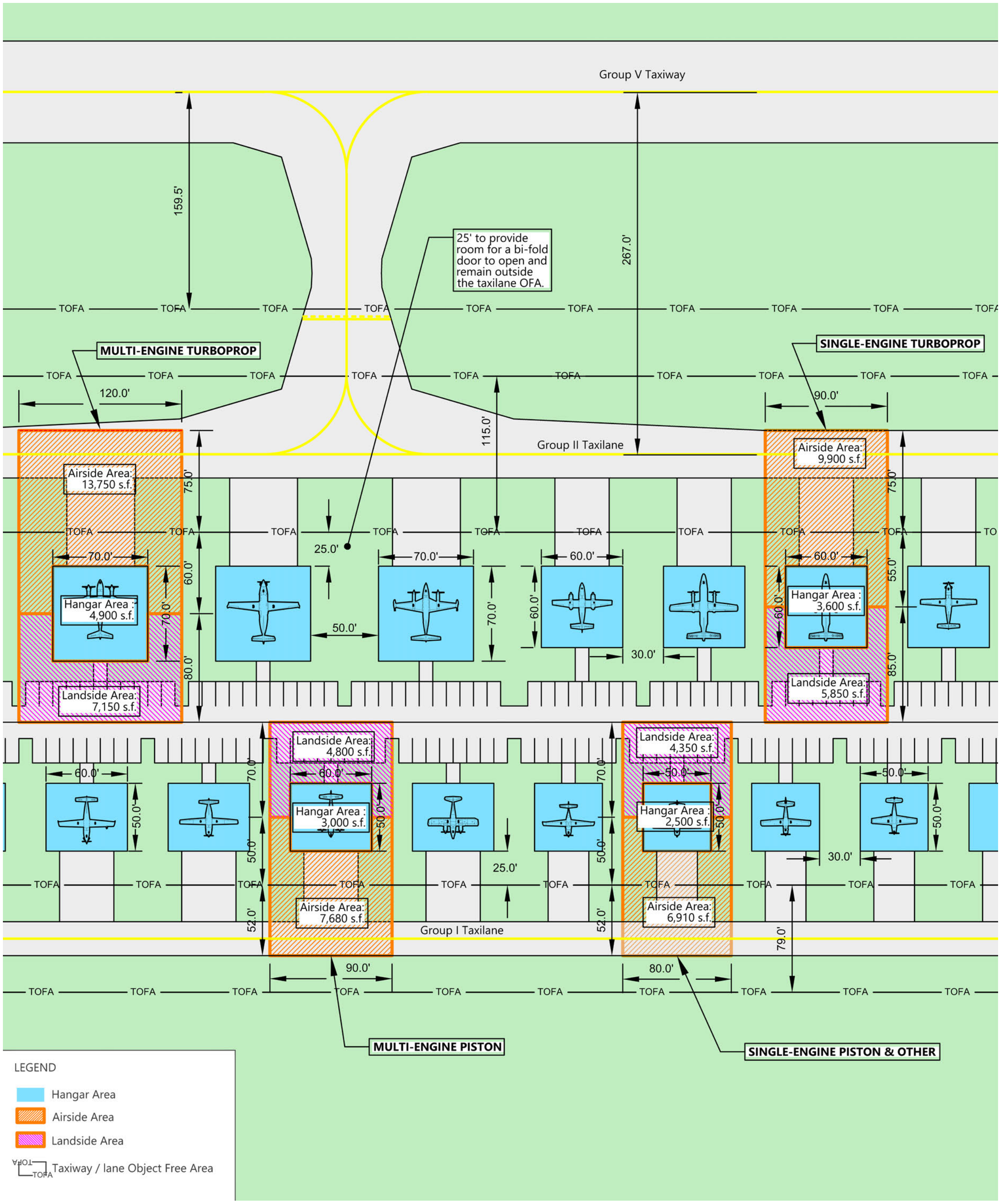
In addition to specific tenant input, the analysis of GA facility requirements also considers general aviation needs based on comprehensive activity and fleet.

4.11.3 FACILITY REQUIREMENTS

GA facility requirements are grouped into three categories: hangars, airside, and landside. Hangar demand is determined by the footprint of the required structures. Airside areas in this section comprise taxilanes, taxiways, and associated safety areas that allow aircraft to circulate between the hangar and the airfield environment. Landside GA facilities refer to those that are not usually accessible by aircraft and that allow for non-airside access to hangar facilities and vehicle parking for employees, passengers, or pilots. Finally, the area on either side of hangars is generally split evenly between landside and airside requirements as a fence or other barrier will prevent unauthorized access to the airfield environment.

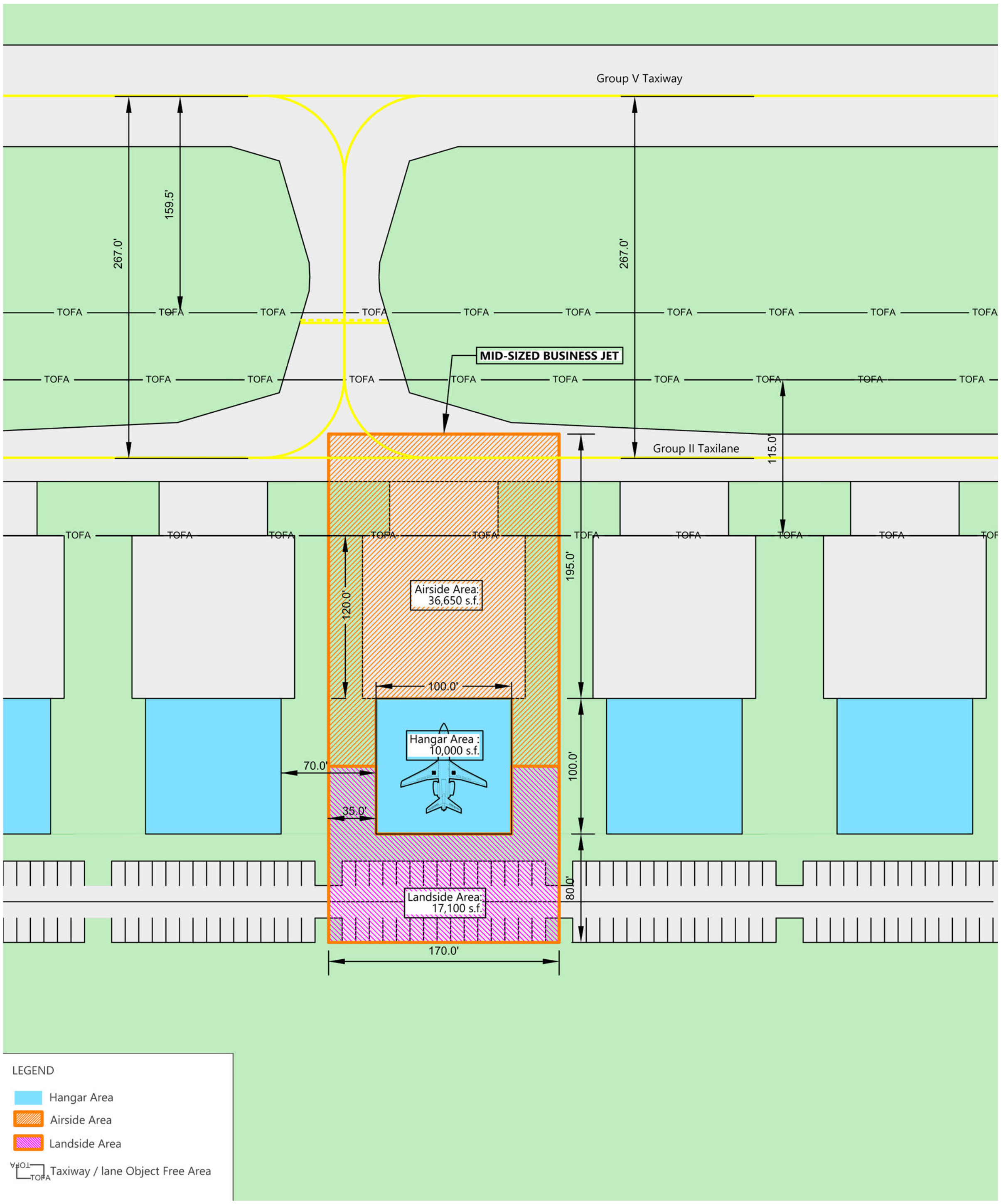
Aircraft type is a significant determining factor when considering the facilities around aircraft. Small piston aircraft are often situated in small hangars with minimal aprons and taxiways to allow for circulation. Large jets, however, often need relatively large hangars with integrated offices to support business and room for maintenance, clients, and employees. In addition, the apron may support passenger loading, unloading, and aircraft servicing and refueling. The supporting taxilanes and taxiways connecting these areas also encompass safety areas required to meet FAA design standards. Space demands for each of these areas are detailed by aircraft type in **Table 4-98**. **Exhibit 4-95** through **Exhibit 4-97** illustrate the cumulative area required for each hangar type.

EXHIBIT 4-95 TYPICAL HANGAR AREA SPACE REQUIREMENTS DESIGN GROUP I AND II AIRCRAFT - SINGLE-/MULTI-ENGINE (PISTON & TURBOPROP)



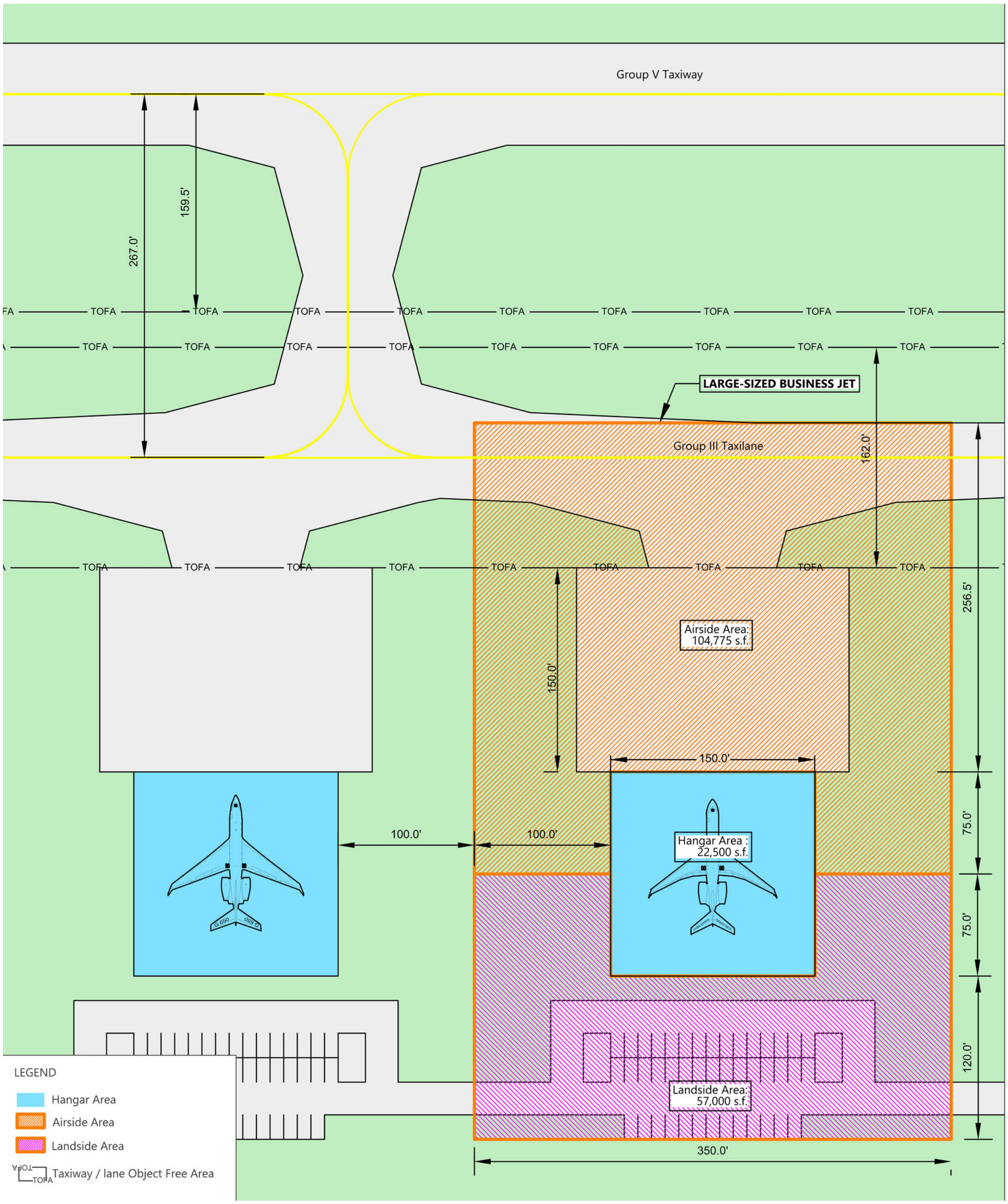
SOURCE: Mead & Hunt, September 2019.

EXHIBIT 4-96 TYPICAL HANGAR AREA SPACE REQUIREMENTS DESIGN GROUP II AIRCRAFT (MID-SIZED BUSINESS JETS)



SOURCE: Mead & Hunt, Inc., September 2019.

EXHIBIT 4-97 TYPICAL HANGAR AREA SPACE REQUIREMENTS DESIGN GROUP III AIRCRAFT (LARGE-SIZED BUSINESS JETS)



SOURCE: Mead & Hunt, Inc., September 2019.

TABLE 4-98 AREA REQUIREMENTS PER AIRCRAFT

GENERAL AVIATION AIRCRAFT TYPE	EXAMPLE AIRCRAFT	HANGAR REQUIREMENT (SQUARE FEET)	AIRSIDE AREA REQUIREMENT (SQUARE FEET)	LANDSIDE AREA REQUIREMENT (SQUARE FEET)
Single-Engine Piston and Other	Cessna 172, Cirrus SR-22, Vans Aircraft	2,500	6,910	4,350
Multi-Engine Piston	Piper Seneca	3,000	7,680	4,800
Single-Engine Turboprop	Pilatus	3,600	9,900	5,850
Multi-Engine Turboprop	Beechcraft King Air	4,900	13,750	7,150
Jet	Learjet, Challenger 600	10,000	36,650	17,100
Large Jet[1]	Gulfstream G550, Global Express	22,500	104,775	57,000

NOTE:
1 GA large jet is considered any jet with a Runway Design Code of C-III or greater.
SOURCE: Mead & Hunt, Inc., September 2019.

4.11.3.1 HANGARS

Hangars provide aircraft storage and shelter from inclement winter weather and from summer heat that can damage or shorten the life of avionics. Hangars also are a place to perform general aircraft maintenance while limiting the surrounding environment from exposure to contaminants. Hangar requirements depend on the type and size of aircraft. Smaller single-engine aircraft, used for recreational activity, are often stored in T-hangars or small box hangars. Multiple T-hangar or small box hangar units may be combined into one structure for a more affordable and spatially efficient solution.

Box hangars can vary in size and in layout but are usually configured in a square and are larger than T-hangar units. Small private box hangars store piston aircraft, whereas medium-sized box hangars generally store multi-engine piston aircraft or single-engine turbine aircraft. Larger box hangars, which are often corporate hangars, are generally used for multi-engine turbine and jet aircraft or may contain multiple smaller aircraft. Corporate hangars often provide additional room compared to private hangars for aircraft storage and maintenance and provide more space to accommodate additional passengers and crew. Corporate hangars are commonly joined with storefronts or customer service areas. For these reasons, corporate hangars are usually situated in more visible locations, to magnify their public presence.

As a result of the rationale described above, the method for determining hangar demand is based on the square footage required for each aircraft. The approximate square footage requirement for each aircraft type includes a buffer to account for varying sizes of aircraft within a group. The requirement also includes the space necessary to perform maintenance and loading but does not include supporting taxilanes, which are associated with different facilities.

T-Hangars

The aircraft fleet mix percentage of single-engine piston aircraft, the main driver of T-hangar demand, is forecast to decrease over time. While T-hangars are not expected to be a primary driver of demand through the planning period, the existing structures at MKE are nearly 20 years old and replacements should be considered over the planning horizon. However, it is not expected that additional T-hangar capacity would be required due to the anticipated decrease in piston aircraft and growth in turbine aircraft counts. Located on the northeast portion of the Airport, T-hangars are relatively isolated from other aviation uses. This is often beneficial as it helps to separate small piston aircraft from larger turbine operated aircraft, which promotes safety and efficiency. The analysis of alternatives offers an opportunity to consider new hangars to meet tenant needs and provide a more efficient layout.

Private Small Box Hangars

Small box hangars located throughout the Airport are expected to meet demand during the planning period. Typically, private individuals occupy, lease, or own these hangars instead of corporations or other entities. Given the transition from small piston to larger turboprop aircraft over the planning horizon, any additional hangars that are required at the Airport are projected to be box hangars measuring at least 50 feet by 50 feet, capable of accommodating small piston aircraft as shown in Exhibit 4-95.

Corporate Hangars

Corporate hangars at MKE are concentrated in the north and south areas of the Airport, as well as the terminal area. For these hangars, business demand will be the primary driver of future development. However, because corporate tenants include a wide range of uses, the specific needs of each hangar will vary depending on the tenant, and individual hangar layouts may also vary. ACRP Report 113 points out that corporate hangars will often include an office space for a variety of uses. In addition, expanding hangars along the same axis as existing users will promote efficiency. However, this does not account for the existing needs previously discussed in this section and the desire for expanded facilities to support aircraft maintenance and included offices. The square footage requirement for each aircraft type is multiplied by the anticipated fleet mix growth for the planning period to determine required hangar capacity in **Table 4-99**.

Although the demand for each aircraft can be determined, the impact to hangar demand may vary based on aircraft and user type. For instance, single-engine turbine aircraft may be either owned and operated by a private or corporate owner and may be kept in either a small box hangar or corporate hangar, while most single-engine piston aircraft, including the other category, are kept in T-hangars. Therefore, 25 percent of single-engine piston aircraft and other aircraft are assigned to T-hangars and the remainder to private small box hangars. All multi-engine aircraft and half of single-engine turboprop aircraft are also assigned to private small box hangars. The remainder of aircraft, including multi-engine turboprop, jets, and the other half of single-engine turboprop aircraft, are placed in corporate hangars due to their high cost to own and operate. This distribution can be seen in **Table 4-100**.

4.11.3.2 AIRSIDE REQUIREMENTS

Aprons and tie down positions provide a place for aircraft to receive services (e.g., refueling) and load or unload passengers and cargo. Itinerant aircraft are the main drivers of apron and tie down space at MKE, because aircraft based at MKE are typically stored/serviced in hangars and therefore, typically do not occupy ramp space. Small aircraft often use tie downs, while larger corporate jets often park in dedicated areas on the apron. Because GA activity at MKE is primarily business-oriented, the apron and tie down positions are particularly important to ensure that passengers can arrive, exit their aircraft, and continue to landside transportation as quickly and safely as possible. The airside aspect of GA space requirements also includes the taxilanes and taxiways that support hangars and allow circulation throughout the area. In addition to the actual pavement of these taxiways, safety areas surrounding them help to ensure that aircraft can travel without obstruction. Therefore, the airside demand includes the safety areas surrounding these taxiways in addition to space for any aprons that may support activity.

TABLE 4-99 HANGAR REQUIREMENTS BY AIRCRAFT TYPE

AIRCRAFT TYPE	HANGAR AREA REQUIREMENTS PER AIRCRAFT	PROJECTED HANGAR AREA REQUIREMENTS			
		2018	2023	2028	2040
Single-Engine Piston and Other	Aircraft	31	29	28	27
	Space per Aircraft (sq ft)	2,500	2,500	2,500	2,500
	Total Space Demand (sq ft)	**77,500**	**72,500**	**70,000**	**67,500**
Multi-Engine Piston	Aircraft	3	3	3	3
	Space per Aircraft (sq ft)	3,000	3,000	3,000	3,000
	Total Space Demand (sq ft)	**9,000**	**9,000**	**9,000**	**9,000**
Single-Engine Turboprop	Aircraft	11	11	12	17
	Space per Aircraft (sq ft)	3,600	3,600	3,600	3,600
	Total Space Demand (sq ft)	**39,600**	**39,600**	**43,200**	**61,200**
Multi-Engine Turboprop	Aircraft	31	31	34	47
	Space per Aircraft (sq ft)	4,900	4,900	4,900	4,900
	Total Space Demand (sq ft)	**151,900**	**151,900**	**166,600**	**230,300**
Jet	Aircraft	16	20	22	28
	Space per Aircraft (sq ft)	10,000	10,000	10,000	10,000
	Total Space Demand (sq ft)	**160,000**	**200,000**	**220,000**	**280,000**
Large Jet	Aircraft	3	4	5	6
	Space per Aircraft (sq ft)	22,500	22,500	22,500	22,500
	Total Space Demand (sq ft)	**67,500**	**90,000**	**112,500**	**135,000**
Total Hangar Space Demand (sq ft)		**505,500**	**563,000**	**621,300**	**783,000**

SOURCE: Mead & Hunt, Inc., September 2019.

TABLE 4-100 HANGAR REQUIREMENTS BY HANGAR TYPE

HANGAR TYPE	PROJECTED HANGAR AREA REQUIREMENTS (SQUARE FEET)			
	2018	2023	2028	2040
Total T-Hangar Demand[1]	19,375	18,125	17,500	16,875
Total Small Box Hangar Demand[2]	86,925	83,175	83,100	90,225
Total Corporate Hangars Demand[3]	399,200	461,700	520,700	675,900
Total Demand	**505,500**	**563,000**	**621,300**	**783,000**
Existing Capacity	410,245	410,245	410,245	410,245
Projected Hangar Area Need	**95,255**	**152,755**	**211,055**	**372,755**

NOTES:
1 Approximately 25 percent of single-engine piston aircraft are expected to occupy T-hangars at MKE.
2 The remaining 75 percent of single-engine piston aircraft are expected to occupy private small box hangars. All multi-engine aircraft and half of single-engine turboprop aircraft are expected to use private small box hangars at MKE.
3 Multi-engine turboprop, jets, and the remaining half of single-engine turboprop aircraft are expected to occupy the corporate hangars at MKE.
SOURCE: Mead & Hunt, Inc., September 2019.

GA aprons are concentrated in the northern portion of the airport near the north GA hangars, northeast GA hangars, corporate complex, and west GA areas. Leases in these areas usually include a portion of the apron in front of the hangars intended for use by the occupant. Existing airside space was determined by subtracting the landside and building areas' square footage from the total lease size. Corporate or cargo facilities will often employ a large apron for staging and service with dedicated taxilane connections leading to it. ACRP 113 states that the apron should ideally not be connected to a parallel taxiway but instead have multiple access points. This lowers the potential for conflict through more controlled aircraft circulation. Both the west and north GA areas have an apron connecting to parallel taxiways. While the west GA area has a deice pad that provides some separation from the adjacent taxiway, the north GA area apron connects directly to Taxiway F. A portion of the north GA area is in the movement area and is not accessible for staging and servicing aircraft. Some of the pavement could be removed to allow for dedicated entrances, at the same time reducing nonpermeable surfaces.

To determine the amount of apron space needed, an analysis of the existing GA areas having a prominent working apron was conducted. The west GA area and north GA area each support various commercial GA activities requiring adequate apron space, such as passenger loading and aircraft servicing. In addition to the pavement that these GA areas make up, these areas include the associated surrounding taxilane and taxiway safety areas, such as the Taxiway Safety Area (TSA) and Taxiway/Taxilane Object Free Area (TOFA), to help provide safe and uninhibited passage for aircraft. The width of these surfaces shown in **Table 4-101** varies depending on the type of aircraft intended to use them.

TABLE 4-101 TAXIWAY AND TAXILANE SURFACE WIDTHS

	AIRPLANE DESIGN GROUP		
SURFACE	I	II	III
Taxiway Safety Area	49 feet	79 feet	118 feet
Taxiway Object Free Area	89 feet	131 feet	186 feet
Taxilane Object Free Area	79 feet	115 feet	162 feet

SOURCES: FAA Advisory Circular 150/5300-13A, *Airport Design (Change 1)*, February 26, 2014; Mead & Hunt, Inc., September 2019.

The number of taxiways and taxilanes required to circulate through an area can vary greatly based on the type of aircraft and users in the location. Smaller GA users, such as private aircraft owners, are often hangared in close proximity and require a network of taxiways and taxilanes leading to each hangar. The size of taxiways and taxilanes compared to hangar space may also vary relative to the efficiency and intent of the layouts. Private piston aircraft hangars may be aligned on either side of a taxiway to improve efficiency, while corporate users may require wider taxilanes and dedicated apron areas. To avoid overbuilding or being overly conservative when planning future land uses, it is assumed that future hangars would be built in an efficient linear manner where they are evenly spaced to maximize efficiency. If the taxiway/taxilane safety areas are accounted for in front of each hangar, then the airside requirements for each type of aircraft can be applied to future based aircraft to determine future airside demands. This process can be seen in **Table 4-102** and **Table 4-103**.

TABLE 4-102 PROJECTED AIRSIDE AREA REQUIREMENTS BY HANGAR TYPE

HANGAR TYPE	PROJECTED AIRSIDE AREA REQUIREMENTS (SQUARE FEET)			
	2018	2023	2028	2040
Total T-Hangar Airside Area Demand[1]	53,552	50,097	48,370	46,642
Total Small Box Airside Area Demand[2]	238,148	227,783	227,550	247,118
Total Corporate Hangars Airside Area Demand[3]	1,381,425	1,632,800	1,857,075	2,385,250
Total Demand	**1,673,125**	**1,910,680**	**2,132,995**	**2,679,010**
Existing Capacity	1,435,769	1,435,769	1,435,769	1,435,769
Projected Airside Area Need	**237,356**	**474,911**	**697,226**	**1,243,241**

NOTES:

1 Approximately 25 percent of single-engine piston aircraft are expected to occupy T-hangars at MKE.

2 The remaining 75 percent of single-engine piston aircraft are expected to occupy private small box hangars. All multi-engine aircraft and half of single-engine turboprop aircraft are expected to use private small box hangars at MKE.

