ST. LOUIS LAMBERT INTERNATIONAL AIRPORT®

AIRPORT MASTER PLAN

CHAPTER 4 - DEMAND/CAPACITY AND FACILITY REQUIREMENTS

FEBRUARY 2023 - FINAL DRAFT

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4 Demand/Capacity and Facility Requirements

Facility requirements reflect the airport's ability to accommodate the projected activity levels determined by the aviation forecast based on existing conditions at the Airport. The required facilities can be identified through comparing the existing capacity at the airport facilities to the forecasted need (demand) for additional capacity.

The analyses in this chapter are based on the conditions at STL as of December 2020.

4.1 AIRFIELD AND AIRSPACE

The analysis of airfield facility requirements can be categorized into the following eight broad categories:

- Airfield capacity – Defines the ability of the existing airfield facilities to accommodate forecast demand and identifies the improvements required to accommodate these volumes.
- Runway length – Estimates the runway length required to accommodate the existing and projected fleet mix.
- Runway exits – Establishes the baseline performance of the existing runway exit system for each runway.
- Taxiways – Identifies taxiway system improvements/modifications needed to accommodate the efficient movement of aircraft about the airfield.
- Airfield design standards – Compares the current airfield geometry to modern design standards to identify where changes may be necessary to enhance airfield safety and reduce the risk of runway incursions.
- Lighting and Navigational Aids – Identifies instances of non-standard airfield marking/lighting as well as areas where navigational aids have potential for upgrading.
- Aircraft Deicing – Presents the findings of separate deicing facility analysis at STL and the recommendations made therein.
- Airspace – Identified potential airspace constraints and improvement needs.

The following sub-sections present the analyses and findings for each of these categories.

4.1.1 AIRFIELD CAPACITY

In 1983, the Federal Aviation Administration (FAA) published Advisory Circular (AC) 150/5060-5, *Airport Capacity and Delay*. This document describes how to compute airfield capacity for airport planning and design and had been the standard for many years. Using this methodology, users could identify an airfield layout, then provide parameters, such as aircraft mix and limitations to taxi flows, to determine an estimated Annual Service Volume (ASV) for an airport.

Subsequently, in 2012, the Airport Cooperative Research Program (ACRP) sponsored ACRP Project 03-17 which published ACRP Report 79 *Evaluating Airfield Capacity*. This report evaluated models beyond AC 150/5060-5 and was further enhanced with a capacity spreadsheet model. This updated tool for determining airfield capacity is the *Airfield Capacity Spreadsheet Model*.

ACRP's *Airfield Capacity Spreadsheet Model* was used to determine the high-level estimate of STL's airfield capacity to support the Airport Layout Plan (ALP) Update. Guidance and procedures were taken from ACRP Report 79 Appendix A: Prototype Airfield Capacity Spreadsheet Model User's Guide.

PARAMETERS AND ASSUMPTIONS

The *Airfield Capacity Spreadsheet Model* requires several parameters and assumptions regarding airfield layout, fleet mix, separation assumptions, and weather conditions to be defined. These assumptions and inputs are described below.

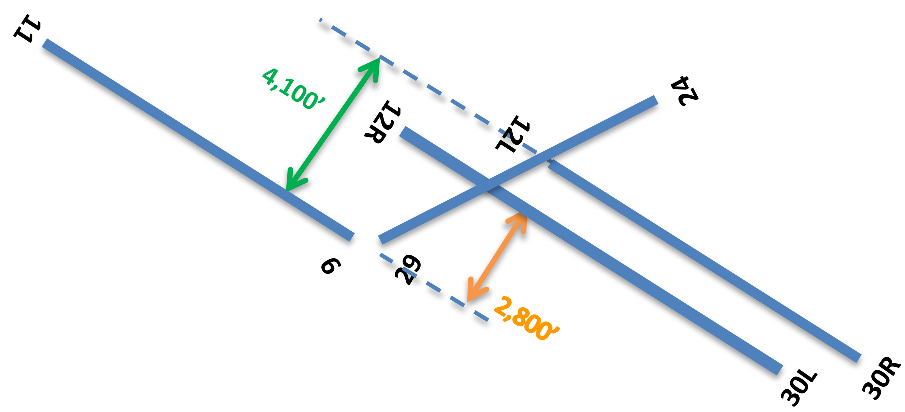
RUNWAY LAYOUT

STL has a total of four runways, as depicted in **Figure 4.1-1**. These consist of three parallel northwest/southeast runways (Runways 11-29, 12L-30R, and 12R-30L) and one intersecting northeast/southwest runway (Runway 06-24).

Runways 12L-30R and 12R-30L are separated by 1,300 feet. Runway 11-29 is approximately 2,800 feet from Runway 12R-30L and offset by approximately 10,000 feet from the Runway 30L end.

For the purposes of this estimate, only the three parallel runways were evaluated. Even though it is an important airfield component, the crosswind runway was not considered, given its low use during high-capacity operations.

Figure 4.1-1: Airport Layout



Source: CMT, September 2020.

RUNWAY UTILIZATION WIND CONDITIONS

Approximately 55 percent of STL's annual operational pattern is "Northwest Flow", while 45 percent of the traffic is "Southeast Flow".

Approximately one percent of the traffic occurs on the crosswind Runway 6-24. With such a small number of operations, the crosswind runway is not considered in this analysis. [1]

VISIBILITY

Based on ten years of weather information gathered from the National Centers for Environmental Information (NCEI) data, STL experiences Visual Meteorological Conditions (VMC) 94 percent of the time and Instrument Meteorological Conditions (IMC) conditions for 6 percent of the time.

TOUCH AND GO

Touch-and-goes are operations where an aircraft touches down on the runway and immediately takes off again. This is primarily used for training operations. For the purposes of the model, touch and go operations were assumed to be less than 1 percent of the annual operations and as such, have no impact on the annual capacity of the Airport.

TAXIWAY FACTORS

The model allows for limiting runway activity if the number of taxiway exits is not sufficient. Since each of the runways in STL has full-length parallel taxiways and a sufficient number of appropriately spaced runway exit taxiways, no limitations on aircraft exiting the runways due to taxiways were considered.

AIRCRAFT MIX

The original AC 150/5060-5 used a mathematical formula to determine aircraft mix based on the size of aircraft. Aircraft between 12,500 pounds and 300,000 pounds were identified as Category C and aircraft heavier than 300,000 pounds were identified as Category D. The formula from the original AC then used C+3D to calculate a fleet mix index number.

For STL, the 2040 forecast aircraft mix shows:

- Class C = 88.4 percent of airport operations
- Class D = 1.0 percent of airport operations

Therefore, for STL, the fleet mix index formula would be:

- C + 3 * D = Fleet Mix Index
- 88.4 + 3*(1.0) = 91.4

The FAA established mix index ranges for use in capacity calculations as listed below:

- 0 to 20
- 21 to 50
- 51 to 180

[1] Runway utilization exceeds 100 percent due to rounding.

Based on the forecasted aircraft mix for STL, it is expected the airport will stay in the 51 to 180 range for the foreseeable future.

The *Airport Capacity Spreadsheet Model* requires these classifications be even further broken down, as shown in **Table 4.1-1**, summarized from the 2040 forecast. Aircraft classification share allocations were estimated from operational data.

Table 4.1-1: Fleet Mix Share Allocations

AIRCRAFT CLASSIFICATION	SMALL - S	SMALL - T	SMALL +1	LARGE-TP	LARGE-JET	LARGE -757	HEAVY
Previous FAA Category	A	B	C	C	C	C	D
Maximum Gross Takeoff Weight (MTOW)	Less than 12,500 lbs (Single Engine)	Less than 12,500 lbs (Twin Engine)	Between 12,500 lbs and 41,000 lbs	Between 41,000 lbs and 255,000 lbs	Between 41,000 lbs and 300,000 lbs	Boeing 757 Series	More than 300,000 lbs
Share Allocations	3.91%	6.76%	3.07%	0%	85.29%	0.0%	0.97%

Note:

[1] The "Small +" category includes both prop and jet aircraft

Sources: Airport Cooperative Research Program, Airfield Capacity Spreadsheet, 2012; Unison, St. Louis Lambert International Airport (STL) Layout Plan Update, Aviation Activity Analysis and Forecasts, August 2, 2020; TransSolutions, STL Capacity Estimation Memo, September 14, 2020.

ARRIVAL RUNWAY OCCUPANCY TIME

The FAA *Landing Events Database* includes two years of landing roll data at STL (2015 and 2016), by aircraft type and runway. Runway occupancy times (ROT) recorded on Runway 11 were extremely long, exceeding 90 seconds for small aircraft and averaging over 75 seconds for all aircraft types. This indicates that aircraft often continue taxiing on the runway after completing the landing roll, as demand does not require aircraft to exit the runway expeditiously. Similarly, ROTs were unusually high for small aircraft landing on Runway 30R. As a result, ROTs for Runways 29 and 12L, presented in **Table 4.1-2**, were deemed the most representative for estimating airfield capacity.

Table 4.1-2: Arrival Runway Occupancy Times on Runways 29 and 12L (in seconds)

Aircraft Classification	Small - S	Small - T	Small +	Large-Jet	Large-757	Heavy
Time on Runway	47	41	48	42	51	52

Source: Federal Aviation Administration, *Landing Events Database*, March 2020.

DEPARTURE-ARRIVAL SEPARATION

For VMC conditions, the departure-arrival separation was set to 1.9 nm. For IMC conditions, the departure-arrival separation was set to 3 nm.

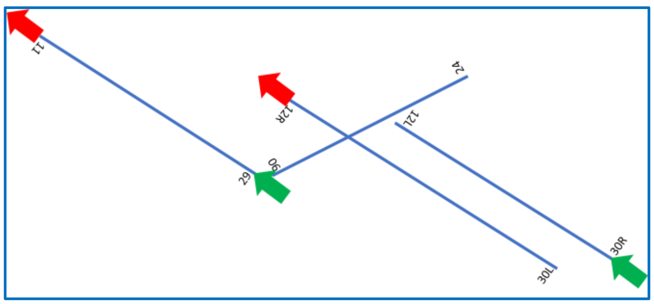
AIRFIELD CAPACITY MODEL AND CALCULATIONS

The calculations use the parameters and assumptions listed above, as well as information from the demand forecasts presented in Chapter 3. Multiple model configurations can be used to estimate hourly capacity for different configurations and the overall capacity can be estimated by summing these hourly capacity values.

To represent the three parallel runways, results from both the dual runway model, representing Runways 12L-30R and 12R-30L, were added to the results from the single runway model, representing Runway 11-29. Separate analyses were run for the four runway use configurations:

- Northwest VMC
- Northwest IMC
- Southeast VMC
- Southeast IMC

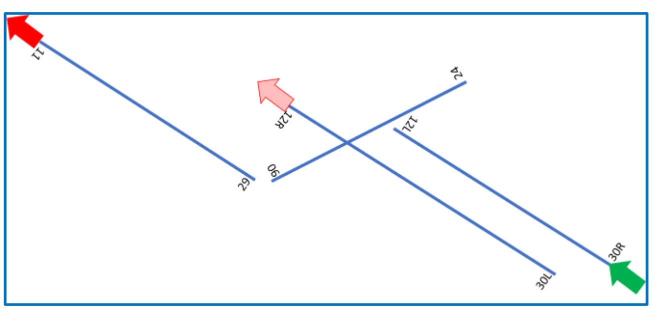
HOURLY CAPACITY: NORTHWEST VISUAL METEOROLOGOCAL CONDITIONS



Northwest VMC accounts for 51.8 percent of the annual operations. For Northwest VMC, the dual runway model was approximated using the dependent parallel runway configuration scenario number 1, with one arrival runway and one departure runway. A screenshot of this capacity calculation of the spreadsheet model is depicted below in **Figure 4.1-2**. Similarly, a screenshot of the single runway capacity, representing Runway 11-29, is provided in **Figure 4.1-3.**

Hourly Northwest VMC capacity was estimated at 80 for the dual configuration and another 67 operations for the single runway, totaling to 147 hourly operations in Northwest VMC. These 147 hourly operations are comprised of 70 arrivals and 77 departures. STL Air Traffic Control Tower (ATCT) personnel generally uses the arrival acceptance rate of 72 arrivals per hour in Northwest VMC, slightly above the spreadsheet model's calculated arrival capacity.

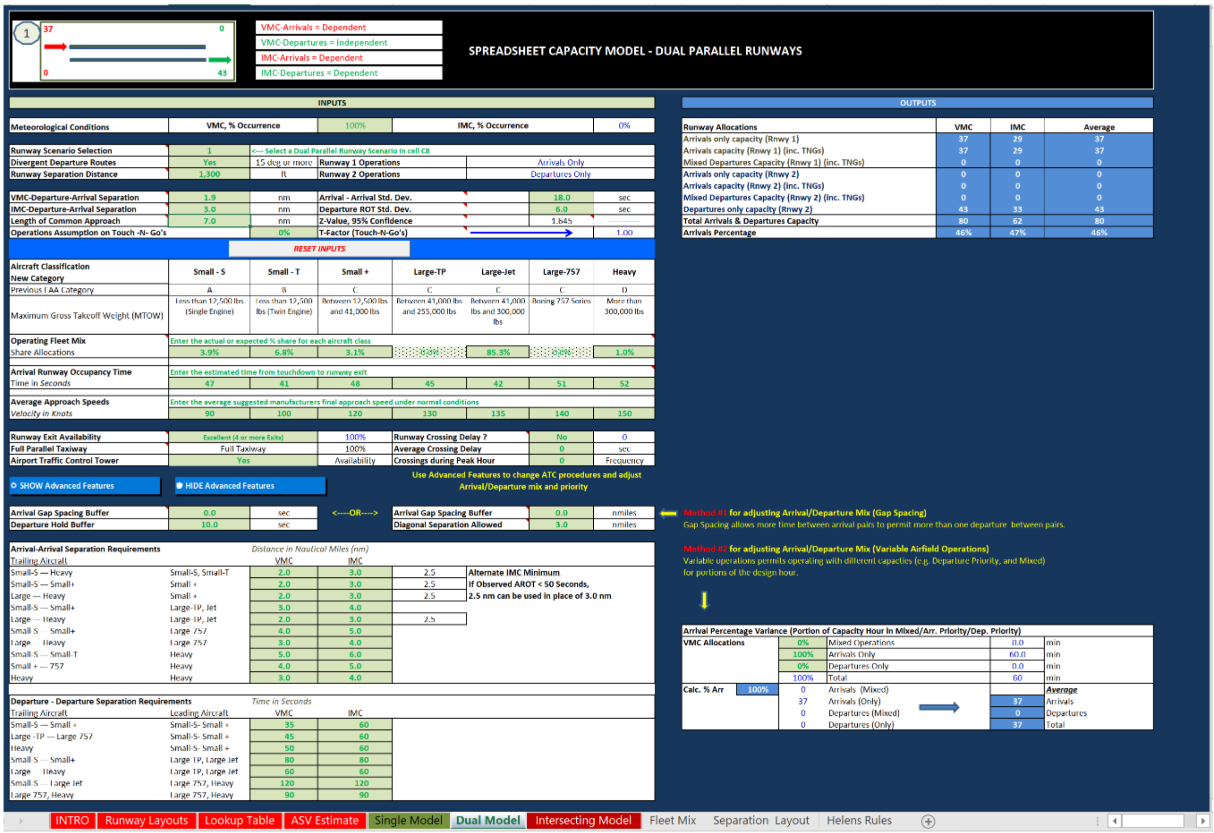
HOURLY CAPACITY: NORTHWEST INSTRUMENT METEOROLOGOCAL CONDITIONS



Northwest IMC accounts for 2.7 percent of the annual operations. For Northwest IMC, the dual runway model was approximated using the dependent parallel runway configuration scenario number 1, with one arrival runway and one departure runway. In IMC, a 15-nmi final approach is used.

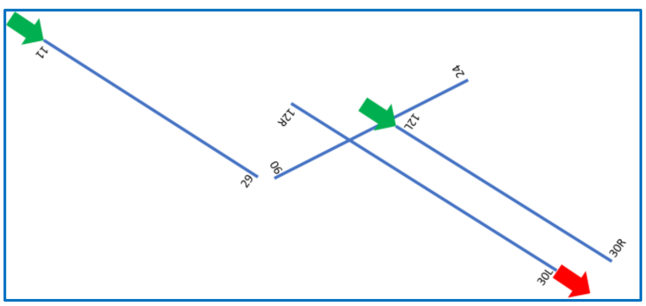
Hourly Northwest IMC capacity was estimated at 61 for the dual configuration and another 49 departure operations for the single runway, totaling to 110 hourly operations in Northwest IMC. These 110 hourly operations are comprised of 27 arrivals and 83 departures. STL ATCT personnel generally uses the arrival acceptance rate of 32 arrivals per hour in Northwest IMC, slightly above the spreadsheet model's calculated arrival capacity.

Figure 4.1-2: Dual Runway Airport Capacity Screenshot



Sources: Airport Cooperative Research Program, Airfield Capacity Spreadsheet, 2012; TransSolutions, St. Louis Lambert International Airport Capacity Estimation Memo, September 14, 2020.

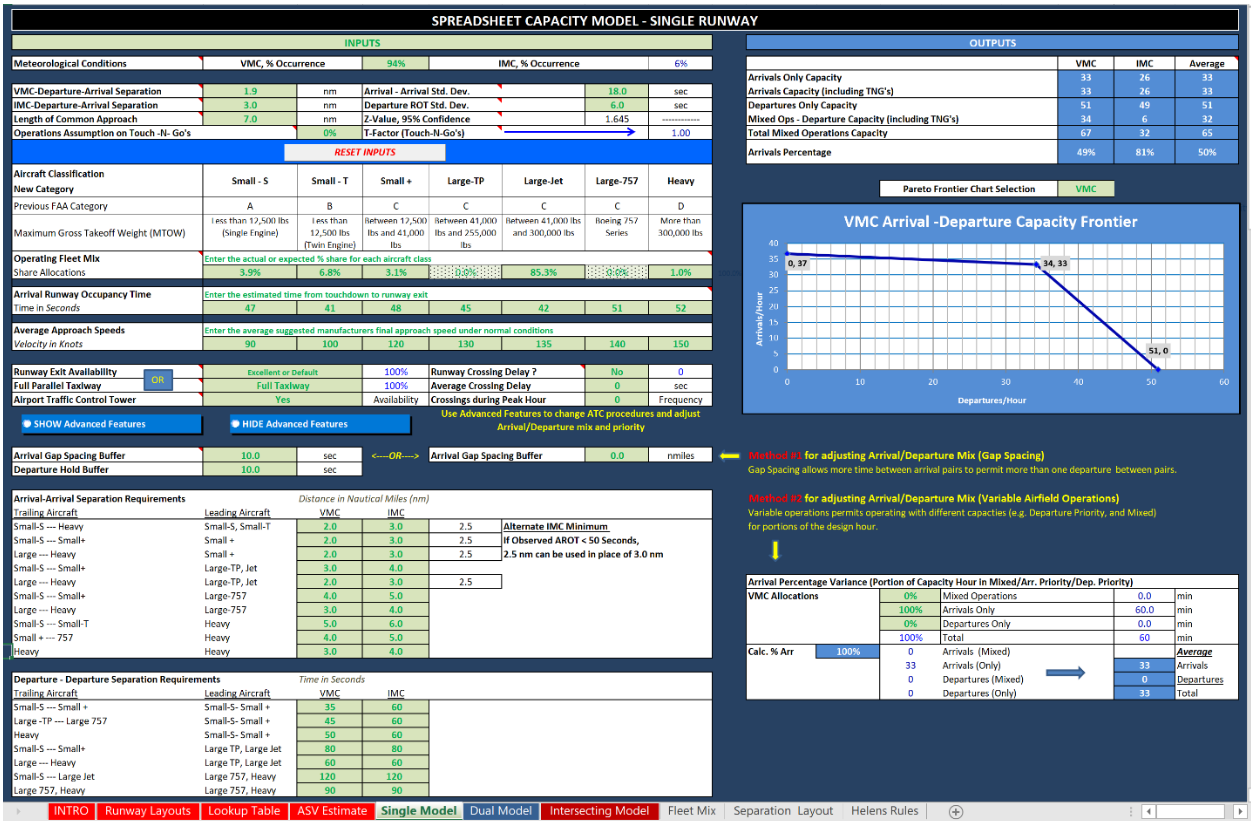
HOURLY CAPACITY: SOUTHEAST VISUAL METEOROLOGOCAL CONDITIONS



Southeast VMC accounts for 42.5 percent of the annual operations. For Southeast VMC, the dual runway model was approximated using the dependent parallel runway configuration scenario number 1, with one arrival runway and one departure runway.

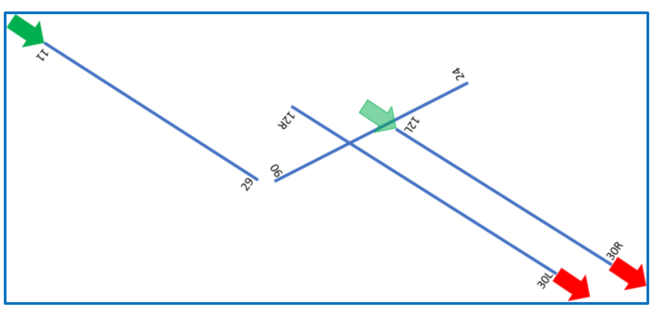
Hourly Southeast VMC capacity was estimated at 81 for the dual configuration and another 33 arrival operations for the single runway, totaling to 114 hourly operations for Southeast VMC. These 114 hourly operations are comprised of 59 arrivals and 55 departures. Another scenario achieved 70 arrivals and 43 departures, totaling 113. STL ATCT personnel generally uses the arrival acceptance rate of 72 arrivals per hour in Southeast VMC, slightly above the spreadsheet model's calculated arrival capacity in this alternate scenario.

Figure 4.1-3: Single Runway Airport Capacity Spreadsheet



Sources: Airport Cooperative Research Program, Airfield Capacity Spreadsheet, 2012; TransSolutions, St. Louis Lambert International Airport Capacity Estimation Memo, September 14, 2020.

HOURLY CAPACITY: SOUTHEAST INSTRUMENT METEOROLOGOCAL CONDITIONS



Southeast IMC accounts for 3.0 percent of the annual operations. For Southeast IMC, the dual runway model was approximated using the dependent parallel runway configuration scenario number 3, with one arrival runway and two departure runways. However, the model output provided departures on only one runway. In IMC, a 15-nmi final approach is used.

Hourly Southeast IMC capacity was estimated at 61 for the dual configuration and another 25 arrival operations for the single runway, totaling to 86 hourly operations. These 86 hourly operations are comprised of 52 arrivals and 34 departures. STL ATCT personnel generally uses the arrival acceptance rate of 52 arrivals per hour in Southeast VMC, the same as the spreadsheet model's calculated arrival capacity.

HOURLY CAPACITY SUMMARY

The hourly capacities for each runway use configuration are summarized in **Table 4-1-3**.

Table 4.1-3*: Hourly Capacity by Runway Use Configuration*

RUNWAY USE CONFIGURATION	ARRIVALS	DEPARTURES	TOTAL
Northwest VMC	70	77	147
Northwest IMC	27	83	110
Southeast VMC	59	55	114
Southeast IMC	52	34	86

Notes:

IMC = instrument meteorological conditions

VMC = visual meteorological conditions

Sources: TransSolutions, St. Louis Lambert International Airport Capacity Estimation Memo, September 14, 2020.

The *Airport Capacity Spreadsheet Model* often produces results with an imbalance in arrival and departures capacity. This is especially true in Northwest IMC, where it estimates the departure capacity to be more than three times the arrival capacity. However, over any extended period of time, arrivals and departures should balance out at an airport. While not done in this analysis, the hourly capacities could be adjusted to achieve an even split of arrival and departure capacity.

ANNUAL SERVICE VOLUME

Annual Service Volume (ASV) is the estimate of the annual capacity of operations at an airport. It is calculated from the hourly capacities noted above, along with factors to adjust for the peak hours and peak days.

ANNUAL SERVICE VOLUME CALCULATIONS

From the ACRP 03-17 Appendix A: *Prototype Airport Capacity Spreadsheet Model User's Guide*:

The following calculation is used to estimate ASV:

ASV = Cw * D * H

Cw is the weighted average of hourly capacities at their respective percent occurrence over a period of time. The model capacity outputs can be calculated for VMC and IMC, and for other marginal conditions, if the user has a more in-depth knowledge of the air traffic control environment and operating requirements. The ASV model asks the user to input the hourly capacity values determined from the single, dual or intersecting models, and also the percent occurrence of those meteorological conditions to arrive at Cw.

D and H are the demand ratios, which represent the Annual Demand/Average Peak Month Daily Demand (D), and the Average Peak Month Daily Demand/Average Peak Hour Demand (H). Daily traffic activity data for at least the peak month and the annual traffic volume is required to best determine these demand ratios.

The FAA *Operations & Performance Data Operations Network* (OpsNet) and *Count of Operations* (CountOps) traffic counts were used to calculate the ASV inputs (D) and (H). For the calculation of (D), the following inputs were used:

- Peak month October 2019 Operations = 16,985
- 16,985 / 31 days in October = 548 Average Day peak month demand
- Total operations for calendar year 2019 = 193,055
- 193,055 / 548 = 352 = D

For the calculation of (H), the following inputs were used:

- Average day of October closest to ADPM of 548 operations is October 29, 2019
- Peak hour operations on October 29 = 44
- 548 / 44 = 12.5 = H

These inputs were used in the ASV calculation spreadsheet, shown in **Figure 4.1-4**.