3 Multi-engine turboprop, jets, and the remaining half of single-engine turboprop aircraft are expected to occupy the corporate hangars at MKE.

SOURCE: Mead & Hunt, Inc., September 2019.

TABLE 4-103 AIRSIDE AREA REQUIREMENTS BY AIRCRAFT TYPE

AIRCRAFT TYPE	AIRSIDE AREA REQUIREMENTS PER AIRCRAFT	PROJECTED AIRSIDE AREA REQUIREMENTS			
		2018	2023	2028	2040
Single-Engine Piston and Other	Aircraft	31	29	28	27
	Space per Aircraft (sq ft)	6,910	6,910	6,910	6,910
	Total Space Demand (sq ft)	**214,210**	**200,390**	**193,480**	**186,570**
Multi-Engine Piston	Aircraft	3	3	3	3
	Space per Aircraft (sq ft)	7,680	7,680	7,680	7,680
	Total Space Demand (sq ft)	**23,040**	**23,040**	**23,040**	**23,040**
Single-Engine Turboprop	Aircraft	11	11	12	17
	Space per Aircraft (sq ft)	9,900	9,900	9,900	9,900
	Total Space Demand (sq ft)	**108,900**	**108,900**	**118,800**	**168,300**
Multi-Engine Turboprop	Aircraft	31	31	34	47
	Space per Aircraft (sq ft)	13,750	13,750	13,750	13,750
	Total Space Demand (sq ft)	**426,250**	**426,250**	**467,500**	**646,250**
Jet	Aircraft	16	20	22	28
	Space per Aircraft (sq ft)	36,650	36,650	36,650	36,650
	Total Space Demand (sq ft)	**586,400**	**733,000**	**806,300**	**1,026,200**
Large Jet	Aircraft	3	4	5	6
	Space per Aircraft (sq ft)	104,775	104,775	104,775	104,775
	Total Space Demand (sq ft)	**314,325**	**419,100**	**523,875**	**628,650**
Total Airside Area Demand (sq ft)		**1,673,125**	**1,910,680**	**2,132,995**	**2,679,010**

SOURCE: Mead & Hunt, Inc., September 2019.

4.11.3.3 LANDSIDE

Landside demand for GA includes any area associated with a hangar but not accessible to aircraft. Primarily, this includes vehicle parking and the hangar entrance, though it may also include things like landscaping or sidewalks based on tenant needs. Like the previous sections, landside demand is determined by applying the space demands based on future based aircraft. This process can be seen in **Table 4-104** and **Table 4-105**.

TABLE 4-104 PROJECTED LANDSIDE AREA REQUIREMENTS BY AIRCRAFT TYPE

AIRCRAFT TYPE	LANDSIDE AREA REQUIREMENTS PER AIRCRAFT	PROJECTED LANDSIDE AREA REQUIREMENTS			
		2018	2023	2028	2040
Single-Engine Piston and Other	Aircraft	31	29	28	27
	Space per Aircraft (sq ft)	4,350	4,350	4,350	4,350
	Total Space Demand (sq ft)	**134,850**	**126,150**	**121,800**	**117,450**
Multi-Engine Piston	Aircraft	3	3	3	3
	Space per Aircraft (sq ft)	4,800	4,800	4,800	4,800
	Total Space Demand (sq ft)	**14,400**	**14,400**	**14,400**	**14,400**
Single-Engine Turboprop	Aircraft	11	11	12	17
	Space per Aircraft (sq ft)	5,850	5,850	5,850	5,850
	Total Space Demand (sq ft)	**64,350**	**64,350**	**70,200**	**99,450**
Multi-Engine Turboprop	Aircraft	31	31	34	47
	Space per Aircraft (sq ft)	7,150	7,150	7,150	7,150
	Total Space Demand (sq ft)	**221,650**	**221,650**	**243,100**	**336,050**
Jet	Aircraft	16	20	22	28
	Space per Aircraft (sq ft)	17,100	17,100	17,100	17,100
	Total Space Demand (sq ft)	**273,600**	**342,000**	**376,200**	**478,800**
Large Jet	Aircraft	3	4	5	6
	Space per Aircraft (sq ft)	57,000	57,000	57,000	57,000
	Total Space Demand (sq ft)	**171,000**	**228,000**	**285,000**	**342,000**
Total Landside Area Demand (sq ft)		**879,850**	**996,550**	**1,110,700**	**1,388,150**

SOURCE: Mead & Hunt, Inc., September 2019.

TABLE 4-105 PROJECTED LANDSIDE AREA REQUIREMENTS BY HANGAR TYPE

HANGAR TYPE	PROJECTED LANDSIDE AREA REQUIREMENTS (SQUARE FEET)			
	2018	2023	2028	2040
Total T-Hangar Demand[1]	33,712	31,537	30,450	29,362
Total Small Box Demand[2]	147,713	141,188	140,850	152,213
Total Corporate Hangars Demand[3]	698,425	823,825	939,400	1,206,575
Total Demand	**879,850**	**996,550**	**1,110,700**	**1,388,150**
Existing Capacity	591,039	591,039	591,039	591,039
Projected Landside Area Need	**288,811**	**405,511**	**519,661**	**797,111**

NOTES:
1 Approximately 25 percent of single-engine piston aircraft are expected to occupy T-hangars at MKE.
2 The remaining 75 percent of single-engine piston aircraft are expected to occupy private small box hangars. All multi-engine aircraft and half of single-engine turboprop aircraft are expected to use private small box hangars at MKE.
3 Multi-engine turboprop, jets, and the remaining half of single-engine turboprop aircraft are expected to occupy the corporate hangars at MKE.
SOURCE: Mead & Hunt, Inc., September 2019.

4.11.4 CONCLUSIONS AND RECOMMENDATIONS

The forecast growth in GA operations at MKE is modest, and the primary driver of associated facility requirements will be the transition to larger aircraft and additional jet operations that follow. Existing needs from tenants, such as Freight Runners Express, Signature Flight, and Whyte Flying, mean that additional space is already desirable and future growth will contribute to the demand for additional GA facilities.

The complex nature of business GA activity at MKE will drive a requirement for additional ramp space and an increase in corporate hangar space to properly serve these operations and accommodate future demand. A summary of future GA facility needs is shown in **Table 4-106**. Overall, MKE is well-positioned to accommodate future demand using several areas of available space to allow for any modifications necessary to support a variety of future GA activity.

TABLE 4-106 GENERAL AVIATION FACILITY REQUIREMENTS SUMMARY

GA FACILITY CATEGORY	PROJECTED TOTAL GA AREA REQUIREMENT (SQUARE FEET)			
	2018	2023	2028	2040
Hangar Demand	95,255	152,755	211,055	372,755
Airside Demand	237,356	474,911	697,226	1,243,241
Landside Demand	288,811	405,511	519,661	797,111
Projected Total GA Area Need	**621,422**	**668,217**	**1,427,942**	**2,413,107**

SOURCE: Mead & Hunt, Inc., September 2019.

4.12 MAINTENANCE/ANCILLARY/SUPPORT FACILITIES

Maintenance and ancillary support facilities play a vital role in the safe operation of MKE. Requirements for these facilities were developed based on aviation demand forecasts, reviews of previous MKE studies/data, and information gathered during interviews with Airport staff. Requirements for the following Airport facilities have been evaluated and the conclusions documented in this section.

- Airport Maintenance
- Airline Maintenance
- Aircraft Rescue and Firefighting (ARFF) Station
- Airfield Lighting Electrical Vault
- Ground Run-Up Enclosure (GRE) and Other Noise Reduction Methods
- Fuel Storage and Conveyance
- FAA Facilities
- Milwaukee Airport Rail Station (MARS)
- Administration Area

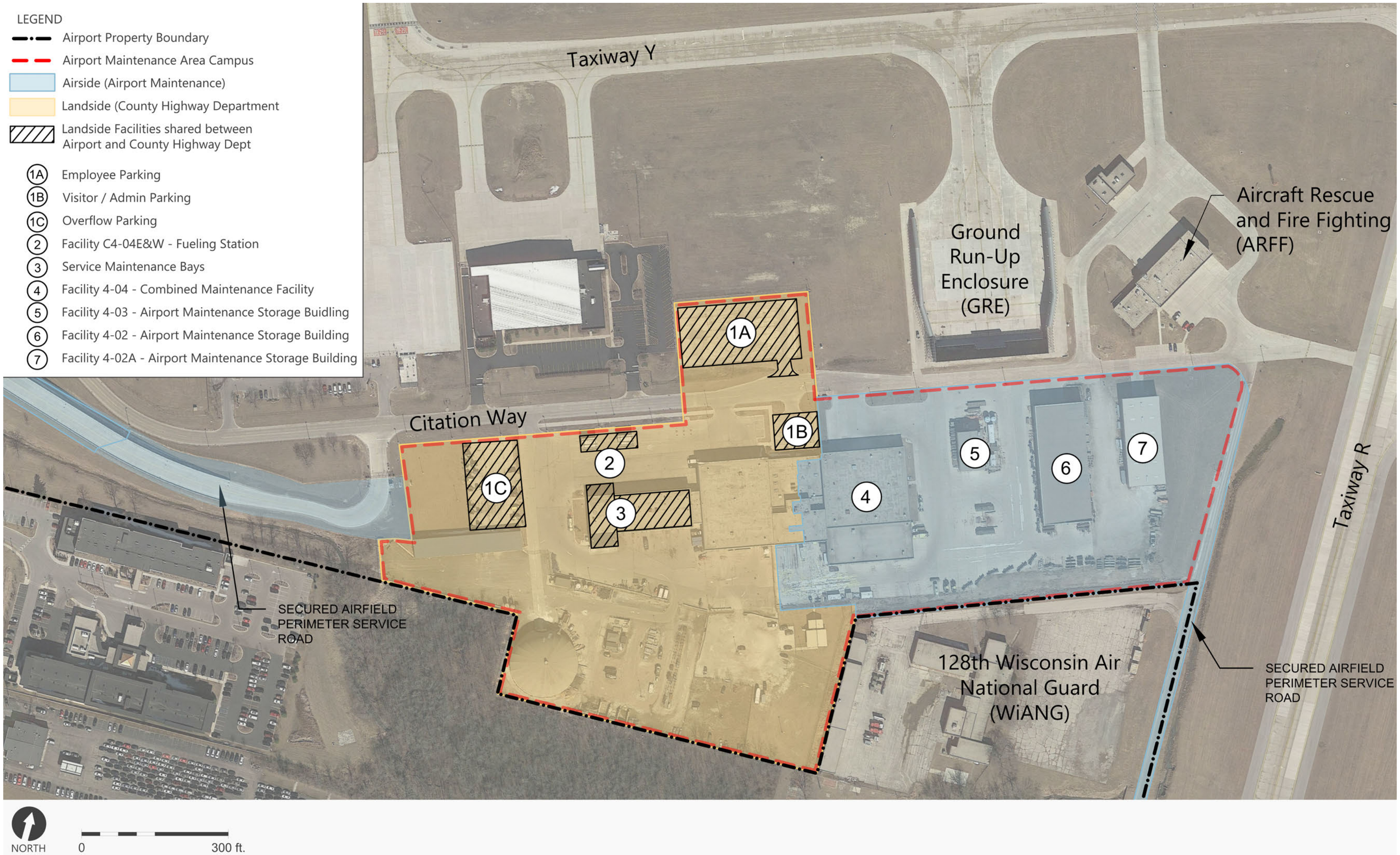
4.12.1 MAINTENANCE FACILITIES

4.12.1.1 AIRPORT MAINTENANCE FACILITIES

The existing primary Airport maintenance campus, located south of Citation Way, is unique in that it is shared with the Milwaukee County Highway Department (Highway Department), which occupies a portion of the campus to house and maintain highway equipment and to conduct other highway-related operations. The Highway Department's facilities are located on the western, non-secure (landside) portion of the maintenance campus, and MKE facilities are on the easterly, secure (airside) portion. The division between the secure and non-secure portions of the maintenance campus is within the primary Combined Maintenance Facility (Facility No. 4-04) and is further delineated by connected security fencing and gates, shown in **Exhibit 4-98**.

The shared-use arrangement presents operational challenges. The vehicle fueling station and maintenance bays are both located on the landside portion of the maintenance campus, which requires Airport equipment to leave the secure airside campus to access these facilities. The shared campus and landside/airside division constrain growth to the west. In addition to the Highway Department, the campus is bounded by adjacent support facilities to the north, drainage features, and the Wisconsin Air National Guard (WI ANG) to the south. As a result of these constraints, buildings within the MKE Regional Business Park are used to meet MKE maintenance equipment storage needs. **Table 4-107** lists the buildings currently used for Airport maintenance purposes, along with the building function, area, and the location of each, relative to the primary maintenance campus. This table also identifies space allocated within the maintenance area campus for ancillary facilities, circulation and staging of equipment, and outdoor equipment storage.

EXHIBIT 4-98 EXISTING AIRPORT MAINTENANCE CAMPUS BUILDINGS AND GROUNDS



SOURCES: FAA Airports Geographic Information System (AGIS) database, December 2018; Aerial Photo – National Aerial Imagery Program, 2015; VFA Asset List Reports, November 27, 2017; Airport Leases – Milwaukee Mitchell International Airport records, November 2018.

TABLE 4-107 EXISTING AIRFIELD MAINTENANCE FACILITIES - BUILDINGS AND GROUNDS

FACILITY NUMBER/SPACE DESCRIPTION	FUNCTION/USAGE	AREA OF BUILDING OR FACILITY (SQUARE FEET)
	On-Campus Airport Maintenance Building Facilities	
4-02	Heated vehicle storage: dump trucks, wheel loaders; sand storage, and paint storage	24,283
4-02A	Cold Storage - broom cartridges, equipment parts, etc.	13,595
4-03	Dry chemical/solid deicer storage	4,146
4-04 (Airside Admin)	Offices, conference rooms, locker rooms, welding, sign shop, paint shop, wood shop, tool room, engine repair	48,368
Ancillary Facilities	Flammable storage, biohazard storage, fertilizer storage, fuel tanker trucks, liquid deicer storage	11,159
	Subtotal On-Campus Buildings	***101,551***
	Off-Campus Airport Maintenance Building Facilities (MKE Regional Business Park)	
102A	Heated Storage Space	1,617
122	Heated Storage for paints, glues, adhesives, and related products	2,046
125	Cold Storage - miscellaneous terminal equipment: spare seating, carpet tile, ceiling tile, ticket counter	772
127	Cold Storage - miscellaneous terminal equipment: spare seating, carpet tile, ceiling tile, ticket counter	775
128	Cold Storage – US Department of Agriculture (wildlife management equipment)	778
130	Cold Storage - miscellaneous terminal equipment: spare seating, carpet tile, ceiling tile, ticket counters	1,548
131	Cold Storage - miscellaneous terminal equipment: spare seating, carpet tile, ceiling tile, ticket counters	1,005
132	Cold Storage - miscellaneous terminal equipment: spare seating, carpet tile, ceiling tile, ticket counter	797
134	Cold Storage - miscellaneous terminal equipment: spare seating, carpet tile, ceiling tile, ticket counter	2,719
220	Electrical maintenance shop	15,043
302	Snow removal equipment storage: 12 combo units, 4 rotary plows, 2 snow melters	23,441
	Subtotal Off-Campus Buildings	**50,541**
	Landside Maintenance Bays (Shared with County Highway Department)	
4-04 (Landside Maintenance Bays)	Two longer bays for combo unit maintenance; four+ additional bays for other equipment maintenance	16,623
	Subtotal Existing Building Space	***168,715***
	On-Campus Exterior Storage	
Yard Storage/lay-down areas	Plow blades, rotary plows, off-season equipment storage, miscellaneous parts, and equipment	43,425
	On-Campus Vehicle Circulation	
Aisle & Maneuvering (On-Campus)	Space between buildings, entrance and exit paths to/from buildings, grass island spaces, etc.	158,400
	Employee Parking (Landside)	
Primary Employee Lot	Lot north of Citation Way - provides approx. 82 spaces	29,500
Admin. / Visitor Parking	Lot Adjacent to Building 4-04 - provides 14 spaces	4,725
	Subtotal Employee Parking Area	***34,225***
	Fueling Station (shared with Highway Department)	
C4-04 (E & W) - Fueling Station	Two islands with six pumps at each island	8,250
	Subtotal Shared Fueling Station Facilities	***8,250***
	Subtotal Existing Exterior Space	**244,300**
	Total Existing Airport Maintenance Space	**413,015**

SOURCES: Milwaukee Mitchell International Airport (airport lease diagrams) generated October 22, 2018; *Asset List Report*, VFA, Inc., 2017; Airports Geographic Information System data - November 2018.

The Airport undertook a facility needs assessment of the Airport maintenance facilities/complex (Assessment Report)[13] that defined several goals and facility requirements that the Master Plan team verified and supplemented during an October 2018 meeting and discussion with senior Airport maintenance staff.

Based on this input, several near- and long-term requirements were identified for the Airport maintenance facilities, discussed individually in the following subsections.

- **Establish a new SRE[14] storage building to appropriately store multi-function (combo-unit) equipment.** Building 302, within the MKE Regional Business Park, is used to store several pieces of SRE. These include twelve multi-function plow/broom implements (referred to as combo units, 72 feet in length with 24-foot plows on the front), four rotary plow units, and two snow melter units. Interviews with Airport maintenance staff indicated that the size of Building 302 prevents the storage of this equipment with the plows attached and does not allow drive-through operations. Additionally, Building 302 is roughly 0.75 miles south of the primary maintenance campus, requiring the shuttling of Airport maintenance staff and combo units between the maintenance campus and Building 302. The process to move a combo unit to the maintenance campus and attach the plow can take as long as 30 minutes.

  The Assessment Report identified a recommended facility size for the storage of the combo units (12 current and 4 future units), encompassing a 57,200-square-foot facility (approximately 300 feet by 191 feet) that provides adequate space for storing units without removing plows. The recommended SRE storage facility includes room for two wash bays to eliminate the need for moving the combo units to the non-secure side of the maintenance grounds for routine cleaning.

- **Consolidate the storage of Airport maintenance equipment and supplies.** Replacement parts and supplies for Airport equipment are stored in the airside facilities of the primary maintenance campus. However, equipment maintenance operations are conducted within the landside bays of the primary maintenance building (Facility 4-04). In interviews, Airport maintenance staff noted that maintenance items and supplies (e.g., tires, broom cartridges, replacement parts, etc.) need to be transferred from the airside (storage) to landside (maintenance) portions of the campus, creating inefficiencies in moving through the security processes.

  The Airport also stores supplies and spare materials associated with the upkeep of the terminal and other items requiring heated storage, within nine individual buildings located in the MKE Regional Business Park, approximately 0.75 mile from the primary maintenance campus. These buildings (listed in Table 4-107 as Facilities 102A through 134) collectively represent approximately 12,000 square feet of storage space that should be preferably located in proximity to the primary maintenance campus.

  Of the MKE maintenance facilities within the MKE Regional Business Park, the electrical shop (Facility 220) on the northern boundary is the only building appropriately located for long-term use. This facility is less likely to constrain potential development within or redevelopment of areas of the MKE Regional Business Park.

- **Improve the depth and overall size of the service maintenance bays.** Interviews with Airport maintenance staff indicated a need for additional space in the landside maintenance bays within Facility 4-04. Vehicles/equipment are typically serviced outside due to insufficient space or depth within the bays. In 2014, the two westernmost maintenance bays were lengthened by roughly 30 feet to move the combo units fully

[13] General Mitchell International Airport (GMIA) - Airport Storage and Maintenance Facility (ASMF) Report, Short Elliot Hendrickson, Inc., May 2011.

[14] Snow Removal Equipment (SRE)

inside the bay. Extending the remainder of the maintenance bays the same 30 feet would increase the total maintenance bay space by approximately 5,000 square feet and allow simultaneous maintenance of a greater number of combo units.

- **Minimize outdoor storage of materials and equipment.** The Assessment Report identified a goal to minimize the outdoor storage of equipment and materials, to avoid the impact of adverse weather conditions. As summarized in Table 4-107, roughly 43,425 square feet of the airside maintenance yard is currently used for outdoor storage or lay-down space. The area devoted to outdoor storage is approximate and fluctuates depending on the season and equipment in use. In recent interviews, Airport maintenance staff noted that summer-use vehicles and equipment are often stored outside during the winter months, and that winter-use vehicles and equipment are often stored outside during the summer months. Much of the outdoor yard space is used to store plows, due to the lack of available space within the existing airport maintenance storage buildings. From a review of aerial photographs, the 24-foot plows that connect to the existing 12 combo units occupy approximately 9,000 square feet of the yard space. Construction of a new SRE storage building would accommodate this plow storage space, as the recommended dimensions include sufficient space for storage of the combo units with plows attached.

  Assuming half of the remaining yard area contains equipment or materials unsuited for all-weather outdoor storage, an additional 18,000 square feet of storage is needed to store these items.

- **Expand Exterior Circulation Space.** Additional/consolidated storage buildings within the Airport maintenance campus should include sufficient circulation space for staff to maneuver vehicles and equipment safely. The circulation space shown in Table 4-107 (158,400 square feet) is roughly proportional to the interior and exterior storage space (144,976 square feet). This 1:1 ratio is carried through in the quantification of facility requirements to ensure that enough space is preserved for both the structure and the circulation needed on the surrounding exterior grounds.

- **Install a Fueling System on the secure side of the maintenance campus.** The Assessment Report identified a need for a separate airside fueling station to increase the efficiency of operations during snow events and to maintain separation between secure and non-secure vehicles. The Assessment Report recommended the future fueling station have the capacity to fuel up to four combo units simultaneously, with the ability to expand to six. The long-term buildout of the airside fueling system would require preserving an area roughly 100 feet wide by 250 feet long, or 25,000 square feet.

- **Improve the functionality of the dry chemical storage.** Airport maintenance staff identified concerns with the dry chemical storage building, Facility 4-03, indicating that the existing doors and the facility's interior orientation create access challenges. The parking/staging of the large combination snow removal units often block access to this facility as well. While of adequate size, the building's location, orientation, and inadequate separation from other facilities need to be improved. Options for relocating or reorienting this building within the primary maintenance campus will be explored as part of the alternative analysis.

- **Preserve overflow parking capacity.** The Airport maintenance campus is staffed with 98 employees that work over two shifts (first and third shifts). The size of the existing employee parking lot (located north of Citation Way) is approximately 29,000 square feet, and the administration parking lot (adjoining the primary maintenance building) is approximately 5,000 square feet. Together these two areas provide a combined 96 parking spaces. Discussion with Airport staff indicated the existing parking capacity has been adequate, but instances were noted where construction or other temporary conditions have posed parking challenges. The overall maintenance campus is also supported by a western parking area (approximately 19,000 square feet) that can accommodate overflow parking, but requires pavement upgrades and/or replacement, and has been more recently used for staging equipment. Upgrade and continued use of the overflow parking area is recommended to accommodate parking demand during shift changes and other isolated spikes in demand. It is also recommended that the undeveloped grass area west of the overflow lot (approximately 25,000 square feet) be preserved to accommodate parking should future developments impact the capacity of the existing lots.

- **Improve flow of the snow removal operations.** During snow events, movement of the snow removal equipment fleet from the primary maintenance campus to the airfield occurs along a roadway extending from the northwest side of the ARFF facility. The snow removal equipment fleet comprises 20 pieces of equipment that stage along Taxiway Y prior to advancing onto the airfield, as illustrated on **Exhibit 4-99**. The remote storage of snow removal equipment in Building 302 also requires Airport maintenance staff to shuttle this equipment to the primary maintenance campus using an access road that extends from the southeast side of the ARFF facility.

  Airport maintenance staff noted that the combo units are moved from the remote Building 302 to the primary maintenance grounds to have the plows attached, six at a time. Construction of an SRE equipment storage building, identified as a demonstrated need, would obviate the need to attach plows prior to snow events, and thereby improve the flow of snow removal operations.

  The flow of SRE traffic across the airfield access routes used by the ARFF facility is not consistent with FAA guidance. Specifically, FAA Advisory Circular 150/5220-18A[15] identifies the siting requirements for SRE storage buildings noting that these buildings must be:

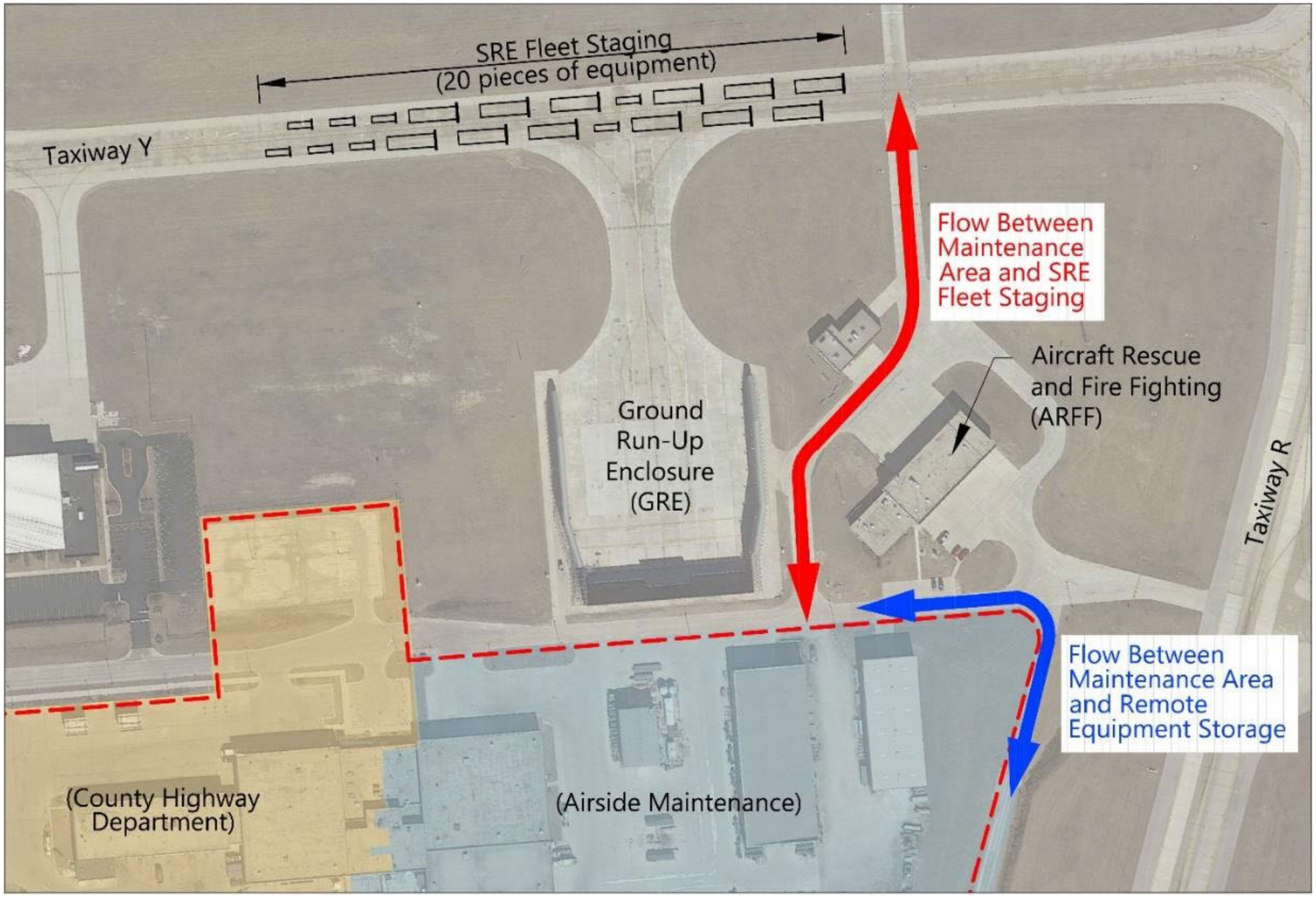
  > *sited in such a manner that activities associated with the facility – in particular, egress/ingress by snow clearing crews, employees, and deliveries – do not interfere with fire lanes used by the ARFF service or hamper aircraft taxiing operations.*

  Exhibit 4-99 illustrates that the SRE movements, both to/from the airfield and to/from the remote equipment storage locations, overlay the fire lane routes extending from both sides of the ARFF Facility. The Assessment Report identifies an access route on the west side of the Ground Runup Enclosure (GRE) to improve and separate the flow of the snow removal equipment from that of ARFF emergency response vehicles. Space/routes are required to allow a separate access route between the maintenance campus and the airfield. Concepts addressing this need will be explored as part of the development and analysis of alternatives.

  Internal airside maintenance campus circulation and flows are also identified as needed improvements as there is insufficient staging space for SRE during a storm event or a shift change. Airport staff noted that currently the staging of the combo units within the primary maintenance campus often blocks access to the dry chemical storage building and other facilities.

[15] FAA Advisory Circular 150/5220-18A, *Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials*, September 14, 2007.

EXHIBIT 4-99 AIRPORT MAINTENANCE – EXISTING FLOW OF SNOW REMOVAL EQUIPMENT



SOURCES: FAA Airports Geographic Information Systems (GIS) database, December 2018; National Imagery Program, (aerial photo), 2015; VFA, Inc., *Asset List Reports*, November 27, 2017; Milwaukee Mitchell International Airport (airport leases), November 2018.

- **Incorporate secure perimeter road through the Airport maintenance campus.** The Airport has been implementing a secure perimeter service road around the airfield, intended to provide a route for service vehicles and maintenance equipment to access all areas of the Airport without crossing runways or otherwise entering the movement areas. The perimeter road system includes two bridge structures (one over College Avenue and the other over Howell Avenue). The primary Airport maintenance campus represents one of the few unfinished segments of the ultimate perimeter service road system because the existing landside portion of the primary maintenance campus poses a barrier. Under the current condition, airport service and maintenance vehicles that transit the Airport maintenance campus must leave the secure (airside) portion of the airport at security gates and traverse roughly 1,000 feet of the non-secure (landside) portion of Citation Way to ultimately reenter the secure environment.

  The Assessment Report identifies an alternative route for the extension of the secure perimeter road through and along the south end of the Highway Department's maintenance grounds, recognizing that this route would require the relocation of the Highway Department's Salt Storage Dome (Facility 4-05), the three-sided storage shelter (Facility 4-06), and other smaller storage structures and facilities.

  The routing and extension of the secure Airport perimeter service road through the airport maintenance grounds is an identified requirement and will be explored in the development and analysis of alternatives.

Airport Maintenance Facility Recommendations

Requirements for Airport maintenance facilities and the storage of associated equipment and supplies are more directly correlated to the amount of Airport pavement and grounds to be maintained than to increases or decreases in Airport activity. While the Airport Layout Plan (ALP) most recently approved by the FAA, on February 25, 2019, identifies several pavement areas recommended for removal or reconfiguration, this master plan update will explore additional alternatives for configuring the airfield to meet current planning and design guidance as well as accommodate future demand. Because the alternatives analysis will be initiated based on the defined facilities requirements, the identified requirements for Airport maintenance facilities focus on resolving existing deficiencies and constraints but will be refined as future airfield and facilities are identified through the planning process (airport maintenance facility needs will reflect the equipment, storage, and activities associated with maintaining airport facilities).

The existing storage deficiencies in the existing Airport maintenance campus have been gradually offset by the temporary use of previously vacated buildings within the MKE Regional Business Park. While these facilities have served as a short-term solution, they were not designed, are not located to support efficient airport maintenance operations, and do not adequately meet the needs of the Airport maintenance staff.

Facility requirements associated with the Airport maintenance campus are summarized in **Table 4-108**. These requirements are based on interviews with Airport maintenance staff, as well as recommendations outlined in the 2011 Assessment Report. The requirements identify 92,200 square feet of additional building space to both replace and consolidate the temporary off-site facilities being used within the MKE Regional Business Park. The overall facility improvements are anticipated to require about 4.81 acres.

TABLE 4-108 AIRPORT MAINTENANCE FACILITY REQUIREMENTS

FACILITY REQUIREMENT	ADDITIONAL SIZE/SPACE REQUIRED [2] (SQUARE FEET)	NOTES ON ADDITIONAL FACILITY NEEDS
New on-campus SRE[1] storage facility for combo units with wash bays (replaces use of Building 302)	57,200	Size based on recommendations in 2011 Assessment Report. SRE building sized to accommodate 16 combo unites (12 existing, 4 future); includes space for two wash bays.
Additional on-campus building storage to consolidate and replace the multiple off-site storage facilities	12,000	Size based on replacement of the storage facilities currently occupied within the MKE Regional Business Park (Facilities 102A through 134 in Table 4-107)
Expansion of the existing service maintenance bays within primary maintenance building (Facility 4-04)	5,000	Size based on 2014 expansions of two westernmost service bays
Additional interior building storage for equipment currently housed outside	18,000	Size based on aerial measurements of yard space used for outdoor storage of materials and equipment, as well as discussions with Airport maintenance staff
Subtotal Additional Building Area Storage	**92,200**	
Building Circulation Space Allowance	92,200	Size based on maintaining 1:1 ratio between circulation/maneuvering space and building footprint
Airside Maintenance Fueling System	25,000	Size based on recommendations in 2011 Assessment Report; facility sized to accommodate fueling operations for up to six combo units
Dry Chemical Storage Facility Improvements	0	Upgrades to the doors, and interior configuration improvements, are needed to improve access by maintenance equipment. Options for reorienting or relocating this building within the primary maintenance campus should also be considered.
Parking	0	Recommend preserving and replacing the 19,000 sq ft of pavement within the western parking area to serve as overflow parking during staff shift changes and other isolated spikes in parking demand. Additionally, recommend that the 25,000 sq ft of grass areas west of this lot be preserved for future parking needs.
Total Airport Maintenance Area Facility Requirement	**209,400**	**Total of 4.81 acres**

NOTES:
1 SRE - Snow Removal Equipment
2 Identified requirements reflect near-term needs (2018-2023) to address inefficiencies and operational challenges that result from fragmented facility locations and the use of repurposed facilities. Required airport maintenance space requirements will be refined through alternatives analysis given that maintenance requirements correlate to changes in airfield and airport facilities.
SOURCES: Short Elliot Hendrickson, Inc., *GMIA Airport Storage and Maintenance Facility (ASMF) Report*, May 2011; Interviews with Airport maintenance staff, October 2018.

Previous alternatives for reconfiguring the Airport maintenance campus were developed as part of the 2011 Assessment Report. The alternatives evaluated under that report were all based on maintaining the improved facilities within existing Airport property. Since that time, the 128th WI ANG has updated their Installation Development Plan,[16] which proposes divesting the portion of WI ANG facilities located south of the Airport maintenance campus. Transfer of this adjoining WI ANG property to the County, if accomplished, would facilitate the configuration of a more efficient and consolidated Airport maintenance campus. These conditions will be further evaluated as part of the analysis of alternatives developed in subsequent sections of the master plan update.

[16] Installation Development Plan - 128th Air Refueling Wing – Wisconsin Air National Guard – Final Submittal September 2015.

4.12.1.2 AIRLINE / AIRCRAFT MAINTENANCE FACILITIES

Several areas of MKE accommodate aircraft maintenance facilities. While requirements for these facilities are affected by changes in aircraft activity at the Airport, future requirements for airline maintenance hangars and ground service equipment (GSE) maintenance facilities cannot be predicted based solely on changes in activity levels. Typically, airlines and those providing aircraft maintenance services to airlines determine the timing and magnitude of maintenance facility expansions or enhancements.

Consolidating aircraft maintenance facilities into a campus or specific area of the Airport should be considered given the nature of these activities, the need for aircraft maneuvering and parking, potential need for GRE access, and dedicated employee parking. A consolidated airline maintenance facility or campus should include space dedicated to hangar areas for the aircraft, workshops, warehousing for storing parts, office space, and building utility areas. Airline maintenance hangars are distinguished from hangars used exclusively for aircraft storage, given the requirement for large open spaces designed to facilitate major aircraft repairs (e.g., servicing aircraft engines and specialized maintenance equipment).

While precise facility requirements cannot be definitively predicted since the needs are determined by tenants based on their business models, agreements, aircraft fleet serviced, numbers of employees, and other factors, identified needs documented during the inventory of facilities conducted as part of the master plan update include:

Air Cargo Carriers

- Air Cargo Carriers (ACC) occupies two hangars on the West Apron (Facility 9-06 and 9-07) to service and store their fleet of roughly 14 Shorts 360 aircraft. These buildings serve as the primary maintenance depot for the company, which includes heavy maintenance operations. ACC also leases four other buildings within the MKE Regional Business Park that are used for storage, training and office space. The separated nature of these facilities is not ideal, and in August 2018 ACC had expressed an interest to the Airport for more ramp space and potential consolidation of their facilities into the building previously occupied by SkyWest (Building 217). In more recent conversations (March 2019), ACC had since determined that Building 217 was not going to work for their needs, and they are currently satisfied with their existing ramp space.
- As part of a tenant survey completed for the Master Plan, ACC identified a lack of office space, but also identified that their facilities are adequate at the present time.
- As part of a March 2019 interview, ACC identified the potential for their company to serve as a final assembly facility for a foreign aircraft production. The aircraft would be similar to the Shorts 360, with high wings, unpressurized fuselage, and similar weight (approximately 6,000 pounds).

Air Wisconsin

- Air Wisconsin operates from a large hangar facility on the northwest area of the airfield (Facility 9-08) and operates exclusively as a United Express carrier.
- In a December 2018 interview, representatives did not identify any specific challenges with the existing facility but did mention the presence and proximity of deice operations that occur immediately to the north (primarily by Southwest) and the inability to park aircraft either north or south of their lease area.
- Air Wisconsin identified the need to park two CRJ-200 aircraft outside. These aircraft are owned by Air Wisconsin themselves, not United, and are used when flying for US Air. At the time of the December 2018 interview, these two aircraft were currently taken out of service but were expected to return at an undetermined time. When

asked if these aircraft could be parked elsewhere, representatives explained the need to conduct preventative maintenance (at least monthly) and that storing them remotely would make that maintenance more challenging.

- MKE receives frequent diversion traffic that is often parked on the West apron. In the December 2018 interview, Air Wisconsin was asked if this presented any challenges to their operation. The response was that these occurrences did not currently pose any challenges as their morning aircraft have typically departed under these instances, but the representatives did acknowledge that it could become a concern in the future.

Freight Runners

- Freight Runners is a MKE-based company providing exclusive cargo feeder service for UPS, passenger charter flights, and a variety of other unscheduled, on-demand services that are conducted both locally and remotely.
- In an April 2019 interview, representatives from Freight Runners identified an immediate need for a minimum 40,000-square-foot maintenance building space to service its fleet of both passenger and charter service aircraft. Freight Runners further expressed a desire for their maintenance operations to be part of a larger hangar that would also provide a variety of other needs for office space, conference and training rooms, storage of parts and related uses.
- As Freight Runners' services include multiple trades and the need to have their maintenance operations consolidated with their other facilities, their requirements have been included within the discussions for cargo and general aviation. However, their specific maintenance needs have also been included in this section for reference.

SkyWest

- In early 2018, SkyWest took occupancy of the two large aircraft hangars within the west cargo area (Facility 3-10). SkyWest maintains and operates regional jet aircraft for United, Delta, and American Airlines.
- In interviews with the Airport and Master Plan team, SkyWest identified some operational challenges that have been experienced since occupying their current facility. These include a congested ramp environment resulting from the nearby cargo operations of UPS to the east and DHL to the west.
- The airfield perimeter service road runs immediately adjacent to the large hangar doors, which face south onto the ramp space. The frequent use and volume of traffic on this roadway by the Airport staff, TSA, and other tenants within the cargo area has also created some congestion and operational challenges for their operations.

Future aircraft maintenance facility requirements are estimated based on a 20 percent increase in space over the 2040 planning horizon. Except for Freight Runners, none of the aircraft maintenance operators had quantified specific facility needs; however, several anecdotal concerns and/or potential future business operations were identified in the bulleted summaries above to suggest that preserving space for future growth or additional maintenance operations over the forecast horizon is warranted. **Table 4-109** summarizes the airside, landside and hangar space currently occupied by the primary aircraft maintenance providers, and the 20 percent increase in area to be preserved over the 2040 horizon. These areas will also be utilized in determining the overall space needs for a consolidated maintenance campus.

Table 4-109 illustrates that the existing aircraft maintenance facilities collectively occupy 27.8 acres, with this area expanding to 33.4 acres over the forecasted year 2040 horizon. The benefits of a consolidated airline maintenance campus and protection for the ability of airline maintenance providers to expand facilities (hangar, ramp, administrative space, and employee parking) will be explored in the development and analysis of alternatives.

TABLE 4-109 CONSOLIDATED AIRCRAFT MAINTENANCE CAMPUS AREA REQUIREMENTS

AIRCRAFT MAINTENANCE FACILITY	EXISTING LANDSIDE AREA (SQ FT)	EXISTING AIRSIDE AREA (SQ FT)	EXISTING HANGAR AREA (SQ FT)	TOTAL EXISTING FACILITY AREA (SQ F)	+20% AREA TO BE PRESERVED FOR FUTURE GROWTH (SQ FT)	TOTAL CONSOLIDATED AIRCRAFT MAINTENANCE CAMPUS AREA REQUIREMENTS (SQ FT)
Air Cargo Carriers	65,866	90,582	68,458	224,906	44,981	269,887
Air Wisconsin	84,381	202,358	62,067	348,806	69,761	418,567
Cessna Citation Service Center	44,491	126,510	46,368	217,369	43,474	260,843
SkyWest	115,436	148,376	157,266	421,078	84,216	505,294
Total Existing Area	310,174	567,826	334,159	1,212,159 (27.8 acres)		
+20% Additional Growth	62,035	113,565	66,832		242,432	
Total Consolidated Aircraft Maintenance Campus Area Requirement	372,209	681,391	400,991			Total Consolidated Campus: 1,454,591 (33.4 acres)

SOURCES: Milwaukee Mitchell International Airport (airport lease diagrams) generated October 22, 2018; *Asset List Report*, VFA, Inc., 2017; Airports Geographic Information System data - November 2018.

4.12.2 SUPPORT FACILITIES

In addition to airport and airline maintenance facilities, general airport support facilities encompass facilities and functions that are necessary for the safe and efficient operation of the Airport.

4.12.2.1 AIRCRAFT RESCUE AND FIRE FIGHTING STATION (ARFF)

MKE is a Class I Part 139 Airport with an ARFF Index C category, with military ARFF Index D equipment capabilities offered on request. The civilian MKE ARFF facility is located central to the airfield (Building 4-01), positioned southwest of the Runways 1L-19R and 7R-25L intersection. The MKE Master Plan ARFF section addresses only civilian ARFF facility requirements.

Under 14 CFR 139.315-319, *Aircraft Rescue and Firefighting*, MKE must comply with requirements for ARFF equipment, staff, and operations that were developed by the FAA, the National Fire Protection Association (NFPA), and the International Civil Aviation Organization (ICAO) Rescue and Fire Fighting guidance. The ARFF facility, equipment, and personnel requirements are prescribed based on the 14 CFR 139.315 ARFF Index classification. The MKE ARFF index is determined from the longest air carrier aircraft, measured by fuselage length, operating an average of five or more daily departures[17].

[17] *CFR Part 139 Regulations: Except as provided in* 139.319(c), *if there are five or more average daily departures of air carrier aircraft in a single Index group serving that airport, the longest aircraft with an average of five or more daily departures determines the Index required for the airport. When there are fewer than five average daily departures of the longest air carrier aircraft serving the airport, the Index required for the airport will be the next lower Index group than the Index group prescribed for the longest aircraft.*

ARFF Index C (Existing Condition)

The ARFF building is approximately 18,745 square feet following an expansion of 4,000 square feet in 2019 to provide additional living quarter space. The ARFF building and equipment storage facilities are reported by Airport staff to be in good condition and adequate to meet ARFF Index C requirements. The ARFF building size and space allocation is consistent with FAA standards in accordance with Advisory Circular 150/5210-15A, Section 3. The Airport staff does not anticipate procuring new ARFF equipment, as a matter of meeting FAA ARFF Index C requirements, which would exceed the capabilities of the existing ARFF building. The ARFF building is located in a centralized area on the airfield and sufficiently meets FAA Part 139 ARFF vehicle response requirements. The existing Index C conditions are briefly summarized below:

- ARFF Index (FAA ARFF Index Aircraft Length): C (126 to less than 159 feet)
- ARFF Index Aircraft Type: Narrow Body Passenger Transport
- ARFF Index Representative Aircraft (Length | FAA ARC):
  - Airbus 321 (146’ | ARC C-III)
  - Boeing 737-700/800/900 Series (138’ | ARC C-III)
  - MD-80/90 Series (152’ | ARC C-III)

The MKE forecast projects additional flight frequency by large narrowbody air carrier aircraft (Airbus 321 Series and Boeing 737-800/900 Series) and a transition to widebody air carrier transports (Boeing 787). Based on the forecast transition to longer air carrier transport aircraft, air carrier activity at MKE will not require an upgrade from ARFF Index C to Index D within the 2040 planning horizon under either the baseline or the high scenario forecasts. Although there is forecast to be scheduled passenger activity by aircraft with a fuselage length ranging from 159 up to 200 feet (e.g., Boeing 787-800), the design day flight schedule does not include five or more daily air carrier departures by aircraft of this length, which would be the trigger for an increase in MKE’s ARFF Index. However, passenger air service changes and/or airline routes changes and equipment upgauging can occur differently than forecast. Therefore, it will be important to monitor increases in aircraft fuselage length as activity increases and/or air service change may occur.

Comparison of ARFF Regulatory Requirements

The FAA Reauthorization Act of 2009 calls for more closely aligning ARFF regulations under 14 CFR Part 139, Certification of Airports, including the promulgation of ARFF standards by the ICAO and the NFPA. The following section compares ARFF standards between the FAA, as the lead regulator, with ICAO and NFPA standards for FAA ARFF Index C and D. This analysis provides facility requirement information that can be used to assess the potential impacts on airports from aligning FAA regulations with the ICAO and NFPA standards. At this time, the FAA has not adopted the ICAO ARFF recommended practices.

Table 4-110 summarizes the comparison of ARFF Index C in reference to FAA, ICAO, and NFPA standards.

FAA ARFF response criteria defined in 14 CFR 139.319 requires at least one ARFF vehicle to reach the midpoint of the farthest runway serving air carrier aircraft and begin applying extinguishing agent within three (3) minutes from the of the time of an alarm. ICAO and NFPA ARFF response times are more stringent, in that the first ARFF vehicle must reach *any point* on the operational air carrier runway within two (2) to three (3) minutes, including rapid response times for areas surrounding the runway pavement. The following is ARFF response time and distance analysis for FAA and ICAO requirements:

TABLE 4-110 ARFF REGULATORY COMPARISONS

ARFF FEATURE	ARFF REGULATORY REQUIREMENT COMPARISON			
	FAA[1]	ICAO[2]	NFPA[3]	REMARKS
Response Time - First Vehicle	3 Minutes	3 Minutes (2 Minutes Recommended)	2 Minutes	FAA Standards Used for MKE Master Plan
Response Location - First Vehicle	Midpoint of Further Air Carrier Runway	Anywhere on the Runway	Any Point on Operational Runway	FAA Standards Used for MKE Master Plan
Response Time - All Other Vehicles	4 Minutes	1 Minute After First Vehicle	Vehicle Intervals Not to Exceed 30 Seconds, Per Required ARFF	FAA Standards Used for MKE Master Plan
ARFF Feature (FAA Index C)	FAA Standard (Index C)	ICAO Standard (Category 7)	NFPA Standards (Category 7)	
Response Vehicles (Minimum)	2 to 3	2	3	3 Existing MKE ARFF Vehicles
Agent Quantity	3,000 Gallons (Water)	3,197 Gallons (Water)	4,880 Gallons (Water)	FAA Standards Used for MKE Master Plan
Firefighter Staffing (Per Shift)	N/A	N/A	7	N/A

NOTES: Assumes existing single MKE ARFF building location.
1 14 CFR Part 139, Subpart D, Sections 313-319.
2 ICAO Annex 14, Volume 1, Part 1, *Rescue and Firefighting* (July 2019 Edition).
3 NFPA 403, *Standard for Aircraft Rescue and Fire-Fighting Services at Airports* (2009 Edition)
SOURCES: Mead & Hunt, Inc., September 2019, based on the sources noted in footnotes 1 through 3 above.

- **FAA ARFF Response Standard – Midpoint of Runway 7L-25R:** The ARFF facility is approximately 6,700 feet from the midpoint of Runway 7L-25R. The first ARFF vehicle would need to average nearly 25 miles per hour to reach this point in 3 minutes.
- **ICAO/NFPA ARFF Response Standard – Runway 13 Approach End (farthest point on active airfield from ARFF):** This point is approximately 8,400 feet from the ARFF. To reach this point in 3 minutes, the first vehicle would need to average nearly 32 miles per hour.

The MKE ARFF staff indicated that there are no existing issues relating to meeting FAA required response times. As shown in Table 4-110, the ICAO and NFPA recommended more stringent ARFF response distance and time.

4.12.2.2 AIRFIELD LIGHTING ELECTRICAL VAULT

The airfield electrical vault is located within the South Maintenance Area and houses the electrical infrastructure that provides power, control, and monitoring of the airfield lighting and signage circuits. The 4,000-square-foot structure, constructed in 2006, is in good condition, has been well maintained, and has ample room for future expansion according to Airport personnel. There are approximately 40 constant current regulators that service the various airfield lighting and signage circuits. Of these, roughly seven are spares that can be swapped if one is damaged or otherwise out of service. The structure is in a centralized area of the Airport, which helps keep the length of edge light circuit cabling manageable and reduces voltage drop. No facility requirements are anticipated for the electrical vault beyond continued maintenance.

4.12.2.3 GROUND RUN-UP ENCLOSURE AND OTHER NOISE REDUCTION METHODS

The GRE, within the South Maintenance Area and constructed in 2003, can accommodate aircraft with a wingspan up to 214 feet (ADG V). It is centrally located on the airfield and easily accessible. Any aircraft conducting an above-idle engine runup operation longer than 10 minutes is required to use the GRE. The facility is used regularly (three times/day on average in 2018) with approximately half of the operations occurring at night. MKE-based aircraft maintenance businesses and the 128th Wi ANG regularly use the GRE.

The GRE is generally in good condition. The Airport made recent isolated repairs to the apron pavement in 2015. Additional large-scale pavement improvements for the GRE apron are currently being evaluated.

If the GRE is unavailable (because of maintenance or weather), the ability to conduct unsuppressed run-up operations on other areas of the Airport is limited to Airport-approved locations. Operations on the north side of the Airport are not preferred given the proximity to residential areas, particularly considering that many runup operations are conducted at night. With Airport approval, alternate run-up locations include the 7R Deice Pad, Zulu Pad, Taxiway Q, and Papa Pad for turboprop run-ups.

The Airport's 2009 CFR Part 150 Noise Study identifies a "low-tech" noise enclosure for engine maintenance run-ups for the northeast hangar area.