Figure 4.1-4: Annual Service Volume Spreadsheet Model

Annual Service Volume Estimation (ASV)

Use the capacities determined in the capacity model to estimate ASV

0.0	Calculated Cells
0.0	Input Cells
0.0	Linked Cells (within this worksheet)
150,000	Output Cells

ASV Calculations: {D * H * Cw = ASV}

D Factor	H Factor	Cw	ASV
352.0	12.5	113.8	500,900

D = Annual Demand/Avg. Peak Month Daily Demand
H = Avg. Peak Month Daily Demand/Avg. Peak Hour Demand

Fleet Mix Index: 51-180 (C+3D)%
(C = Large Aircraft (i.e. Large-TP + Large-Jet + Large-757), D = Heavy Aircraft)

Weighted Average Capacity Calculations:

Runway use / weather	Hourly Capacity	% Occurrence	% Max Capacity	Weighting Factor	P*C*W	P*W
VMC (Northwest)	147.0	51.8%	100.0%	1	76.1	51.8%
IMC (Northwest)	110.0	2.7%	74.8%	15	44.6	40.5%
VMC (Southeast)	114.0	42.5%	77.6%	15	726.8	637.5%
IMC (Southeast)	86.0	3.0%	58.5%	20	51.6	60.0%
			0.0%	0	0.0	0.0%
	(C)	(P)		(W)		
			Weighting Factors USED			
		100.00%			899.0	789.8%

Weighting Factors

% of Max Cap	VMC Mix 0 - 180	IMC Mix Indexes 0-20	21-50	51-180
91+	1	1	1	1
81 - 90	5	1	3	5
66 - 80	15	2	8	15
51 - 65	20	3	12	20
0 - 50	25	4	16	25

Above Table is from AC 150/5060-5, Airport Capacity and Delay Table 3-1

Cw = 113.8

Sources: Airport Cooperative Research Program, Airfield Capacity Spreadsheet, 2012; TransSolutions, St. Louis Lambert International Airport Capacity Estimation Memo, September 14, 2020.

ANNUAL SERVICE VOLUME RESULTS

Based on these inputs, STL's ASV was calculated to be 500,900 operations. Compared to the demand forecasts, the annual demand in 2019 was at 39 percent of ASV.

FAA guidance is to begin planning for capacity improvements when an airport reaches 60 percent of ASV. Compared to the ASV, STL's forecast annual operations through 2040 will never even exceed 50 percent of ASV, as summarized in **Table 4.1-4**.

Note that if the hourly capacities of each runway use configuration were adjusted to be 50/50 arrival/departure split, the resulting ASV would be reduced to 471,100. Still, the 2040 demand forecast is just 49 percent of this lower balanced capacity ASV, again indicating that the airfield can accommodate traffic demand well beyond 2040.

Table 4.1-4*: Annual Service Volume vs. Annual Demand*

YEAR	ANNUAL AIRCRAFT OPERATIONS	ANNUAL SERVICE VOLUME	PERCENT OF ANNUAL SERVICE VOLUME
2019	195,242	500,900	39%
2025	191,824	500,900	38%
2030	196,394	500,900	39%
2040	230,118	500,900	46%

Sources: Unison, St. Louis Lambert International Airport (STL)Layout Plan Update, Aviation Activity Analysis and Forecasts, August 2, 2020; TransSolutions, STL Capacity Estimation Memo, September 14, 2020.

SUMMARY OF FINDINGS

The ACRP *Airfield Capacity Spreadsheet Model* was used to calculate hourly capacities for STL's four runway use configurations. These hourly capacities were then used to estimate STL's Annual Service Volume (ASV), at 500,900 aircraft operations. Comparing the 20-year ALPU forecasts to the ASV, the airport is expected to have adequate airfield capacity to meet the traffic demand throughout the planning horizon.

4.1.2 RUNWAY LENGTH

RUNWAY LENGTH ANALYSIS METHODOLOGY

A runway length analysis was performed to understand the adequacy of the runways and their respective lengths at STL, to accommodate the existing and projected aircraft fleet. As part of this analysis, takeoff and landing requirements were calculated according to the FAA Advisory Circular (AC) 150/5325-4B, *Runway Length Requirements for Airport Design*. These guidelines establish the process and considerations to assess existing runways and determine adequate runway length recommendations at a planning level. It should be noted that the results of these calculations can differ from more detailed analysis performed by aircraft operators.

FAA AC 150/5325-4B prescribes several methodologies for calculating runway length requirements based on the weight of the aircraft using the Airport. In the case of STL, the methodology prescribed in Chapter 4 of FAA AC 150/5325-4B, *Runway Lengths for Regional Jets and those Airplanes with a Maximum Certificated Takeoff Weight of More than 60,000 Pounds (27,200kg),* was used for this analysis. As such, the Aircraft Characteristics Manuals (ACMs) from each aircraft manufacturer were utilized with the recommended forecast fleet mix to calculate the runway length requirements. To determine the runway length required, the following information was obtained and utilized:

- Density Altitude
- Aircraft Fleet
- Runway Characteristics

DENSITY ALTITUDE

Density altitude is a natural phenomenon that decreases aircraft and engine performance as density altitude increases. It is a combination of an airport's elevation and temperature. The higher the elevation and/or temperature, the higher the density altitude and the greater degradation on aircraft performance. When the density altitude is higher, it decreases an aircraft's operational performance, requiring longer runway distances for takeoffs and landings.

In each ACM, there is a chart that identifies the runway length requirements based on temperature and altitude. The requirements may be calculated based on "standard day" (defined as 59 degrees Fahrenheit at zero feet mean sea-level [MSL]), and on "hot day" (defined as 86 degrees Fahrenheit). The hot day charts will then depend on each aircraft type.

The FAA recommends the Airport's Mean Maximum Temperature (MMT) be used in runway length calculations. MMT is defined as the average daily maximum temperature of the hottest month. To determine this temperature, historical weather data was pulled from National Oceanographic and Atmospheric Administration's (NOAA) National Climate Weather data center for STL, for the last ten years. The data revealed MMT for the hottest month at STL is 89 degrees Fahrenheit.

For landing requirements, ACMs only contain charts for standard day weather conditions. It is not required by the FAA to include the MMT when calculating landing length. The landing length requirements were assessed at the standard day temperature (59 degrees Fahrenheit).

Airfield elevation also plays an important role in determining the takeoff and landing requirements, as it is a component of density altitude. When the airport elevation is higher, the less efficient an aircraft wing is at producing lift, which then requires higher airspeeds to produce a comparable amount of lift. The airport elevation at STL is 618 feet MSL.

AIRCRAFT FLEET MIX

Runway length requirements are determined for specific aircraft types, referred to as the fleet mix. The 15 most common and most critical aircraft types operating at STL were determined through:

- Historical aircraft operations data for the calendar years 2016 through 2019
- Known aircraft orders by the predominant air carriers operating at STL
- Projected aircraft fleet mix to operate at STL during the 20-year planning horizon, including destinations

The resulting fleet mix was used to determine the takeoff and landing length requirements at STL, recognizing airlines are continually evaluating specific aircraft utilization on routes. Along with the aircraft type, the furthest destination each aircraft type travels on a regular basis from STL is included in **Table 4.1-5**.

Table 4.1-5: Projected Aircraft Fleet Mix

MANUFACTURER	MODEL	FURTHEST DESTINATION	DISTANCE (NM)
Airbus	A319	Los Angeles, CA (LAX)	1,383
Airbus	A320	Denver, CO (DEN)	669
Airbus	A321	Las Vegas, NV (LAS)	1,192
Boeing	717-200	Salt Lake City, UT (SLC)	1,005
Boeing	737-700W	Seattle, WA (SEA)	1,485
Boeing	737-800	Punta Cana (PUJ)	1,666
Boeing	737-900	Salt Lake City, UT (SLC)	1,005
Boeing	737MAX8	Seattle, WA (SEA)	1,485
Boeing	747-400F	Riyadh (RUH)	6,297
Boeing	757-200	Atlanta, GA (ATL)	421
Boeing	767-300F	Ontario, CA (ONT)	1,343
Boeing	787-8	Roissy Charles de Gaulle/CDG	3,822
Bombardier	CRJ-700LR	Denver, CO (DEN)	669
Embraer	145LR	New York, NY (LGA)	772
Embraer	175LR	San Francisco, CA (SFO)	1,508

Note:

NM = nautical miles

Sources: St. Louis Airport Authority, *L3 Harris Operations Data,* 2016-2019 (aircraft operations); Unison, FINAL DRAFT Forecast of Aviation Activity, June 2020; CMT, June 2020.

RUNWAY CHARACTERISTICS

Runway characteristics such as surface contamination and runway gradients are also an important part of the inputs used to determine runway length requirements for an airport. Runways that are plagued by surface contaminants, such as rain and snow, often require longer landing lengths than dry surfaces, and changes in elevation along the length of the runway also require longer takeoff lengths in uphill conditions.

FAA AC 150/5325-4B requires airport sponsors to consider contaminated surfaces when calculating landing length requirements, as surface contaminants affect the breaking ability of aircraft, and therefore increase the distance required to come to a stop. This increased distance is approximately 15 percent added length. Additionally, FAA AC 150/5325-4B prescribes that for every foot of difference between the high point and low point along the runway centerline, a correction of plus 10 feet may be applied to the runway length required for takeoff. **Table 4.1-6** lists the elevations of the high points and low points of each runway at STL, along with their corresponding runway length correction. The maximum correction for elevation change is +760 feet on Runway 12L-30R.

Table 4.1-6: Runway Elevation and Corrections

RUNWAY	HIGH POINT (FT. MSL)	LOW POINT (FT. MSL)	CORRECTION (FT.)
Runway 11-29	617.92	555.95	+620
Runway 12R-30L	586.16	532.83	+530
Runway 12L-30R	604.88	528.49	+760

Notes:

Runway length requirements corrections are rounded to the closest 10 feet.

Ft. = Feet

MSL = Above Mean Sea Level

Source: St. Louis Lambert International Airport, *Airport Layout Plan*, 2013; CMT, June 2020 (analysis.

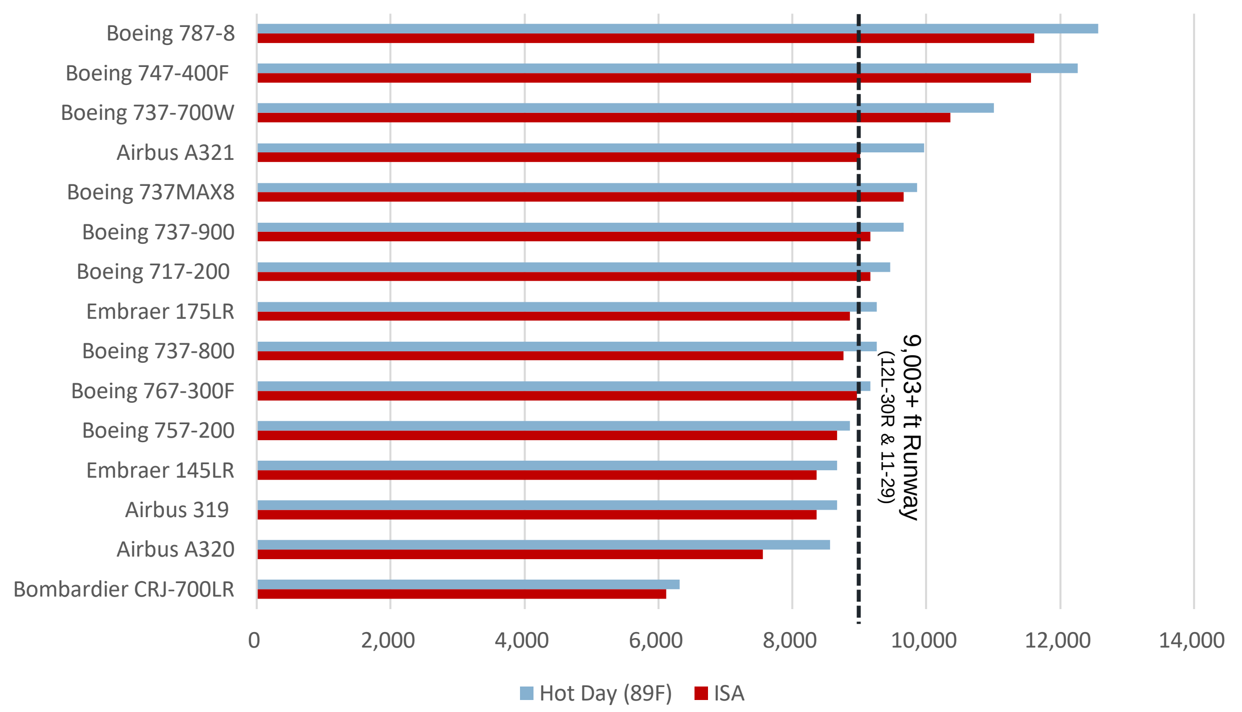
RUNWAY LENGTH REQUIREMENTS

Runway length requirements were calculated using the methodology prescribed in Chapter 4 of FAA AC 150/5325-4B. The following section outlines the STL runway length requirements analysis and results.

RUNWAY TAKEOFF LENGTH REQUIREMENTS

Takeoff requirements for each runway were calculated for maximum takeoff weight (MTOW) conditions. FAA AC 150/5325-4B stipulates that takeoff length requirements be calculated using dry runway conditions, therefore, all takeoff length requirements presented herein are indicative of dry or “noncontaminated” runway conditions. This condition was used to determine the maximum runway length needed for takeoff with no operational restrictions from STL. To determine the lengths, the ACMs takeoff charts were utilized for International Standard Atmosphere (ISA) or standard day with the elevation curve for 618 feet MSL. With STL’s MMT being 89 degrees Fahrenheit, the hot day charts provided in the ACM were also utilized. This analysis yielded two takeoff length requirements; standard day and hot day, which include the correction for runway elevation change of +760 feet. **Figure 4.1-5** presents the takeoff runway length requirements for the fleet mix under MTOW conditions.

Figure 4.1-5: Takeoff Length Requirements (Maximum Takeoff Weight)



Sources: Various Aircraft Characteristics for Airport Planning Manuals; CMT, June 2020 (analysis).

The resulting takeoff runway length requirements for hot day conditions range from just over 6,300 feet for the Bombardier CRJ-700LR, to over 12,500 feet for the Boeing 787-8. Most of the fleet mix requires a minimum of 9,000 feet of runway length to depart at MTOW under hot day conditions, which is the minimum runway length provided by the three parallel runways at STL. Those aircraft within the fleet mix requiring over 9,000 feet of runway length, as noted, represent approximately 46 percent of all operations during calendar years 2016 to 2019.

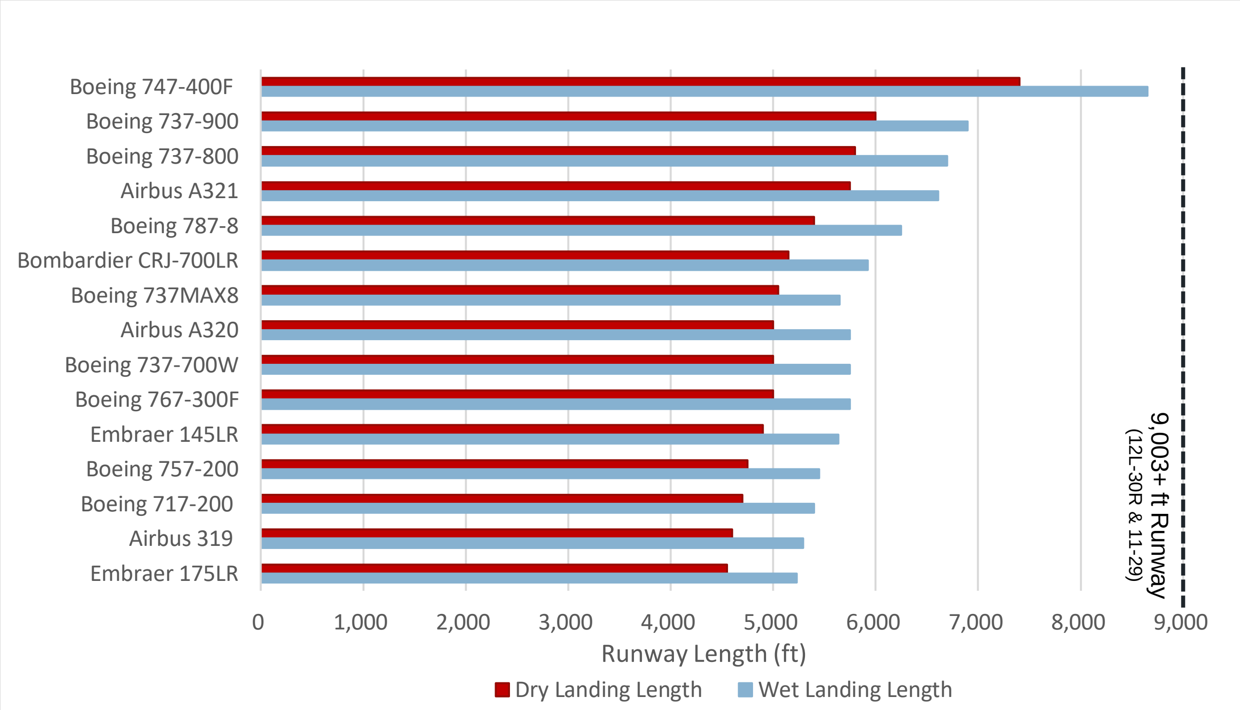
The existing runway length provided at STL (11,019 feet) is adequate to accommodate nearly unrestricted operations by all aircraft that regularly operate at the airport today.

RUNWAY LANDING LENGTH REQUIREMENTS

The landing lengths were calculated by using the maximum landing weight (MLW) provided by the ACMs for dry and contaminated surface conditions. When the runway is contaminated, aircraft will often require a longer landing length then when it is dry. The FAA AC 5235-4b, *Runway Length Requirements for Airport Design,* requires airports to consider contaminated surfaces when calculating landing length requirements. While some aircraft manufacturers provide a landing chart for contaminated surfaces, others do not. The landing length requirements for the recommended forecast fleet are presented in **Figure 4.1-6.**

As shown in Figure 4.1-6, the aircraft fleet mix analyzed can land at MLW under both dry and wet conditions, on either of the three parallel runways at STL.

Figure 4.1-6: Landing Length Requirements (Maximum Landing Weight)



Note:

For aircraft that do not have a wet landing length chart, 15 percent was added to the dry landing lengths

Sources: Various Aircraft Characteristics for Airport Planning Manuals; CMT, June 2020 (analysis).

PAYLOAD AND RANGE CALCULATIONS

Payload and range calculations identify the balance between the variables of runway length, payload available, fuel load, and the flight's stage length. These calculations were completed for all aircraft in the STL fleet mix for runway lengths of 9,003 feet and 11,019 feet, under hot day conditions.

AVAILABLE PAYLOAD BASED ON RUNWAY LENGTH

Table 4.1-7 presents the payload available to each aircraft's furthest destination, for runway lengths of 9,003 feet and 11,019 feet. Runway 6-24 was not included in this analysis, as it is primarily used by aircraft types not considered critical in runway length needs, and therefore not included in the analyzed fleet mix for payload and range calculations.

Based on the results of this analysis, all the aircraft in the fleet mix can accommodate their maximum payload from any of the three parallel runways at STL to their critical destination, except for the following aircraft types:

- Airbus A321
- Boeing 717-200
- Boeing 737-900
- Boeing 747-400F

- Embraer 175LR – Payload reduction due to range, not limitations to takeoff weight

Table 4.1-7: Available Payload

			AVAILABLE PAYLOAD (LBS)		
MANUFACTURER	MODEL	DESTINATION	ON 11,019-FT. RUNWAY	ON 9,003-FT. RUNWAY	PAYLOAD DIFFERENTIAL (LBS)
Airbus	A319	LAX	39,000	39,000	-
Airbus	A320	DEN	44,000	44,000	-
Airbus	A321	KEF	-	-	-
Boeing	717-200	SLC	32,000	31,500	(500)
Boeing	737-700W	SEA	38,700	38,700	-
Boeing	737-800	PUJ	47,000	47,000	-
Boeing	737-900	SLC	43,720	41,420	(2,300)
Boeing	737MAX8	SEA	-	-	-
Boeing	747-400F	RUH	188,600	112,600	(76,000)
Boeing	757-200	ATL	51,720	51,720	-
Boeing	767-300F	ONT	88,250	88,250	-
Boeing	787-8	CDG	90,500	90,500	-
Bombardier	CRJ-700LR	DEN	18,750	18,750	-
Embraer	145 LR	LGA	12,755	12,755	-
Embraer	175 LR	SFO	20,250	20,250	-

Notes:
Ft. = Feet
LBS = Pounds
Assumes hot day conditions.
Payload/Range information published by Airbus is insufficient to estimate available payloads on A321 to KEF.
Operating empty weight (OEW) and payload information not available for the Boeing 737-MAX8

Sources: Aircraft Manufacturers Planning Manuals (Airbus, Boeing, Bombardier, Embraer); CMT, June 2020.

RANGE DIFFERENTIAL BASED ON RUNWAY LENGTH

Analysis was performed to determine the effective increase in aircraft range available when departing with a maximum payload from a 11,019-foot-long runway (Runway 12R-30L) versus departing from any parallel runway at STL. **Table 4.1-8** presents the range available for each aircraft type in the fleet mix from both departure runway lengths.

Table 4.1-8: Effective Range Increase

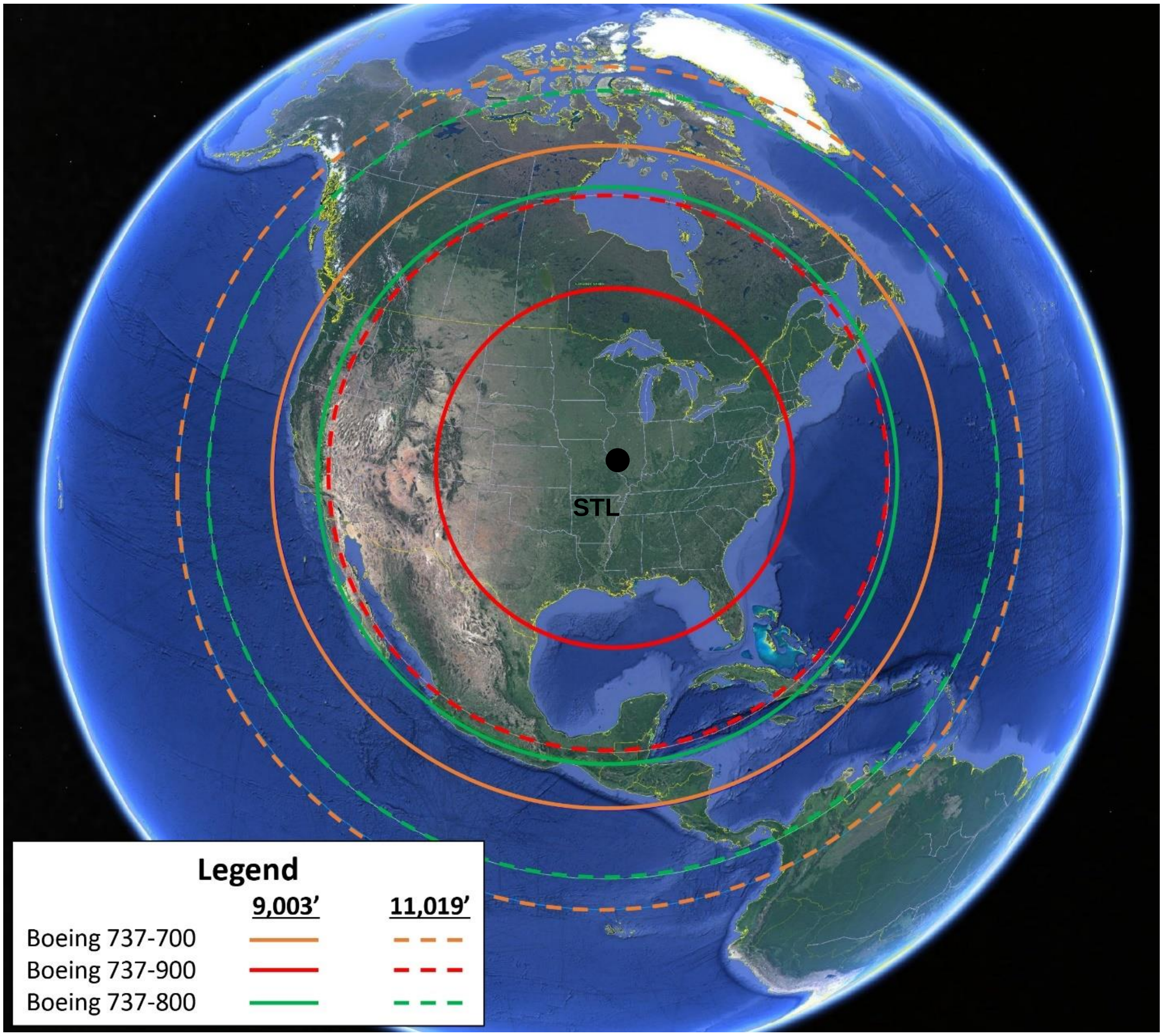
MANUFACTURER	MODEL	RANGE (NM) AT MAXIMUM PAYLOAD ON 11,019-FT. RUNWAY	RANGE (NM) AT MAXIMUM PAYLOAD ON 9,003-FT. RUNWAY	RANGE DIFFERENTIAL (NM)
Airbus	A319	2,700	2,700	-
Airbus	A320	2,100	2,100	-
Airbus	A321	2,300	2,050	(250)
Boeing	717-200	1,250	950	(300)
Boeing	737-700W	2,200	1,600	(600)
Boeing	737-800	2,000	1,650	(350)
Boeing	737-900	1,300	800	(500)
Boeing	737MAX8	2,500	2,000	(500)
Boeing	747-400F	2,800	2,450	(350)
Boeing	757-200	2,300	2,300	-
Boeing	767-300F	2,200	2,200	-
Boeing	787-8	4,700	3,600	(1,100)
Bombardier	CRJ-700LR	940	940	-
Embraer	145 LR	1,150	1,150	-
Embraer	175 LR	1,300	1,300	-

Notes:
Ft. = Feet
NM = Nautical Miles

Sources: Aircraft Manufacturers Planning Manuals (Airbus, Boeing, Bombardier, Embraer); CMT, June 2020.

Figure 4.1-7 identifies the range rings for each variant of the Boeing 737 in the fleet mix, for both a 9,003-foot-long runway and a 11,019-ft long runway. The Boeing 737 is projected to be critical to the Airport's future air service development efforts within the western hemisphere.

Figure 4.1-7: Boeing 737 Series Range Rings Map (by Runway Length)



Sources: The Boeing Company (range information), Google Earth (basemap); CMT, June 2020 (analysis).

RUNWAY BENCHMARKING

As part of this analysis, a benchmarking exercise was completed comparing the available runway length at airports serving metropolitan areas of similar size by population to St. Louis. **Table 4.1-9** presents the 20 closest metropolitan areas in terms of population, centered on STL (next ten larger, previous ten smaller), their total population, and the overall length of the longest runway serving each. The findings indicate that the average runway length available to each metropolitan area is 11,204 feet. Only San Diego (9,400 feet), Sacramento (8,605 feet), and San Antonio (8,505 feet) are served by a runway less than 10,000 feet in length (note that San Diego is unable to extend its runway due to geography and San Antonio is currently considering runway extension alternatives in its master plan).

Table 4.1-9: Runway Length Benchmarking

METROPOLITAIN AREA	TOTAL POPULATION (MILLIONS)	AIRPORT	LONGEST RUNWAY (FT.)
Miami, FL	5.58	MIA	13,016
Atlanta, GA	5.30	ATL	12,390
Boston, MA	4.57	BOS	10,083
San Francisco, CA	4.34	SFO	11,870
Detroit, MI	4.29	DTW	12,003
Inland Empire, CA	4.24	SBD	10,000
Phoenix, AZ	4.20	PHX	11,489
Seattle, WA	3.45	SEA	11,901
Minneapolis, MN	3.34	MSP	11,006
San Diego, CA	3.10	SAN	9,400
St. Louis, MO	2.79	STL	11,019
Tampa/St. Petersburg, FL	2.79	TPA	11,002
Baltimore, MD	2.72	BWI	10,503
Denver, CO	2.55	DEN	16,000
Pittsburg, PA	2.36	PIT	11,500
Charlotte, NC	2.25	CLT	10,000
Portland, OR	2.23	PDX	11,000
Kansas City, MO	2.16	MCI	10,801
Sacramento, CA	2.15	SMF	8,605
San Antonio, TX	2.15	SAT	8,505
Cincinnati, OH	2.14	CVG	12,000

Note: Ft. = Feet

Sources: Woods & Poole Economics, Inc., *The Complete Demographic Data Source – Volume 1*, 2019; FAA; CMT, June 2020 (analysis).

SUMMARY OF FINDINGS

Using the methodology prescribed by FAA AC 150/5325-4B to determine the runway length requirements at STL, the following findings were determined:

- The existing airfield provides adequate runway length (11,019 feet) to accommodate nearly unrestricted departure operations by all aircraft types regularly operating at STL today and are projected to do so in the future.
- A sizable portion of the fleet mix at STL (approximately 46 percent of operations during the period of 2016 to 2019) may require more runway length for departure than is available on any parallel runway, thereby requiring the use of Runway 12R-30L.

- The existing length of all three parallel runways at STL is adequate to accommodate landing runway length requirements by all aircraft types in the fleet mix.
- Based on the benchmarking analysis presented herein, a runway length of 11,000 feet is justifiable and standard amongst metropolitan areas with a population similar to that of St. Louis. The average maximum runway length of the 20 peer metropolitan areas is 11,204 feet.

4.1.3 RUNWAY WIDTH

As shown in **Table 4.1-10** the controlling runway width for the projected fleet mix at STL is 150 feet. Runways 11-29, 12L-30R and 6-24 are currently 150 feet wide, and Runway 12R-30L is 200 feet wide. The Airport and their consultancy team are currently designing a reconstruction of Runway 12R-30L. This reconstruction presents the opportunity to reduce the width of the runway to 150 feet, to match the anticipated fleet mix at the Airport.

Table 4.1-10: Projected Aircraft Fleet Mix

MANUFACTURER	MODEL	APPROACH SPEED CATEGORY	AIRPLANE DESIGN GROUP (ADG)	REQUIRED RUNWAY WIDTH
Airbus	A319	C	III	150 ft
Airbus	A320	C	III	150 ft
Airbus	A321	C	III	150 ft
Boeing	717-200	C	III	150 ft
Boeing	737-700W	C	III	150 ft
Boeing	737-800	C	III	150 ft
Boeing	737-900	C	III	150 ft
Boeing	737MAX8	C	III	150 ft
Boeing	747-400F	E	V	150 ft
Boeing	757-200	D	IV	150 ft
Boeing	767-300F	D	IV	150 ft
Boeing	787-8	E	V	150 ft
Bombardier	CRJ-700LR	B	II	75 ft
Embraer	145LR	B	II	75 ft
Embraer	175LR	C	III	150 ft

Sources: St. Louis Airport Authority, *L3 Harris Operations Data,* 2016-2019 (aircraft operations); Unison, *FINAL DRAFT Forecast of Aviation Activity*, June 2020; CMT, June 2020 (analysis); Transoft Solutions, *Aircraft Data Viewer*; Federal Aviation Administration, *Advisory Circular 150-5300-13A*, February 2012.

4.1.4 RUNWAY EXITS

Entrance/exit taxiways, also referred to as runway exits, connect runways to the taxiway system. These taxiways provide a path for aircraft to enter the runway for departure or exit the runway after arrival. The placement and type of runway exits depend on many factors, including the type of aircraft using the runway, airport specific environmental data, surface conditions, and other factors such as human factors. The following section describes the methodology and results of the runway exit analysis performed for this ALP Update.

RUNWAY EXIT ANALYSIS INPUT AND METHODOLOGY

The FAA's Runway Exit Design Interactive Model (REDIM) Version 3 was used to analyze the existing and projected fleet mix at STL on the existing runway system. The primary objective of the REDIM analysis is to determine average Runway Occupancy Time (ROT) of each runway. ROT is the time from which an aircraft crosses the runway threshold to when it exits the runway. In general, the lower the ROT, the greater number of operations a runway can accommodate. The ROT for each runway is influenced by the number, type, and location of the runway exits. A reduced ROT will also help to increase airfield capacity by allowing for a reduction in the in-trail separation between arriving aircraft. In the case of an airport with many existing runway exits, such as STL, a REDIM analysis can be used to determine if the removal or reconfiguration of a particular exit or group of exits adversely impacts the performance of a runway. All four runways were analyzed in REDIM to determine the existing average ROT, while serving both the existing and projected fleet mix.

FLEET MIX AND DEMAND LEVEL

Based on historic operations data at STL for 2016 through 2019, a specific fleet mix was created for each runway. For runways where aircraft may exit to either the right or the left, fleet mixes were further broken down by exit direction based on their ultimate destination on the airport (i.e., air cargo and general aviation aircraft will exit to the left on Runways 12R and 12L). Runway 11-29 is the only runway with exits to one side. The future fleet mix was then determined by applying the same directional assumptions to the fleet mix develop in the ALPU Aviation Activity Analysis and Forecasts. The existing and future fleet mixes for each runway are depicted in various tables in **Appendix 4A**, *REDIM Assumptions* (**Tables 4A-1** through **4A-8**).

AIRPORT INPUTS

Amongst many standard inputs used in the program, Airport-specific data was needed to conduct the exit analysis. The Airport-specific inputs are considered fixed inputs and applied to each runway end analysis in the REDIM model. Airport-specific inputs are presented in Appendix 4A, **Table 4A-9**.

Additionally, many model inputs are specific to the runway being analyzed. The specific runway inputs and the associated values are presented in Appendix 4A, **Table 4A-10***.*

RUNWAY EXIT ANALYSIS RESULTS

After applying the fleet mix to each runway, the analysis yielded the weighted average ROT for each runway during all, wet, and dry conditions. These weighted average ROTs for the existing and future fleet are presented in **Tables 4.1-11** through **4.1-18**.

Table 4.1-11: Runway 11 Runway Occupancy Times

CONDITIONS	EXITS	EXISTING	FUTURE
All	Right	-	-
	Left	50.7	50.7
Wet	Right	-	-
	Left	56.7	56.6
Dry	Right	-	-
	Left	49.9	49.8

Source: CMT, September 2020 (analysis).

Table 4.1-12: Runway 29 Runway Occupancy Times

CONDITIONS	EXITS	EXISTING	FUTURE
All	Right	48.8	49.2
	Left	-	-
Wet	Right	55.5	55.8
	Left	-	-
Dry	Right	47.8	48.3
	Left	-	-

Source: CMT, September 2020 (analysis).

Table 4.1-13: Runway 6 Runway Occupancy Times

CONDITIONS	EXITS	EXISTING	FUTURE
All	Right	59.1	58.9
	Left	67.7	68
Wet	Right	64	63.8
	Left	72.6	72.6
Dry	Right	58.4	58.3
	Left	67.1	67.3

Source: CMT, September 2020 (analysis).

Table 4.1-14: Runway 24 Runway Occupancy Times

CONDITIONS	EXITS	EXISTING	FUTURE
All	Right	55.3	55.1
	Left	54.8	54.6
Wet	Right	60	59.7
	Left	58.4	58.2
Dry	Right	54.7	54.4
	Left	54.7	54.1

Source: CMT, September 2020 (analysis).

Table 4.1-15: Runway 12L Runway Occupancy Times

CONDITIONS	EXITS	EXISTING	FUTURE
All	Right	48.6	48.4
	Left	55.9	56.1
Wet	Right	58.4	54.5
	Left	59.2	59.2
Dry	Right	47.7	47.6
	Left	55.4	55.7

Source: CMT, September 2020 (analysis).

Table 4.1-16: Runway 30R Runway Occupancy Times

CONDITIONS	EXITS	EXISTING	FUTURE
All	Right	54.4	54.5
	Left	48.8	48.7
Wet	Right	59.7	59.9
	Left	56.2	55.8
Dry	Right	53.7	53.7
	Left	47.8	47.8

Source: CMT, September 2020 (analysis).

Table 4.1-17: Runway 12R Runway Occupancy Times

CONDITIONS	EXITS	EXISTING	FUTURE
All	Right	50.3	50.2
	Left	55	55.8
Wet	Right	55	54.9
	Left	60.1	61
Dry	Right	49.6	49.5
	Left	54.3	55.1

Source: CMT, September 2020 (analysis).

Table 4.1-18: Runway 30L Runway Occupancy Times

CONDITIONS	EXITS	EXISTING	FUTURE
All	Right	57.9	57.8
	Left	50.6	50.4
Wet	Right	64.1	64.2
	Left	57.1	56.7
Dry	Right	57	57
	Left	49.7	49.6

Source: CMT, September 2020 (analysis).

SUMMARY OF FINDINGS

The REDIM results show that ROTs of each runway are not impacted negatively by changes to the fleet mix. Therefore, additional exits are not required to solve ROT issues. In fact, in most cases, ROT slightly improves for the future fleet mix, as the fleet becomes more consistent.

4.1.5 TAXIWAY CAPACITY

Requirements for improvements and/or modifications to taxiway infrastructure are typically driven by either a need for additional airfield capacity or improvements to overall airfield safety through taxiway geometry. In the case of airfield capacity, taxiway improvements can have the ability to optimize airfield capacity by allowing for more efficient movement of aircraft between the runways and the aircraft parking aprons. The analysis presented in the *Airfield Capacity section* indicates that the existing airfield has adequate capacity to accommodate projected demand through the planning period. In addition, extensive consultation with STL ATCT personnel indicated that the airfield at STL provides adequate flexibility to accommodate nonstandard operations when they occur. Therefore, no taxiway improvements/modifications are required based on airfield capacity or flow conflicts.

While it has been determined that taxiway improvements at STL are not warranted based on requiring additional capacity, an extension of Taxiway F to the southeast, to the Runway 30R end, was given additional consideration. Coordination with STL ATCT personnel indicated that aircraft originating from the north apron (i.e., Cargo and GA aircraft) are offered a departure on Runway 30R from Taxiway H. Aircraft that are unable to depart from the shorter runway length are instructed to cross Runway 30R and then depart from Runway 30L. Today, this occurrence is infrequent. However, prudent planning would require that in order to limit the number of runway crossings in the future, the extension of Taxiway F should be planned for if/when these crossings rise to the frequency of regular occurrence.

Taxiway improvements/modifications that are justified on the basis of improving airfield safety are discussed later in Section 4.1.6., Airfield Design Standards.

4.1.6 AIRFIELD DESIGN STANDARDS

CRITICAL AIRCRAFT

The demand forecasts presented in Section 3 of this ALP Update identified the Airport's existing and future critical aircraft. This determination applies to the most critical aircraft currently operating and projected to operate at the Airport. Given the existing configuration of the airfield at STL and the different uses/roles that each runway serves, each runway has its own distinct fleet mix. Therefore, it was important to identify the critical aircraft for each runway complex on the airfield. To determine the existing critical aircraft, independent analysis was performed for each of the four runways at STL. This analysis examined each runway's historical operational data from 2016 to 2019 to determine the most demanding aircraft type(s) that meet the threshold of "regular use" (500 annual operations).

RUNWAYS 12R-30L AND 12L-30R

Upon review of historical operations data and coordination with STL ATCT personnel, it was determined that the fleets operating on both Runways 12R-30L and 12L-30R are similar and can therefore be analyzed as a single runway system in terms of critical aircraft. This approach is further supported by the physical configuration of the two runways and their supporting taxiway system.

Table 4.1-19 presents the total number of operations occurring during 2019 for each of the most demanding aircraft types that utilized Runways 12L-30R and 12R-30L. The Boeing 767-300ER is the most demanding aircraft type with regular operations on Runways 12L-30R and 12R-30L. Therefore, the critical aircraft designation for Runways 12R-30L and 12L-30R is a D-IV.

Table 4.1-19: Runways 12L-30R and 12R-30L Critical Aircraft - 2019 Operations

AIRCRAFT	AIRCRAFT APPROACH CATEGORY	AIRPLANE DESIGN GROUP	RUNWAY 12L-30R OPERATIONS	RUNWAY 12R-30L OPERATIONS
Airbus A300-6 (A306)	C	IV	278	353
Boeing 737-800 (B738)	D	III	8,232	16,166
Boeing 747-400 (B744)	D	V	1	2
Boeing 757-200 (B752)	C	IV	356	404
Boeing 767-300ER (B763)	D	IV	470	501
Boeing 787-8 (B788)	D	V	2	3
Douglas (Boeing) (DC10)	D	IV	51	30
McDonnel Douglas (Boeing) (MD11)	D	IV	36	42

Source: St. Louis Airport Authority, *L3 Harris Operations Data,* 2019 (aircraft operations); CMT, September 2020 (analysis).

RUNWAY 11-29

The same methodology was used to determine the critical aircraft of runway 11-29. **Table 4.1-20** presents the total number of operations occurring during 2019 for each of the most demanding aircraft types that utilized Runway 11-29. The Boeing 737-800 is the most demanding aircraft type with regular operations on Runway 11-29. Therefore, the critical aircraft designation for Runway 11-29 is a D-**III**.

Table 4.1-20: Runways 11-29 Critical Aircraft - 2019 Operations

AIRCRAFT	AIRCRAFT APPROACH CATEGORY	AIRPLANE DESIGN GROUP	OPERATIONS
Airbus A300-6 (A306)	C	IV	12
Boeing 737-800 (B738)	D	III	4,181
Boeing 737-900 (B739)	D	III	416
Boeing 747-400 (B744)	D	V	1
Boeing 757-200 (B752)	C	IV	144
Boeing 757-300 (B753)	D	IV	2
Boeing 767-200 (B762)	C	IV	4
Boeing 767-300ER (B763)	D	IV	29
Boeing 767-400 (B764)	D	IV	1
Boeing 777-200LR (B77L)	C	V	1
Boeing 787-8 (B788)	D	V	1
Douglas (Boeing) (DC10)	D	IV	3
Gulfstream G-IV (GLF4)	D	III	7
McDonnel Douglas (Boeing) (MD11)	D	IV	7
McDonnel Douglas (Boeing) (MD83)	D	III	519
McDonnel Douglas (Boeing) (MD88)	D	III	775

Source: St. Louis Airport Authority, *L3 Harris Operations Data,* 2019 (aircraft operations); CMT, September 2020 (analysis).

RUNWAY 6-24

The same methodology was used to determine the critical aircraft of runway 6-24. **Table 4.1-21** presents the total number of operations occurring during 2019 for each of the most demanding aircraft types that utilized Runway 6-24. The Boeing 737-700 is the most demanding aircraft type with regular operations on Runway 6-24. Therefore, the critical aircraft designation for Runway 6-24 is a C-**III**.

Table 4.1-21: Runways 6-24 Critical Aircraft 2019 Operations

AIRCRAFT	AIRCRAFT APPROACH CATEGORY	AIRPLANE DESIGN GROUP	OPERATIONS
Airbus A300-6 (A306)	C	IV	2
Airbus A319 (A319)	C	III	39
Airbus A320 (A320)	C	III	27
Boeing 737-400 (B734)	C	III	6
Boeing 737-700 (B737)	C	III	514
Boeing 737-800 (B738)	D	III	230
Boeing 737-900 (B739)	D	III	14
Boeing 757-200 (B752)	C	IV	7
Boeing 767-300ER (B763)	D	IV	3
Gulfstream G-IV (GLF4)	D	III	5
Gulfstream G-V (GLF5)	C	III	10
Gulfstream G5 (GL5T)	C	III	2
Gulfstream G-VI (GLF6)	C	III	3
McDonnel Douglas (Boeing) (MD83)	D	III	17
McDonnel Douglas (Boeing) (MD88)	D	III	12
McDonnel Douglas (Boeing) (MD90)	C	III	16
McDonnel Douglas (Boeing) (MD88)	D	III	775

Source: St. Louis Airport Authority, *L3 Harris Operations Data,* 2019 (aircraft operations); CMT, September 2020 (analysis).

CRITICAL AIRCRAFT SUMMARY

Table 4.1-22 summarizes the critical aircraft designations for each runway at STL.

Table 4.1-22: Critical Aircraft Summary

RUNWAY	CRITICAL AIRCRAFT	AIRCRAFT APPROACH CATEGORY	AIRPLANE DESIGN GROUP
12L-30R / 12R-30L	B763	D	IV
11-29	B738	D	III
6-24	B737	C	III

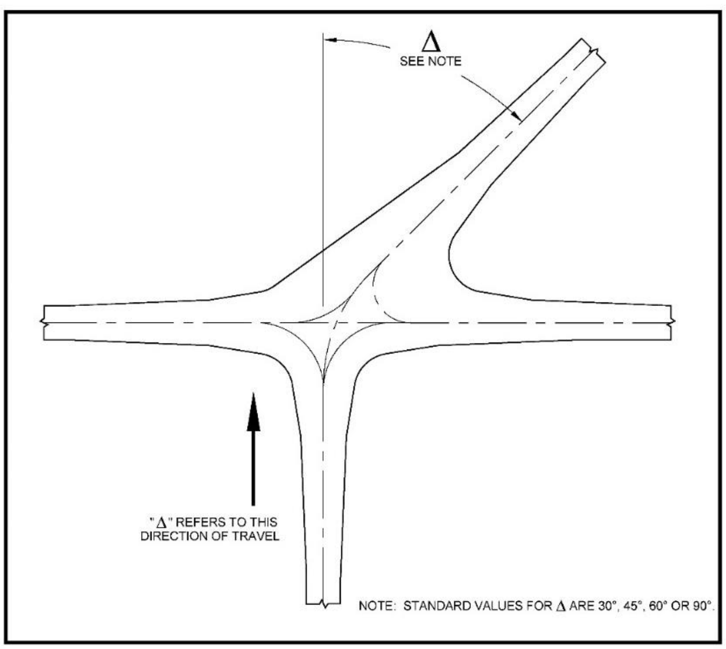
Source: St. Louis Airport Authority, *L3 Harris Operations Data,* 2019 (aircraft operations); CMT, September 2020 (analysis).

PREVENTION OF RUNWAY INCURSIONS

Runway incursions are defined by the FAA as “any occurrence at an aerodrome involving the presence of an aircraft, vehicle, or person on the protected area of a surface designated for the landing and takeoff of aircraft.” FAA AC 150/5300-13A, *Airfield Design,* provides the following guidance on how to design taxiways and taxilanes in order to enhance safety and operator awareness (aircraft or vehicle), thereby reducing the probability of runway incursions:

- Keep taxiway systems simple by using the three-node concept. As illustrated in **Figure 4.1-8**, good airfield design practices keep taxiway intersections simple by reducing the number of taxiways intersecting at a single location which allows for the proper placement of airfield markings, signage, and lighting. Complex intersections increase the possibility of pilot or vehicle operator error. The three-node concept means that a pilot or vehicle operator is presented with no more than three choices at an intersection, ideally left, right, or straight ahead.
- Avoid direct access with taxiway-to-runway interfaces. For example, an aircraft parking apron should not be directly connected to a runway by a taxiway without forcing the pilot or vehicle operator to consciously make a turn.
- Avoid wide expanses of pavement that force airfield signage, marking, and lighting to be further than normal from the location of the aircraft cockpit.
- Reduce the need for aircraft and vehicles to cross runways.
- Avoid “high-energy “intersections. High-energy intersections are intersections in the middle third of the runway where aircraft are operating too fast to fully maneuver on the ground, but not fast enough to become fully airborne and aviate to avoid a potential collision.
- Provide right angle intersections (between two taxiways and between a taxiway and a runway). Do not use acute angle runway exits as a runway entrance point or a runway crossing.
- Avoid dual-purpose pavements. Do not use runways as taxiways and vice-versa.

Figure 4.1-8: Three Node Concept



Source: Federal Aviation Administration, Advisory Circular 150/5300-13A, *Airport Design*, Change 1, September 2012.

The following section identifies the areas of the airfield at STL that are currently noncompliant with these taxiway geometry standards.

COMPLIANCE WITH DESIGN STANDARDS

Ideally, all runways and taxiways are designed and constructed in accordance with FAA guidelines and requirements at the time of construction. These guidelines will stipulate basic geometric requirements that enable a runway or runway system to accommodate traffic by a certain type or size of aircraft and will assist in identifying any airfield constraints that require modification. The following subsections present the runway compliance constraints at STL based on FAA AC 150/5300-13A, *Airfield Design*, and AC 150/5000-17, *Critical Aircraft and Regular Use Determination*.

RUNWAY TO PARALLEL TAXIWAY/TAXILANE SEPARATION

There are currently two instances of noncompliant separation distances on the airfield. One is the separation distance from Runway 12R-30L to Taxiway D. The second is the separation distance between Taxiway D and Taxilane C.

Based on the current Runway Design Code (RDC) for Runway 12R-30L, D-VI, the separation distance between the runway and parallel Taxiway D is inadequate. There is approximately 430 feet of separation between the two pavements, but separation requirements are 500' feet. Funding was obtained to reconstruct Runway 12R-30L, however, and as part of the reconstruction project, the RDC for Runway 12R-30L will be designated as D-IV, and thus the width of the runway and corresponding separation distance requirement from its parallel taxiways will decrease. Once this reconstruction is complete, Taxiway D will meet the separation requirements for a runway with an RDC of D-IV.

Based on the size of aircraft that may use Taxiway D or Taxilane C, the separation distance is not adequate. At times, there may be ADG V or larger aircraft that traverse either of these pavements. When an aircraft this size is present on either pavement surface, the required separation distance is 267 feet. The current distance is 215 feet or equivalent to the separation requirements for ADG IV. There are currently operational restrictions in place to govern movement of certain aircraft on these pavements that are detailed in Section 2, *Inventory of Existing Conditions*.

TAXIWAY PAVEMENT GEOMETRY

Runway 12R-30L Corridor

Runway 12R-30L and its surrounding taxiways see a majority of the Airport's traffic, through direct utilization or by crossing this area on the way to and from other runways and the terminal apron. Positioned directly adjacent to the terminal, Runway 12R-30L is used primarily for departures in the operational flows used by STL ATCT personnel. Aircraft depart from Runway 12R when the airfield is operating in a Southeast Flow, and from Runway 30L in a Northwest Flow.

RUNWAY 12R-30L DIRECT ACCESS

Direct access exists when access is available directly from an apron to a runway without a turn in the taxiway system. Providing direct access is considered a contributing factor to runway incursions.

There are 12 connecting taxiways on the south side of Runway 12R-30L that connect the runway to the terminal environment, and 9 connecting taxiways on the north side that connect it with additional airfield infrastructure. The majority of geometric standards issues surrounding Runway 12R-30L originate on the south side of the runway, through direct access issues from the terminal apron to the runway environment. **Figure 4.1-9** depicts the direct access issues from the terminal apron to Runway 12R-30L, which include the following taxiways:

- Taxiway R
- Taxiway Q
- Taxiway P
- Taxiway M
- Taxiway J
- Taxiway N

Reconfiguration of these direct access points through reconfiguration of the connecting taxiways between the apron and parallel taxiway, or reconfiguration of the connecting taxiways between the parallel taxiway and Runway 12R-30L is recommended. Temporary measures were taken using pavement markings and implementation of aircraft movement restrictions by ATC while on the terminal apron.

Figure 4.1-10 shows direct access issues from the Hotel Pad and Taxiway C to Runway 30L end via Taxiway H and Taxiway G.

Reconfiguration of these direct access points through reconfiguration of the connecting taxiways on both the north and south sides of Runway 12R-30L will be considered during the alternatives analysis.