4.12.2.4 FUEL STORAGE AND CONVEYANCE

The review of fuel storage and conveyance focused on meeting the demands of passenger and large cargo air carriers like FedEx and UPS that have the greatest fuel demand at MKE. Fuel is provided to these users through a fueling system managed by the MKE Fuel Company, which is a consortium comprising most of the passenger and large cargo air carriers operating at MKE. The MKE Fuel Company owns and operates the primary fueling system at MKE that is the focus of this fuel storage and conveyance analysis. The fuel demands of general aviation operators, feeder air cargo operators, and some large cargo air carriers like DHL that have a lesser demand for fuel at MKE are supplied through other means such as Fixed Base Operators (FBOs) and other contracted suppliers who provide fuel independent of the primary fueling system managed by the MKE Fuel Company. Thus, the demand for fuel by these users was not included as a part of this fuel storage and conveyance analysis.

The West Shore Pipeline Company delivers fuel for passenger and large cargo air carriers to an off-Airport, Jet-A fuel terminal that has a total storage capacity of 8 million gallons. Fuel is then piped through a series of 16-inch and 10-inch diameter pipes equipped with multiple 2,400 gallons-per-minute (GPM) pumps to a hydrant system that delivers fuel directly to gate positions on the air carrier terminal apron. The MKE Fuel Company indicated the tanks at the fuel farm will be removed and replaced with equipment to test fuel quality and fill trucks that deliver fuel to large cargo air carrier aircraft on the cargo apron.

The review of fuel storage and conveyance evaluated the system's ability to meet demand under the baseline forecast and high growth scenario of future demand.

Historical fuel demand was first analyzed to establish a baseline for projecting future demand. As **Table 4-111** shows, the annual fuel consumption by passenger and large cargo carriers decreased from 58,175,188 gallons in 2013 to 56,533,669 gallons in 2018.

TABLE 4-111 2013-2018 PASSENGER AND LARGE CARGO CARRIER FUEL DEMAND (GALLONS)

	2013	2014	2015	2016	2017	2018
Fuel Use (gallons)	58,175,188	53,996,890	54,434,993	53,713,978	55,145,854	56,533,669

SOURCE: Milwaukee Mitchell International Airport, 2019.

Historical operations by passenger and large cargo air carriers were analyzed to establish a historical gallons-per-operation ratio. As **Table 4-112** shows, passenger and large cargo air carriers increased annual operations between 2013 and 2018. Combined, total annual operations grew from 60,785 in 2013 to 67,266 operations in 2018.

TABLE 4-112 2013-2018 HISTORICAL PASSENGER AND LARGE CARGO AIR CARRIER OPERATIONS

YEAR	AIR CARRIER OPERATIONS		TOTAL OPERATIONS
	PASSENGER	LARGE CARGO	
2013	58,245	2,540	60,785
2014	55,342	2,654	57,996
2015	56,003	2,640	58,643
2016	58,282	3,006	61,288
2017	61,647	3,070	64,717
2018	64,338	2,928	67,266
Average	58,976	2,806	61,783

SOURCES: Air carrier operations – FAA OPSNET database, 2019; Milwaukee Mitchell International Airport (large cargo carrier operations [FedEx & UPS]), 2019.

Summarizing the comparison between operations and fuel demand, **Table 4-113** presents the gallon-per-operations ratio of total fuel consumed by passenger and large cargo air carrier operations. While the total number of annual operations increased, the total amount of fuel consumed decreased during this same period. In fact, the gallons-per-operation ratio has steadily decreased during this same period from 957.065 gallons-per-operation in 2013 to 840.449 gallons-per-operation in 2018. This decrease can be attributed to the introduction of aircraft with more fuel-efficient engine types that have been introduced in passenger and large cargo air carrier fleets in recent years to replace aircraft with less fuel-efficient engines. With most of this passenger and large cargo air carrier fleet transition complete, it is assumed the 2018 gallons-per-operation ratio of 840.449 will remain constant through the planning period.

TABLE 4-113 2013-2018 PASSENGER AND LARGE CARGO AIR CARRIER GALLONS-PER-OPERATION RATIO

FACTOR	2013	2014	2015	2016	2017	2018
Fuel Demand (gallons)	58,175,188	53,996,890	54,434,993	53,713,978	55,145,854	56,533,669
Passenger Aircraft Operations	58,245	55,342	56,003	58,282	61,647	64,338
Large Cargo Aircraft Operations	2,540	2,654	2,640	3,006	3,070	2,928
Total Aircraft Operations	60,785	57,996	58,643	61,288	64,717	67,266
Gallons-per-Aircraft Operation	957.065	931.045	928.244	876.419	852.108	840.499

SOURCES: FAA OPSNET database (air carrier operations), 2019; Milwaukee Mitchell International Airport (large cargo operations [FedEx and UPS] and fuel records), 2019.

Fuel demand for both the baseline and high-growth forecast scenarios for the planning period can be projected using the 2018 fuel-per-operation ratio for the duration of the planning period. **Table 4-114** presents the projected demand for fuel by passenger and large cargo air carrier operations at MKE. Assuming 840.499 gallons of fuel are consumed per operation, the demand for fuel at MKE (assuming the baseline forecast scenario) will increase from 56,533,669 annual gallons in 2018 to 82,943,110 annual gallons in 2040. This equates to an average daily demand of 154,887 gallons consumed in 2018 and 226,621 gallons per day in 2040.

TABLE 4-114 FORECAST PASSENGER AND LARGE CARGO AIR CARRIER AIRCRAFT FUEL DEMAND

YEAR	FORECAST SCENARIO	PASSENGER & LARGE CARGO CARRIER AIRCRAFT OPERATIONS	GALLONS PER OPERATION	AVERAGE ANNUAL DEMAND (GALLONS)	AVERAGE DAILY DEMAND (GALLONS)
Historical					
2018		67,226	840.499	56,533,669	154,887
Forecast					
2023	Baseline	79,589	840.499	66,890,527	183,262
	High-Growth	94,194	840.499	79,169,963	216,904
2028	Baseline	84,749	840.499	71,227,246	194,610
	High-Growth	104,198	840.499	87,578,315	239,285
2040	Baseline	98,689	840.499	82,943,110	226,621
	High-Growth	133,469	840.499	112,180,561	306,504

SOURCES: FAA OPSNET (historical operations), 2018; Ricondo & Associates, Inc., (forecast operations), 2018; Mead & Hunt, Inc., (fuel demand), 2019.

Providing a reserve of fuel allows aircraft fueling operations to continue should an interruption occur in the delivery of fuel to the Jet-A Fuel Terminal. To evaluate if the capacity of the Jet-A Fuel Terminal can provide this reserve, a five-day period was selected to represent any interruption in fuel delivery that would likely occur within this timeframe. Capacity for the Jet-A fuel terminal for both the baseline and high growth scenarios is presented in **Table 4-115**. In 2018, the Jet-A fuel terminal had capacity to store 51.7 days of fuel, based on average daily demand. Under the baseline forecast scenario this capacity decreases to 35.3 days of fuel in 2040. Under the high growth scenario, the Jet-A Fuel Terminal would have capacity to provide fuel for 36.9 days in 2023, later decreasing to 26.1

days of fuel in 2040. Because the existing Jet-A Fuel Terminal has capacity to provide at least a five-day supply of fuel, even under the high growth scenario, there does not appear to be a need to improve capacity.

TABLE 4-115 JET-A FUEL TERMINAL DEMAND AND STORAGE PROJECTIONS

YEAR	FORECAST SCENARIO	AVERAGE 5-DAY DEMAND (GALLONS)	FUEL TERMINAL CAPACITY (GALLONS)	SURPLUS / (DEFICIT) TO MEET 5-DAY DEMAND (GALLONS)	AVAILABLE CAPACITY TO MEET DEMAND
Historical					
2018		774,435	8,000,000	7,225,565	51.7 days
Forecast					
2023	Baseline	916,310	8,000,000	7,083,690	43.7 days
	High Growth	1,084,520	8,000,000	6,915,480	36.9 days
2028	Baseline	973,050	8,000,000	7,026,950	41.1 days
	High Growth	1,196,425	8,000,000	6,803,575	33.4 days
2040	Baseline	1,133,105	8,000,000	6,866,895	35.3 days
	High Growth	1,532,520	8,000,000	6,467,480	26.1 days

SOURCES: Milwaukee Mitchell International Airport (fuel records), 2019; Mead & Hunt, Inc., 2019.

In the past, the fuel pipeline managed by the West Shore Pipeline Company ran north of MKE to provide fuel to airports in Northern Wisconsin. Currently, the fuel pipeline terminates at MKE, which means that airports in Northern Wisconsin must truck fuel to their fuel storage facilities from off-site providers. While no plans have been formalized, there have been discussions about the Airport's Jet-A Fuel Terminal supplying other airports in the state. If this occurs, trucks will carry fuel from the MKE Jet-A Fuel Terminal to these additional airports. Should this arrangement be desired, it is recommended that a separate fuel storage analysis be conducted to quantify how the additional demand would affect available capacity, based on the number of airports and gallons of Jet-A fuel supplied by the Jet-A Fuel Terminal. Despite the recommendation for a separate analysis, the capacity of the existing tanks provides fuel to meet 51.7 days of average demand for fuel at MKE; therefore, initial estimates indicate that additional fuel storage capacity would not be required to meet an increase in demand for fuel attributed to airports in Northern Wisconsin.

Likewise, inquiries have been made for the fuel system used by passenger and large cargo air carriers to also provide fuel for additional tenants such as FBOs, based GA users, and the 128th WI ANG. While no plans have been formalized by other users to receive fuel from this fueling system, this change would increase demand on available supply. A separate analysis of anticipated fuel demand from these users is recommended to quantify the impacts to the existing fuel storage capacity of the Jet-A Fuel Terminal in order to support these additional fueling needs. However, given the 8-millon gallon storage capacity of the Jet-A Fuel Terminal, initial estimates indicate that supplying fuel to these additional users would not significantly impact capacity or the ability to provide fuel to users for consecutive days should an interruption be experienced in the delivery of fuel.

The storage capacity of the existing fuel farm, which temporarily stores fuel delivered from the Jet-A Fuel Terminal before it is conveyed by a hydrant fuel system that supplies the terminal gates, was not analyzed because of plans by the MKE Fuel Company to remove two 40,000-gallon below-ground tanks at the fuel farm and eliminate this component of the fuel storage system when it takes ownership of the off-Airport Jet-A Fuel Terminal. While the MKE Fuel Company plans to install a 20,000-gallon above-ground Jet-A fuel tank at this fuel farm facility, its purpose is to support fuel quality testing and loading of fuel trucks for delivery to large cargo carrier aircraft on the cargo apron.

Conveyance

The MKE Fuel Company indicated that a series of pumps providing a flow rate of 2,400 GPM would be installed to transfer fuel from the Jet-A Fuel Terminal to the fuel farm and hydrant system for delivery to the terminal gates. At this flow rate, the current total average daily demand of 154,887 gallons can be fully transferred from the Jet-A Fuel Terminal to the fuel farm and terminal hydrant system in a little over an hour. While the total average daily demand for fuel is projected to grow to 226,621 gallons by 2040 under the baseline scenario, it would only take an hour and a half to fully transfer this fuel from the Jet-A Fuel Terminal to the fuel farm and terminal hydrant system. Under the high growth scenario, it would take just over two hours to transfer the total daily demand for fuel (306,504 gallons) projected for 2040. Thus, the flow rate and GPM capability of the conveyance system appears to meet demand anticipated for the planning period.

Enhanced Containment

As a part of the review of fuel storage facility requirements, MKE and the MKE Fuel Company identified a need to enhance the fuel containment system surrounding the Jet-A Fuel Terminal to prevent and minimize the impacts of a leak or an unexpected release of fuel. This concern is primarily driven by the need to prevent fuel from entering the storm sewers near these facilities if a leak or unexpected release occurs. MKE and the MKE Fuel Company have planned a project to install hydrant containment pits around the Jet-A Fuel Terminal and Fuel Farm to enhance the containment capability of current systems already installed at these facilities. Installation of monitoring devices proposed at the Jet-A Fuel Terminal, as well as to complement new fueling equipment being installed at the Fuel Farm, would also provide immediate notifications if fuel is leaking from the storage tanks or system piping. In combination with existing fuel containment systems, implementation of these methods offers increased protection to control fuel leaks and prevent discharge into adjacent storm sewer systems. This is documented for reference as other future infrastructure improvements are planned at MKE.

4.12.2.5 FAA FACILITIES

The FAA owns and maintains several navigational instruments, approach lighting systems, radar, and related instrumentation that support the various approach procedures in place for each runway end. The existing navigational aids are in good condition and the critical areas extending out from these facilities meet current FAA standards and provide the needed visibility and cloud ceiling minimums for accessibility of the airport during inclement weather conditions.

The FAA has near-term plans to improve the localizer for the CAT I ILS approach to Runway 7R from an 8-element to a 14-element array to improve the performance of the localizer array and reduce the potential for reflectivity of the signal from hangars or other facilities located along the sides of the runway. While not a requirement, the improvement of this localizer to a 14-element array advances the potential for implementing a Special CAT II approach to Runway 7R in the future.

The FAA also owns, operates and maintains the Air Traffic Control Tower (ATCT). In conversations with FAA staff and tower representatives, the tower is in good condition and is of adequate height to provide the proper line of sight to the airfield. The FAA also noted adequate space within the tower cab, adequate employee parking around the base buildings of the ATCT, and adequate space for the TRACON radar control operations.

No requirement for expansion or modification of FAA facilities is identified. Required enhancements to navigational aids, lighting, or other instrumentation will be a function of the ultimate airfield configuration adopted during the master plan update and will be defined as the preferred concept is finalized.

4.12.2.6 MILWAUKEE AIRPORT RAIL STATION (MARS)

The Wisconsin Department of Transportation (WisDOT) Bureau of Rails and Harbors provided input on planned improvements to the Milwaukee Airport Rail Station (MARS) that would have an impact to the schedule and operation of service along the Amtrak Hiawatha line or to the use and demand of the MARS that could require expansion of the station's vehicle parking capacity.

Since 2012, the MARS has averaged over 163,000 riders annually. The existing vehicle parking lot is revenue-controlled and has 300 parking spaces. According to the WisDOT, weekday passenger volumes represent a greater share of the traffic than weekend volumes. For this analysis, 80 percent of the MARS passenger rail traffic was assumed to occur during the work week (Monday through Friday), with the remaining 20 percent of traffic occurring during the weekend. A summary of historical ridership volume (arrivals and departures), and the ratio of passengers to existing parking capacity, is provided In **Table 4-116**.

TABLE 4-116 HISTORICAL MARS RIDERSHIP AND VEHICLE PARKING CAPACITY

YEAR	ANNUAL ON-OFF PASSENGERS	AVERAGE WEEKLY ON-OFF PASSENGERS	AVERAGE WEEKDAY ON-OFF PASSENGERS	VEHICLE PARKING SPOTS PER RAIL PASSENGER
2012	163,800	3,141	503	0.60
2013	160,300	3,074	492	0.61
2014	159,900	3,067	491	0.61
2015	157,000	3,011	482	0.62
2016	159,600	3,061	490	0.61
2017	164,100	3,147	504	0.60
2018	180,300	3,458	553	0.54
Average	**163,571**	**3,137**	**502**	**0.60**

NOTE: Annual rail passenger volumes represent both arrivals to and departures from the MARS. Weekday traffic assumed to represent 80 percent of weekly total.
SOURCE: Rail Passengers Association, https://www.railpassengers.org/site/assets/files/2210/mka.pdf, accessed 2019.

Since 2012, the ratio of vehicle parking capacity (300 spaces) to average weekday ridership (502 on-off passengers) has averaged 0.60. According to the WisDOT, the typical design ratio for passenger-rail train station parking is between 0.50 (low) and 0.80 (high). The current MARS ratio falls within this range; however, the WisDOT noted that the MARS station would be better-suited for the higher end of the design range, as the ridership is currently not associated with activity at the Airport; the MARS facility is a convenient park-and-ride location for those not wanting to access the train at the downtown Milwaukee station. Additionally, improvements to the MARS are being planned as part of an overall objective to increase daily roundtrips on the Hiawatha Line from seven to ten. Increased service on this line can enhance the opportunity for riders to connect to departing flights in the future.

The WisDOT, in partnership with CP Rail and Amtrak, is currently planning to develop a second platform at the MARS that will enable the addition of two one-way trips (Sundays) to improve weekend service on the Hiawatha Line. The second platform project is one of nine required infrastructure projects needed to support an increase in daily roundtrips on this line. The increased daily service is factored into the projections of future Amtrak activity at the MARS station as provided in conversations with the WisDOT, and more fully discussed below.

MARS Parking Requirements – Rail Passenger Baseline Growth Scenario

The most recent WisDOT passenger rail ridership forecasts were developed in 2015. Under those 2015 projections, 2030 MARS ridership is forecast to grow 13 percent from the 2015 baseline, and the 2040 MARS ridership is projected to increase 22 percent from the 2015 baseline. Both projections represent a compounded annual growth rate of 0.81 percent.

While an increase on the Hiawatha Line to ten daily round trips will increase ridership activity, it is also assumed that greater connectivity with the Airport will be realized. The additional round trip stops will allow rail passengers to get to the Airport earlier and enhance the ability to connect to morning flights. The planned increase in Airport connectivity will help offset the overall parking requirements (riders intending to connect to MKE are less likely to drive and park). However, the MARS is also anticipated to remain a popular park and ride option for those not wanting to drive to the downtown Milwaukee station in order to access the train. Considering these factors both add and subtract from future parking needs, a modest increase in the ratio of parking to daily MARS passengers (0.65) was used to represent the middle of the design ranges provided by the WisDOT (0.5 to 0.8) and to reflect the continued use of the MARS facility for park-and-ride activity.

From this baseline, **Table 4-117** extrapolates the projected annual growth in ridership through the planning year horizon and identifies parking capacity needs. The MARS existing parking capacity (300 spaces) is projected to have a deficit of 26 spaces by 2023 with a need for an additional 74 spaces by 2040 to accommodate a 0.65 passengers-to-vehicles ratio.

TABLE 4-117 FORECAST MARS RIDERSHIP AND PARKING REQUIREMENTS – BASELINE FORECAST

YEAR	ANNUAL ON-OFF PASSENGERS	AVERAGE WEEKLY ON-OFF PASSENGERS	AVERAGE ON-OFF PASSENGERS (WEEKDAY)	PARKING SPACES-PER-WEEKDAY PASSENGER	PARKING SPACES REQUIRED	EXISTING MARS PARKING LOT CAPACITY	SURPLUS / (DEFICIT) PARKING SPACES
Historical							
2015	157,000	3,011	482	0.62	300	300	--
Projections							
2023	163,462	3,135	502	**0.65**	326	300	(26)
2028	170,191	3,264	522	**0.65**	339	300	(39)
2040	187,490	3,596	575	**0.65**	374	300	(74

NOTES:
Annual On-Off MARS passengers represent both arrivals and departures; weekday traffic assumed to represent 80 percent of weekly total.
MARS - Milwaukee Airport Rail Station
SOURCES: WisDOT Bureau of Rail and Harbors (2015 forecasts and rail passenger compound annual growth rate of 0.81 percent); Mead & Hunt (analysis), June 2019.

MARS Parking Requirements – Rail Passenger High Growth Scenario

In 2018, MARS ridership increased significantly—from 164,100 passengers in 2017 to 180,300 in 2018. The high growth scenario uses the 2018 passenger volume as the base year to reflect this recent increase, and projects the previous 0.81 percent compounded annual growth across the planning horizon to forecast MARS passenger activity and the associated parking capacity requirements.

As discussed in the baseline scenario, the ratio of parking to daily MARS passengers is projected to decrease as greater roundtrips and connectivity to the Airport are implemented. However, the MARS is also anticipated to remain a popular park and ride option for those not wanting to drive to the downtown Milwaukee station in order to access the train. The median parking space-per-rail passenger design ration of 0.65 was utilized for the high growth scenario as well. As shown in **Table 4-118**, the rail passenger high-growth scenario shows an existing (2018) deficit of 60 parking spaces. This deficit grows to 129 parking spaces by 2040.

TABLE 4-118 PROJECTED MARS RIDERSHIP AND PARKING REQUIREMENTS – RAIL PASSENGER HIGH GROWTH SCENARIO

YEAR	ANNUAL ON-OFF PASSENGERS	AVERAGE WEEKLY ON-OFF PASSENGERS	AVERAGE DAILY ON-OFF PASSENGERS (WEEKDAY)	PARKING SPACES-PER-WEEKDAY PASSENGER	PARKING SPACES REQUIRED	EXISTING MARS PARKING LOT CAPACITY	SURPLUS / (DEFICIT) PARKING SPACES
Historical							
2018	180,300	3,458	553	0.65	360	300	(60)
Forecast							
2023	187,721	3,600	576	0.65	374	300	(74)
2028	195,448	3,748	600	0.65	390	300	(90)
2040	212,315	4,129	661	0.65	429	300	(129)

NOTE: Annual Rail Passenger Volumes represent both arrivals and departures; weekday traffic assumed to represent 80 percent of weekly total.
SOURCE: WisDOT Bureau of Rail and Harbors (historical activity and rail passenger compound annual growth rate of 0.81 percent).; Mead & Hunt (analysis), June 2019.

4.12.2.7 ADMINISTRATION AREA

Administration area requirements for airport offices are not explicitly stated in industry guidance. ACRP Report 25: *Airport Passenger Terminal Planning and Design* and Advisory Circular 150/5360-13A, *Airport Terminal Planning* do not provide specific metrics or methodologies for calculating administration space. ACRP Report 25 states, "There is no rule of thumb for sizing airport offices because each airport has different staffing requirements and management structures." For instance, the size and location of offices may be determined by staff size and space availability. Airport administration versus terminal space should be considered as there may be benefits in dedicating office space separate from the terminal.

The methodology for determining administration offices at MKE is directly correlated to enplanements. In 2018 there were 228 enplanements per square feet of administration space. This ratio was applied to future enplanements for the baseline forecast and high growth scenario to provide an estimate of future area requirements for administration space.

Since existing administration space is currently constrained based on the functions and personnel occupying the space, a 25 percent increase in the ratio is applied. This provides a range for administration space requirements. The requirements for administration space at MKE are presented in **Table 4-119**.

TABLE 4-119 RECOMMENDED SQUARE FOOTAGE FOR ADMINISTRATIVE AREAS

YEAR	EXISTING RATIO METHOD		EXISTING RATIO +25% METHOD	
	BASELINE	HIGH GROWTH	BASELINE	HIGH GROWTH
2018	15,865	15,865	19,831	19,831
2023	18,000	20,000	22,500	25,000
2028	19,000	23,000	23,750	28,750
2040	24,000	31,000	30,000	38,750

SOURCE: Mead & Hunt, September 2019.

4.13 UTILITIES

4.13.1 STORMWATER DRAINAGE

Section 2, Inventory of Existing Conditions, describes the Airport's storm sewer and drainage system. The system comprises a combination of open channels (ditches) and enclosures (pipes and culverts) that flow into two watersheds: the Kinnickinnic River to the north, and the Oak Creek Watershed to the south. The entire Airport property ultimately drains into Lake Michigan.

The Airport experiences known drainage problems. Isolated flooding occurs in and around the 128th WI ANG facilities and on the approach ends of Runways 31 and 25L in the vicinity of Bailey's Pond, immediately north of the WI ANG facilities as shown on Exhibit 2-45, Storm Sewer and Airport Drainage Utilities, in Section 2, Inventory of Existing Conditions. This area is mapped as a floodplain and receives considerable stormwater runoff from an older developed area within the City of Cudahy by way of a ditch that flows east along West Grange Avenue.

Stormwater management at the Airport is subject to both the State of Wisconsin and local municipal regulation. State and local regulations require using best management practices to mitigate impacts that projects may have on both stormwater quantity and quality. Applying some of the most effective best management practices at airports can be challenging. For example, wet detention ponds are a very effective water quality best management practice, but they are also known to attract wildlife, which can threaten safe aircraft operations. As a result, wet detention ponds conflict with the FAA's mission to provide for a safe airfield environment.

The Airport's Sustainability Plan identified 11 focus areas, including water management. The Airport is currently developing a more regional and comprehensive approach to stormwater management in an effort to avoid the need for project-specific detention and promote use of other best management practices. This regional stormwater management approach will be considered as alternatives are identified and developed, to identify opportunities where regional facilities could be located. The alternatives analysis will consider the need to identify and reserve areas for project-specific stormwater facilities. Increases in impervious areas at the Airport will increase stormwater runoff quantities; however, specific requirements to accommodate the increased runoff will be influenced by stormwater management techniques and other factors.

The Airport is committed to the use of green infrastructure. Guidance in ARCP Research Report 174: *Green Stormwater Infrastructure: Volume 2: Guidebook*[18] suggests potential strategies for handling the unique challenges

[18] Transportation Research Board (TRB) Airport Cooperative Research Program (ACRP). ACRP Research Report 174: *Green Stormwater Infrastructure, Volume 2: Guidebook*, ACRP. Washington, D.C.: National Academy of Sciences, 2017.

of designing and maintaining surface water management systems in an airport environment. Incorporating some of these strategies may reduce the footprint associated with stormwater management facilities at MKE.

Along with developing new facilities, the Airport is considering strategies for maintaining MKE's current drainage infrastructure. A study of the drainage system is currently underway to document the system's existing condition and indicate what stormwater and drainage facilities need replacement or upgrades for the system to continue to function reliably.

4.13.2 WATER

Projections of future annual water use at the Airport were completed by consulting the Airport's Sustainability Plan for annual water consumption data from 2013-2016. This data was used to develop a metric tying total annual Airport water consumption to total annual passengers, as shown in **Table 4-120**. The metric ranged from an annual use of 28.48 gallons/passenger to 36.44 gallons/passenger with an average of 32.85 gallons/passenger, which was the value selected to project future annual water consumption. This average consumption value was then applied to baseline forecast and the high growth scenario for total passengers in 2040[19]. The total passenger estimate is used in this methodology to be consistent with the Airport's Sustainability Plan report.