RUNWAY 12R-30L HIGH ENERGY INTERSECTIONS

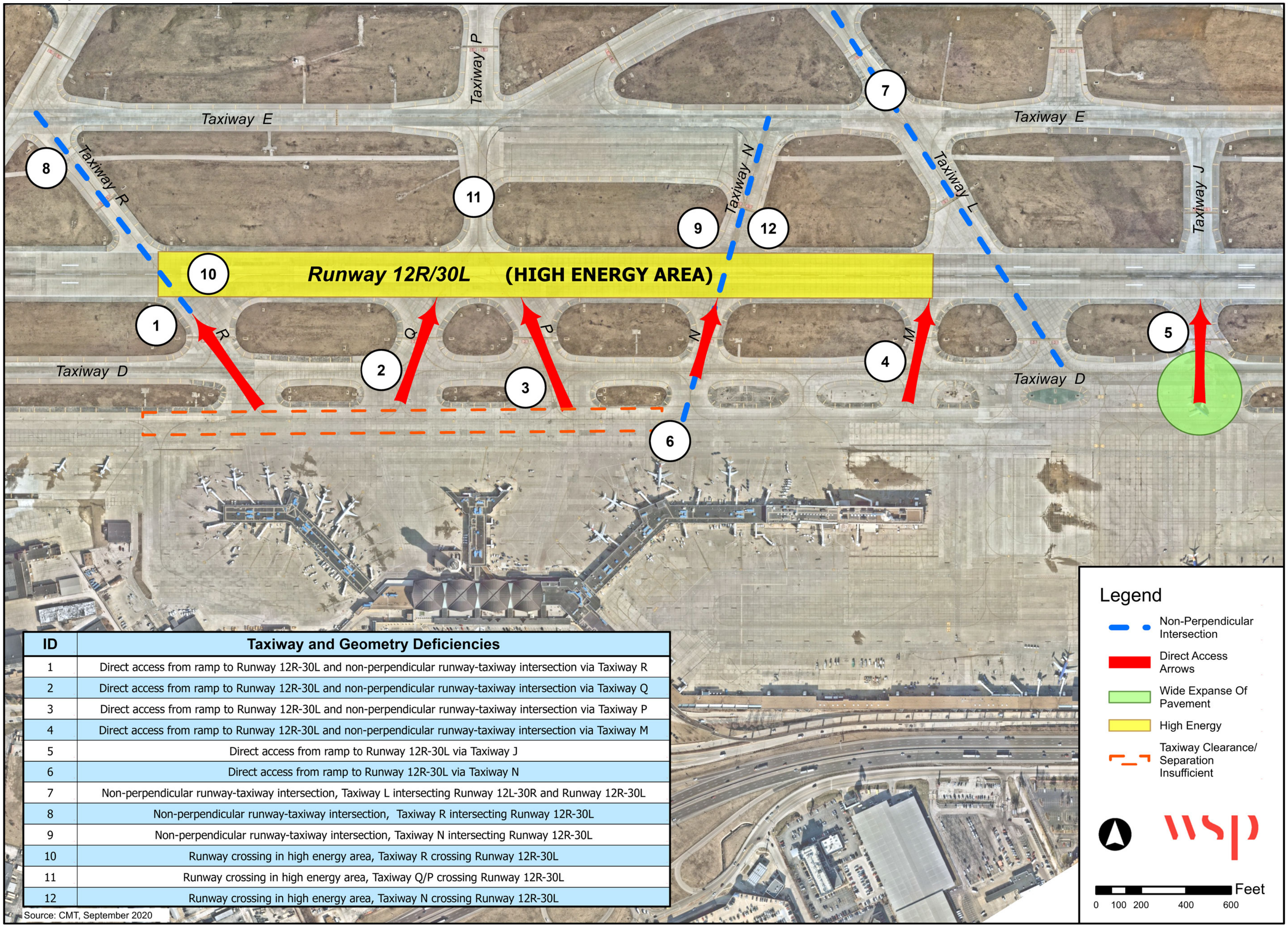
Several of the taxiways that contribute to direct access issues on the south side of Runway 12R-30L also contribute to intersections in the high energy zone in the middle third of the runway. As shown in Figure 4.1-9, the following taxiways are part of intersection or crossing movements from one side of Runway 12R-30L to the other:

- Taxiway R → Taxiway R
- Taxiway Q & P → Taxiway P
- Taxiway N → Taxiway N

It is recommended that these crossing opportunities are mitigated through relocation or removal of taxiways to prohibit crossing within the middle third of Runway 12R-30L.

Figure 4.1-9

Runway 12R-30L
Nonstandard Taxiway Geometry



ID	Taxiway and Geometry Deficiencies
1	Direct access from ramp to Runway 12R-30L and non-perpendicular runway-taxiway intersection via Taxiway R
2	Direct access from ramp to Runway 12R-30L and non-perpendicular runway-taxiway intersection via Taxiway Q
3	Direct access from ramp to Runway 12R-30L and non-perpendicular runway-taxiway intersection via Taxiway P
4	Direct access from ramp to Runway 12R-30L and non-perpendicular runway-taxiway intersection via Taxiway M
5	Direct access from ramp to Runway 12R-30L via Taxiway J
6	Direct access from ramp to Runway 12R-30L via Taxiway N
7	Non-perpendicular runway-taxiway intersection, Taxiway L intersecting Runway 12L-30R and Runway 12R-30L
8	Non-perpendicular runway-taxiway intersection, Taxiway R intersecting Runway 12R-30L
9	Non-perpendicular runway-taxiway intersection, Taxiway N intersecting Runway 12R-30L
10	Runway crossing in high energy area, Taxiway R crossing Runway 12R-30L
11	Runway crossing in high energy area, Taxiway Q/P crossing Runway 12R-30L
12	Runway crossing in high energy area, Taxiway N crossing Runway 12R-30L

Source: CMT, September 2020

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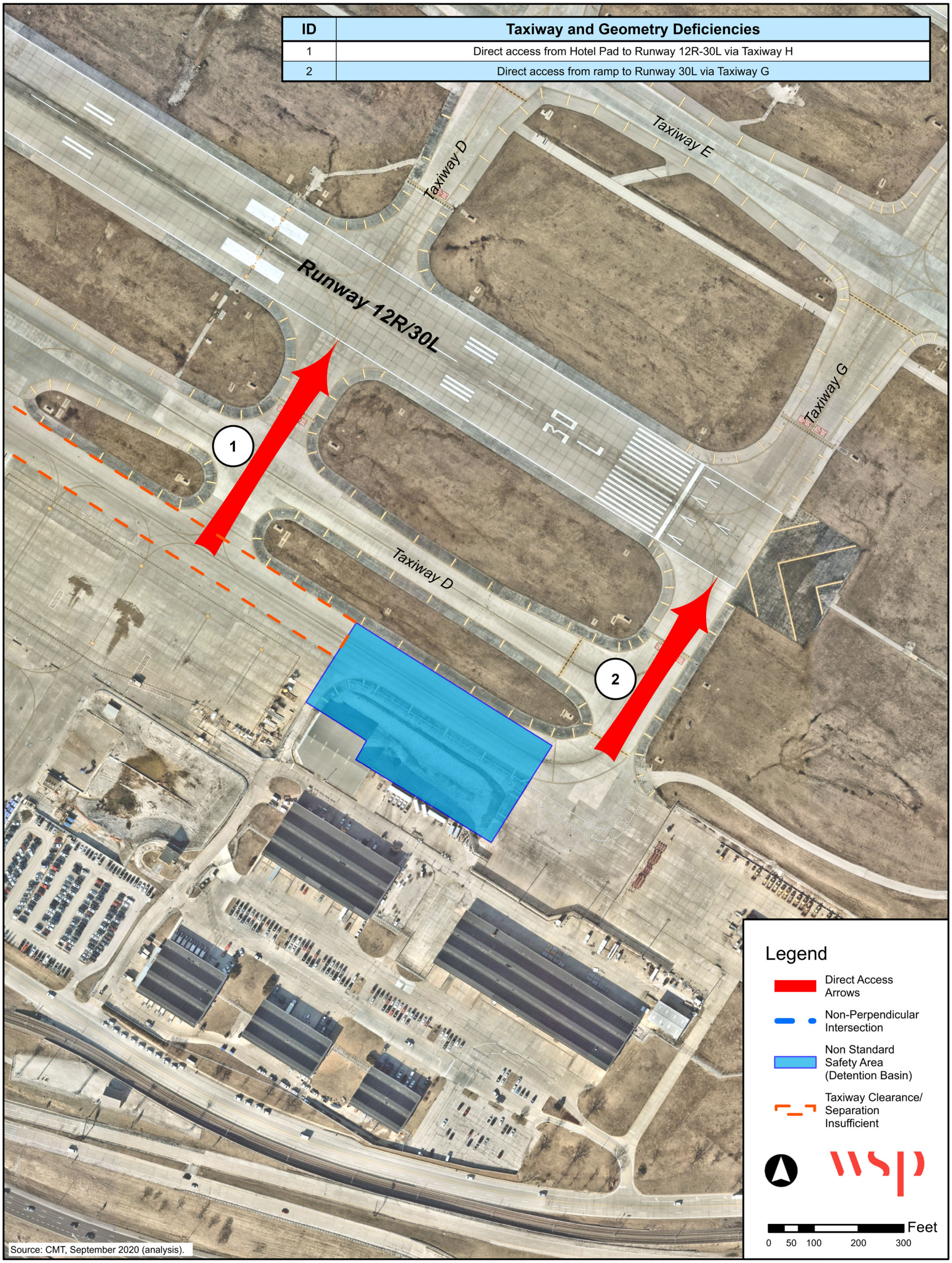
Figure 4.1-10

Runway 30L Direct Access

ID	Taxiway and Geometry Deficiencies
1	Direct access from Hotel Pad to Runway 12R-30L via Taxiway H
2	Direct access from ramp to Runway 30L via Taxiway G



Source: CMT, September 2020 (analysis).

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RUNWAY 12R-30L NONSTANDARD ANGLE INTERSECTIONS

As mentioned above, several of the taxiways that contribute to direct access compliance issues in the terminal area also contribute to intersections that intersect Runway 12R-30L at nonstandard angles. Per FAA guidance, 90° runway-to-taxiway intersections are preferred, to optimize pilot visibility.

As depicted in Figure 4.1-9, Taxiways L, N and R intersect Runway 12R-30L at a nonstandard angle. Opportunities to remove or realign these taxiways, to better comply with FAA geometric standards, while remaining cognizant of the high-energy zone and direct access issues, will be considered during the Alternatives Analysis.

Figure 4.1-9 also shows that Taxiway V intersects Runway 12R-30L at an acute angle. This results in pilots at the runway hold line having a clear view of inbound traffic on Runway 12R, but a limited view of aircraft that may be departing Runway 30L or exiting via the Runway 12R threshold taxiways.

RUNWAY 12R-30L LARGE EXPANSE OF PAVEMENT

There are several areas directly adjacent to Runway 12R-30L that represent large expanses of pavement. Large expanses of pavement can result in pilot disorientation/confusion and make it difficult to provide proper signage, marking and lighting. This can be mitigated through the use of green painted islands in well lighted conditions, in-pavement lighting to provide clear delineation in darkness, or removal of the pavement to eliminate any ambiguity. Alternatives and mitigation options will be discussed in the Alternatives Analysis.

The intersection of Taxiways D, C and T, which is adjacent to both Runways 6-24 and 12R-30L, is considered a large expanse of pavement (see Figure 4.1-9). Based on FAA guidance, and especially because of its proximity to both runways, it recommended that mitigating measures be implemented to clearly delineate these taxiway intersections.

The intersection of Taxiway D, Taxiway J and the terminal apron also creates a large expanse of pavement. While there is currently a green painted island delineating unusable pavement directly adjacent to Taxiway D, there is still a wide throat created by the Taxiway D, Taxiway J, terminal apron intersection that is immediately adjacent to Runway 12R-30L and also contributes to the direct access issue. This intersection will also be studied during the Alternatives Analysis.

Nonstandard Safety Areas

Both the Runway Safety Area (RSA) and Runway Object Free Area (ROFA) on the Runway 12R end are penetrated by an airfield access road, and do not meet FAA standards. Beyond the Runway 12R end, there is 940 feet of full-width RSA available and 875 feet of full-width ROFA available. Both areas should meet the 1,000-foot width standard for their entire length. These safety areas are depicted in **Figure 4.1-11**, and options to improve them will be considered during the Alternatives Analysis.

Runway 12L-30R Corridor

Runway 12L-30R accounts for approximately 28% of STL's operations. Runway 12L is used for both arrivals and departures in Southeast flow while Runway 30R is used primarily for arrivals in Northwest flow. All of the design standards issues related to Runway 12L-30R occur in the middle third of the runway.

Figure 4.1-11

Runway 12R Safety Areas

#	Airfield Design Deficiencies	Standard
1	Runway 12R Safety Area (Length 940'), Runway 12R Object Free Area (Length 875')	1,000'

Source: CMT, September 2020 (analysis).

RUNWAY 12L-30R DIRECT ACCESS

There are two points of direct access to Runway 12L-30R, as depicted on **Figure 4.1-12**. Taxiway L provide access from just outside Boeing's facility, and could be disorienting to an aircraft that has just entered the movement area. Taxiway K provide access from the UPS cargo apron.

RUNWAY 12L-30R HIGH ENERGY INTERSECTIONS AND NONSTANDARD ANGLE INTERSECTIONS

Also depicted in Figure 4.1-12, in addition to providing direct access, both of these taxiways also intersect the high-energy area of the runway. Taxiway L also intersects both Runway 12L-30R and Taxiway E at nonperpendicular intersections. These types of intersections may be confusing to pilots and also do not allow for a clear view in both directions of the runway.

It is recommended that these taxiways be reconfigured, or mitigations put in place, to better meet FAA design standards.

Runway 6-24 Corridor

RUNWAY 6-24 DIRECT ACCESS

Taxiway S1 provides direct access to Runway 6-24 from the Jet Linx apron, as displayed in **Figure 4.1-13**. While this is the only direct access point to 6-24, potential mitigations will be studied during the alternatives analysis.

RUNWAY 6-24 NONSTANDARD ANGLE INTERSECTIONS

As displayed in **Figure 4.1-14**, Taxiway P intersects Runway 24 at a less than a 90° angle. This results in pilots at the runway hold line having a clear view of inbound traffic on Runway 24, but a limited view of aircraft that may be departing Runway 6. In order to comply with FAA standards, it is recommended that a realignment of Taxiway P be studied.

RUNWAY 6-24 NONSTANDARD SAFETY AREAS AND BLAST PAD

In addition to the nonperpendicular taxiway intersecting the Runway 24 end, the RSA, ROFA, and Blast Pad do not meet standards. Both the RSA and ROFA should be full-width for 1,000 feet beyond the runway end; they are currently full-width for 982 feet and 725 feet beyond the runway end, respectively. Additionally, the Blast Pad should be 200 feet long, but is only 100 feet long. All of these issues are depicted in **Figure 4.1-15**, and should be mitigated to improve runway end safety.

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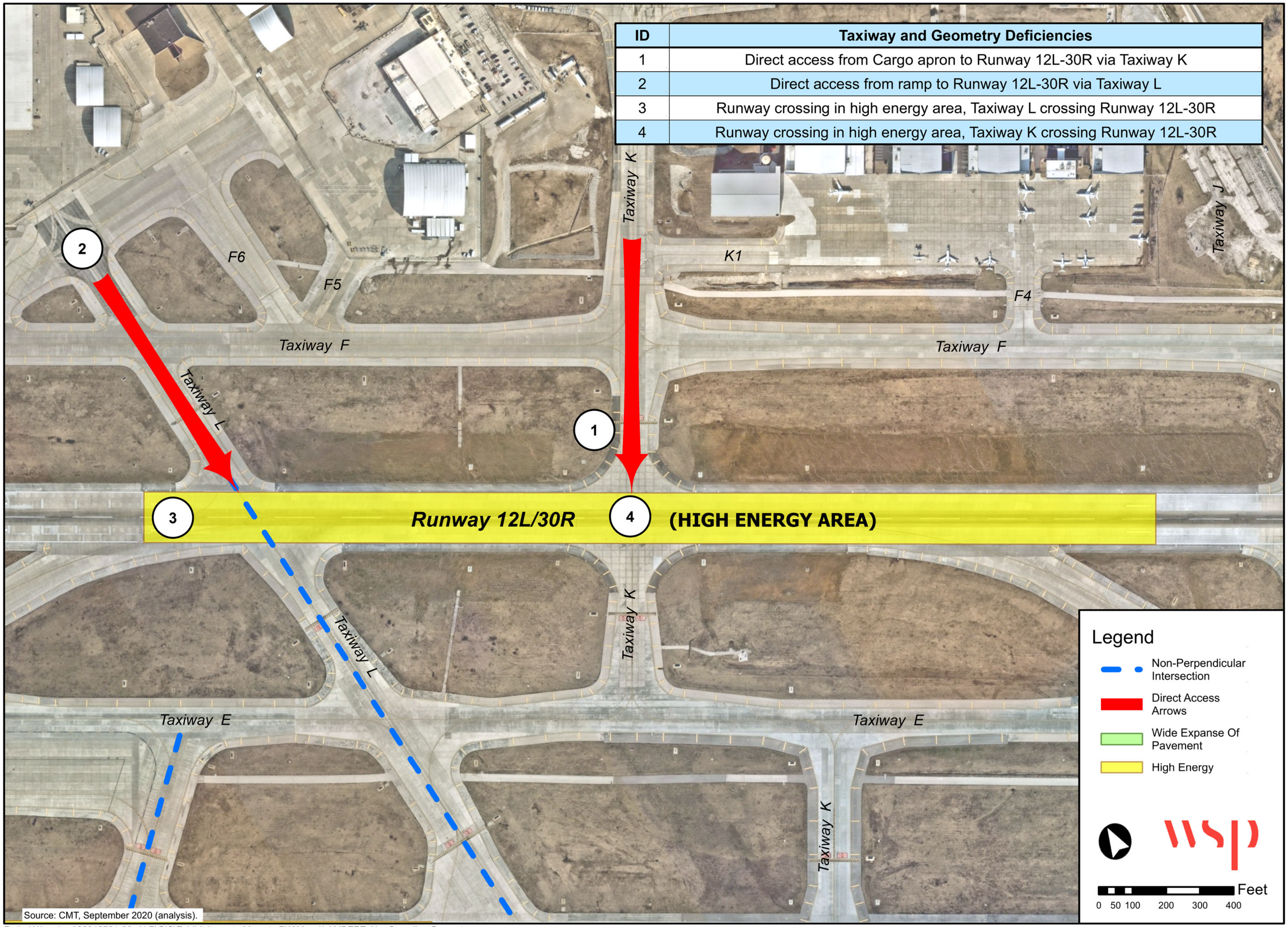
Figure 4.1-12

Runway 12L-30R
Nonstandard Intersection

ID	Taxiway and Geometry Deficiencies
1	Direct access from Cargo apron to Runway 12L-30R via Taxiway K
2	Direct access from ramp to Runway 12L-30R via Taxiway L
3	Runway crossing in high energy area, Taxiway L crossing Runway 12L-30R
4	Runway crossing in high energy area, Taxiway K crossing Runway 12L-30R



Source: CMT, September 2020 (analysis).

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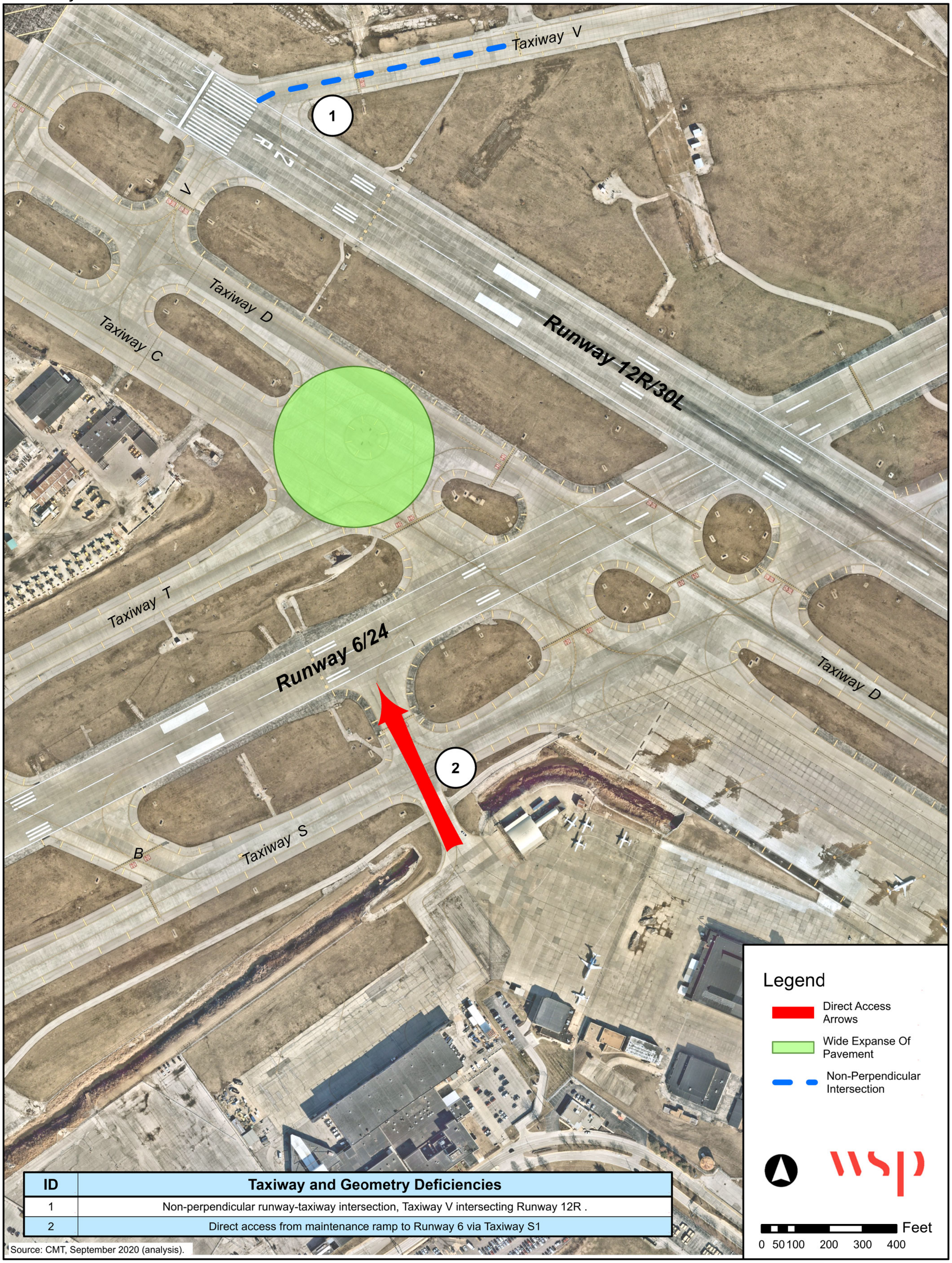
Figure 4.1-13

Taxiway S1 Direct Access to Runway 6-24



ID	Taxiway and Geometry Deficiencies
1	Non-perpendicular runway-taxiway intersection, Taxiway V intersecting Runway 12R .
2	Direct access from maintenance ramp to Runway 6 via Taxiway S1

Source: CMT, September 2020 (analysis).

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Figure 4.1-14

Taxiway P Hold Line

ID	Taxiway and Geometry Deficiencies
1	Non-perpendicular runway-taxiway intersection, Taxiway P intersecting Runway 24

Source: CMT, September 2020 (analysis).

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Figure 4.1-15

Runway 24 Nonstandard Safety Areas

#	Airfield Design Deficiencies	Standard
1	Runway 6-24 Safety Area (Length 982'), Runway 12R Object Free Area (Length 725')	1,000'
2	Runway 6-24 Blast Pads (Length 100')	200'

Source: CMT, September 2020 (analysis).

RUNWAY 6-24 LARGE EXPANSE OF PAVEMENT AND HOT SPOT

An airfield hot spot is a location on an airport movement area with a history of potential risk of collision or runway incursion, and where heightened attention by pilots and drivers is necessary. STL has one FAA-identified hot spot, HS-1, for the turn from Taxiway F onto Taxiway S for aircraft accessing Runway 12L. It is depicted in **Figure 4.1-16**. A reconfiguration of the taxiways, and options to eliminate HS-1, will be studied during the Alternatives Analysis.

This figure also depicts the wide expanse of pavement at the intersection of Taxiways E, S, and R. Taxiway S leads to the Runway 12L threshold and Taxiway R provides access to Runway 12R-30L. Pilots operating at this intersection need to be vigilant, due to the access to two runways and the non-standard angles created by the intersecting taxiways. Alternatives for improving this intersection will be assessed in the Alternatives Analysis.

Runway 6-24 and 11-29 Corridor

NONSTANDARD SAFETY AREAS AND BLAST PAD

Both the Taxiway S OFA and Taxiway Safety Area (TSA) are reduced from the standard size because of penetrations by the Runway 29 approach light system and the airport service road. These issues, which are displayed in **Figure 4.1-17**, impact the level of safety for aircraft operating on Taxiway S as they taxi to or from Runway 6-24. Additionally, the Runway 6 end blast pad should be 200 feet long instead of the existing 100 feet. Alternatives to mitigate these issues will be reviewed in the Alternatives Analysis.

LARGE EXPANSE OF PAVEMENT

There is a large expanse of pavement at the intersection of Taxiways A, B, U, and T that falls within the corridor of both Runways 6-24 and 11-29, as depicted in **Figure 4.1-18**. While there are some markings and taxiways signs at the center of this intersection, a reconfiguration of the pavement or more visible markings are recommended to eliminate this wide area of pavement, especially with its proximity to the Runway 6 and 29 ends.

TAXIWAY GRADE

Taxiway B, east of Taxiway Tango, has a Modification to Standards (MOS) for non-standard pavement grades, dated from 2003. Any proposed taxiway improvements should address these non-standard pavement grades.

OPERATIONAL RESTRICTIONS

There are 11 operational restrictions placed on aicraft operating at STL. The locations and issues are detailed out in **Figure 4.1-19**. The restrictions impact various sizes of aircrat and are carried out by ATC, which impacts the flow of taxing aircraft. Potential changes to the airfield geometry will be studied during the development of the alternatives.