TABLE 4-120 AIRPORT WATER CONSUMPTION FORECAST

YEAR[1]	AIRPORT WATER CONSUMPTION (MILLION GALLONS/YEAR)	TOTAL PASSENGERS (ENPLANED + DEPLANED)	WATER CONSUMPTION (GALLONS PER PASSENGER)	AIRPORT CONSUMPTION INCREASE ABOVE 2015 MWW[2] ANNUAL PUMPING VOLUME[3]
Historical				
2013	185.8	6,525,181	28.48	--
2014	202.7	6,554,152	30.93	--
2015	238.7	6,549,353	36.44	--
2016	240.3	6,763,542	35.54	0.004%
Estimated				
2040 Baseline Forecast	356.8	10,864,530	32.85	0.34%
2040 High Scenario	456.2	13,888,934	32.85	0.63%

NOTES:
1 2017 and 2018 data were not provided.
2 MWW – Milwaukee Water Works
3 Increase reflects estimated incremental Airport water consumption (over 2015 Airport consumption) as a percentage of total 2015 MWW pumping volume (35,770 million gallons).
SOURCES: Metric from Milwaukee Mitchell Airport Sustainability Management Plan, 2018; City of Milwaukee Water Works, https://city.milwaukee.gov/water/about#.XJw_OZhKg2w, accessed March 28, 2019.

Resulting projected Airport water consumption was then compared to Milwaukee Water Works (MWW) historic pumping volumes. MWW supplies water to 861,882 people in 16 communities in Milwaukee, Ozaukee, and Waukesha Counties. MWW's daily average pumpage decreased from 35,770 million gallons in 2015 to 34,420 million gallons in 2017. This reduction is the result, in part, of efficiencies gained from improvements to fixtures and

[19] Total forecast passengers were estimated based on the assumption that annual deplaned passengers would be approximately equal to annual enplaned passengers. Enplaned passenger forecasts were doubled to estimate total passengers.

conservation measures. The MWW's average daily water use per person is 41 gallons[20], lower than both the national average (90 gallons/day per person) and the Wisconsin average (56 gallons/day per person)[21].

With the baseline forecast, estimated annual Airport water consumption is 356.8 million gallons in 2040, an increase of 118.2 million gallons over 2015 consumption, representing 0.34 percent of the annual water MWW pumped in 2015. With the high forecast scenario, in 2040, the estimated annual consumption is 456.2 million gallons, an increase of 217.5 million gallons over 2015 consumption, representing 0.63 percent of the annual water MWW pumped in 2015.

Assuming water use in the future will decline with increased efficiencies, water reuse, and other conservation measures, these estimates of water consumption over the planning horizon indicate that the increased demand for water at the Airport can be satisfied with the MWW and will not constrain future Airport growth. Distribution facilities may require upgrades, including increased pipe sizes and pumps, for specific projects such as terminal or facility expansion and those requiring fire protection, water main extensions for new facilities. These needs would be determined during project formulation.

4.13.3 WASTEWATER

The City of Milwaukee in conjunction with Milwaukee Metropolitan Sewerage District (MMSD) provides wastewater conveyance and treatment service to MKE. An example bill from the City of Milwaukee showed that wastewater fees are based on the volume of potable water the Airport purchases from MWW. This formed the basis for determining future wastewater needs (per MMSD billing, wastewater flow is equal to the volume of potable water used). The forecast of future wastewater flows from this analysis employed the same methodology used to estimate future water consumption. **Table 4-121** shows the forecast future wastewater discharge from MKE.

Anticipating that the average water use per enplaned passenger will decline in the future with increased efficiencies, water reuse, and other conservation measures, these forecast values are considered to be conservative; future volumes may be below estimated future volumes. Given the magnitude of the projected increase in water demand and wastewater generation (less than 1 percent), it is assumed that the increase in wastewater discharge for the planning horizon can be satisfied by the City of Milwaukee and MMSD and is not a constraint to future growth in activity or future development at MKE. As with the Airport water system, certain system facilities may require upgrades (e.g., increased pipe sizing and pump station capacity) for specific projects, and these needs would be determined during project planning.

[20] City of Milwaukee Water Works, https://city.milwaukee.gov/water/about#.XJw_OZhKg2w, accessed March 28, 2019.

[21] University of Wisconsin – Wisconsin Water Library, https://waterlibrary.aqua.wisc.edu/water-facts/, accessed March 28, 2019; Mead & Hunt (analysis), April 2019.

TABLE 4-121 FORECAST FUTURE AIRPORT WASTEWATER GENERATION

YEAR[1]	AIRPORT WASTEWATER DISCHARGE (MILLION GALLONS/YEAR)	TOTAL (ENPLANED + DEPLANED) PASSENGERS	WASTEWATER GENERATION (GALLONS PER PASSENGER)	AIRPORT GENERATION INCREASE ABOVE 2015 ANNUAL MMSD[2] WASTEWATER VOLUME[3]
Historical				
2013	185.8	6,525,181	28.48	
2014	202.7	6,554,152	30.93	
2015	238.7	6,549,353	36.44	
2016	240.3	6,763,542	35.54	0.004%
Forecast				
2040 Baseline Forecast	356.8	10,864,530	32.85	0.34%
2040 High Scenario Forecast	456.2	13,888,934	32.85	0.63%

NOTES:
1 2017 and 2018 data were not provided.
2 MMSD – Metropolitan Milwaukee Sewerage District
3 Increase reflects estimated incremental Airport wastewater generation (over 2015 Airport generation) as a percentage of total 2015 MMSD wastewater volume (35,770 million gallons).

SOURCE: Milwaukee Mitchell Airport Sustainability Management Plan, 2018; City of Milwaukee Water Works, https://city.milwaukee.gov/water/about#.XJw_OZhKg2w, accessed March 28, 2019; Mead & Hunt (analysis), April 2019.

4.13.4 ELECTRIC AND GAS

Electrical power and natural gas are both supplied to the Airport by We-Energies, which serves southeast Wisconsin. We-Energies provides electrical power to the Airport terminal core via two primary service routes. The first route consists of overhead lines from Howell Avenue that transition underground once on Airport property. The second service feed comes from College Avenue via underground lines and is generally considered the safer and more reliable of the two lines. While not technically a redundant feeder system, the two electrical service paths are both routed to two primary points within the terminal area: the electrical distribution building located west of the Parking Garage (Facility 1-08A), and the chiller/boiler house located north of the Parking Garage (Facility 1-07). The Airport has an agreement with We-Energies that guarantees the Airport will have power to either service line at all times, and the Airport pays We-Energies an extra fee for that assurance.

The Airport's Electrical Engineer indicated the electrical capacity supplied by We-Energies is adequate and the Airport currently uses just under 6 mega kilowatt hours per month. Capacity for electrical service is not anticipated to be a barrier to future Airport development; however, other elements of Airport-owned electrical infrastructure are aged, difficult to access, and/or of a condition where near-term replacement is necessary.

Beyond the terminal core, We-Energies also provides electrical power distribution to other areas of the Airport. No capacity or service concerns were identified.

The Airport is currently transitioning ownership of the electrical facilities within the MKE Regional Business Park to We-Energies. Much of the existing electrical power infrastructure running through this area of the Airport comprises aging overhead lines of questionable condition. As part of the ownership transition, We-Energies would move the overhead lines underground, install service meters on the buildings, and make other upgrades to the condition of the service lines.

Natural gas is routed to the Airport's terminal core through one 4-inch main and one 6-inch main. These mains are looped and fed from a larger We-Energies mainline running along Howell Avenue. These service lines and other natural gas services all have adequate capacity, and no barriers to future Airport development are anticipated from either We-Energies supplied utility.

4.14 LANDSIDE ACCESS STRATEGY

The Landside Access Strategy was prepared as a comprehensive long-term ground transportation strategic plan predicated on the review and assessment of recent ground transportation activity and revenue patterns at the Airport as well as projected future activity. The assessment of recent activity includes an evaluation of the impact of emerging technologies and evolution of air service at the Airport on customer preferences and utilization of existing landside facilities. The forecast of future activity considers distinct mode share scenarios to project a range of outcomes for the Airport under different assumptions with regard to adoption of new technologies and the resulting impact to customer behavior. A benchmarking analysis of ground transportation policies, business arrangements and fees also informed the development of recommendations.

4.14.1 ANALYSIS OF RECENT GROUND TRANSPORTATION TRENDS

The Ricondo Team collected and consolidated historical ground transportation transactions and revenue by month for CY 2015 through CY 2018 for analysis to derive estimates of transaction and revenue mode share trends. This study evaluates the following ground transportation modes:

- Taxis
- Limos
- Transportation Network Companies (TNCs)
- Shared-ride vans
- Courtesy vehicles
- Rental cars
- Off-Airport parking
- On-Airport parking
- Mass Transit

Revenues and transactions were evaluated on a per terminating passenger basis as growth in terminating passengers typically correlated to growth in ground transportation activity. While some ground transportation products are predominately used by originating passengers as opposed to terminating passengers, terminating passengers were used to evaluate historical activity across all modes for the sake of consistency. The proportion of originating versus terminating passengers is assumed to have not meaningfully changed between 2015 and 2018. Our analysis of ground transportation trends highlights which ground transportation modes are currently gaining or losing market share and monitors their growth relative to terminating passenger levels.

The historical transactions referenced in the analysis are presented in **Table 4-122**. Historical revenues are presented in **Table 4-123**. The historical data represent CY 2015 through CY 2018 and are presented on a monthly basis.

TABLE 4-122 MONTHLY GROUND TRANSPORTATION TRANSACTIONS

MONTH	TNC	TAXI	LIMO	RENTAL CAR	COUNTY SHUTTLE	CHARTER BUS	SCHEDULE BUS	HOTEL COURTESY SHUTTLE	TOTAL OFF-AIRPORT PARKING 1/	GARAGE PARKING	SURFACE PARKING	SUPERSAVER PARKING	TOTAL
JAN-15		7,673	11,542	26,455	1,175	265	127	106	11,107	63,767	11,466	7,209	140,893
FEB-15		7,645	11,277	26,560	1,142	257	124	121	13,473	63,462	10,700	7,502	142,263
MAR-15		8,509	15,483	31,584	1,606	362	174	1,023	16,017	80,376	16,103	12,513	183,751
APR-15		10,121	13,601	33,880	1,365	308	148	391	14,060	74,701	15,472	11,877	175,923
MAY-15		10,425	13,267	32,608	1,371	309	148	271	12,931	72,589	15,997	10,361	170,278
JUN-15		10,783	14,179	40,510	1,430	322	155	351	6,586	76,063	17,115	9,556	177,050
JUL-15		10,071	14,885	32,199	1,544	348	167	340	12,546	71,382	17,673	8,585	169,740
AUG-15		10,553	14,116	45,012	1,481	334	160	242	10,701	69,420	17,112	8,957	178,088
SEP-15		10,360	12,434	30,971	1,225	276	133	337	14,316	59,998	13,144	8,458	151,653
OCT-15		10,277	13,679	23,154	1,418	320	153	227	18,497	68,695	14,711	9,886	161,016
NOV-15		9,456	12,398	25,991	1,307	295	142	245	13,248	65,953	14,681	9,769	153,483
DEC-15		7,026	12,234	25,106	1,247	281	135	169	9,585	68,301	16,774	7,847	148,704
JAN-16		7,221	5,635	28,866	1,244	280	135	113	11,760	64,029	11,891	7,795	138,968
FEB-16		7,884	5,612	29,494	1,270	286	138	135	14,987	61,619	11,654	8,330	141,409
MAR-16	2,340	8,013	7,455	32,833	1,658	374	179	1,056	16,532	77,421	16,489	12,268	176,619
APR-16	5,644	8,963	5,877	35,505	1,315	297	142	377	13,547	67,008	15,047	10,805	164,526
MAY-16	5,746	8,211	6,275	39,727	1,403	316	152	278	13,230	66,668	16,263	10,464	168,733
JUN-16	7,438	8,378	6,714	42,596	1,481	334	160	364	6,820	70,624	17,572	9,179	171,661
JUL-16	8,575	8,072	6,952	45,272	1,540	347	167	339	12,512	67,693	18,341	8,244	178,053
AUG-16	8,025	8,121	6,531	46,221	1,485	335	161	243	10,735	67,693	16,910	8,805	175,264
SEP-16	8,888	8,552	6,130	43,792	1,330	300	144	366	15,538	61,709	14,190	8,682	169,621
OCT-16	10,205	7,929	6,526	43,623	1,488	335	161	238	19,411	64,533	10,742	10,092	175,283
NOV-16	9,922	6,118	5,958	37,787	1,347	304	146	252	13,660	63,841	15,059	9,424	163,819
DEC-16	8,419	4,771	5,731	32,132	1,273	287	138	172	9,782	65,840	16,581	4,850	149,975
JAN-17	10,217	5,137	4,619	13,305	1,251	282	136	113	11,831	61,453	12,117	5,792	126,253
FEB-17	9,185	4,546	4,577	13,992	1,246	281	135	132	14,706	57,566	11,859	7,887	126,113
MAR-17	12,087	5,976	6,077	17,021	1,701	383	184	1,084	16,964	75,496	16,645	12,003	165,621
APR-17	12,407	6,032	5,412	53,625	1,425	321	154	408	14,681	68,658	15,484	11,617	190,224
MAY-17	13,132	6,211	5,203	35,623	1,421	320	154	281	13,399	69,801	15,969	10,287	171,801
JUN-17	15,178	6,824	5,668	43,842	1,533	346	166	377	7,060	69,867	19,881	9,061	179,803
JUL-17	16,385	5,623	5,800	49,993	1,581	356	171	348	12,852	67,120	18,656	8,850	187,736
AUG-17	15,288	5,502	5,754	48,823	1,592	359	172	260	11,503	70,397	18,255	9,030	186,934
SEP-17	14,922	5,449	4,717	38,998	1,284	290	139	354	15,000	57,146	14,353	8,145	160,796
OCT-17	16,953	6,458	5,227	38,223	1,441	325	156	230	18,801	64,533	14,818	9,073	176,237
NOV-17	15,964	4,701	5,118	32,363	1,397	315	151	261	14,159	66,217	16,254	8,796	165,695
DEC-17	13,628	3,452	4,935	29,972	1,336	301	145	181	10,273	65,971	18,074	7,743	156,011
JAN-18	16,084	3,959	1,378	26,230	1,355	306	147	123	12,811	63,065	13,338	8,223	147,018
FEB-18	15,962	4,012	1,375	24,800	1,352	305	146	144	15,959	61,773	12,616	8,885	147,329
MAR-18	18,021	5,073	1,792	29,589	1,763	397	191	1,123	17,581	75,718	17,411	12,945	181,604
APR-18	19,535	5,486	1,395	32,204	1,371	309	149	393	14,129	65,897	16,017	10,186	167,070
MAY-18	20,171	5,314	1,499	37,509	1,475	332	160	292	13,907	68,021	17,893	9,460	176,032
JUN-18	21,566	5,844	1,571	42,369	1,546	349	167	380	7,117	68,704	18,726	8,741	177,080
JUL-18	22,168	5,347	1,702	51,034	1,676	378	181	369	13,619	64,845	21,625	9,469	192,412
AUG-18	21,268	4,712	1,607	51,073	1,581	356	171	258	11,428	68,350	24,612	8,359	193,775
SEP-18	21,018	4,820	1,359	40,128	1,337	302	145	368	15,617	57,852	18,535	8,202	169,682
OCT-18	25,181	7,372	1,540	39,909	1,515	342	164	242	19,762	65,263	20,870	9,026	191,186
NOV-18	21,068	5,053	1,422	32,437	1,399	315	151	262	14,181	64,767	21,921	8,166	171,143
DEC-18	16,433	3,691	1,358	30,496	1,335	301	145	180	10,264	61,158	21,667	6,807	153,835
Year-Over-Year Change													
2015-2016	n.a.	-18.3%	-52.6%	22.4%	3.2%	3.2%	3.2%	2.8%	3.6%	-4.3%	-0.1%	-3.2%	1.1%
2016-2017	119.9%	-28.5%	-16.3%	-9.2%	2.2%	2.2%	2.2%	2.5%	1.7%	-0.6%	6.4%	-0.6%	1.0%
2017-2018	44.2%	-7.9%	-71.5%	5.3%	2.9%	2.9%	2.9%	2.6%	3.2%	-1.1%	17.1%	0.2%	3.8%

NOTE: Off-Airport Parking Includes: Economy Parking, Exec Parking, FastPark & Relax, and Wally Park.
SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

TABLE 4-123 MONTHLY GROUND TRANSPORTATION REVENUES

MONTH	TNC	TAXI	LIMO	RENTAL CAR	COUNTY SHUTTLE	CHARTER BUS	SCHEDULE BUS	HOTEL COURTESY SHUTTLE	TOTAL OFF-AIRPORT PARKING 1/	GARAGE PARKING	SURFACE PARKING	SUPERSAVER PARKING	TOTAL
JAN-15		$7,673	$34,626	$501,356	$2,358	$2,119	$1,718	$286	$29,870	$1,966,640	$99,467	$321,630	$3,469,099
FEB-15		$7,645	$33,831	$458,170	$2,292	$2,060	$1,669	$279	$31,001	$2,103,689	$104,604	$303,989	$3,507,399
MAR-15		$8,509	$46,449	$548,519	$3,222	$2,895	$2,347	$2,820	$44,140	$2,521,329	$169,635	$508,733	$4,407,118
APR-15		$10,121	$40,803	$596,665	$2,740	$2,462	$1,995	$1,105	$39,768	$2,305,417	$169,328	$485,987	$4,253,055
MAY-15		$10,425	$39,801	$703,724	$2,752	$2,472	$2,004	$704	$33,517	$1,906,314	$140,946	$384,709	$3,931,091
JUN-15		$10,783	$42,537	$824,287	$2,870	$2,580	$2,090	$1,573	$29,497	$1,749,097	$124,328	$368,369	$3,982,298
JUL-15		$10,071	$44,655	$1,085,732	$3,097	$2,782	$2,255	$721	$26,634	$1,515,515	$115,368	$348,222	$4,240,784
AUG-15		$10,553	$42,348	$1,071,787	$2,971	$2,670	$2,163	$666	$29,445	$1,637,965	$118,970	$357,629	$3,277,166
SEP-15		$10,360	$37,302	$789,994	$2,460	$2,211	$1,791	$667	$28,308	$1,627,942	$114,474	$312,961	$2,928,471
OCT-15		$10,277	$41,037	$773,406	$2,845	$2,557	$2,072	$409	$33,349	$2,076,612	$144,011	$360,456	$3,447,032
NOV-15		$9,456	$37,194	$602,944	$2,623	$2,357	$1,910	$601	$32,580	$1,891,779	$121,558	$359,730	$3,062,732
DEC-15		$7,026	$36,702	$578,427	$2,503	$2,249	$1,823	$475	$26,990	$1,832,073	$96,442	$309,478	$2,894,188
JAN-16		$7,221	$16,905	$520,051	$2,497	$2,243	$1,818	$303	$31,624	$1,999,889	$93,796	$337,190	$3,013,538
FEB-16		$7,884	$16,836	$517,358	$2,550	$2,291	$1,857	$310	$34,485	$2,155,014	$112,106	$324,811	$3,175,502
MAR-16	$7,022	$8,013	$22,365	$586,165	$3,326	$2,988	$2,422	$2,911	$45,559	$2,482,903	$168,038	$516,488	$3,848,200
APR-16	$16,932	$8,963	$17,631	$650,262	$2,640	$2,372	$1,922	$1,065	$38,315	$2,252,640	$148,199	$428,548	$3,569,489
MAY-16	$19,199	$8,211	$18,825	$730,309	$2,816	$2,530	$2,050	$720	$34,293	$1,983,722	$137,581	$381,833	$3,322,088
JUN-16	$21,082	$8,378	$20,142	$866,875	$2,973	$2,672	$2,165	$1,629	$30,549	$1,820,308	$125,854	$356,194	$3,258,820
JUL-16	$25,229	$8,072	$20,856	$1,071,880	$3,089	$2,774	$2,249	$719	$26,561	$1,551,037	$110,407	$344,783	$3,167,656
AUG-16	$24,075	$8,121	$19,593	$1,008,539	$2,981	$2,678	$2,170	$668	$29,538	$1,688,621	$115,118	$346,871	$3,248,973
SEP-16	$26,664	$25,656	$18,390	$817,579	$2,670	$2,400	$1,944	$724	$30,723	$1,819,458	$120,310	$314,316	$3,180,834
OCT-16	$30,615	$23,787	$19,578	$813,357	$2,985	$2,683	$2,175	$429	$34,997	$2,010,689	$129,322	$368,511	$3,439,129
NOV-16	$29,766	$18,354	$17,874	$607,739	$2,705	$2,430	$1,970	$620	$33,594	$1,827,221	$123,136	$355,215	$3,020,624
DEC-16	$25,257	$14,313	$17,193	$627,725	$2,555	$2,296	$1,860	$484	$27,546	$1,663,795	$86,833	$252,338	$2,722,195
JAN-17	$30,651	$15,411	$13,857	$518,650	$2,512	$2,257	$1,829	$1,209	$31,643	$1,982,043	$101,146	$309,083	$3,010,292
FEB-17	$27,555	$13,638	$13,731	$472,167	$2,502	$2,248	$1,822	$1,396	$34,543	$2,059,766	$120,009	$324,462	$3,073,840
MAR-17	$36,261	$17,928	$18,231	$584,688	$3,413	$3,066	$2,486	$1,665	$45,676	$2,664,380	$175,622	$490,480	$4,043,896
APR-17	$37,221	$18,096	$16,236	$691,086	$2,861	$2,571	$2,083	$1,438	$36,836	$2,323,803	$157,230	$471,718	$3,761,179
MAY-17	$39,396	$18,633	$15,609	$754,506	$2,852	$2,562	$2,076	$1,438	$34,774	$1,999,377	$136,056	$367,454	$3,374,733
JUN-17	$45,534	$20,472	$17,004	$1,009,010	$3,077	$2,766	$2,241	$910	$31,507	$1,786,224	$158,351	$343,598	$3,420,694
JUL-17	$49,155	$16,869	$17,400	$1,166,592	$3,173	$2,850	$2,310	$655	$28,009	$1,579,313	$119,015	$348,891	$3,334,231
AUG-17	$45,864	$16,506	$17,262	$1,072,669	$3,194	$2,870	$2,325	$581	$31,196	$1,785,257	$139,768	$352,686	$3,470,178
SEP-17	$44,766	$16,347	$14,151	$830,372	$2,578	$2,317	$1,877	$545	$30,547	$1,656,851	$120,528	$301,502	$3,022,380
OCT-17	$50,859	$19,374	$15,681	$797,130	$2,892	$2,599	$2,106	$596	$34,837	$2,005,516	$137,264	$327,999	$3,396,853
NOV-17	$47,892	$14,103	$15,354	$692,196	$2,804	$2,519	$2,042	$671	$34,221	$1,877,561	$125,836	$325,415	$3,140,614
DEC-17	$40,884	$10,356	$14,805	$620,149	$2,683	$2,411	$1,954	$570	$29,220	$1,684,140	$101,472	$296,982	$2,805,625
JAN-18	$48,252	$11,877	$4,134	$535,150	$2,720	$2,444	$1,981	$330	$34,450	$2,062,004	$111,986	$333,744	$3,149,072
FEB-18	$47,886	$12,036	$4,125	$523,591	$2,715	$2,440	$1,977	$330	$36,720	$2,229,549	$121,162	$348,438	$3,330,969
MAR-18	$54,063	$15,219	$5,376	$606,662	$3,537	$3,178	$2,576	$3,095	$48,450	$2,855,206	$196,511	$595,505	$4,389,378
APR-18	$58,605	$16,458	$4,185	$647,732	$2,753	$2,474	$2,005	$1,111	$39,961	$2,407,936	$154,729	$461,610	$3,799,559
MAY-18	$60,513	$15,942	$4,497	$765,912	$2,960	$2,659	$2,155	$757	$36,047	$2,139,534	$143,673	$389,227	$3,563,875
JUN-18	$64,698	$17,532	$4,713	$932,161	$3,102	$2,788	$2,259	$1,700	$31,879	$1,950,155	$135,680	$411,321	$3,557,989
JUL-18	$66,504	$16,041	$5,106	$1,231,512	$3,362	$3,020	$2,448	$783	$28,911	$1,636,603	$123,791	$380,560	$3,498,641
AUG-18	$63,804	$14,136	$4,821	$1,184,213	$3,173	$2,851	$2,310	$711	$31,444	$1,884,699	$129,901	$362,660	$3,684,723
SEP-18	$63,054	$14,460	$4,077	$912,795	$2,684	$2,412	$1,954	$728	$30,880	$1,847,789	$125,044	$328,200	$3,334,076
OCT-18	$75,543	$22,116	$4,620	$897,786	$3,040	$2,732	$2,214	$437	$35,630	$2,192,672	$144,364	$365,153	$3,746,307
NOV-18	$63,204	$15,159	$4,266	$701,667	$2,808	$2,523	$2,045	$644	$34,875	$2,041,177	$125,219	$349,230	$3,342,817
DEC-18	$49,299	$11,073	$4,074	$637,724	$2,681	$2,409	$1,952	$508	$28,904	$1,715,002	$95,983	$303,771	$2,853,380
Year-Over-Year Change													
2015-2016	n.a.	30.2%	-52.6%	3.3%	3.2%	3.2%	3.2%	2.7%	3.3%	0.5%	-3.2%	-2.1%	-10.2%
2016-2017	119.6%	34.5%	-16.3%	4.4%	2.2%	2.2%	2.2%	10.3%	1.3%	0.6%	8.3%	-1.5%	2.3%
2017-2018	44.2%	-7.9%	-71.5%	4.0%	2.9%	2.9%	2.9%	-4.6%	3.8%	6.7%	1.0%	8.7%	6.0%

NOTE: Off-Airport Parking Includes: Economy Parking, Exec Parking, FastPark & Relax, and Wally Park.

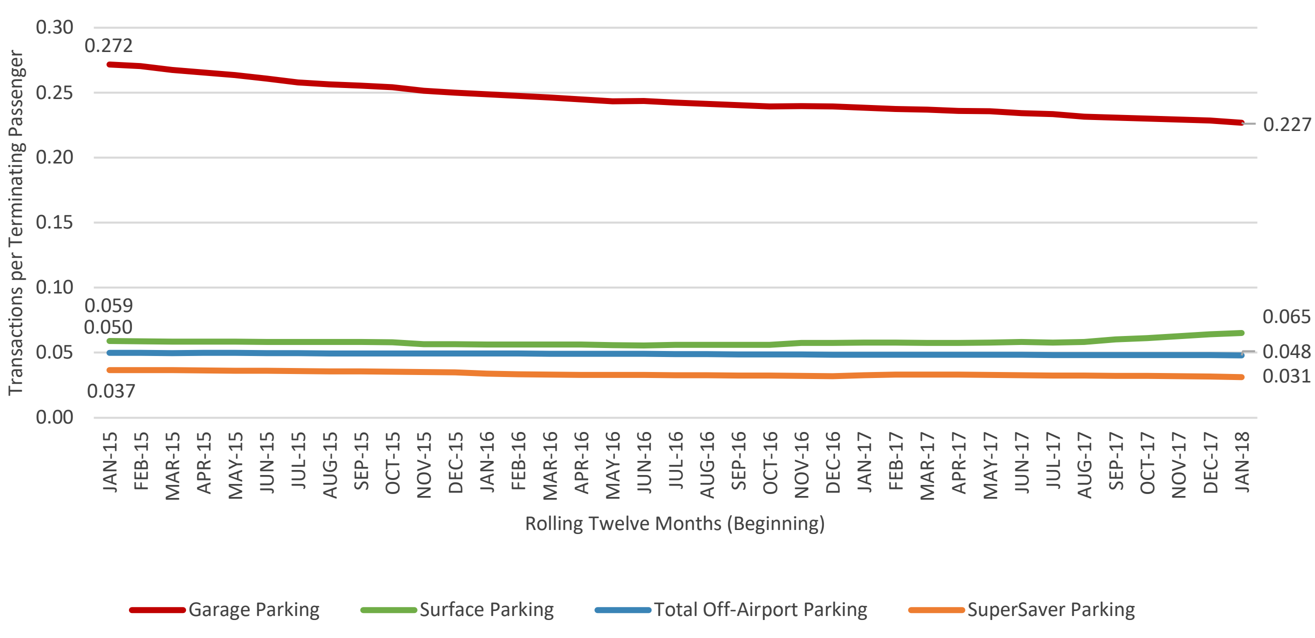
SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

4.14.1.1 PARKING

MKE offers three on-Airport parking products: garage, surface, and SuperSaver, all which are operated by Interflight Parking. The garage parking has spaces designated for hourly parking and daily parking with maximum daily rates of $14 and $24, respectively. Hourly parking is accommodated on floors 3 and 4 nearest the terminal, while Daily parking is located at the back of levels 3 and 4, and all remaining areas of the garage not occupied by rental car on levels 1 and 2. The surface parking product is located 1,000 feet south of the terminal building and is priced at $15/day. The SuperSaver parking products are located west of the terminal in SuperSaver Lot A, SuperSaver Lot B, and Amtrak Lot. Each SuperSaver/Amtrak Lot is served by a shuttle bus to transfer customers between the lots and the terminal. Each lot has a maximum daily rate of $8. All lots charge at a rate of $2/hour up to the daily maximum rate, except for hourly and surface parking which offer the first 30 minutes or less for free.

Off-airport parking is also available near the Airport. Currently there are four off-airport parking companies operating at the Airport; Economy Parking, Exec Parking, Fast Park & Relax, and Wally Park. Each off-airport parking operator has their own parking rates and pays the Airport a $500/annual permit per shuttle vehicle fee plus 6 percent of annual gross receipts. **Exhibit 4-100** presents historical parking transactions per terminating passenger at the Airport from January 2015 through January 2018. The results in Exhibit 4-100 and subsequent exhibits are presented on a rolling twelve-month basis to even out month-over-month fluctuations in activity that occur due to seasonal demand patterns.

EXHIBIT 4-100 HISTORICAL PARKING TRANSACTIONS PER TERMINATING PASSENGER

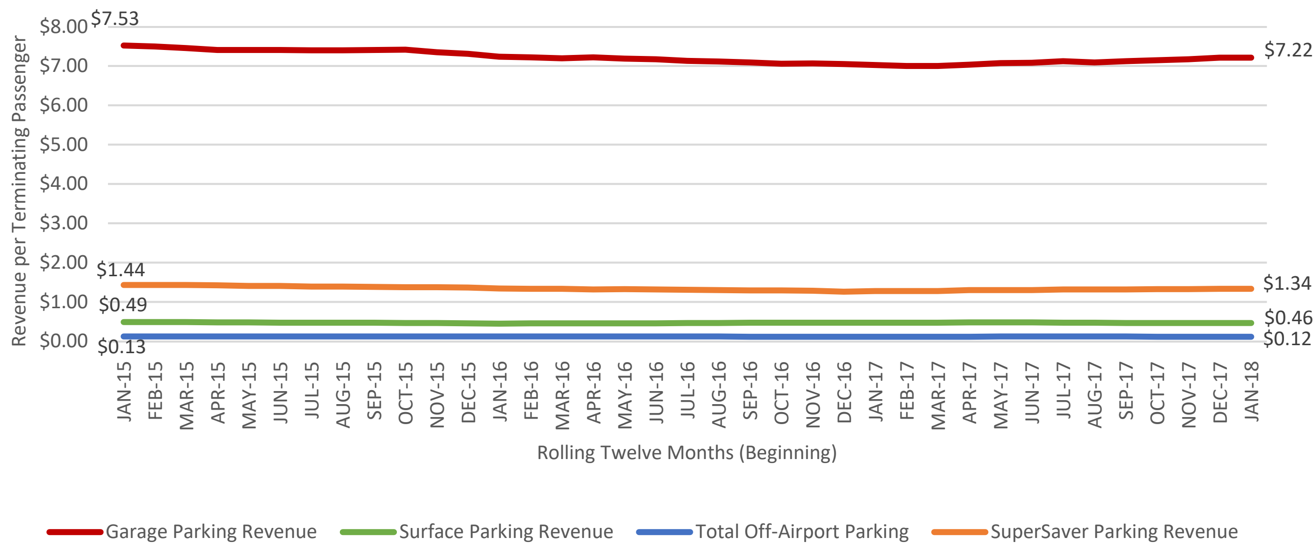


SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

The Garage product generates the highest volume of parking transactions, accounting for approximately 61 percent of the total on-airport and off-airport parking transactions for the 12-month period ending CY 2018. Over the past four years garage parking transactions per terminating passenger have decreased a total of 16.5 percent while SuperSaver transactions per terminating passenger have decreased a total of 16.2 percent. Small changes in the transactions per terminating passenger for the other parking products do not represent an offset to the decrease in garage parking, indicating there has been general decrease in parking activity on a per terminating passenger basis.

Exhibit 4-101 presents the Airport's parking revenues per terminating passenger by product from January 2015 through December 2018. During this period the Garage revenue per terminating passenger decreased from $7.53 to $7.22, which represents a 4.1 percent decrease as compared to a 16.5 percent decrease in transactions per terminating passenger. SuperSaver revenue per terminating passenger has decreased 6.9 percent, which also represents a smaller decrease than transactions per terminating passenger during this period. One dollar increases in daily maximum for each product which occurred between 2017 and 2018 partially offset the decrease in parking activity.

EXHIBIT 4-101 HISTORICAL PARKING REVENUE PER TERMINATING PASSENGER



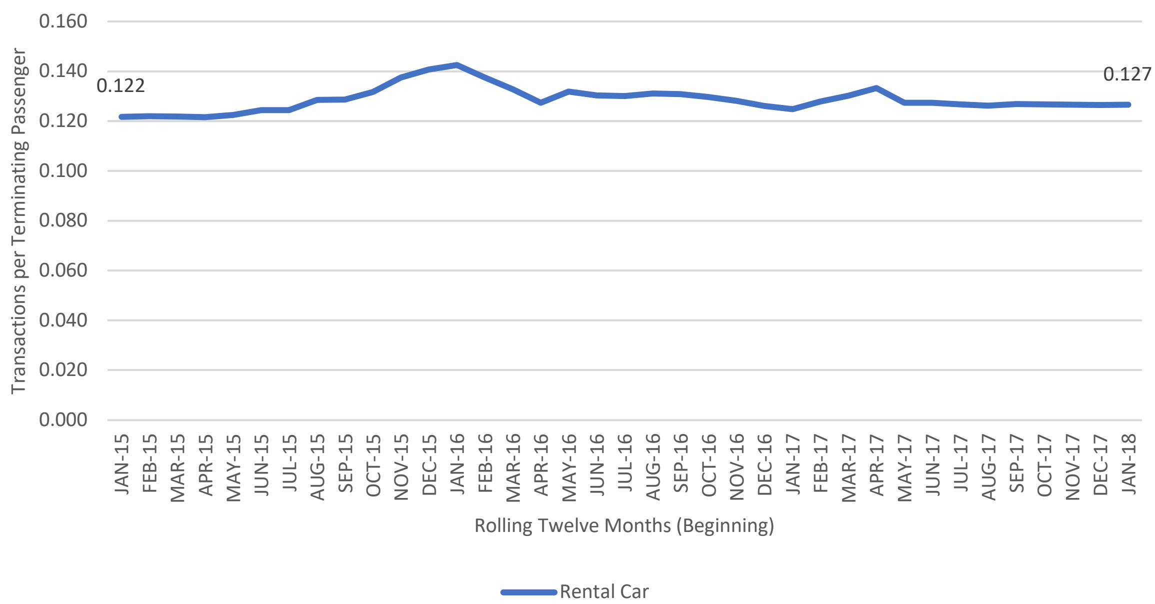
SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

4.14.1.2 RENTAL CAR

Currently, eight rental car brands operate at the on-Airport rental car facility. **Exhibit 4-102** presents historical rental car transactions per terminating passenger on a rolling twelve-month basis for the last 4 years for on-Airport operators. Over this period transactions per terminating passenger have increased a total of 4.1 percent from 0.122 to 0.127.

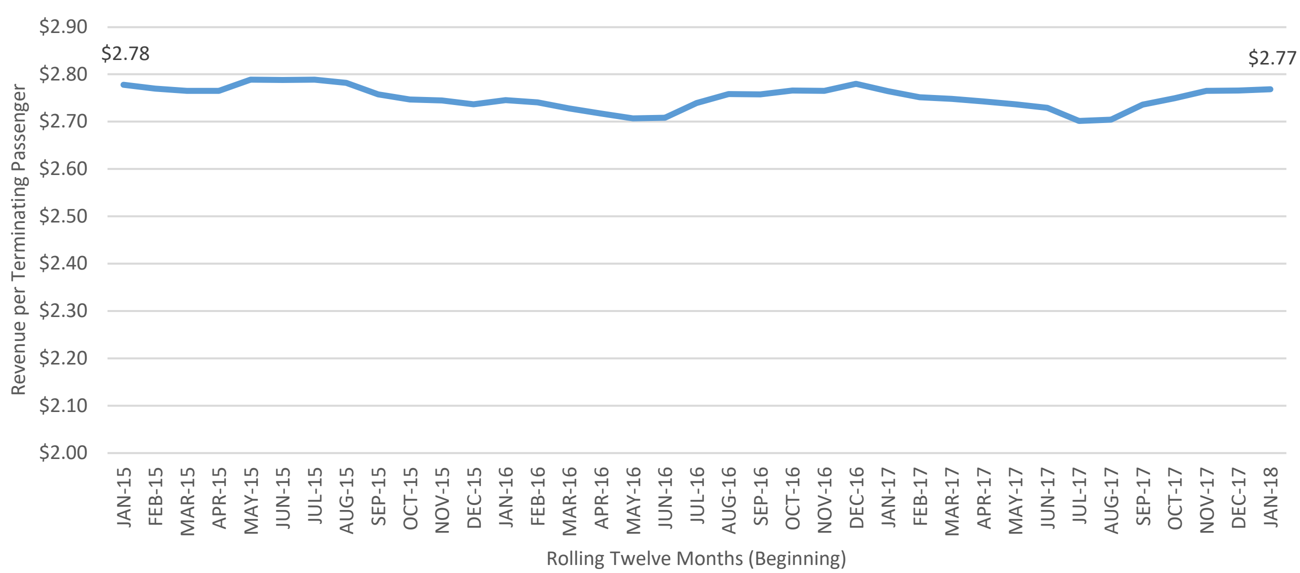
The Airport collects two types of revenues from the on-airport rental car companies: 11.11 percent of gross rental car revenues and a customer facility charge (CFC) from each rental car transaction. Prior to April 2017, the Airport collected a CFC of $1.00 per transaction, but starting in April 2017, the CFC was changed to $0.50 per transaction day. Utilizing an average of four days per rental car transaction, this effectively doubles the CFC revenue collected per vehicle rented. As a result, CFC revenues per terminating passenger have increased from $0.14 in CY 2016 to $0.25 in CY 2018 but is offset by a decrease in the percent of gross revenue over that same period, resulting in a net gain of $0.02 revenue per terminating passenger between CY 2016 and CY 2018. **Exhibit 4-103** presents the rental car revenue per terminating passenger on a rolling twelve-month basis.

EXHIBIT 4-102 RENTAL CAR TRANSACTIONS PER TERMINATING PASSENGER



SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

EXHIBIT 4-103 RENTAL CAR REVENUE PER TERMINATING PASSENGER



SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

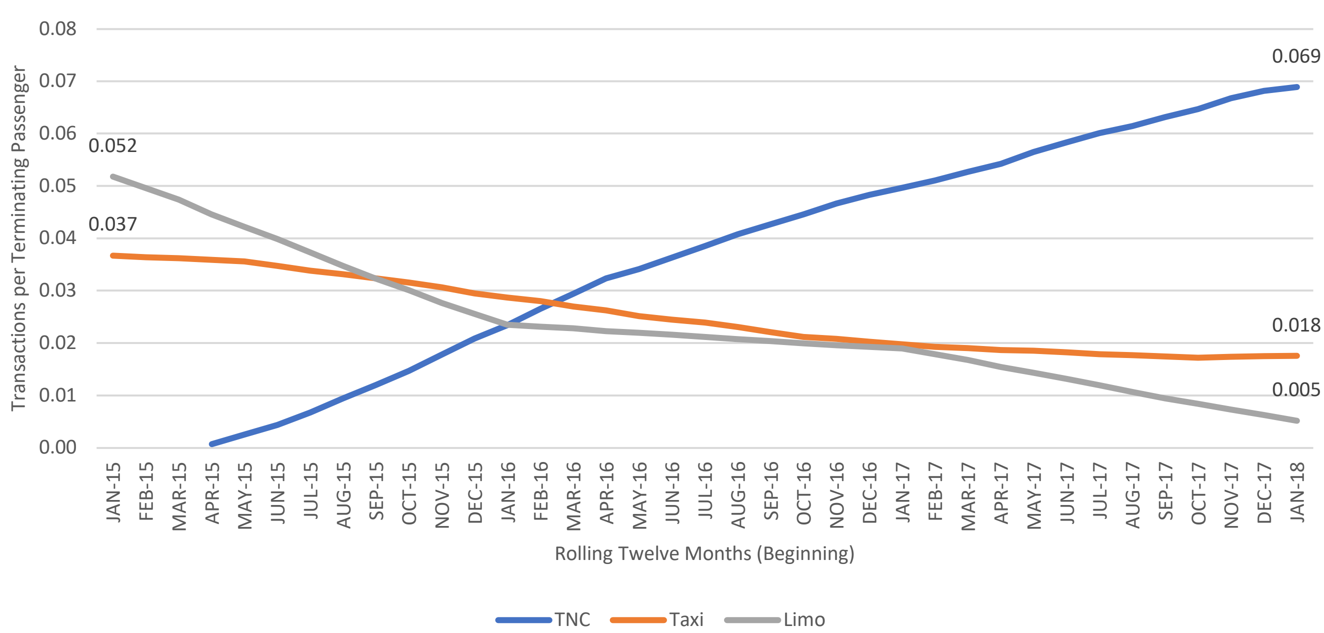
4.14.1.3 COMMERCIAL AND COURTESY VEHICLES

TNCs, taxis, and limos, also provide access to MKE's passenger terminal. The Airport has collected $3.00 per TNC pick-up trip since TNCs started officially operating at the Airport in March 2016. Prior to this time TNCs may have been picking up and dropping off customers at the Airport but the activity was not tracked, and revenues were not collected. Limousines are charged $3.00 per entrance into the designated parking area. Taxicabs prior to September 2016 were charged $1.00 per pick-up trip, with the rate increasing to $3.00 per pick-up trip after September 2016.

Exhibit 4-104 presents transactions per terminating passenger on a rolling twelve-month basis for TNCs, taxis and limos. TNC transactions per terminating passenger have increase from zero before March 2016 to 0.069 for CY 2018. During this same period limos transactions per terminating passenger decreased 78% and taxi transactions per terminating passenger decreased 39% from CY 2016 to CY 2018. The increase in TNC activity more than offsets the decrease in limo and taxi activity, indicating that TNCs shifted share from other ground transportation modes.

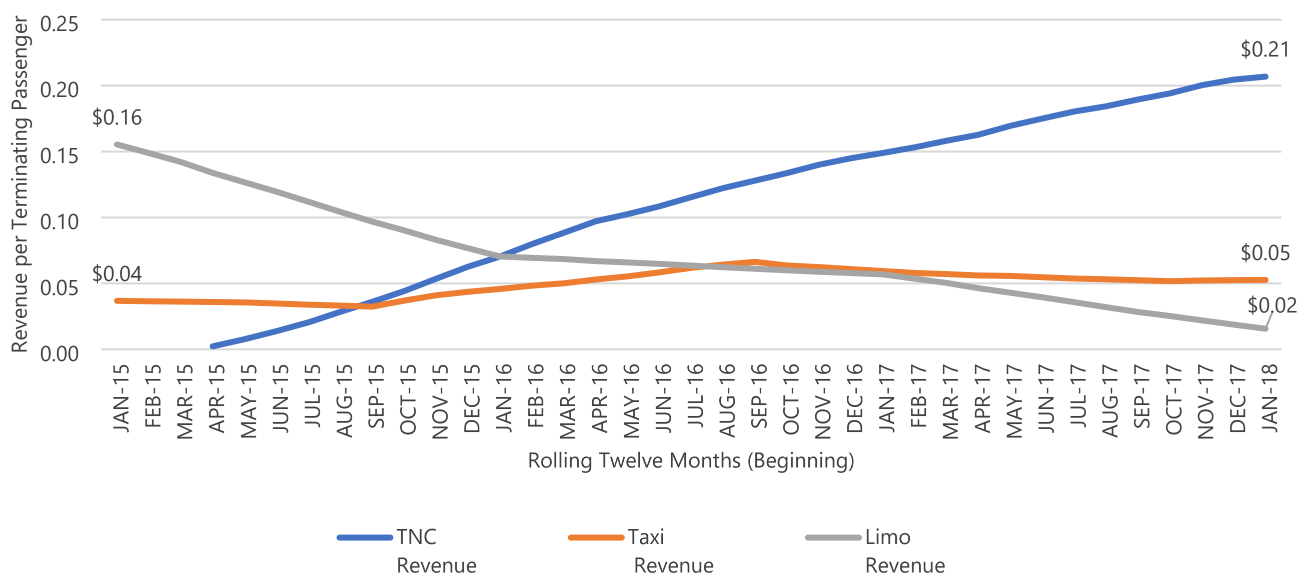
Revenue per terminating passenger trends for TNCs, taxis, and limos are presented in **Exhibit 4-105**, and reflect the changing trends in transactions. By CY 2018, TNC revenue per terminating passenger increased to $0.21 per terminating passenger. During the same period, taxi revenues increased from $0.04 to $0.05 per terminating passenger due to the per trip fee increase from $1/trip to $3.00/trip in September 2016. Limo revenue per terminating passenger decreased from $0.16 in 2015 to $0.02 in 2018.

EXHIBIT 4-104 GROUND TRANSPORTATION TRANSACTIONS PER TERMINATING PASSENGER



SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

EXHIBIT 4-105 GROUND TRANSPORTATION REVENUE PER TERMINATING PASSENGER



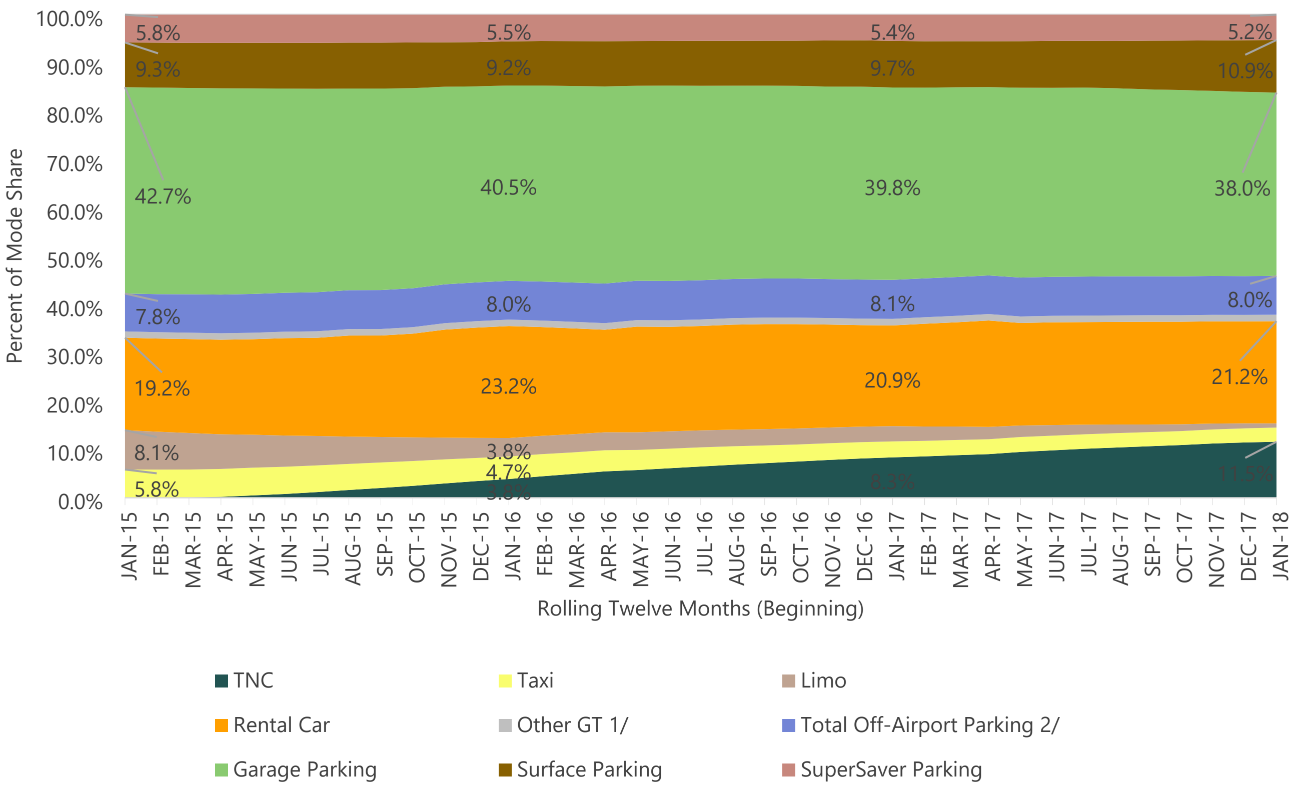
SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

A portion of the growth in TNC activity and revenues appears to have come at the expense of other ground transportation products. However, decreases in activity for other ground transportation products does not fully account for the growth in TNCs. While private vehicle pick-up and drop-off activity is not tracked by the Airport, activity trends suggest a component of the growth in TNC activity represents a shift from private vehicles picking up and dropping off passengers at the Airport.

4.14.1.4 TRANSACTIONAL MODE SHIFT

To better understand the transactional mode-shift, all ground transportation products were assessed at a percentage of overall transactions on a rolling twelve-month basis. **Exhibit 4-106** graphically depicts each ground transportation product's respective market share from CY 2015 through CY 2018.

EXHIBIT 4-106 TRANSACTION MODE SHARE TREND 2015-2018



NOTES:

1 Other GT includes: County Shuttle Charter Bus, Scheduled Bus and Hotel Courtesy Shuttles; Other GT has represented approximately 1.3% of transaction mode share.