Figure 4.1-16

Runway 6-24 Hot Spot and Large Expanse of Pavement

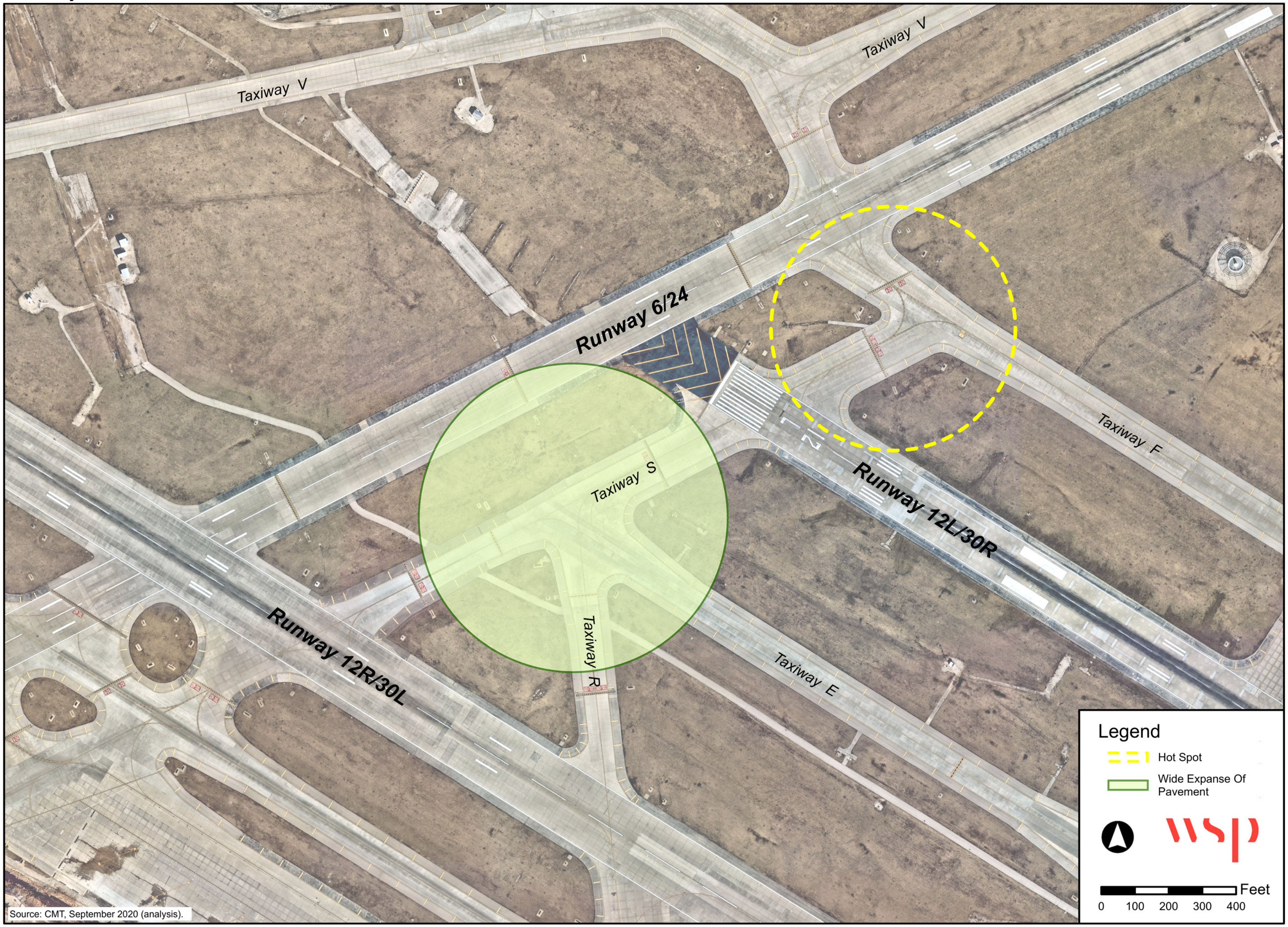

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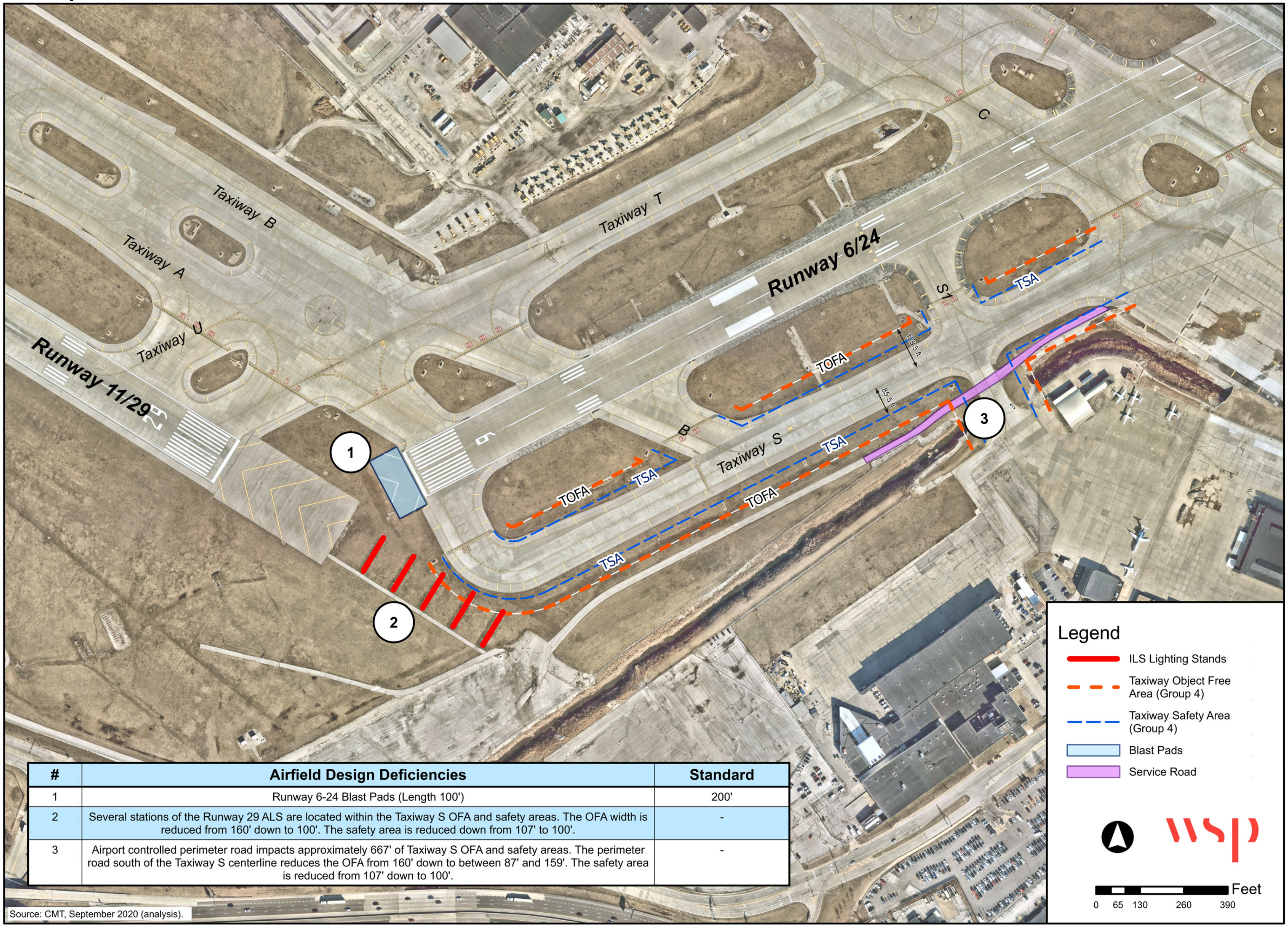
Figure 4.1-17

Taxiway S Object Free Area and Taxiway Safety Area



#	Airfield Design Deficiencies	Standard
1	Runway 6-24 Blast Pads (Length 100')	200'
2	Several stations of the Runway 29 ALS are located within the Taxiway S OFA and safety areas. The OFA width is reduced from 160' down to 100'. The safety area is reduced down from 107' to 100'.	-
3	Airport controlled perimeter road impacts approximately 667' of Taxiway S OFA and safety areas. The perimeter road south of the Taxiway S centerline reduces the OFA from 160' down to between 87' and 159'. The safety area is reduced from 107' down to 100'.	-

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Figure 4.1-18

Large Expanse of Pavement

ID	Taxiway and Geometry Deficiencies
1	Non-perpendicular runway-taxiway intersection (Taxiway A/B at Runway 6-24 and Taxiways U/T at Runway 11-29).

Source: CMT, September 2020 (analysis).

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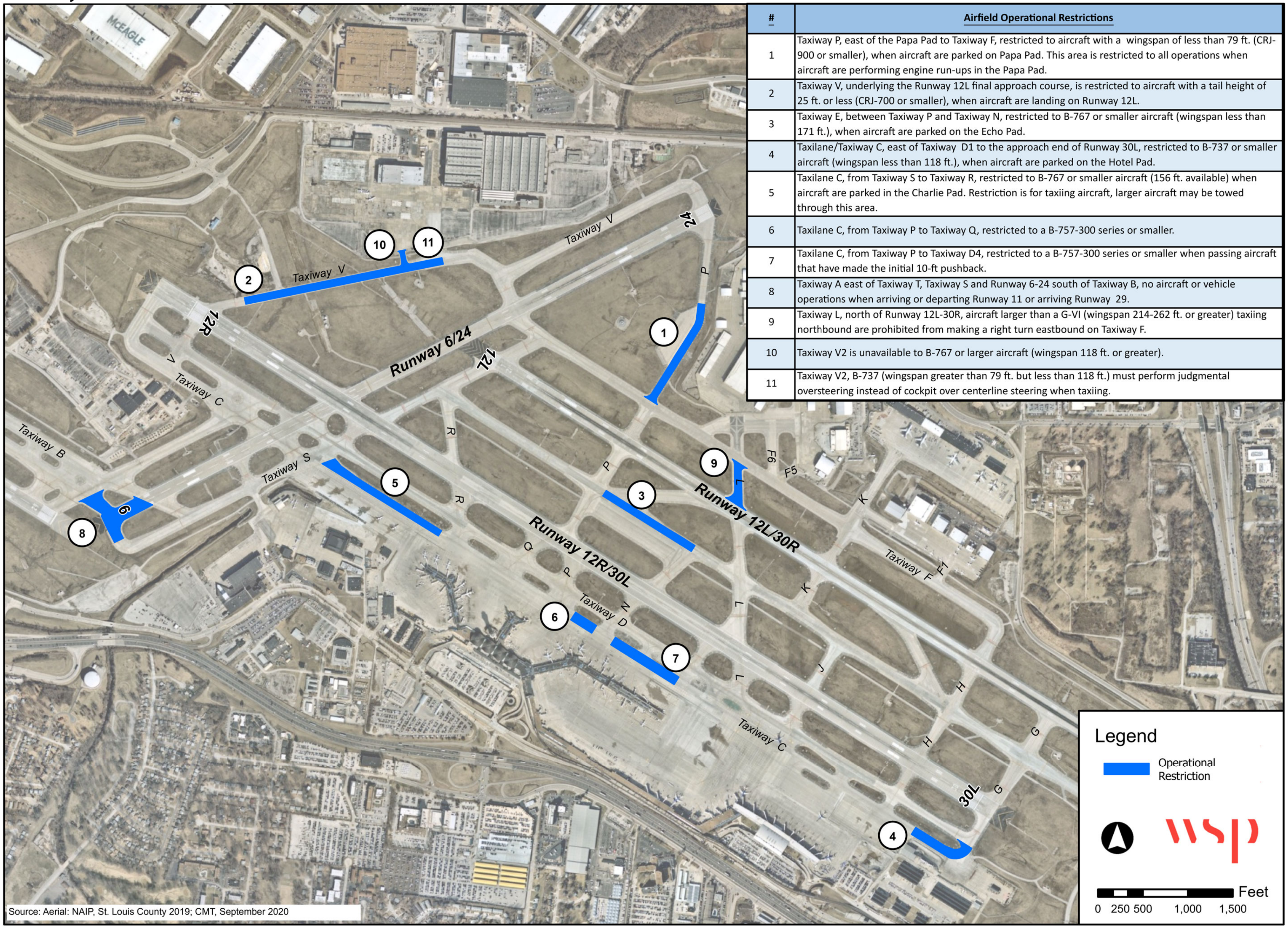
Figure 4.1-19

Operational Restrictions



#	Airfield Operational Restrictions
1	Taxiway P, east of the Papa Pad to Taxiway F, restricted to aircraft with a wingspan of less than 79 ft. (CRJ-900 or smaller), when aircraft are parked on Papa Pad. This area is restricted to all operations when aircraft are performing engine run-ups in the Papa Pad.
2	Taxiway V, underlying the Runway 12L final approach course, is restricted to aircraft with a tail height of 25 ft. or less (CRJ-700 or smaller), when aircraft are landing on Runway 12L.
3	Taxiway E, between Taxiway P and Taxiway N, restricted to B-767 or smaller aircraft (wingspan less than 171 ft.), when aircraft are parked on the Echo Pad.
4	Taxilane/Taxiway C, east of Taxiway D1 to the approach end of Runway 30L, restricted to B-737 or smaller aircraft (wingspan less than 118 ft.), when aircraft are parked on the Hotel Pad.
5	Taxilane C, from Taxiway S to Taxiway R, restricted to B-767 or smaller aircraft (156 ft. available) when aircraft are parked in the Charlie Pad. Restriction is for taxiing aircraft, larger aircraft may be towed through this area.
6	Taxilane C, from Taxiway P to Taxiway Q, restricted to a B-757-300 series or smaller.
7	Taxilane C, from Taxiway P to Taxiway D4, restricted to a B-757-300 series or smaller when passing aircraft that have made the initial 10-ft pushback.
8	Taxiway A east of Taxiway T, Taxiway S and Runway 6-24 south of Taxiway B, no aircraft or vehicle operations when arriving or departing Runway 11 or arriving Runway 29.
9	Taxiway L, north of Runway 12L-30R, aircraft larger than a G-VI (wingspan 214-262 ft. or greater) taxiing northbound are prohibited from making a right turn eastbound on Taxiway F.
10	Taxiway V2 is unavailable to B-767 or larger aircraft (wingspan 118 ft. or greater).
11	Taxiway V2, B-737 (wingspan greater than 79 ft. but less than 118 ft.) must perform judgmental oversteering instead of cockpit over centerline steering when taxiing.

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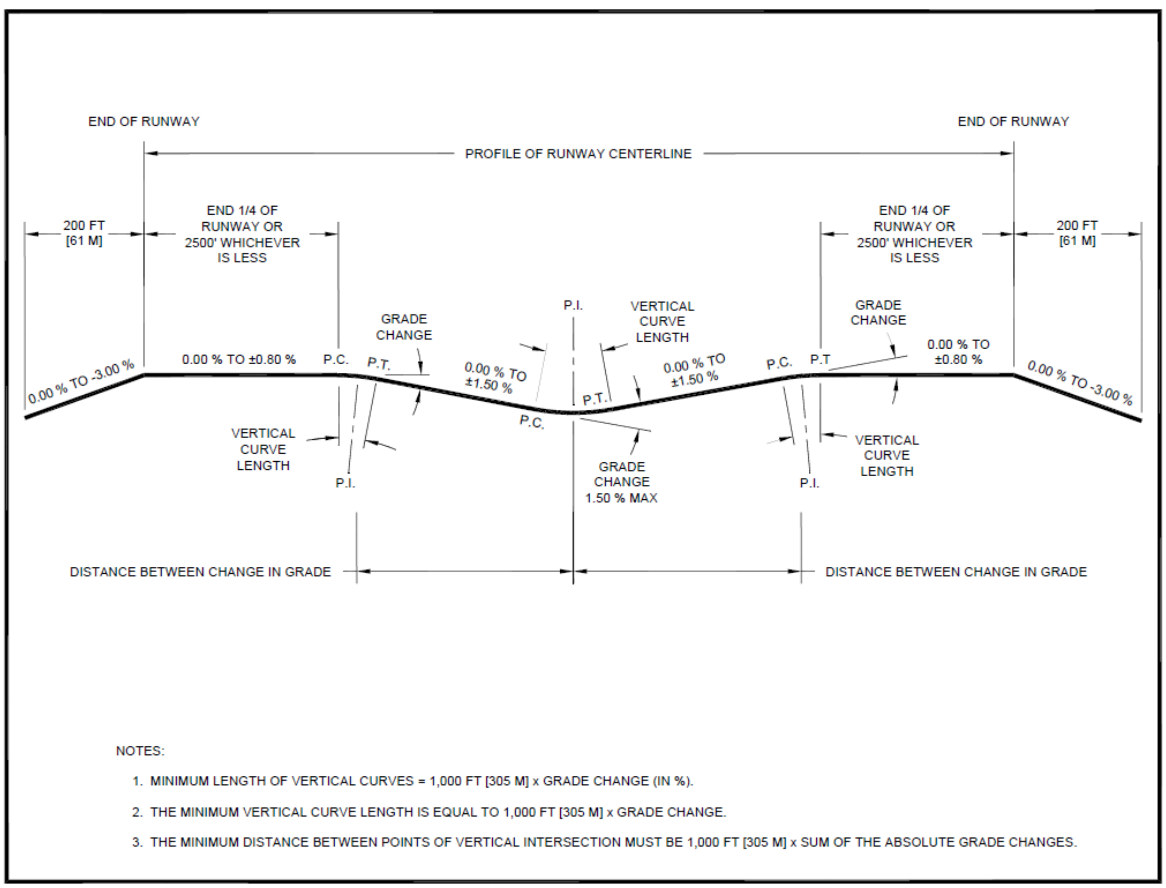
RUNWAY VERTICAL CURVES AND GRADE

There are areas of noncompliant vertical curves on Runways 6-24 and 12R-30L. Per FAA AC 150/5300-13A, Section 313 *Surface Gradient*, "provide a smooth transition between the intersecting pavement surfaces as well as adequate drainage of the intersection. Give precedence for the dominant runway (e.g., higher speed, higher traffic volume, etc.) in a runway-runway situation." Since Runway 12R-30L is considered the dominant runway when considering the runway-runway intersection of Runway 12R-30L and Runway 6-24, its grades are given precedence over the Runway 6-24 grades. Therefore, what would normally be a deviation from standards on the Runway 6-24 vertical curve spacing, is negated by circular guidance to provide precedence for the dominant runway.

Figure 4.1-20 depicts the FAA standards prescribed in AC 150/5300-13A. Longitudinal Grade Limitations for Aircraft Approach Categories, C, D and E, dictates that within the last quarter of the runway (or 2,500 feet, whichever is less) grades should be a constant 0.00% to ±0.80%. Within the final quarter of Runways 12R, 30L, 6 and 24, however, vertical curves exist. Based on the definition and need for a vertical curve as defined by FAA, these vertical curves contained within the first or last quarter of each of these runways represent a deviation from standards and will be further evaluated in the Alternatives Analysis.

Figure 4.1-20: Runway Vertical Guidance

Figure 3-22. Longitudinal grade limitations for aircraft approach categories C, D, and E



Source: Federal Aviation Administration, Advisory Circular 150/5300-13A, *Airport Design*, Figure 3-22, September 2012.

AIRFIELD SAFETY AREAS

RUNWAY SAFETY AREAS AND RUNWAY OBJECT FREE AREAS

FAA AC 150/5300-13A prescribes the geometric standards for RSAs and ROFAs. Each of these safety areas are defined as follows:

- Runway Safety Area (RSA) – A defined surface surrounding the runway prepared or suitable for reducing the risk of damage to an aircraft in the event of an overshoot, or excursion from the runway.
- Runway Object Free Area (ROFA) – An area centered on the ground on a runway centerline provided to enhance the safety of aircraft operations by remaining clear of objects, except for objects that need to be located in the ROFA for air navigation or aircraft ground maneuvering purposes.

FAA requires airports to have RSAs and OFAs that are free and clear of any penetrations or objects that are not frangible and fixed by function. The dimensions of these safety areas are determined by the RDC of each runway. Based on the RDC of each runway at STL, the RSA width is 250 feet on each side of the runway centerline, the length is 600 feet prior to the arrival threshold and 1,000 feet beyond the far end of the runway. The ROFA has a width of 400 feet on each side of the runway centerline, a length that is 600 feet prior to the arrival threshold and 1,000 feet beyond the far end of the runway.

There are several instances of incompatible object(s), that are not fixed by function, within each RSA and ROFA. They are identified in **Table 4.1-23**. **Figures 4.1-21** through **4.1-24** depict the identified penetrations for each runway.

Mitigation of these objects may be achievable through one or a combination of operational restrictions, frangible mounting, or removal, and will be considered during the in *Chapter 5 - Alternatives Development*.

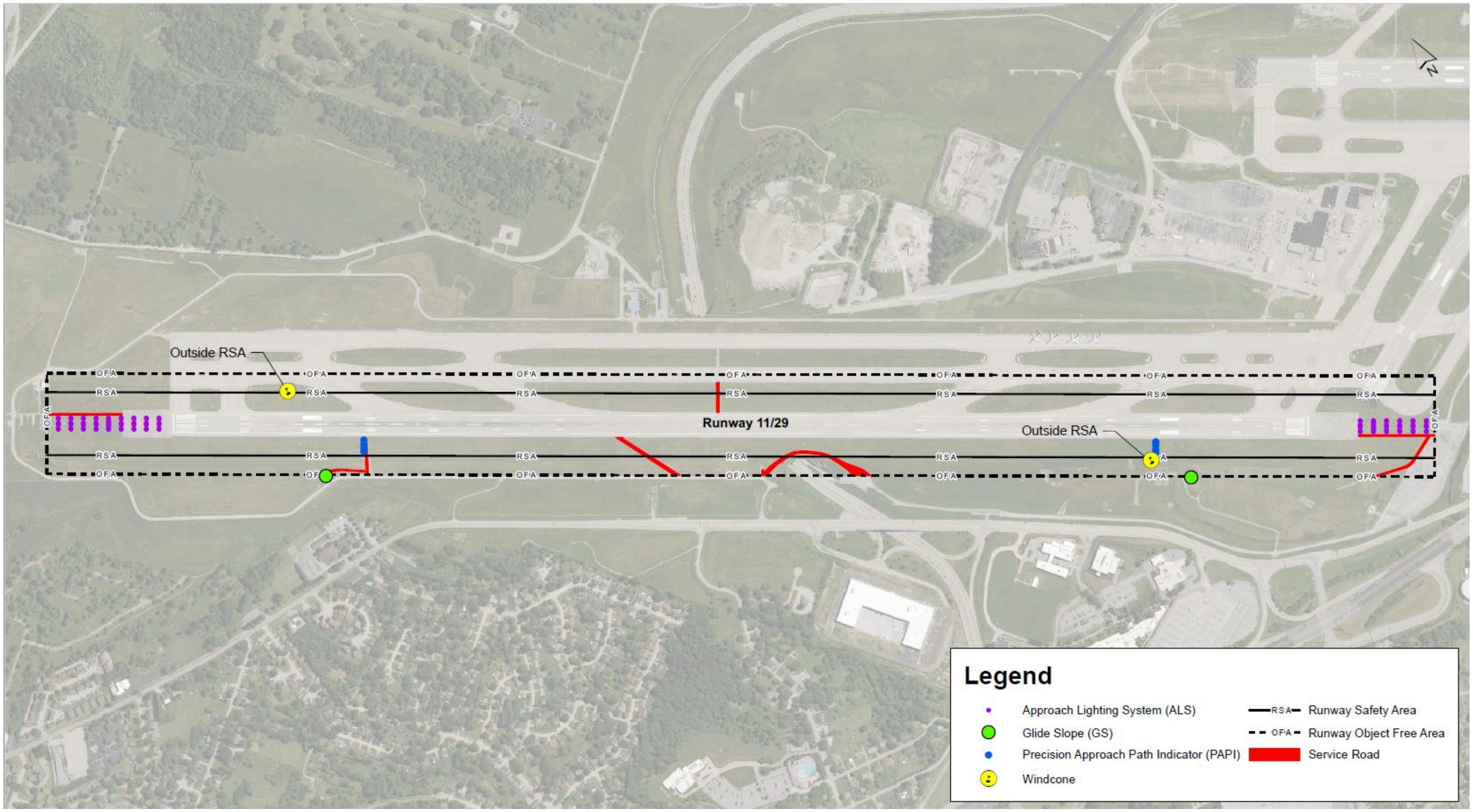
Table 4.1-23: Runway Safety Areas and Runway Object Free Areas

	RUNWAY SAFETY AREA (RSA)		RUNWAY OBJECT FREE AREA (ROFA)	
RUNWAY	PENETRATION	FIXED BY FUNCTION	PENETRATION	FIXED BY FUNCTION
6	Service Roads	PAPI MALSR Glide Slope	Service Roads	PAPI MALSR Glide Slope
24	Service Roads Banshee Road	PAPI MALSR	Service Roads Banshee Road Norfolk-Southern Railroad Windsock	PAPI MALSR Glide Slope
11	Service Road Windsock	PAPI Approach Light Systems	Service Road Windsock	PAPI Approach Lighting Systems Glide Slope
29	Service Road	PAPI Approach Lighting Systems	Service Roads	PAPI Approach Lighting Systems Glide Slope
12R	Service Roads Windsock Bridgeton Station Road / Airport Access Road	PAPI MALSR	Service Roads Windsock Bridgeton Station Road / Airport Access Road Banshee Road	PAPI MALSR Glide Slope
30L	Service Roads Windsock	PAPI MALSR	Service Roads Windsocks	PAPI MALSR Glide Slope
12L	Service Roads	PAPI Approach Lighting System Runway End Identifier Lights	Service Roads	PAPI Approach Lighting System Runway End Identifier Lights Glide Slope
30R	Service Roads	PAPI Approach Lighting System	Service Roads	PAPI Approach Lighting System Glide Slope

Note: All roads, except Banshee Road, have restricted access and penetrations are mitigated via operational restrictions.