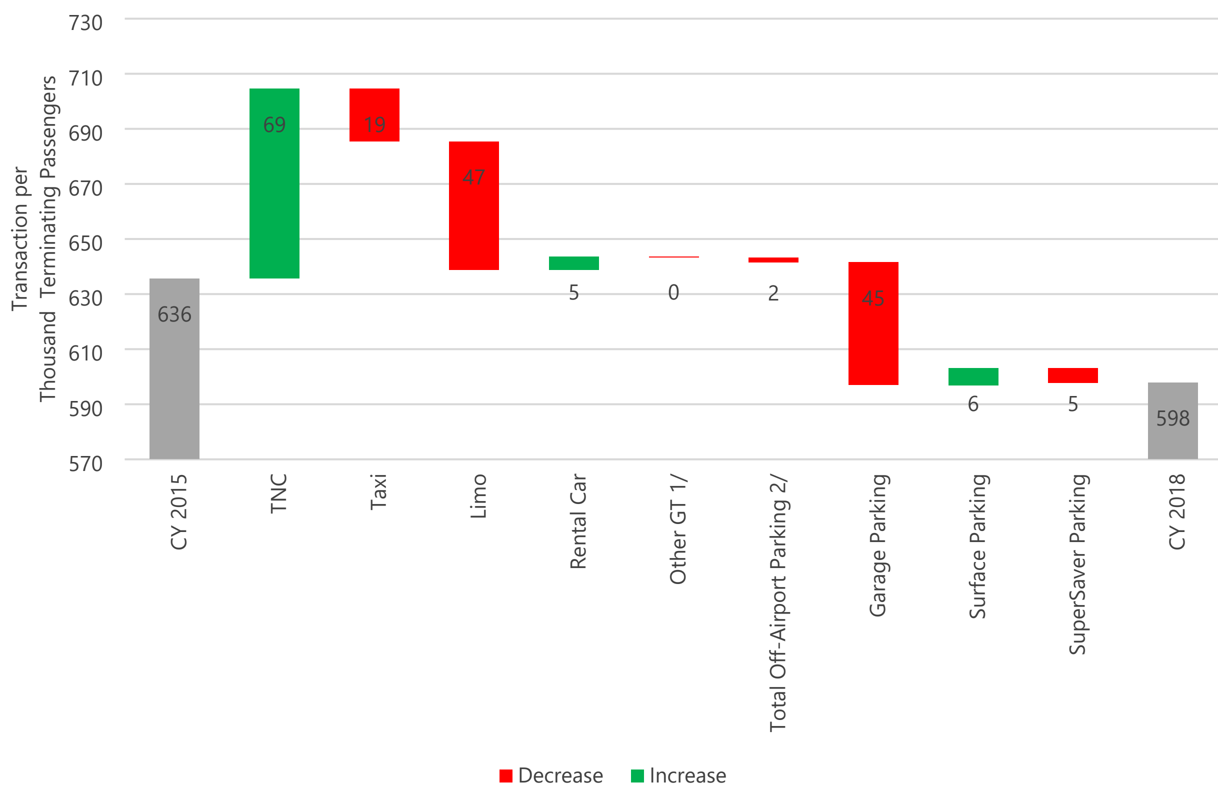
2 Off-Airport Parking Includes: Economy Parking, Exec Parking, FastPark & Relax and Wally Park.

SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

During this period TNC share of total ground transportation transactions has increased from zero to approximately 11.5 percent. While TNC transactions were not recorded until March 2016, TNCs were picking up and dropping off passengers at the Airport before this time and their actual (though unrecorded) share of ground transportation was greater than zero. Garage parking is holding the largest portion of the market share of total transactions at the airport, but that market share has decreased from 42.7 percent in CY 2015 to 38.0 percent in CY 2018. The more price sensitive surface parking, SuperSaver and off-airport parking have all retained approximate constant market share. On a consolidated basis, taxi and limo share has decreased from 13.9 percent to 3.8 percent. Rental car share of transactions has increased marginally from 19.2 percent to 21.2 percent. Rental car is the only mode to experience an increase of greater than 1 percent in market share of transactions other than TNC's. Surface parking has grown 1.6 percent in market share from 2015 to 2018, but those increases are likely attributed to increases in the use of the lot as a cellphone lot, which do not generate any revenue per transaction.

Exhibit 4-107 presents the change in transactions per thousand deplaned terminating passengers between CY 2015 and CY 2018. During this period, total transactions per thousand terminating passengers decreased 5.97 percent from 636 to 598. TNCs experience the greatest transactional growth along with smaller growth from surface parking and rental car. This growth was offset by decreases in activity for taxis, limos and garage parking. All other modes of ground transportation experienced relatively no change in transactions per terminating passenger during the study period from CY 2015 to CY 2018.

EXHIBIT 4-107 TRANSACTIONS PER THOUSAND TERMINATING PASSENGERS: CY 2015 VERSUS CY 2018



NOTES:

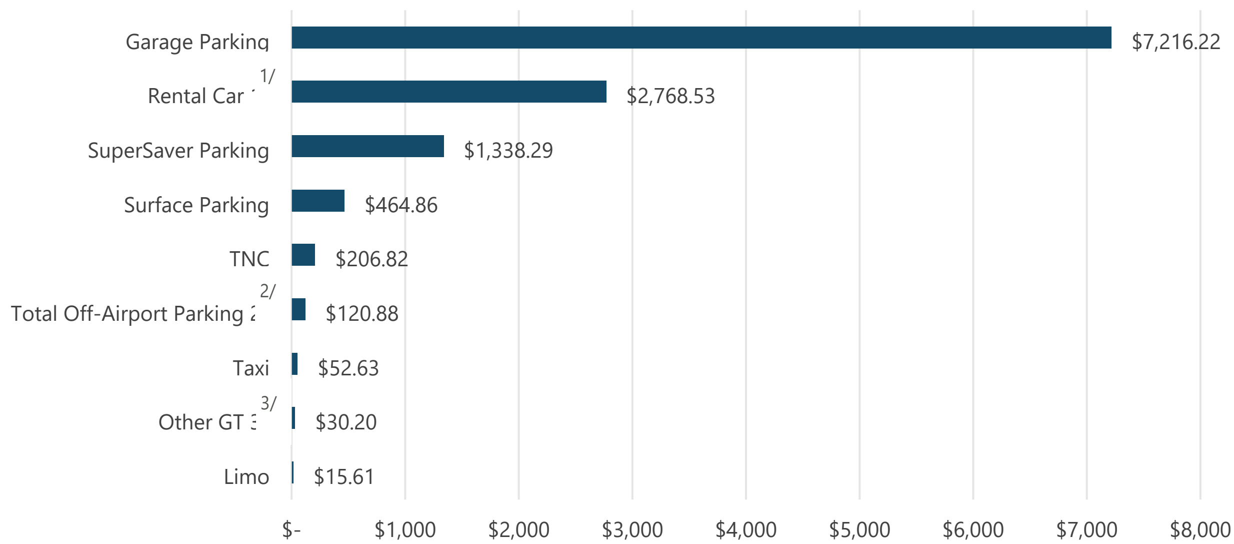
1 Other GT includes: County Shuttle Charter Bus, Scheduled Bus, and Hotel Courtesy Shuttles.

2 Off-Airport Parking Includes: Economy Parking, Exec Parking, FastPark & Relax, and Wally Park.

SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

Exhibit 4-108 presents the average revenue per terminating passenger for each of the ground transportation modes. Garage Parking generates the largest source of ground transportation revenue at $7,216 per thousand terminating passengers, which represents 59 percent of all ground transportation revenue on a per terminating passenger basis. Other sources generating the highest revenue for the airport are rental car (23 percent), SuperSaver parking lots (11 percent) and on-airport parking at the surface parking lot (3.7 percent), followed by TNC fees (1.7 percent).

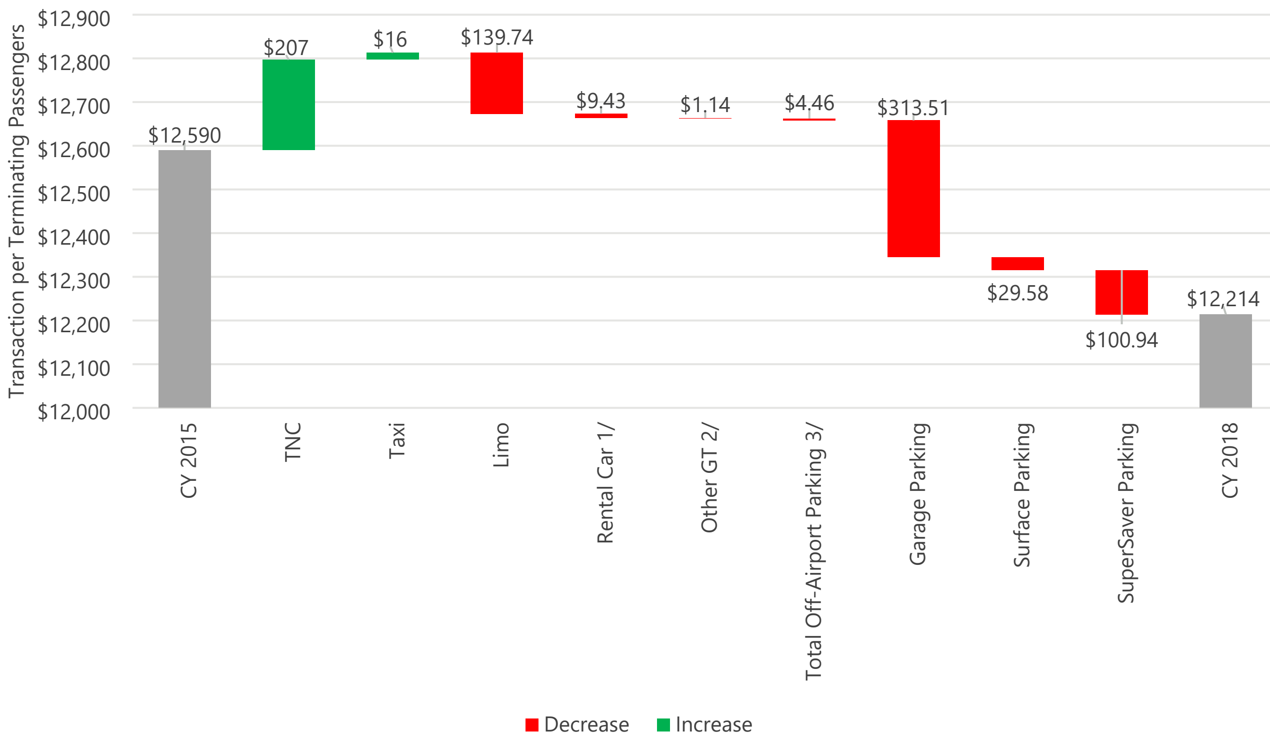
EXHIBIT 4-108 SOURCES OF LANDSIDE REVENUE PER THOUSAND TERMINATING PASSENGERS: CY 2018



NOTES:
1 Rental Car includes: CFC Revenue and 11.11% of Gross Revenue.
2 Off-Airport Parking Includes: Economy Parking, Exec Parking, FastPark & Relax and Wally Park.
3 Other GT includes: County Shuttle Charter Bus, Scheduled Bus and Hotel Courtesy Shuttles.
SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

Exhibit 4-109 presents the change in revenue per thousand terminating passengers between CY 2015 and CY 2018. During this period, total revenue per thousand terminating passengers decreased $376.09, which represents a 3.0% decrease since CY 2015. Since TNC began operations in March 2016, they have grown to generate $206.82 per thousand terminating passengers, and taxicabs have marginally increased $15.88 per thousand terminating passengers mostly due to the increase in trip fees imposed by the Airport from $1.00/trip to $3.00/trip, effective September 2016, but have been losing market share monthly to TNCs. Rental car revenues per terminating passenger have also decreased $9.43 per thousand terminating passengers, mostly due to the change in CFC structure from changing $1.00 per contract to $.50 per day. The largest decline in revenue per terminating passenger are the garage parking vehicles, which have fallen 5.9 percent in transactions and $313.51 in revenue per thousand terminating passengers. Also notable, limousines have fallen 89 percent in transaction and $139.74 in revenue per thousand terminating passengers.

EXHIBIT 4-109 REVENUE PER THOUSAND TERMINATING PASSENGERS: CY 2015 VERSUS CY 2018



NOTES:

1 Rental Car Revenue includes: CFC Revenue and 11.11% of Gross Revenue.

2 Other GT includes: County Shuttle Charter Bus, Scheduled Bus, and Hotel Courtesy Shuttles.

3 Off-Airport Parking Includes: Economy Parking, Exec Parking, FastPark & Relax, and Wally Park.

SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

4.14.2 GROUND TRANSPORTATION BENCHMARKING AND FEE STRUCTURE ANALYSIS

This section presents the ground transportation business arrangements and fee structures at select medium hub airports as well as an estimate of the ground transportation revenues the Airport might generate through the adoption of alternative fee structures and policies currently in place at peer airports.

4.14.2.1 BENCHMARKING

Ricondo compared the Airport's ground transportation fee structures to six other United States airports that participated in the 2018 Airport Ground Transportation Association (AGTA) survey that have similar passenger volumes and proportion of O&D versus connecting passengers. **Table 4-124** presents the six peer airports analyzed for this study.

The fees charged by airport operators throughout the United States vary by both the type of fee and the mode of transportation. The most typical types of fees are as follows:

- Access/Trip fee – An access or "trip" fee is typically a fee charged on a per-trip basis each time a commercial vehicle accesses the airport. Trip fees are often implemented to equitably charge ground transportation operators for their use of airport facilities. An Automated Vehicle Identification (AVI) system may be used to track commercial vehicles and to charge them accordingly. The airport operator categorizes this as a fee assessed against certain commercial operators each time the operator's vehicle(s) enters(s) the commercial roadway system for transporting airport passengers.
- Dwell-time fee – A dwell-time fee is typically implemented on a punitive basis to charge commercial vehicles according to how much time they spend at the airport on each trip. The airport operator categorizes a dwell-time fee as a varying fee equivalent to the amount of one per-trip fee for each additional specified minute interval that a commercial operator's vehicle is within the commercial roadway system beyond the applicable dwell-time allowance.
- Permit fee – A permit fee is typically an administrative fee used to establish a formal business arrangement between an airport and a commercial vehicle operator. Permits may be issued on a per-company or per-vehicle basis.
- Privilege fee – A privilege fee is charged to a commercial vehicle operator for the privilege of doing business at an airport. A privilege fee is typically charged as a percentage of gross revenue and is usually reserved for operators that draw most or all their business from the airport. The airport operator categorizes this as a fee assessed against certain commercial vehicle operators, and it is calculated based on a percentage of the operator's gross revenues.

Table 4-124 lists the peer airports corresponding fee structures and associated characteristics. It is important to note that under the Federal Aviation Administration's Airport Compliance Manual, that non-aeronautical revenues can be market based, assist in supporting aeronautical activity, and not solely based on cost recovery.[22]

[22] Airport Compliance Manual, United States Department of Transportation, Federal Aviation Administration, Order 5190.6B (2009).

TABLE 4-124 COMMERCIAL GROUND TRANSPORTATION FEES AND CHARGES AT BENCHMARKED AIRPORTS

AIRPORT	2018 ENPLANED PASSENGERS	OFF-AIRPORT PARKING	HOTEL/MOTEL COURTESY VEHICLE	OFF-AIRPORT RENTAL CAR	ON-AIRPORT RENTAL CAR	ON-DEMAND SHARED RIDE SERVICES (DOOR-TO-DOOR VANS)	LIMOUSINES	CHARTER	TNC	TAXICABS
General Mitchell International Airport (MKE)	*3,548,817*	*$500.00 annual permit/vehicle fee +6% of gross receipts*	*Permit: $500/vehicle (plus $25 application fee) Per Trip: N/A Dwell Time: N/A*	*$150 annual permit/vehicle (plus $25 application fee) 6.5% of gross receipts*	*Minimum guarantee or 11.11% of gross receipts and: +$6.24/sq.ft. annual fee for ready car spaces +$35/sq.ft. annual fee for counter space*	*In-county: $125 annual permit + $2/User Fee Out-of-county: $250 annual permit + $3/trip*	*$3/trip and no annual permit*	*Scheduled: $1.00/Trip Fee plus $.50 per passenger Unscheduled bus size: 12-23 pass. $6.00/day; 24 or >pass. $10.00/day Convention see 4.05.07 $6/bus $10/convention + $0.15 per passenger*	*$3/trip per pickup Annual Fee: $125*	*Gate Fee: $3/user fee Annual Fee: $125*
2018 MKE Revenue [1/]		$418,000	$11,000	Not available	$9,577,000	Not available	$54,000	$32,000 + $26,000	$715,000	$182,000
Cleveland Hopkins International Airport (CLE)	4,836,580	$500/vehicle/year	Permit: $550/vehicle/year	Is a consortium	N/A	N/A	Corporate limousines: $550 permit fee/year/vehicle Special events limousines: $10/day/vehicle	$550/vehicle/year	$4 pickup/drop-off surcharge added to all fares	Gate Fee: $4/trip
Southwest Florida International Airport (RSW)	4,719,568	4% of gross revenue <$20,000/month 8% of gross revenue in excess of $20,000/month $1/trip fee (self-reported) Monthly vehicle permit	Permit: N/A Per Trip: $2 billed monthly Dwell Time: Trip fee every 15 minutes	4% of gross revenue <$20,000/month 8% of gross revenue in excess of $20,000/month $1/trip fee (self-reported) Monthly vehicle permit	No separate shuttle charge (no shuttles are operated) 10% of gross revenues	No operators- would need to be contracted	$100/year/vehicle Based on Airport's fiscal year (October 1-September 30). Fee not prorated or refundable	$20/trip billed monthly $80/trip for companies operating without a license/permit unless it's an IROPS event-- then fee is $20 No charge for a license/permit	$2 pickup fee	Gate Fee: $2/trip payment without billing Annual Fee: None
Cincinnati/ Northern Kentucky International Airport (CVG)	4,440,014	10% gross revenues and report parking transactions	Permit: Yes Per Trip: $2/trip with $100/vehicle annual registration fee Dwell Time: N/A	10% of gross revenues	10% of gross revenues	Contract with single operator - $2/trip	With a per trip permit: $3/trip with $100/vehicle annual registration Daily permit: $50/vehicle/day	Pre-arranged buses 14 passengers or less: $50/vehicle/day Buses 15 passengers or more: $100/vehicle/day	$3 pickup surcharge	Concession Fee: Contract with a single operator - $2/trip or 2% of gross revenues, whichever is higher
John Glenn Columbus International Airport (CMH)	4,054,572	10% of gross revenues	Permit: Yes Per Trip: $3/trip Dwell Time: No charge	10% of gross revenues	10% of gross revenues	N/A	$3/trip	$10/trip	$3 pickup surcharge	Gate Fee: $3/trip Annual Fee: N/A Concession Fee: Annual Fee $131,000; additional monthly fee $0.01 per deplanement after $280,000
Jacksonville International Airport (JAX)	3,118,540	6% of gross revenues	Permit: $50/annual per company Per Trip: $3.25/trip Dwell Time: No charge	6% of gross revenues	10% of gross revenues	$3.25/pickup	$3.25/pickup	$20/pickup	$3.25 for each trip	Gate Fee: $3.25/user fee Annual Fee: $5,000
Will Rogers World Airport (OKC)	2,170,947	Shuttle buses $660/year/vehicle paid to OCAT	Permit: $660/year	$660/year/vehicle paid to OCAT	10% of gross/minimum guarantee (bid/agreement)	$660/year/vehicle paid to OCAT	$660/year/vehicle paid to OCAT	N/A	None listed	Gate Fee: N/A Annual Fee: $660/year/vehicle paid to OCAT

NOTE: MKE Revenue reported is only the per transaction portion of the total revenue and does not include the per vehicle annual fees.
SOURCES: Milwaukee Mitchell International Airport, June 2019; CODE OF ORDINANCES County of MILWAUKEE, WISCONSIN Codified through Ordinance No. 19-4, adopted April 25, 2019. (Supp. No. 72); *AGTA 2018 Ground Transportation Vehicle Fees and Fares Survey*, March 2018.

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4.14.2.2 FEE STRUCTURE

The current fee structure at MKE for each ground transportation mode is within comparable range of the peer airports included within this benchmark study. The Airport currently only charges for TNC pick-ups while two of the six peer airports charge an airport fee for both pick-up and drop-offs. Adding a $3 trip fee for drop-offs would double the amount of revenue generated by transportation network companies/autonomous vehicles (TNCs/AVs), which are expected to be the Airport's fastest growing mode, and help offset the decrease in revenues from ground transportation modes with declining mode share. While adding a drop-off fee for TNC's represents an opportunity to generate incremental ground transportation revenue, any changes in TNC fees must comply with state regulations requiring TNC fees not to exceed airport access fees charged for other for-hire vehicles.[23]

Other sources of potential fee structure changes include charging a higher percent of gross receipts for off-airport parking and off-airport rental car. All other per vehicle annual fees or per trip fees at MKE are in line with those charged by peer airports and no adjustments to the fee structure are recommended at this time.

4.14.3 DEVELOPMENT OF FUTURE GROUND TRANSPORTATION SCENARIOS

Evaluation of historical ground transportation activity patterns served as the basis for developing three different future mode share scenarios to project landside activity and revenues at the Airport through the planning horizon. The development of these scenarios took into consideration the following variables:

- *Growth of TNCs and ride-sharing* — Growth of TNC activity and share of airport access accelerated mode share changes that have already occurred and have begun to displace modes that have not yet been impacted. The scenarios assumed different growth rates for TNC mode share and residual impact to other modes.
- *Evolution of the TNC business model* — The TNC business model is not at steady state. The relevance and relative size of the current players in this space are still changing. Their business models are evolving as they pursue new product and service offerings to achieve sustained profitability. These changes could impact customer preferences for TNCs and volume of activity at the Airport.
- *Autonomous vehicles* — Autonomous vehicle technology is rapidly evolving, and fully autonomous vehicles may be operating on public roadways within the next few years. This technology could potentially reset the economics of TNCs, driving down costs and increasing activity and mode share. The "transportation-as-a-service" (TaaS) business model incorporates fleets of autonomous vehicles operated by TNCs, rental car companies or other entities. The TaaS model could blur the line between existing forms of ground transportation. The scenarios developed in this analysis consider how the development of technology, public policy, and regulations as well as public acceptance of autonomous vehicles influence how quickly this technology drives changes in ground transportation patterns. For the purposes of projecting future mode share, TNCs and autonomous vehicles have been consolidated (referred to as TNC/AV) under the assumption that most or all TNC trips are operated by autonomous vehicles in the future.
- *Trends in private vehicle ownership* — Demographics may drive a reduction in private vehicle ownership as younger generations increasingly prefer the convenience and economics of using TNCs and public transportation over owning and driving vehicles. This trend could be accelerated by the development of autonomous vehicles operated as shared fleets. These factors would reduce the demand for parking and

[23] 2015 Wisconsin Act 16 Regulation of Transportation Network Companies

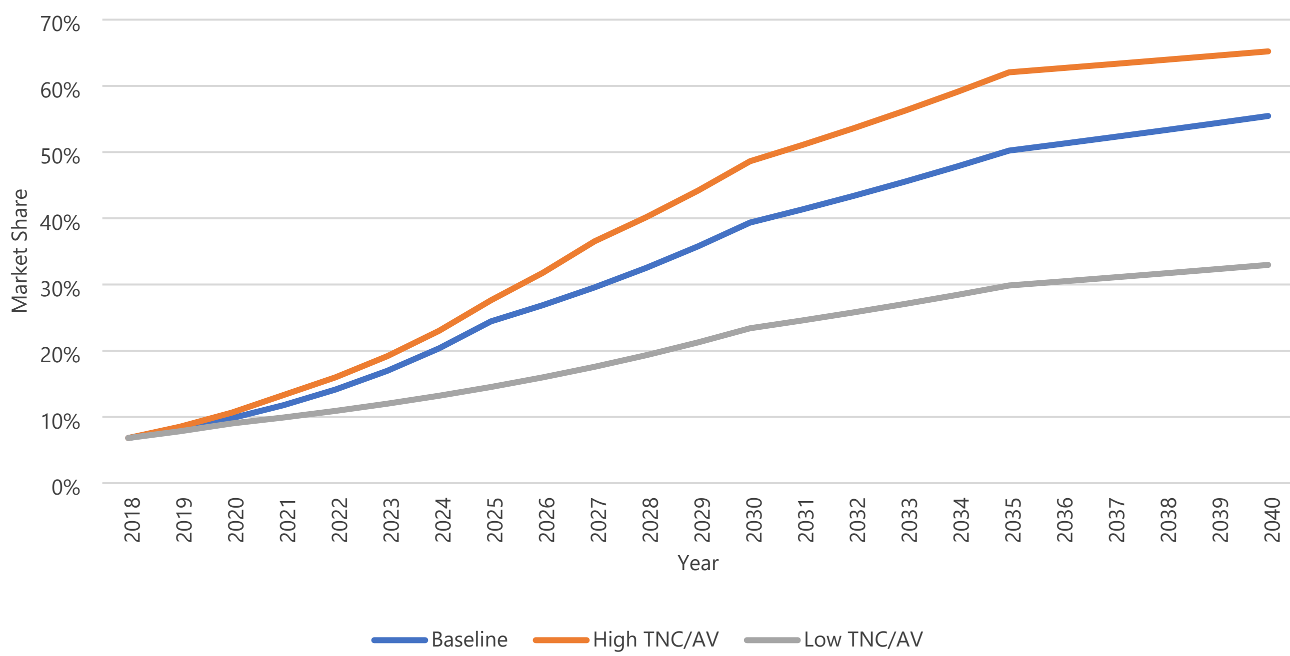
increase demand for TNCs and mass transit. The scenarios consider different rates of change in private vehicle ownership.

- *Development and expansion of mass transit infrastructure* — The Airport is currently served directly by Milwaukee County Transit System Green line. The Amtrak Hiawatha line links downtown Milwaukee and downtown Chicago and stops at the Milwaukee Airport Rail Station where passengers can take a shuttle to the Airport. Expansion of the regional transit system as well as other integrated public transportation networks could increase use of this mode to access the Airport. However mass transit is not a component of the mode share scenarios as it has represented a very small share of total mode share and any growth in this sector is not expected to meaningfully shift demand away from TNCs and private vehicles.
- *Air traffic and passenger segmentation trends* — Changing passenger segmentation patterns, such as a shift in the proportion of origin/destination (O&D) versus connecting passengers, could impact the demand for ground transportation products. None of the passenger forecast scenarios project a large enough change in the composition of passengers as to substantially impact the share different ground transportation products represent.

The three scenarios, each of which consider different rates of growth for the TNC/AV mode share over the course of the projection period, are presented in **Exhibit 4-110** and further defined below:

- In the Baseline scenario, TNC transactions per O&D passenger are projected to grow initially at approximately 20 percent per year before slowing to a plateau at 55.5 percent of the market share by 2040. Other ground transportation modes will regress at 2.0 percent per year, and the remaining private vehicle/non-transactional modes demand will assume the remaining market share starting at 40.6 percent in 2018 and decreasing to 11.7 percent in 2040.
- In the High TNC/AV scenario, TNC/AV transactions per O&D passenger are projected to grow initially at approximately 25 percent per year before slowing to a plateau at 65.2 percent of the market share by 2040. Other ground transportation modes regress at 3.0 percent per year, and the remaining private vehicle/non-transactional modes demand will assume the remaining market share starting at 40.9 percent in 2018 and decreasing to 8.0 percent in 2040. This high scenario assumes private vehicle ownership decreases at an accelerated rate and is displaced by the TaaS business model of mobility.
- In the Low TNC/AV scenario, TNC/AV transactions per O&D passenger are projected to grow initially at approximately 15 percent per year before slowing to a plateau at 33 percent of the market share by 2040. Other ground transportation modes will regress at 1.5 percent per year, and the remaining private vehicle/non-transactional modes demand will assume the remaining market share starting at 40.9 percent in 2018, decreasing to 29.5 percent in 2040. This low TNC/AV scenario presents a maturation of the current TNC level of market share penetration and is likely to be obtained even if AVs are not developed or implemented on a meaningful scale.

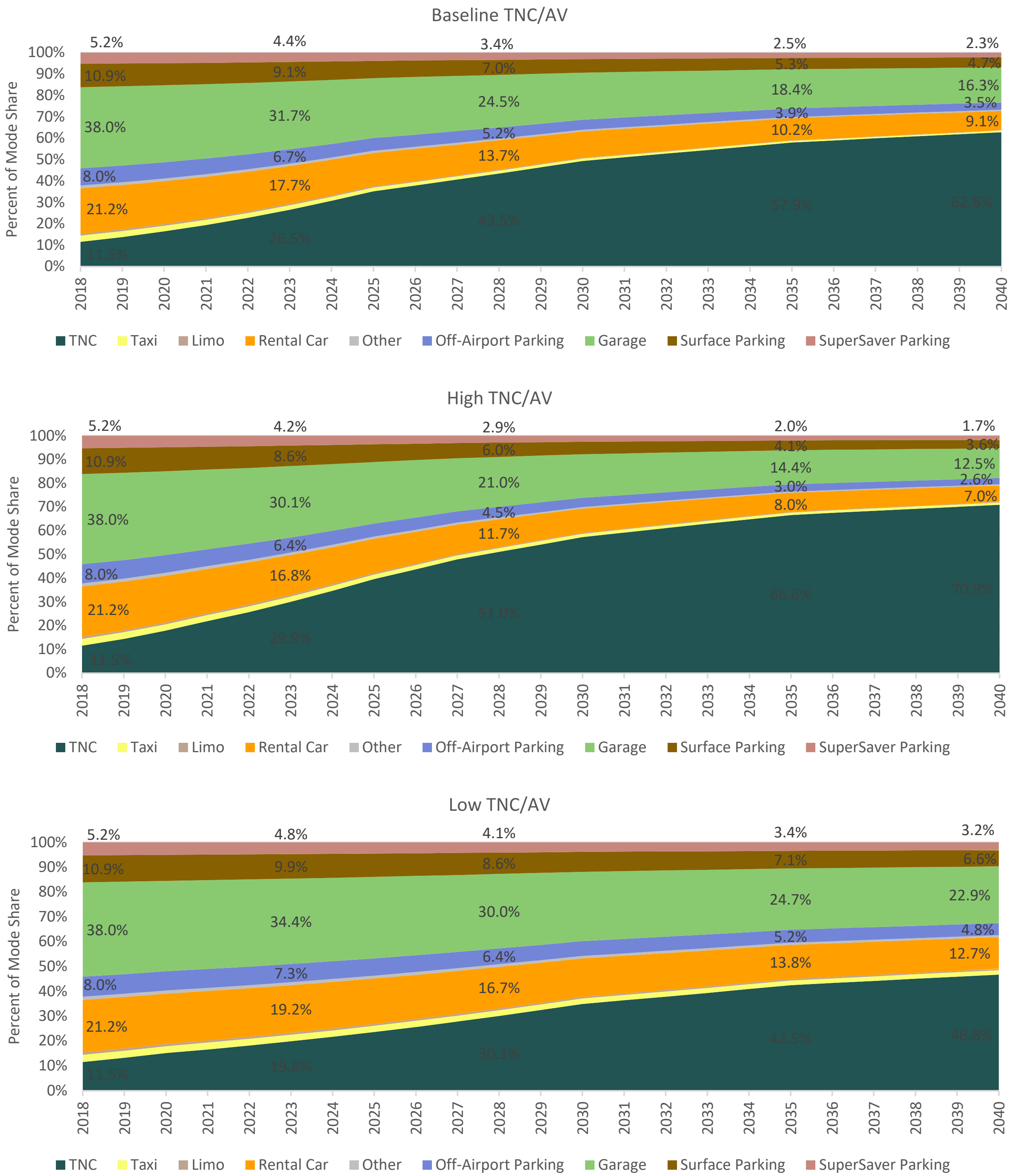
EXHIBIT 4-110 FUTURE TNC/AV GROWTH SCENARIOS



SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

In comparison to Exhibit 4-106, which shows the Transaction Mode Share Trend (2015-2018), similar mode share between the revenue generating Ground Transportation Modes (does not include Private Vehicles at curbsides) is presented for the three scenarios (Baseline/High TNC AV/Low TNC/AV) in **Exhibit 4-111**.

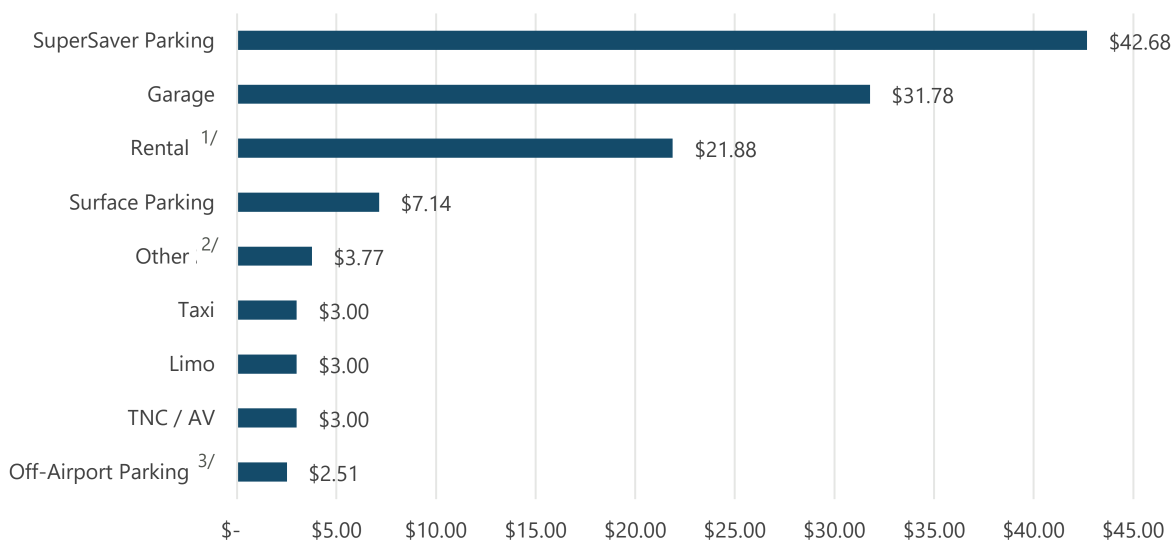
EXHIBIT 4-111 PROJECTED TRANSACTION MODE SHARE FOR THREE SCENARIOS



SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

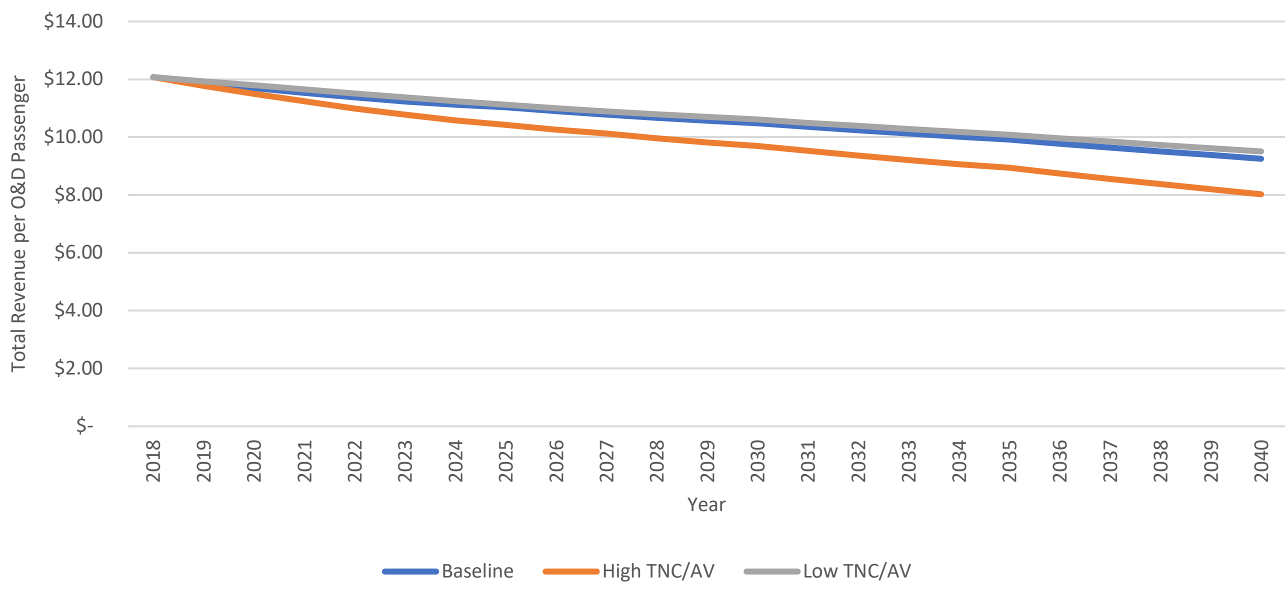
Changes in ground transportation modes may shift activity away from high revenue per transaction products such as on-airport parking and rental car. **Exhibit 4-112** presents the 2018 average revenue per transaction for each of the ground transportation modes. TNCs currently represent $3.00 per pick-up transaction, whereas the Rental Car ($21.88/transaction), Garage Parking ($31.78/transaction) or SuperSaver Parking ($42.68/transaction) generate higher revenue per transaction. Growth in TNC/AV mode share that displaces higher revenue per transaction modes is projected to dilute total revenue per O&D passenger as presented in **Exhibit 4-113**. Despite the projected decrease in revenue per O&D passenger, growth in the volume of O&D passengers will enable growth in total ground transportation revenue as presented in **Exhibit 4-114**. Total revenue is projected to increase in both the baseline and low TNC/AV scenarios and revenue is essentially unchanged in the high TNC/AV scenario which projected the lowest revenue per O&D passenger of the three scenarios. Note that the representation of future revenue per O&D passenger and total ground transportation revenue is based on current revenue per transaction values and does not assume any increases over time. Changes in fee structures and arrangements with ground transportation providers would likely result in higher revenue on a per passenger basis as well as in aggregate.

EXHIBIT 4-112 AVERAGE REVENUE PER TRANSACTION (CY 2018)



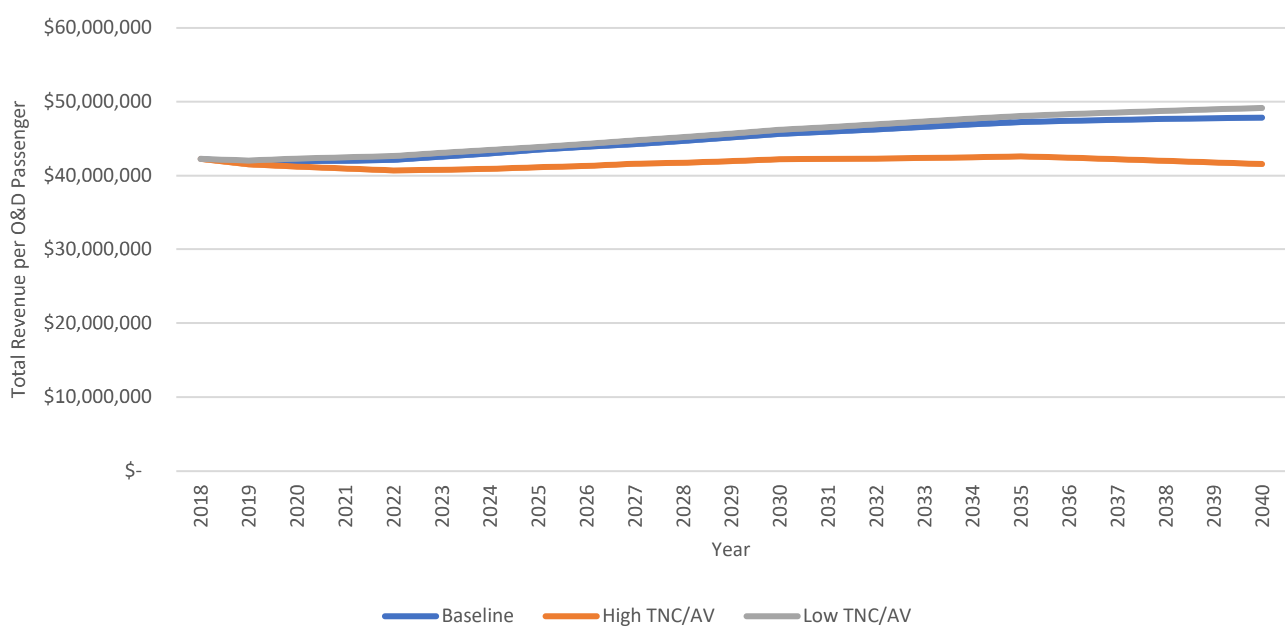
NOTES:
1 Rental Car Revenue includes: CFC Revenue and 11.11% of Gross Revenue.
2 Other GT includes: County Shuttle Charter Bus, Scheduled Bus, and Hotel Courtesy Shuttles.
3 Off-Airport Parking Includes: Economy Parking, Exec Parking, FastPark & Relax, and Wally Park.
SOURCES: Milwaukee Mitchell International Airport, June 2019 (data), Ricondo & Associates, Inc., June 2019 (analysis).

EXHIBIT 4-113 PROJECTED GROUND TRANSPORTATION REVENUE PER O&D PASSENGER



NOTE: Projected revenue is based on current revenue per transaction values and does not reflect any assumed increases over the analysis horizon.
SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

EXHIBIT 4-114 PROJECTED TOTAL GROUND TRANSPORTATION REVENUE



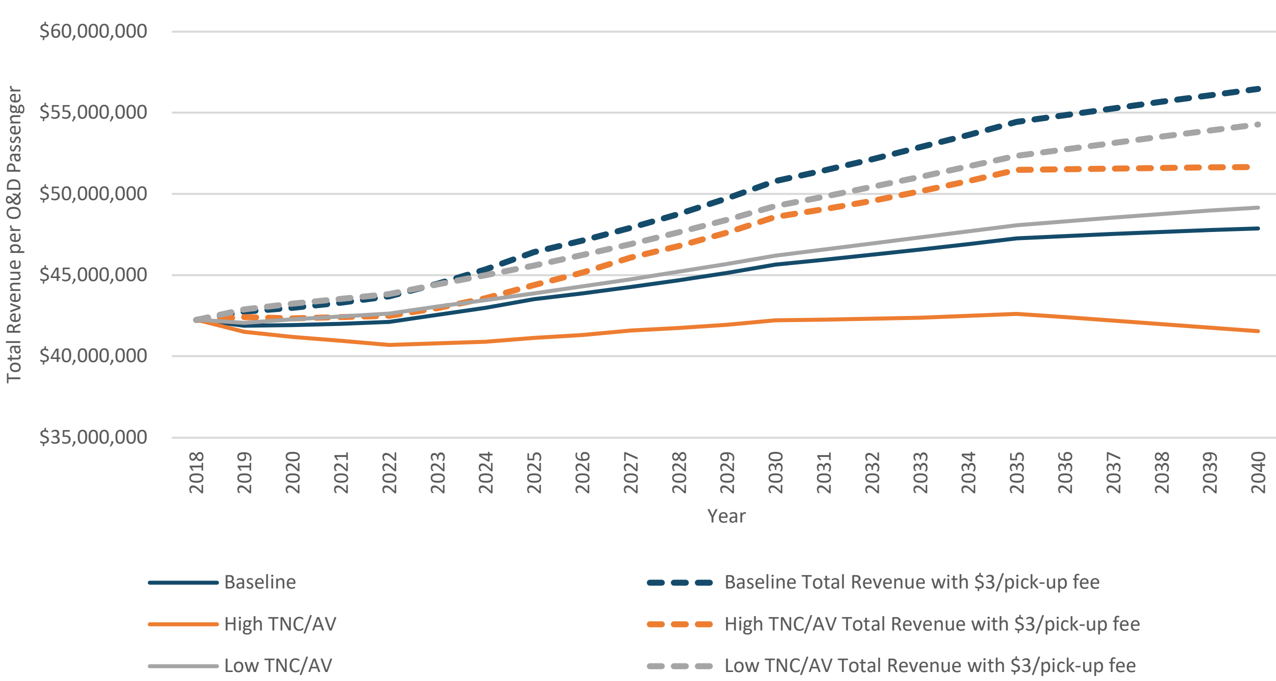
NOTE: Projected revenue is based on current revenue per transaction values and does not reflect any assumed increases over the analysis horizon.
SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

4.14.4 LONG TERM STRATEGIC RECOMMENDATIONS

Given that either of the three future of Baseline, High TNC/AV or Low TNC/AV scenarios are possible depending on the maturation of the TNC/AV market, we have projected that all three scenarios result in a lower revenue per O&D passenger without any adjustments to the current ground transportation fees. New fees adopted by the airport need to be in line with industry trends as researched in the benchmarking but also need to cover the applicable operating costs for the Airport. Therefore, the existing fees and charges at MKE are similar to the other airports but should increase bi-annually to keep up with the changing demands. Also, the rates need to be reasonable as to not make a trip to the Airport via a TNC/AV no longer cost effective for the passenger versus a TNC/AV trip somewhere other than the Airport.

The most obvious recommended Long-Term strategy to help offset the decline in potential revenues per O&D passenger highlighted earlier would be to have the county ordinances changed so that the TNC/AV fees can be changed to add TNC drop-off fee of $3/trip. Incorporating a TNC drop-off fee, in compliance with state and county regulations, represents the largest opportunity to offset a decrease in ground transportation revenues resulting from changes in mode share. **Exhibit 4-115** plots the projected annual ground transportation revenue with current fees versus the total revenue with the addition of the TNC $3/pick-up fees. In year 2040, when the TNC/AV market has matured, and a large mode shift to TNC/AV is expected, the addition of the TNC $3/pick-up fee can add as much as $10.1 million in the high scenario but has the most potential on overall revenues in the Baseline scenario where annual ground transportation revenues can top $56 million, of which $17 million will be TNC drop-off and pick-up fees. Incremental TNC drop-off fees would help compensate for some of the decline of the higher revenues per O&D passenger the airport is expected to experience as passengers change how they choose to travel to/from the Airport.

EXHIBIT 4-115 PROJECTED TOTAL GROUND TRANSPORTATION REVENUE WITH $3 TNC PICK-UP FEE



SOURCES: Milwaukee Mitchell International Airport, June 2019 (data); Ricondo & Associates, Inc., June 2019 (analysis).

As demand increases for TNCs/AVs, so do the demands on the curbside and other staging areas that support these modes of transport. The demand for curbside loading areas for TNCs/AVs will continue to grow and evolve as new TNC/AV curbside loading procedures develop to efficiently match passengers with vehicles.

In addition to providing enough curbside capacity to accommodate higher levels of TNC/AV activity, the Airport should consider additional measures to monitor ground transportation activity, improve operational efficiency, and maximize ground transportation revenues:

- Implement advanced TNC tracking technology to monitor TNC activity in real time to manage TNC operations, measure activity, and audit TNC billing
- Explore technology solutions to track all vehicles accessing the curbside which will enable a broader analysis of mode share changes inclusive of private vehicles
- Develop processes to continuously monitor all ground transportation activity and revenues to detect changes in patterns and mode share. Passenger survey data can supplement tracking of activity and support comprehensive analysis of patterns and passenger preferences.
- Collaborate with TNCs to develop and test operational enhancements such as PIN matching technology enabling TNC drivers to queue at the curbside, speeding up pick up times, and reducing congestion
- Explore opportunities to relocate TNCs or other ground transportation service providers to the garage depending on levels of congestion at the curbside and utilization of garage facilities
- Analyze segmented business models by charging higher fees for premium pick-up and drop-off locations

4.14.5 TERMINAL AREA CURBSIDE DEMAND/CAPACITY ANALYSIS

Curbside Utilization and Level of Service calculations were computed using the static spreadsheet model to determine the performance of the existing curbside allocations for each of the morning and afternoon peak hours for the future Planning Activity Levels for the three future demand scenarios (Baseline, High TNC/AV, Low TNC/AV). These analyses were performed to stress test the existing curbside facilities to understand which section of the curbside would be over capacity and experience a significantly diminished level of service (LOS) and which sections of curbside would be underutilized. In this analysis, double loading was only permitted in the designated private vehicle areas, and all commercial vehicle sections of the curbside had LOS computed using single-loading parameters. The results of these calculations are presented in **Exhibit 4-116** for the Departures curbside and **Exhibit 4-117** for the Arrivals and Ground Transportation curbsides.

The results show that all areas of planned TNC/AV loading and unloading eventually fail with LOS F, as TNC/AV volumes are planned to increase to over 14 times their current volumes. Other areas of commercial vehicle activity such as the Courtesy Shuttles, also fail as their volumes are already at a high level and continue to grow with the rise of passenger growth. Further refinement of the curbside allocation is addressed in Section 5, Alternatives Analysis.

4.14.6 TAXICAB AND COMMERCIAL VEHICLE STAGING

Staging area capacity and condition forecasted for the landside requirements are sufficient to meet demand as projected in the three mode share scenarios.

EXHIBIT 4-116 DEPARTURES CURBSIDE UTILIZATION LEVEL OF SERVICE – LANDSIDE STRATEGY DEMAND SCENARIOS

Courtesy Shuttles

150 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	E	E	E	F	F	F
2023	E	E	E	F	F	F
2028	E	E	E	F	F	F
2040	E	E	E	F	F	F

Go Shuttles

130 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	A	A	A	D	D	D
2023	A	A	A	D	D	D
2028	A	A	A	D	D	D
2040	A	A	A	D	D	B

Taxis

110 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	C	C	C	A	A	A
2023	C	C	C	A	A	A
2028	C	A	C	A	A	A
2040	C	A	A	A	A	A

Charter/Transit

125 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	A	A	A	A	A	A
2023	A	A	A	A	A	A
2028	A	A	A	A	A	A
2040	A	A	A	A	A	A

Charter

120 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	B	B	B	A	A	A
2023	B	B	B	A	A	A
2028	B	B	B	A	A	A
2040	B	B	A	A	A	A

Super Saver Shuttles

105 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	B	B	B	E	E	E
2023	B	B	B	E	E	E
2028	B	B	B	E	E	E
2040	B	B	B	E	E	E

Private Vehicles (Double Loading)

460 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	A	A	A	B	B	B
2023	A	A	A	C	C	B
2028	A	A	A	A	B	A
2040	B	B	B	B	A	A

LOS C or better

SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale), Ricondo & Associates, Inc., June 2019 (analysis).

EXHIBIT 4-117 ARRIVALS CURBSIDE UTILIZATION LEVEL OF SERVICE – LANDSIDE STRATEGY DEMAND SCENARIOS

Courtesy Shuttles

150 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	E	E	E	F	F	F
2023	E	E	E	F	F	F
2028	E	E	E	F	F	F
2040	E	E	E	F	F	F

Go Shuttles

130 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	A	A	A	D	D	D
2023	A	A	A	D	D	D
2028	A	A	A	D	D	D
2040	A	A	A	D	D	B

Taxis

110 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	C	C	C	A	A	A
2023	C	C	C	A	A	A
2028	C	A	C	A	A	A
2040	C	A	A	A	A	A

Charter/Transit

125 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	A	A	A	A	A	A
2023	A	A	A	A	A	A
2028	A	A	A	A	A	A
2040	A	A	A	A	A	A

Charter

120 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	B	B	B	A	A	A
2023	B	B	B	A	A	A
2028	B	B	B	A	A	A
2040	B	B	A	A	A	A

Super Saver Shuttles

105 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	B	B	B	E	E	E
2023	B	B	B	E	E	E
2028	B	B	B	E	E	E
2040	B	B	B	E	E	E

Private Vehicles (Double Loading)

460 ft.	AM			PM		
	Low	Base	High	Low	Base	High
Existing	A	A	A	B	B	B
2023	A	A	A	C	C	B
2028	A	A	A	A	B	A
2040	B	B	B	B	A	A

LOS C or better

SOURCE: Google Earth Pro, April 2019 (aerial photography-for visual reference only, may not be to scale), Ricondo & Associates, Inc., June 2019 (analysis).

4.14.7 CONCLUSIONS

Emerging technologies have impacted ground transportation activity and revenues at the Airport in recent years, driving changes in mode share and the composition of ground transportation revenues. Continued evolution of these technologies, development of new technologies such as autonomous vehicles and changing customer preferences are expected to accelerate the pace of these changes. While the timing and the patterns of these changes cannot be precisely projected, the future mode share scenarios present a range of potential outcomes for consideration in future facility and strategic business planning. Proper consideration of these scenarios, supported by consistent tracking of activity and solicitation of customer feedback, will help the Airport minimize disruption to operations and maintain proper levels of service. Additionally, the Airport can strategically manage fees and ground transportation business arrangements to minimize any dilution of revenues as demand for historically lucrative ground transportation products shifts to other modes.

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