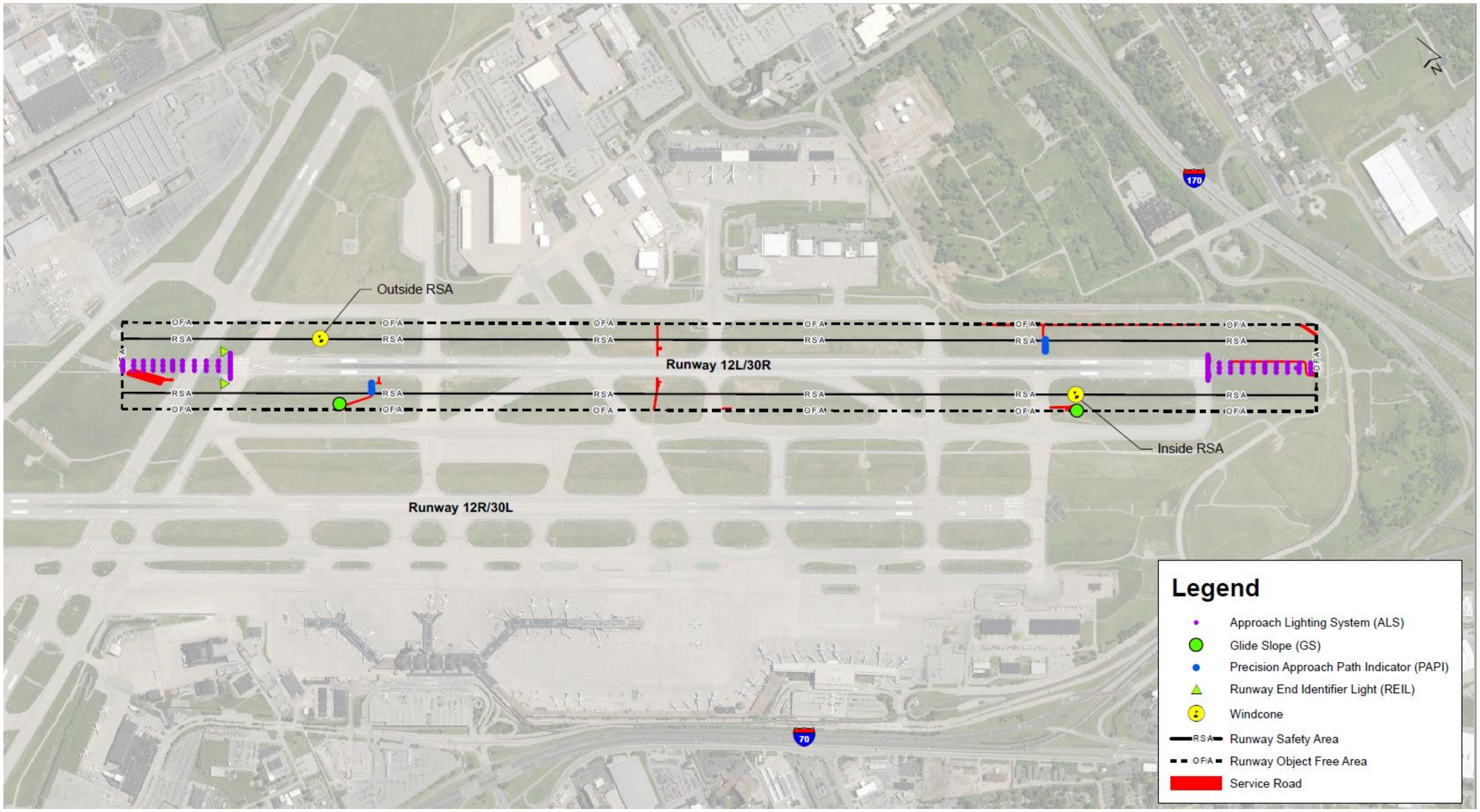
Source: CMT, September 2020 (analysis)

Figure 4.1-21: Runway 11-29 Runway Safety Area and Object Free Area Penetrations



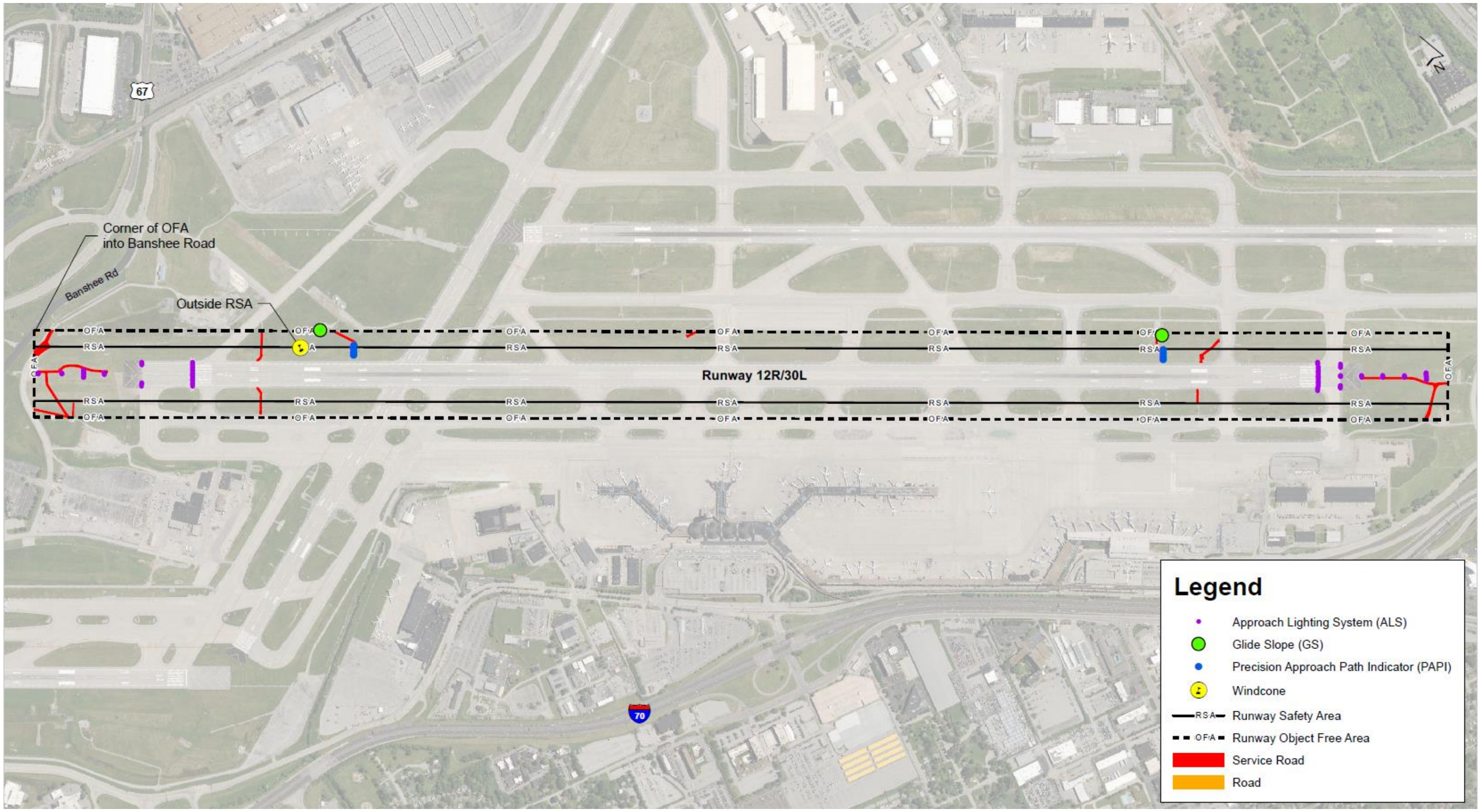
Source: CMT

Figure 4.1-22: Runway 12L-30R Runway Safety Area and Object Free Area Penetrations



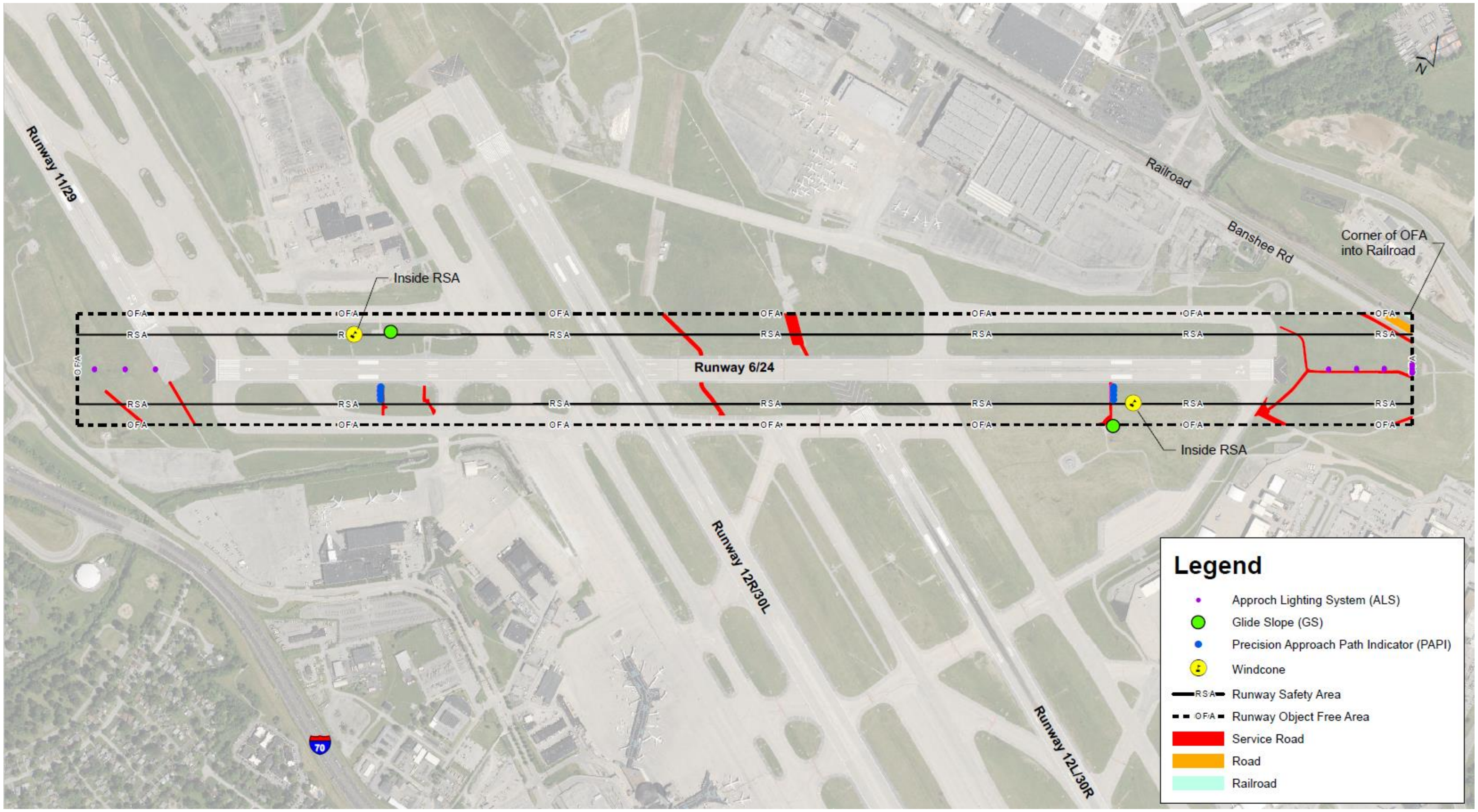
Source: CMT, 2022.

Figure 4.1-23: Runway 12R-30L Runway Safety Area and Object Free Area Penetrations



Source: CMT, 2022.

Figure 4.1-24: Runway 6-24 Runway Safety Area and Object Free Area Penetrations



Source: CMT, 2022.

RUNWAY PROTECTION ZONES

The Runway Protection Zone's (RPZ) function is to enhance the protection of property and people on the ground. This is best achieved through airport owner control of the land area(s) that fall within the RPZ. Control is preferably exercised through the acquisition of property interest in the RPZ and includes clearing the RPZ areas (and maintaining them clear) of incompatible objects and activities.

Similar to RSAs and ROFAs, the dimensions of RPZs are determined by the RDC. The majority of the RPZs are within Airport property and the land uses are compatible with FAA guidance. **Table 4.1-24** summarizes land use compatibility for each runway end. **Figures 4.1-25** through **4.1-29** depict RPZ penetrations.

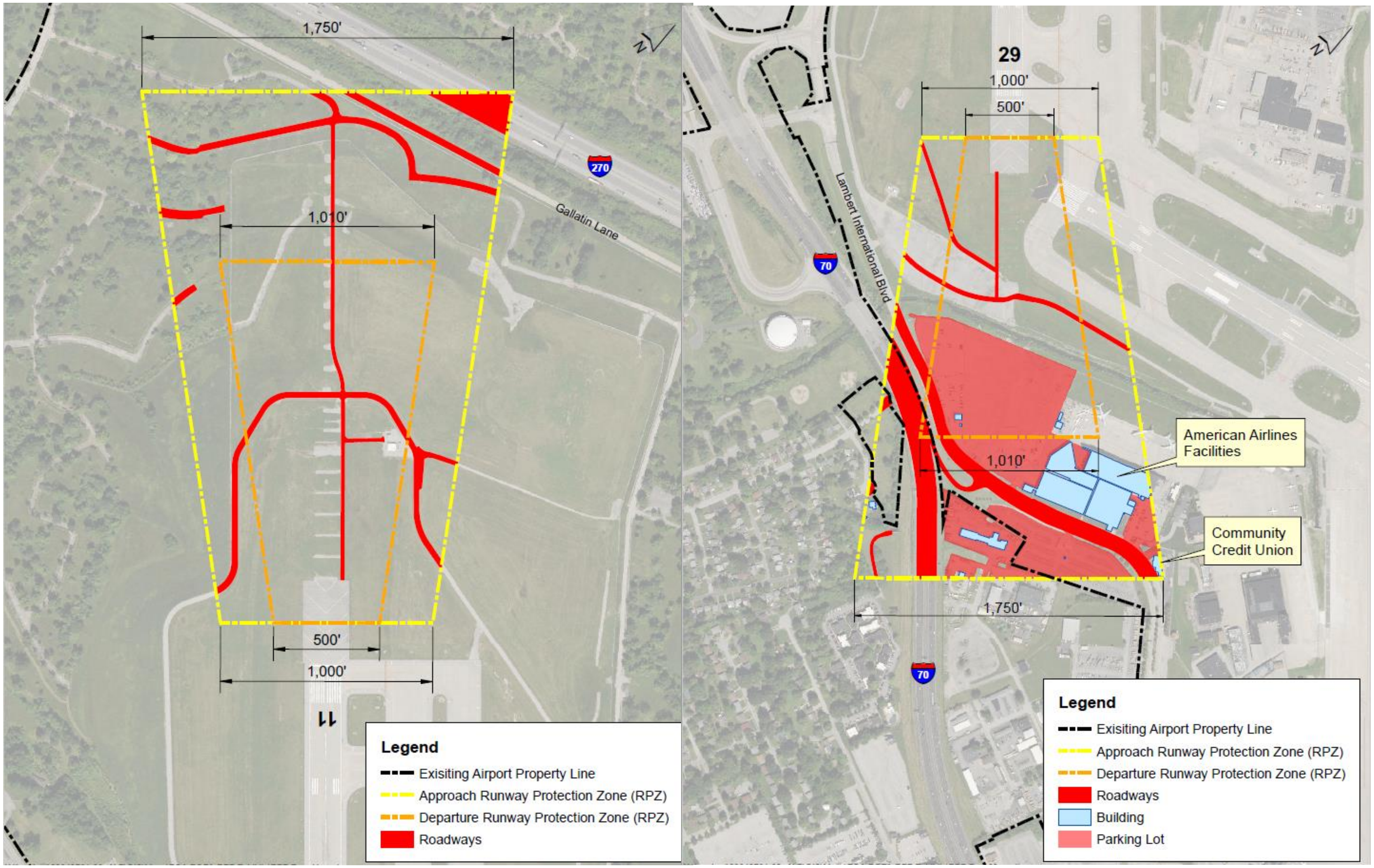
Table 4.1-24: Runway Protection Zones

RUNWAY	COMPATIBLE LAND USE	INCOMPATIBLE LAND USE
6	Portion of Mount Lebanon Cemetery	Portion of Hunter Engineering Campus Cypress Road Natural Bridge Road Interstate 70 Super Park – Lots B & D
24	See Table Note	Banshee Road James S. McDonnell Blvd FUSRAP Rail Sliding and Load Up Area Norfolk-Southern Railroad
11	See Table Note	Gallatin Lane Interstate 270
29	Coldwater Creek Runway 29 ALSF Equipment Shelter	Community Credit Union Lambert International Blvd Interstate 70 Cell Phone Parking Lot American Airlines Maintenance Dock
12R	See Table Note	Banshee Road N Lindbergh Road Missouri Bottom Road Fee-Fee Road
30L	See Table Note	Bi-State Development Metrolink Tracks James S. McDonald Blvd. Interstate 70
12L	Runway 12L ALSF-2 Equipment Shelter	None
30R	See Table Note	James S McDonnell Blvd. Interstate 70 N Hanley Road

Notes:
All compatible land uses are not individually listed in this table.
NAVAIDs that are considered fixed-by-function are permissible within the RPZ and are not listed individually in this table.

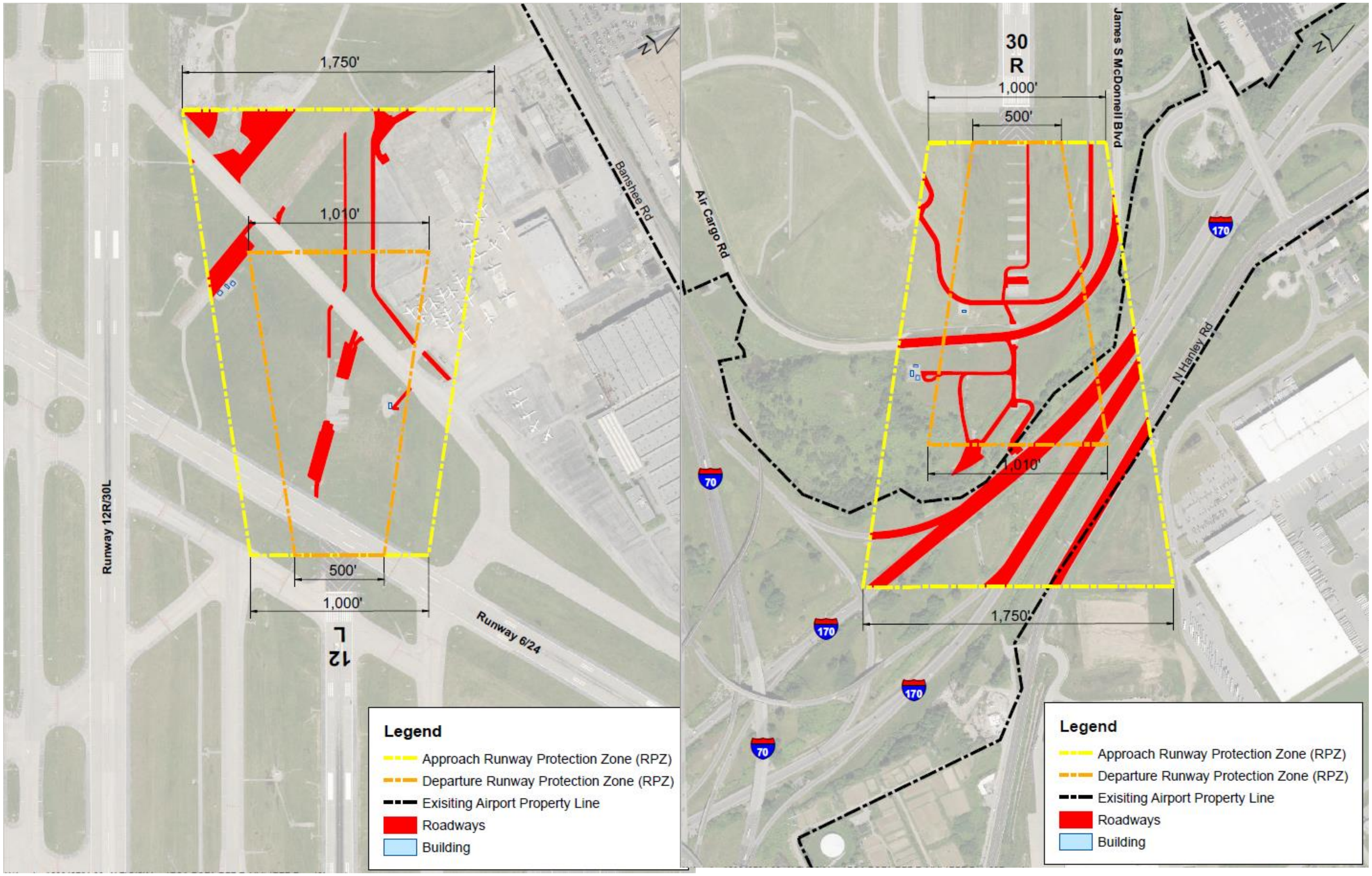
Source: CMT, September 2020 (analysis)

Figure 4.1-25: Runway 11-29 RPZ Penetrations



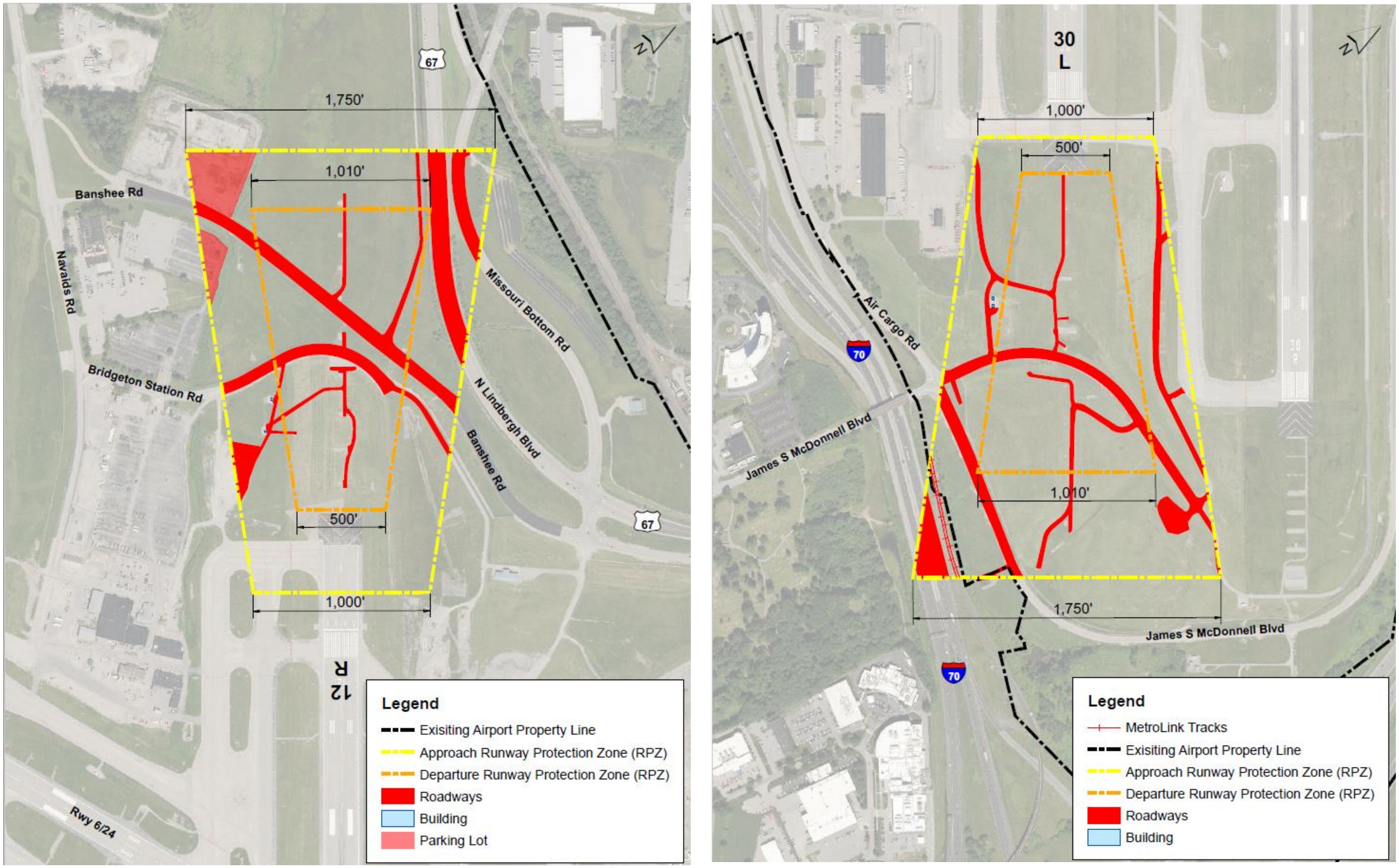
Source: CMT

Figure 4.1-26: Runway 12L-30R RPZ Penetrations



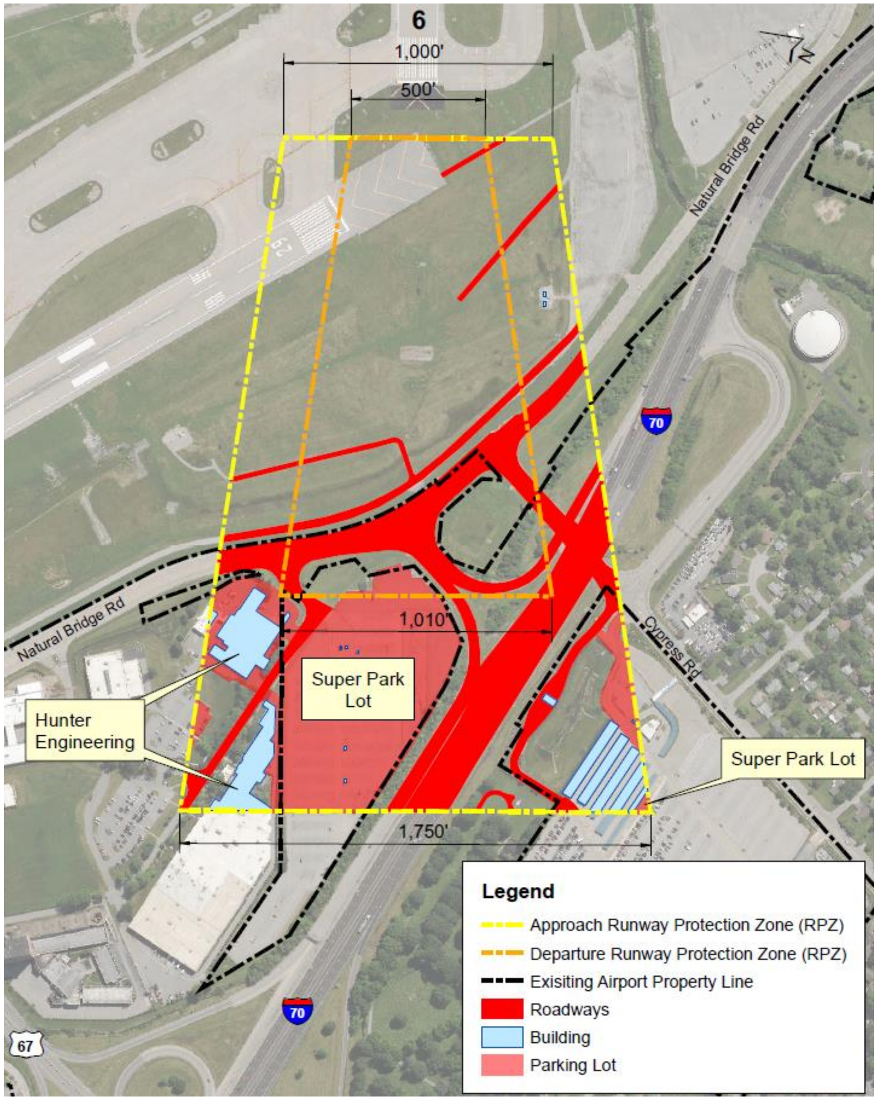
Source: CMT

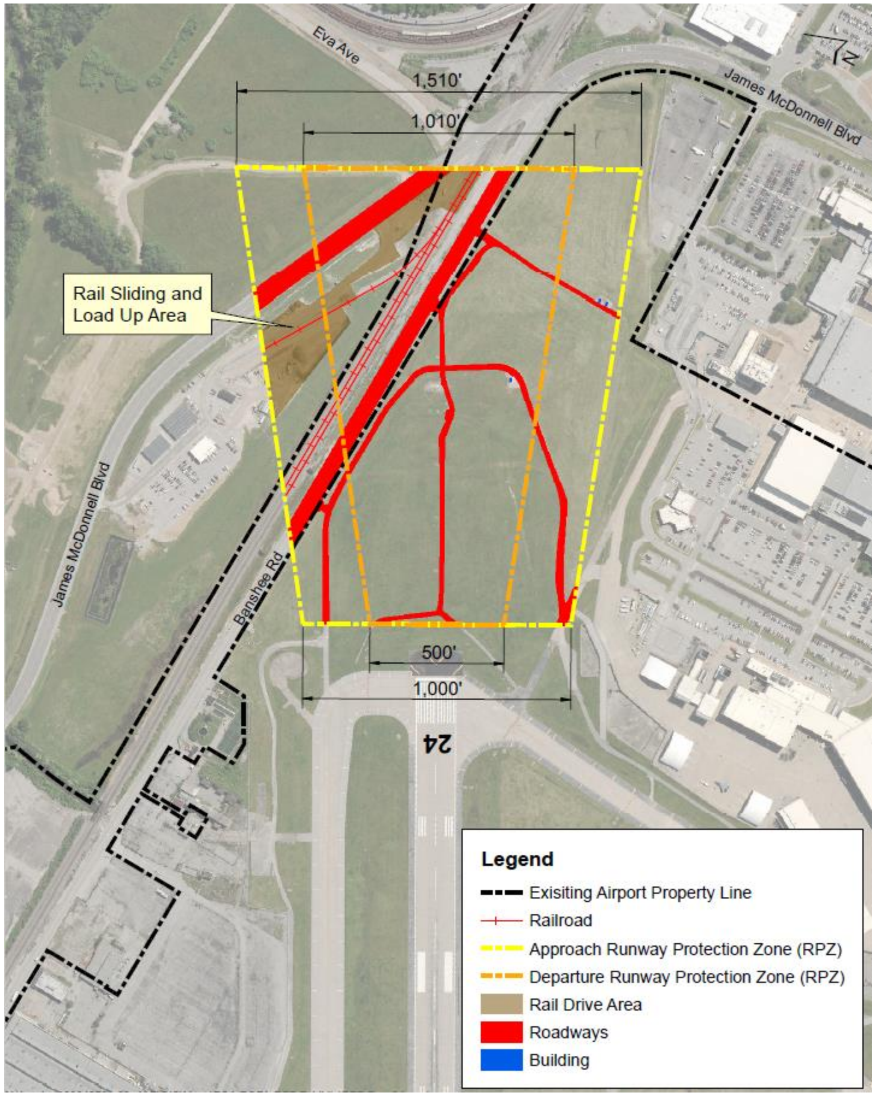
Figure 4.1-26: Runway 12R-30L RPZ Penetrations



Source: CMT

Figure 4.1-27: Runway 6-24 RPZ Penetrations





Source: CMT, 2021

MODIFICATIONS OF DESIGN STANDARDS

Several Modifications of Design Standards (MOS) were recorded in the 2013 STL ALP. While some of them were mitigated, a number are still in place and are listed in **Table 4.1-25**. Options to mitigate these issues will be considered during the development of the alternatives.

Table 4.1-25: Modification of Design Standards

DESCRIPTION	FAA APPROVAL DATE
Taxiway B (East of Runway 6-24)	12/3/2003
Runway 6 and Runway 29 Extended Safety Areas	12/3/2003
Airfield Signage	12/3/2003
Runway 11-29 nonstandard runway designation	12/3/2003
P-620 Runway and Taxiway painting specification	3/17/2004
P-209 Substitution with MODOT Type 5 Aggregate	6/1/2004
Several Stations of the Runway 29 ALS are located within the Taxiway S OFA and safety areas. The OFA width is reduced from 160' down to 100'. The safety area is reduced from 107' down to 100'.	Requested June 25, 2009
Airport controlled perimeter road impacts approximately 667' of Taxiway S OFA and safety areas. The perimeter road south of the Taxiway S centerline reduces the OFA from 160' down to between 87' and 159'. Taxiway S safety area will be reduced from 107' down to 100'	Requested June 25, 2009

Source: Landrum & Brown, St. Louis Lambert International Airport, Airport Layout Plan Update, 2012.

New design standards deficiencies were identified in the *Airfield Design Standards* section. Mitigation measures will be considered in the Alternatives Analysis.

4.1.7 AIRFIELD SIGNAGE, MARKINGS, LIGHTING AND NAVIGATIONAL AIDS

INSTRUMENT APPROACH PROCEDURES

As mentioned in the *Inventory of Existing Conditions*, instrument approach procedures help guide pilots into airports during times of inclement weather and poor visibility. The runways at STL are served by both ground-based and satellite-based approach systems. Each runway end is equipped with a localizer approach, an ILS-CAT I approach, and an RNAV-GPS approach. Given the level of service provided by the existing approach procedures at STL, and the review of historical weather data that is presented in the *Inventory of Existing Conditions*, no upgrades or improvements to the NAVAIDs are necessary through the planning period. It is envisioned that over the long-term, the approach procedures may be modernized to rely more heavily on satellite-based navigational systems, in line with the FAA's NextGen strategy.

AIRFIELD SIGNAGE AND PAVEMENT MARKINGS

Based on discussions with STLAA staff and a review of the Airport's *Signage and Marking Plan*, five instances of nonstandard airfield markings and signage were identified:

- Each entrance taxiway is required to have its own elevated signage. Taxiways signage in the Taxiways D/C/U/T intersections are too low.
- The blast pads for Runway 12R-30L are not marked per standard. Currently, they are marked for greater than 250 feet when they should be marked as less.
- The hold lines on Runways 6-24, 12L and 12R are incorrect. The Airport has a waiver approving this discrepancy, per a Part 139 inspection.
- The arrows within the displaced threshold of Runway End 12R are 100 feet apart; they should be 80 feet apart.
- There are two hold signs along Runway 6-24. According to Advisory Circular 150/5340-1M, *Standards for Airport Markings*, Paragraph 4.5.1, “surface painted holding position sign[s] [are] used only on taxiways (not runways) that connect a runway and have a Pattern A holding position marking.”

AIRPORT BEACON

The beacon is programmed for relocation later in 2020. It will be moved to the West ARFF.

4.1.8 AIRCRAFT DEICING

Aircraft deicing is critical to ensure safe operations during winter weather, including rain, snow, and ice. The FAA requires that all of an aircraft’s critical surfaces be free of contamination at takeoff in accordance with the FAA’s “Clean Aircraft” concept.[2] In order to achieve this during winter weather conditions, deicing of aircraft is required, which involves the removal of frost, snow, and ice. The deicing process is accomplished with a combination of physical removal techniques and the application of specialized deicing and anti-icing products. The primary function of deicing facilities at an airport are to provide an area for the deicing process to occur while collecting any deicing/anti-icing product runoff/overspray thus preventing its entrance into normal stormwater collection and discharge.

The deicing needs documented in this section were determined through coordination with STLAA personnel, STL ATCT personnel, and a review of the *Deicing Upgrade and Improvements Report* dated July 2020, prepared by Gresham Smith. **Table 4.1-26** provides a brief summary of the findings/recommendations of this study.

Coordination with both STLAA and STL ATCT personnel during the inventory process identified similar deicing project needs. The primary ALP Update deicing need is that of dedicated East/West Deicing Pads in the long-term, dependent on future terminal development configuration. A deicing position also needs to be added to St. Louis Cargo. Options for these pads will be considered during the Alternatives Analysis.

[2] An aircraft cannot depart when frost, ice, or snow is adhering to the wings, control surfaces, or propellers of an aircraft (Federal Aviation Regulation Sections 121.629 and 135.227). The presence of even minute amounts of frost, ice, or snow on particular aircraft surfaces can cause potentially dangerous degradation of aircraft performance and unexpected changes in aircraft flight characteristics.

Table 4.1-26: Deicing Findings and Recommendations

ITEM	GOOD CONDITION/ NO ACTION	IMPROVEMENT RECOMMENDED	NOT RECOMMENDED	NEITHER RECOMMEDED NOR REJECTED
Existing System Condition	X			
Maintenance Safety Items		X		
Second Discharge Line to AST		X		
Additional Pumping Capacity		X		
Upgrade SCADA System		X		
Online Deicer Analysis System		X		
Capture System for All Cargo SADF		Short-term		
Additional Storage Capacity		X		
Additional Deicing Positions between Lima and Hotel Pads		X		
Overspray Trench at Gates E4-24		X		
Trench Drains at Gates E29, E31, E33		X		
Dedicated East/West Deicing Pads		Long-term		

Notes:
AST – Aboveground Storage Tank
SADF – Spent Aircraft Deicing Fluid
SCADA – Supervisory Control and Data Acquisition

Source: Gresham Smith, Deicing Upgrade and Improvements Report, July 2020.

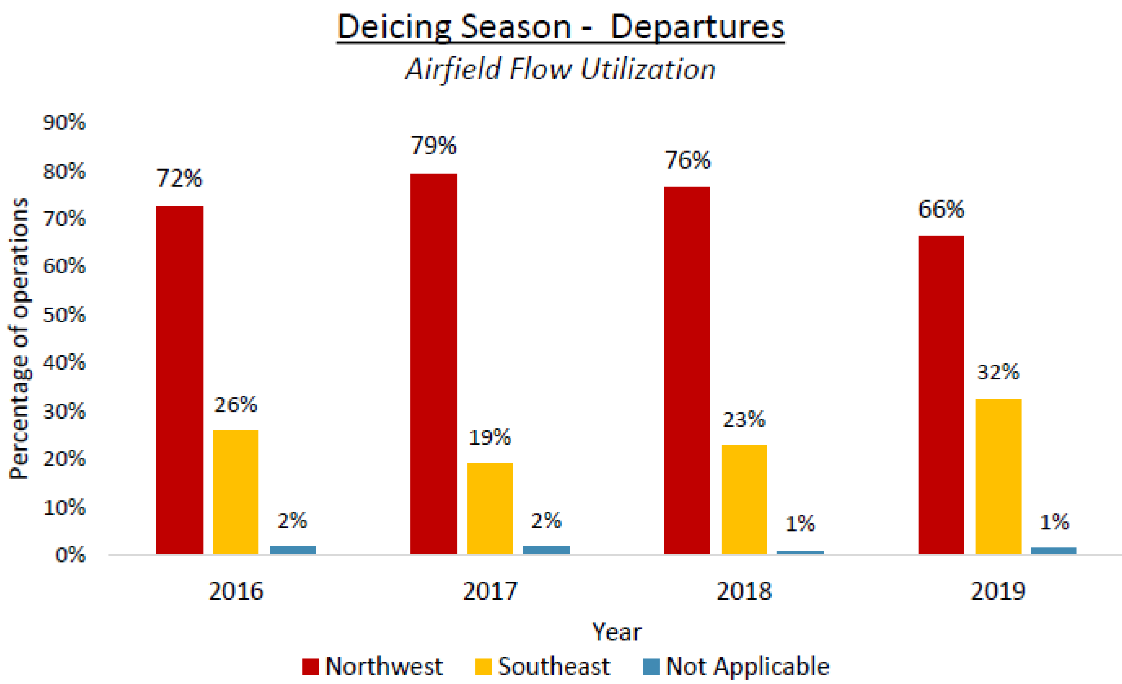
DEICING PAD LOCATION

A detailed analysis was conducted to determine the optimal location of new deicing pad(s).

The overall Airport departure flow was assessed to understand if a predominant flow would influence the siting of the new deicing pad. The results showed that the northwest flow is the predominant configuration during winter conditions.

It is important to note that deicing season is defined as November through March with an hourly reported temperature of 36 or below. **Figure 4.1-28** shows the airfield utilization during deicing season.

Figure 4.1-28: Deicing Season Airfield Utilization



Source: CMT

Based on the airfield flow utilization, a long-term deicing pad strategy was developed to consolidate locations for deicing activities and operational efficiency. The main objectives that comprise this strategy are as follows:

- Consolidate deice activities and obtain operational efficiency
- Reduce the number of deice locations/pads
- Consider the influence of the proposed consolidated terminal
- Accommodate cargo and GA through planned improvements and future facilities designed to provide deice collection

The northwest and southeast flows were analyzed to understand the optimal location of the proposed deicing pads.

- It was determined that to serve the Northwest Flow (aircraft utilizing Runways 30L and 29 for departure), a West and an East Pad would be required.
- In a similar way, it was determined that to serve the Southeast Flow (aircraft utilizing Runways 12R and 12L for departure), a West pad would be required.

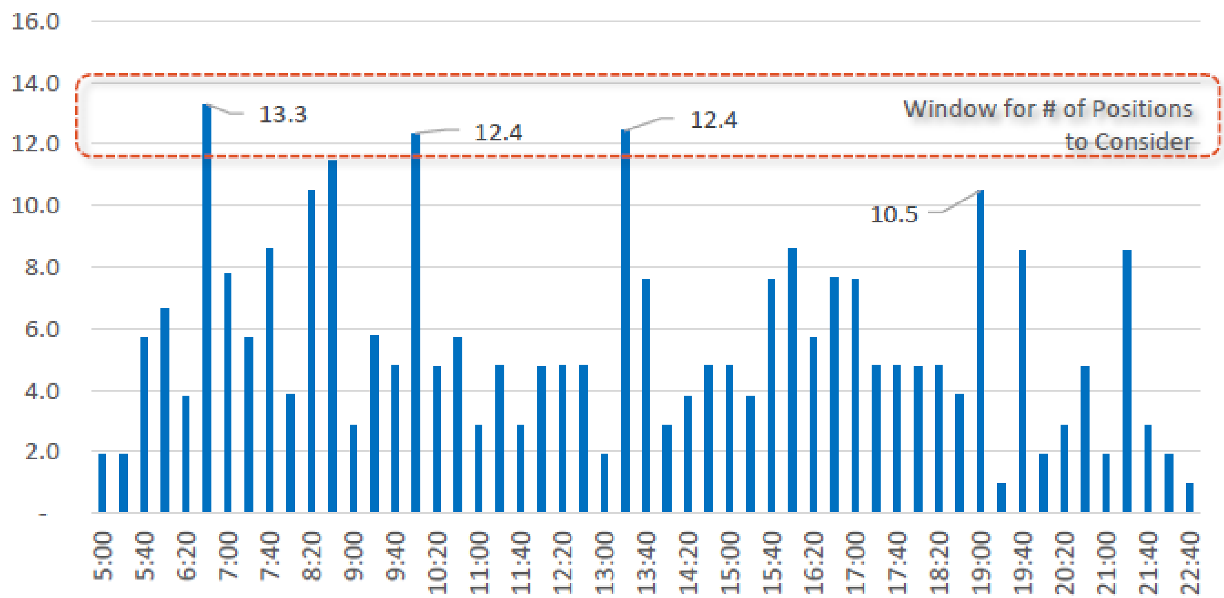
DEICING PAD CAPACITY

To determine the number of positions that each deicing pad needs to accommodate, a Design Day Flight Schedule (DDFS) was developed under the ALP Narrative forecast effort (2019 and 2040).

- Seasonality adjustment was included in the DDFS to reflect primarily the December, January, and February timeframe.
- This DDFS included commercial feet, GA, and cargo.
- DDFS also included an assessment of widebody aircraft to understand overall deicing pad requirements.
- DDFS established a 20-minute rolling window to deice aircraft.

Figure 4.1-29 shows the DDFS developed for the determination of deicing position. By 2040, there will be a need to accommodate 14 aircraft deicing positions.

Figure 4.1-29: 2040 Deicing Pad Design Day Flight Schedule



Notes: adjusted for seasonality and widebody demand

Source: CMT

4.1.9 AIRSPACE

This section presents a review of the existing airspace capacity and identifies potential improvements needed to maximize efficiency of operations.

AIRSPACE CAPACITY AND STRUCTURE

Based on discussions with FAA, there are no concerns or challenges with the airspace structure or utilization at STL. The proximity of St. Louis Downtown (KCPS) and Spirit of St. Louis (KSUS) Airports can create challenges when these airports and STL experience moderate or greater demand simultaneously. At the same time, TRACON operating positions are split appropriately, and the TRACON airspace is subdivided among positions to segregate the traffic and manage demand. Additionally, the airspace of TRACON operating positions, Class B design, and operating procedures generally favor STL traffic, since it is the primary airport, negating any real issues for STL

STL currently has seven Standard Terminal Arrival Routes (STARS) and 17 Standard Instrument Departures (SIDS). Based on discussions with FAA, these procedures and airspace layout meet the needs of aircraft operating at STL.

The four RNAV STARs were designed to reduce communication with “descend via” profiles that terminate at the Initial Approach Fixes (IAFs), KAYLA, PETTI, QBALL, or LORL, for twelve RNP approaches. During 2019, FAA estimates that hourly demand at the arrival fixes was about 50-60 percent of capacity. In September 2020, demand was only at 25 percent of capacity at these fixes.

There are thirteen RNAV SIDs that standardize routings and allow for reduced communication. Both the STARs and SIDs will allow the TRACON to continue to provide STL traffic efficient service, even if traffic increases by as much as 20 percent over current demand, as forecast in the demand projections presented in the *Forecast of Aviation Activity* of this Update.

CRITICAL AIRSPACE SURFACES

As part of the data acquisition for the ALP, both aerial imagery and obstacle data was collected. There were over 1,800 obstacles identified for Runway 6-24, over 1,000 identified for Runway 11-29, over 1,600 for Runway 12L-30R and over 3,800 for Runway 12R-30L.

There are several airspace surfaces that will be reviewed and analyzed during the development of the ALP to determine which of the obstacles are actual obstructions.

In order to maintain their current instrument approach procedure capabilities on each runway, the Airport has prioritized the airspace surfaces. All Terminal Instrument Procedure (TERPS) surfaces will be considered the priority or controlling surface for clearing potential obstructions. Once the TERPS surfaces are clear of obstructions, the Threshold Siting Surfaces (TSS), Departure Surfaces and Part 77 Surfaces will be considered for obstruction clearance, in that order.

Once the obstruction analysis is completed as part of the ALP development, alternatives will be considered to mitigate specific obstructions or areas where there may be groups of obstructions.

4.1.10 SUMMARY OF AIRFIELD REQUIREMENTS

- Airfield capacity: adequate through the planning horizon
- Runway length: adequate through the planning horizon
- Runway exits: adequate through the planning horizon
- Taxiway capacity:
  - Extension of Twy F to the east
- Airfield design standards:
  - Twy D-Twy/Tln C separation insufficient at times
  - Taxiway geometry: numerous areas of non-compliance

  - Runway vertical curves: non-standard grades within the final quarter of Runways 12R, 30L, 6 and 24.
  - RSA/ROFA penetrations: operations restrictions on service roads
  - RPZs: roadways and incompatible land uses inside RPZs. Mitigate if possible.
- Airfield signage/markings: five non-standard markings/signs
- Aircraft Deicing:
  - Consolidated off-gate deicing operations in proximity to departure runway ends
  - Glycol collection infrastructure needs improvements

4.2 PASSENGER TERMINAL AND GATES

A major element of the Airport Layout Plan Update is the passenger terminal building. The Airport has two terminals, described in the *Inventory of Existing Conditions*.

Developing a terminal facilities program begins with examining the adequacy of each existing component to serve current activity. From that basis, forecast changes in activity are applied to develop recommendations for future planning horizons. These recommendations use actual activity and facilities at STL as a basis, and are the subject of quantitative, as well as qualitative, analyses. Although some "industry standard" criteria are used, the recommendations for future facilities are based on local conditions and circumstances.

4.2.1 DESIGN LEVEL ACTIVITY

Airport terminal facilities are sized to accommodate the peak hour passenger volumes of a design day. Annual enplanements are an indicator of overall airport size; however, peak hour volumes more accurately determine the demand for airport facilities based on the specific user patterns of a given airport. Peak hour passengers are typically defined as Peak Hour-Average Day-Peak Month (PHADPM) passengers, and are also often referred to as Design Hour passengers. The Design Hour measures the number of enplaned and deplaned passengers departing, or arriving, on aircraft in an elapsed hour of a typically busy (design) day. The Design Hour typically does not correspond exactly to a "clock hour", such as 7:00-7:59, but usually overlaps two "clock hours", i.e., 7:20-8:19, reflecting airline scheduling patterns.

The Design Hour is typically not the absolute peak level of activity, nor is it equal to the number of people occupying the terminal at a given time. It is, however, a level of activity which the industry has traditionally used to size many terminal facilities. The number of people in the terminal during peak periods, including visitors and employees, is also typically related to Design Hour passengers.

Each airport also has its own distinct peaking characteristics, due to differences in airline schedules, business or leisure travel, long or short haul flights, and the mix of mainline jets and regional aircraft. These peaking characteristics determine the size and type of terminal facilities. Thus, two airports with similar numbers of annual passengers may have different terminal requirements, even if the Design Hour passenger volumes are similar.

EXISTING ACTIVITY

Since the deregulation of the airlines, most major airlines have developed "hub and spoke" route systems, such as TWA had in STL. At these hubs, there are a number of banks of flights when most passengers change planes to reach their final destination. These banks of connecting flights form a series of peaks during the day, typically seven to 10.

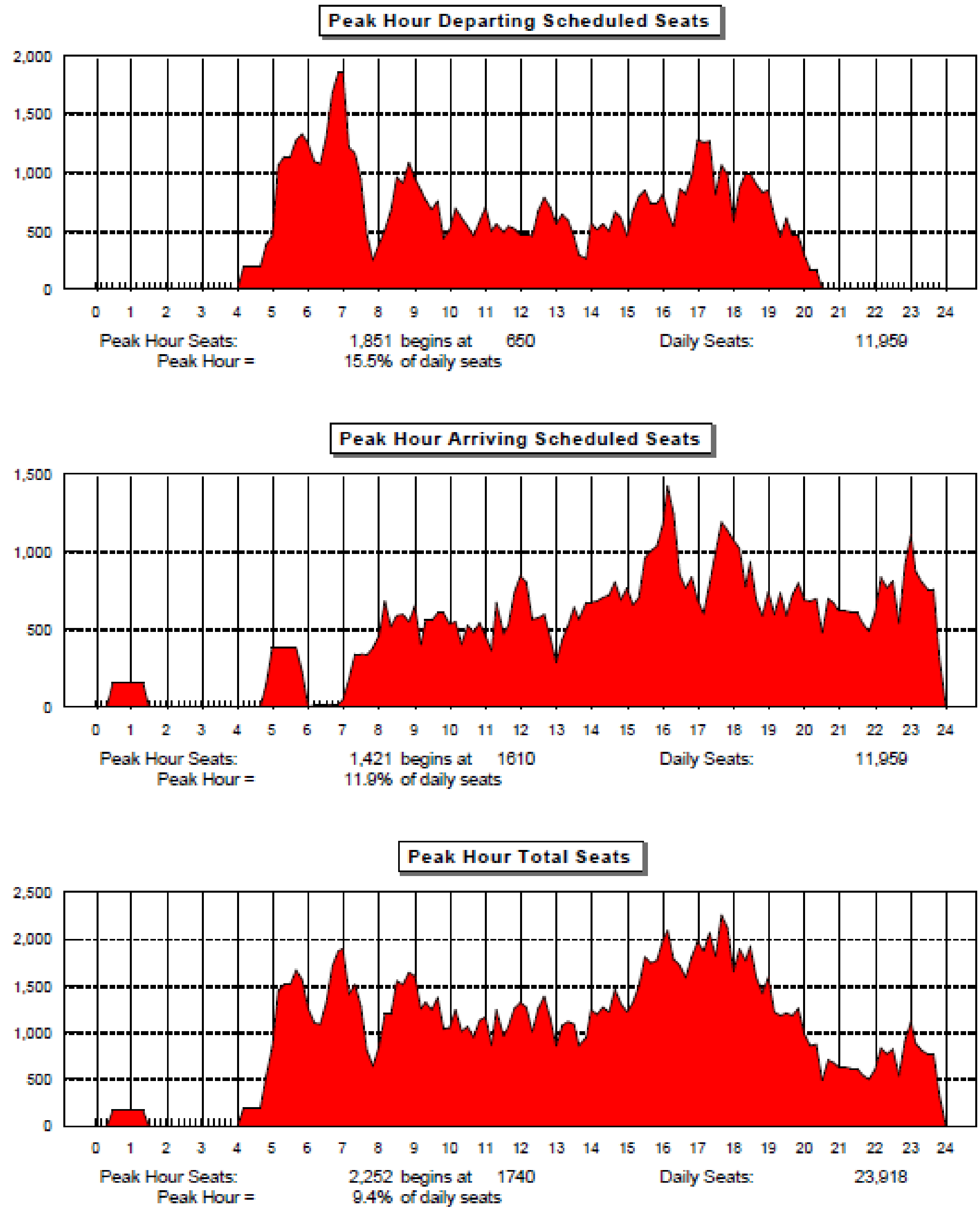
In contrast, the other cities served by the airlines are referred to as "spokes". Individual airline schedules at the spoke cities are generally tied to the connecting banks at the hub. Most airlines have similar scheduling patterns, and these tend to reinforce each other at the spoke airports resulting in, for example, a large number of departures between 6 a.m. and 8 a.m. at STL for the Terminal 1 carriers. As passenger volumes on specific routes increase, the number of flights also tends to increase, which can fill in the 'valleys' during the day.

The daily pattern of flight activity and passenger peaking at STL's Terminal 1 is typical of spoke activity at a medium sized airport (medium hub in FAA terminology). Morning departures have flights to all of the major hub destinations served from STL and other selected markets. In the evening, there are corresponding arrivals, which serve to position equipment for the next day's departure peak. There are also a number of midday secondary peaks for both arrivals and departures. **Figure 4.2-1** depicts typical weekday activity for Terminal 1 in July 2019.

Figure 4.2-2 depicts Terminal 2 activity by Southwest Airlines, which has a smaller number of early departures, but then reflects a hub-type scheduling pattern with six distinct banks of flights. Although not as tightly scheduled as some other hub airports, this pattern does allow connections, which account for approximately 35-37 percent of all flights.

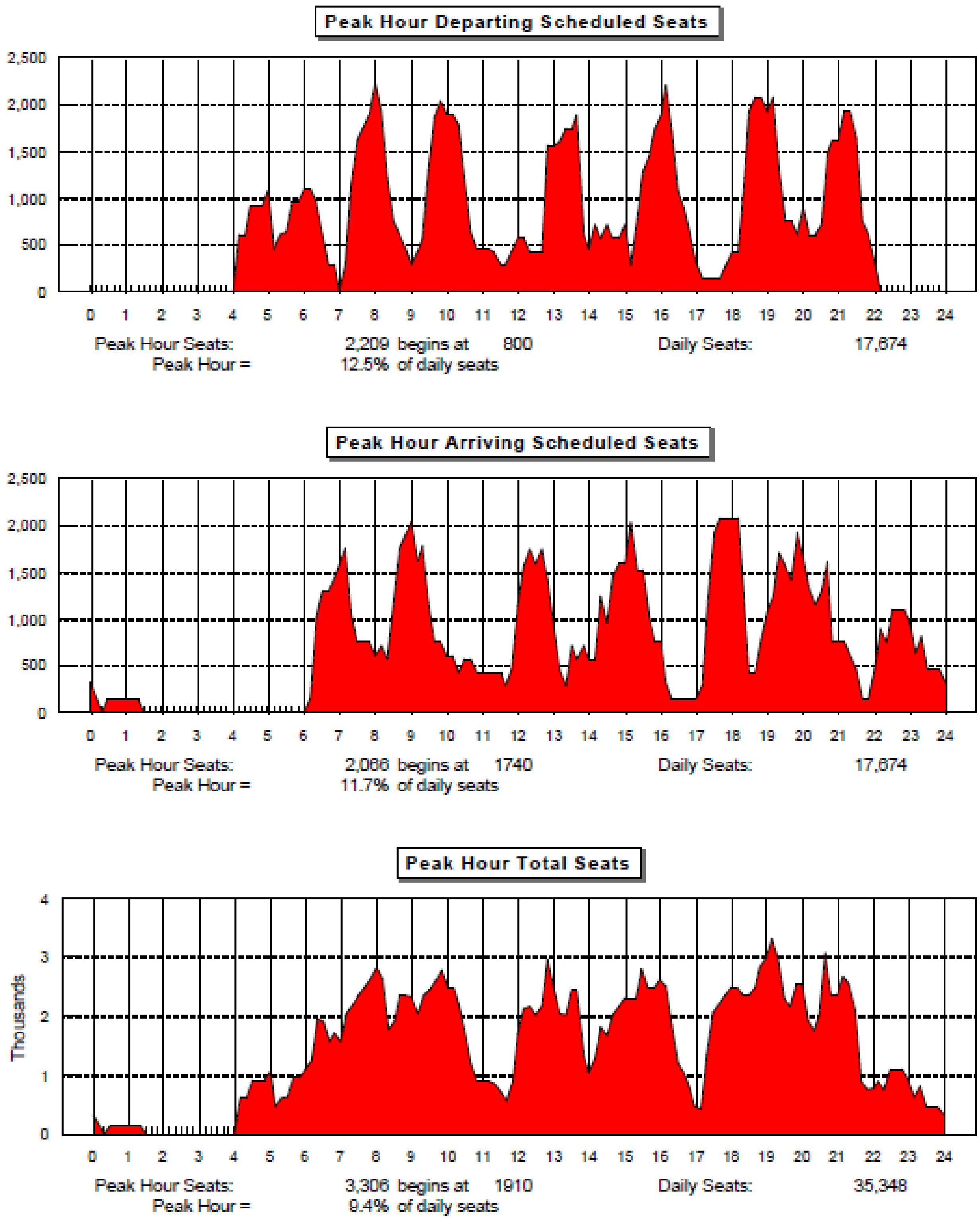
If all STL activity were to be combined in a single terminal, the early morning departures bank would be strong, but the peak in term of seats would be in the early evening, as a Terminal 1 secondary peak overlaps with one of Southwest Airlines' banks, as depicted on **Figure 4.2-3**. The combined activity was analyzed to provide a programming basis for terminal concepts that have a single terminal.

Figure 4.2-1: Terminal 1 Typical Weekday Activity (July 2019)



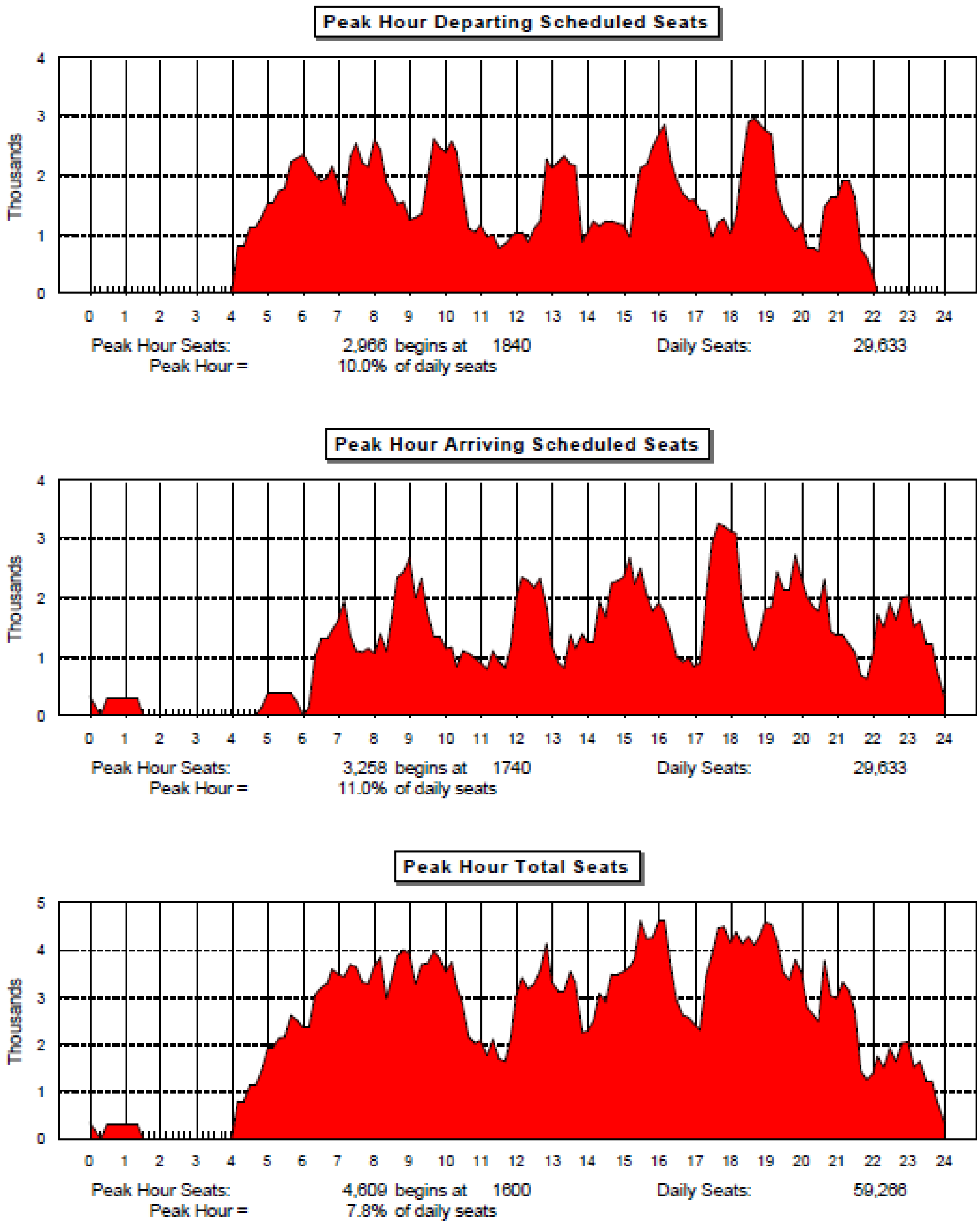
Sources: Hirsh Associates, October 2020.

Figure 4.2-2: Terminal 2 Typical Weekday Activity (July 2019)



Sources: Hirsh Associates, October 2020.

Figure 4.2-3: Combined Terminals 1 and 2 Typical Weekday Activity (July 2019)



Sources: Hirsh Associates, October 2020.

PROJECTED DESIGN HOUR ACTIVITY

The *Aviation Activity Analysis and Forecasts* section outlined a range of possible forecast scenarios. The Scenario 1 forecast (20-year forecast through 2040) is the primary basis for facilities planning.

PEAK MONTH PASSENGERS

The peak month has averaged 9.2 percent of annual enplanements for the past five years. The peak month was in July most years, which was assumed to continue in the future.

DESIGN HOUR PASSENGERS

Figures 4.2-1 through 4.2-3 illustrate a typical busy day during the peak month (July 2019). This was used as the Design Day Flight Schedule (DDFS) for current (2019) activity. Additional DDFSs were developed for 2025, 2030 and 2040. See **Appendix 4B** for the basis of these DDFSs.

Based on observations and discussions with the airlines, it is assumed that the peak hour has a 90 percent average load factor in the peak month. This was used with the DDFS to estimate design hour passengers for each forecast activity level, as shown in **Table 4.2-1**.

CONNECTING PASSENGERS

As noted, Southwest Airlines has a significant percentage of connecting passengers. A small number of online connections are also reported by American Airlines and Frontier Airlines, and between the operators of Essential Air Service routes and other carriers. However, Southwest Airlines connections are estimated to be approximately 98 percent of the airport total in 2019. It is forecast that Southwest Airlines' connecting passengers would grow to approximately 40 percent, while the Terminal 1 carriers would be less than 2 percent of their total[3]. From a terminal planning perspective, the Terminal 1 activity can be considered all origination/destination passengers (O&D) during the design hours.

INTERNATIONAL PASSENGERS

International design hour activity varies seasonally and by day of the week. There is almost daily service by Frontier Airlines to Cancun or Punta Cana, Mexico, and Saturday service by Southwest Airlines to Cancun. These arrived at similar times. In January 2018, low-cost carrier WOW Air initiated almost daily service to Reykjavik, Iceland with A321s, which allowed connections to European cities. This ended when WOW Air ceased all operations in March 2019. The Airport is actively seeking to resume flights to European cities, which may eventually use widebody aircraft.

Air Canada also provided multiple daily flights to Toronto, Canada. Since flights from Canada are pre-cleared, from a terminal planning perspective, these flights are treated as domestic flights.

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3 Unison, *St. Louis Airport Layout Plan Update, Aviation Activity Analysis and Forecasts*, June 2020.

Table 4.2-1: Forecast Design Hour Passengers Based on Design Day Flight Schedules

Terminal 1			Forecast Activity Level		
		2019	2025	2030	2040
Peak Hour Seats					
Departures		1,851	1,726	1,758	1,910
Arrivals		1,421	1,298	1,275	1,459
Total		2,252	2,080	2,057	2,431
Design Hour Load Factor	90%				
Design Hour Passengers					
Enplaning		1,670	1,550	1,580	1,720
Deplaning		1,280	1,170	1,150	1,310
Total		2,030	1,870	1,850	2,190

Terminal 2			Forecast Activity Level		
		2019	2025	2030	2040
Peak Hour Seats					
Departures		2,209	2,416	2,416	2,719
Arrivals		2,066	2,194	2,209	2,719
Total		3,306	4,149	4,149	4,418
Design Hour Load Factor	90%				
Design Hour Passengers					
Enplaning		1,990	2,170	2,170	2,450
Deplaning		1,860	1,970	1,990	2,450
Total		2,980	3,730	3,730	3,980

Combined Activity			Forecast Activity Level		
		2019	2025	2030	2040
Peak Hour Seats					
Departures		2,966	3,082	3,114	3,556
Arrivals		3,258	3,339	3,249	3,432
Total		4,609	4,973	5,145	6,055
Design Hour Load Factor	90%				
Design Hour Passengers					
Enplaning		2,670	2,770	2,800	3,200
Deplaning		2,930	3,010	2,920	3,090
Total		4,150	4,480	4,630	5,450

Source: Hirsh Associates, October 2020.

4.2.2 AIRCRAFT GATES

The Airport has a large number of gates, due to TWA's previous hub operations, later downsized in phases after the acquisition by American Airlines. Many of these gates have been "mothballed", with the holdrooms and related operations areas closed off and passenger loading bridges (PLBs) removed. Thus, while there is the potential to rapidly expand gate capacity by reactivating these gates, there are costs associated with such a reactivation.

Existing gate utilization is described in the *Inventory of Existing Conditions*. Forecast gate demand is discussed herein. Terminal facilities requirements were estimated separately for the airlines in Terminal 1 and Terminal 2 (assumed to only be Southwest Airlines). In the case of gates, the demand for a single consolidated terminal is assumed to be the sum of Terminal 1 and Terminal 2 gates.

Gate demand was estimated for each of the forecast planning activity levels. There are several methodologies that can be used to project future gate demands. These include ratios of annual passengers per gate, daily flights per gate, and projecting DDFSs. As noted above, DDFSs were developed for each forecast period, and were used as the basis for gate forecasting.

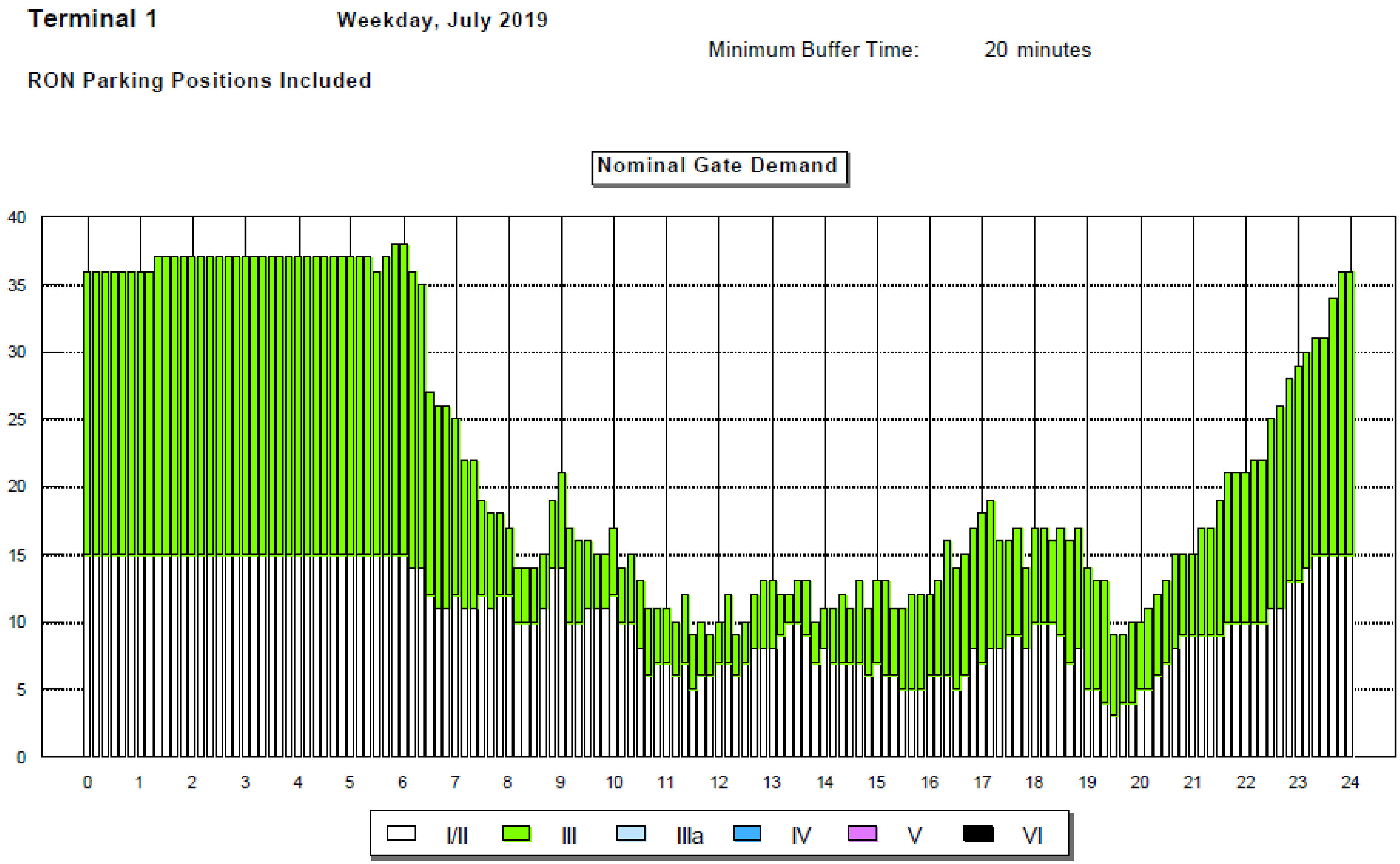
Each DDFS was analyzed to determine the number of active gates and remain overnight aircraft (RON) separately for Terminal 1 and Terminal 2. The July 2019 schedule is illustrated in the following figures:

- **Figure 4.2-4** illustrates the number of aircraft parking positions including RON aircraft required to support the Terminal 1 2019 DDFS. A 20-minute buffer time is assumed between a scheduled departure and the next arrival. This results in a maximum number of 38 aircraft on the ground during the overnight period. Of the 15 ADG I/II RONs, three are the very small ADG I commuter aircraft, with the balance being small RJs. The remaining 23 aircraft are larger regional jets or mainline narrowbody aircraft falling within ADG III.
- **Figure 4.2-5** illustrates the same schedule, but only for active gates. The assumptions in this analysis are that an ADG III RON aircraft requires a gate from 50 minutes before departure time or 30 minutes after arrival. Smaller aircraft would be on gate 30 minutes before departure time and 30 minutes after arrival. These would be the parameters by which an aircraft may be towed to or from a remote RON parking pad. The peak active gate demand for ADG III aircraft is just after 6 a.m. for 16 gates. The peak time for smaller aircraft is around 9 a.m. for 13 gates, of which 8 are for the smallest aircraft.

  Thus, the 25 active Terminal 1 ADG III gates are considered well-utilized for the morning peak, since many of these are used by smaller RJs. Almost all of the ADG I commuter gates are occupied at some point during the day.
- **Figures 4.2-6** and **4.2-7** illustrate the same RON and active gate activity for Southwest Airlines in Terminal 2. Of the 17 gates available to Southwest Airlines, a maximum of 15 gates are in use, either overnight or during their seven banks during the day. The two extra gates are considered operational spares and are necessary for hub-type operations to handle irregular operations. The 18th City-controlled international gate is not included in this analysis and the need for international gates is discussed in a later section.

Per STLAA staff, RON/hardstand apron for approximately 18 aircraft should be provided in 2040.

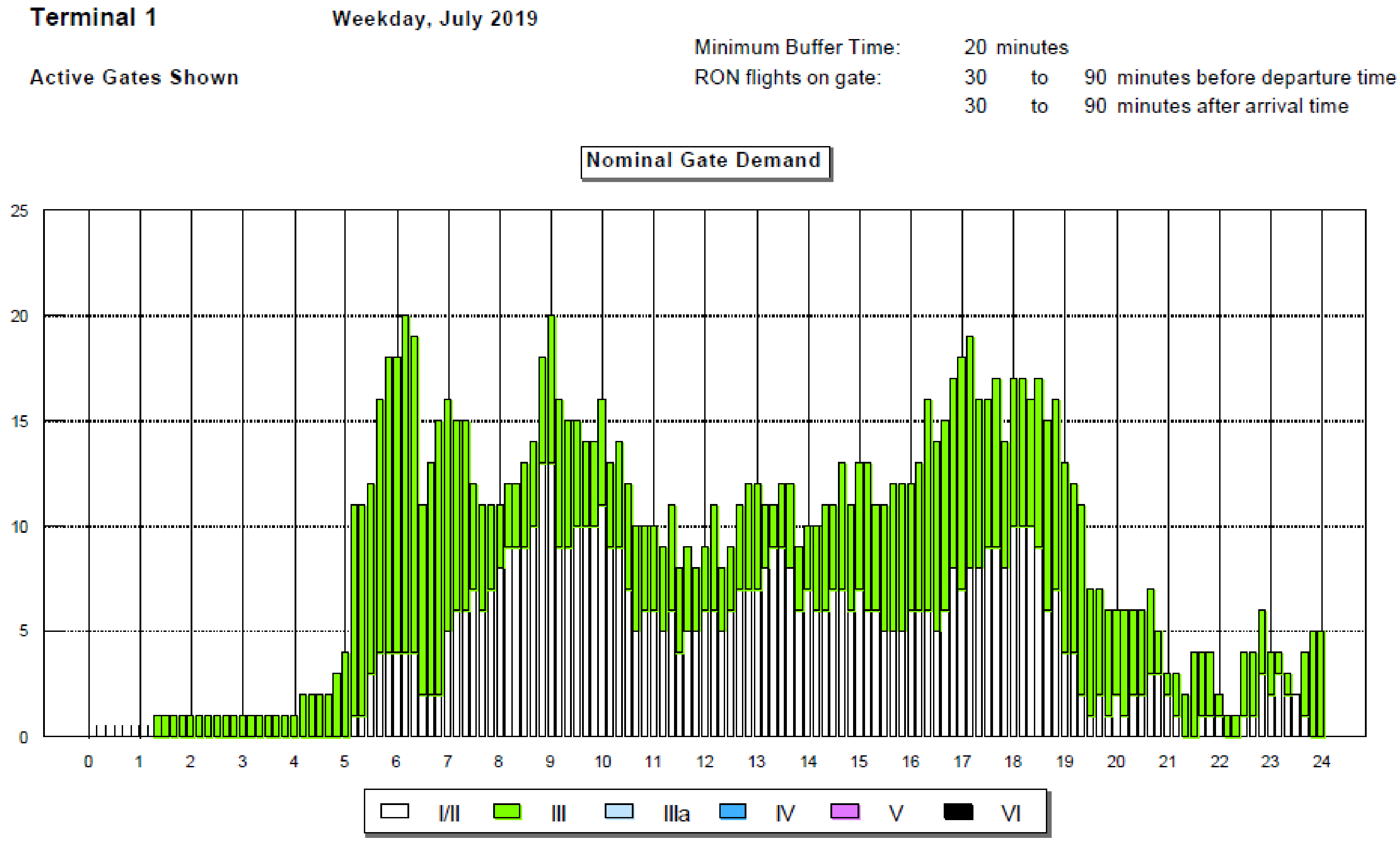
Figure 4.2-4: Terminal 1 Gate Demand (Active Gates and RON Positions)



	I/II	III	IIIa	IV	V	VI	Combined
Maximum Number of Gates:	15	23	0	0	0	0	38
begins at:	0	550					550
Avg. Scheduled Time on Gate:	166	142	NA	NA	NA	NA	153 minutes

Source: Hirsh Associates, October 2020.

Figure 4.2-5: Terminal 1 Gate Demand (Active Gates Only)



	I/II	III	IIIa	IV	V	VI	Combined
Maximum Number of Gates:	13	16	0	0	0	0	20
begins at:	850	610					610
Avg. Scheduled Time on Gate:	68	51	NA	NA	NA	NA	59 minutes

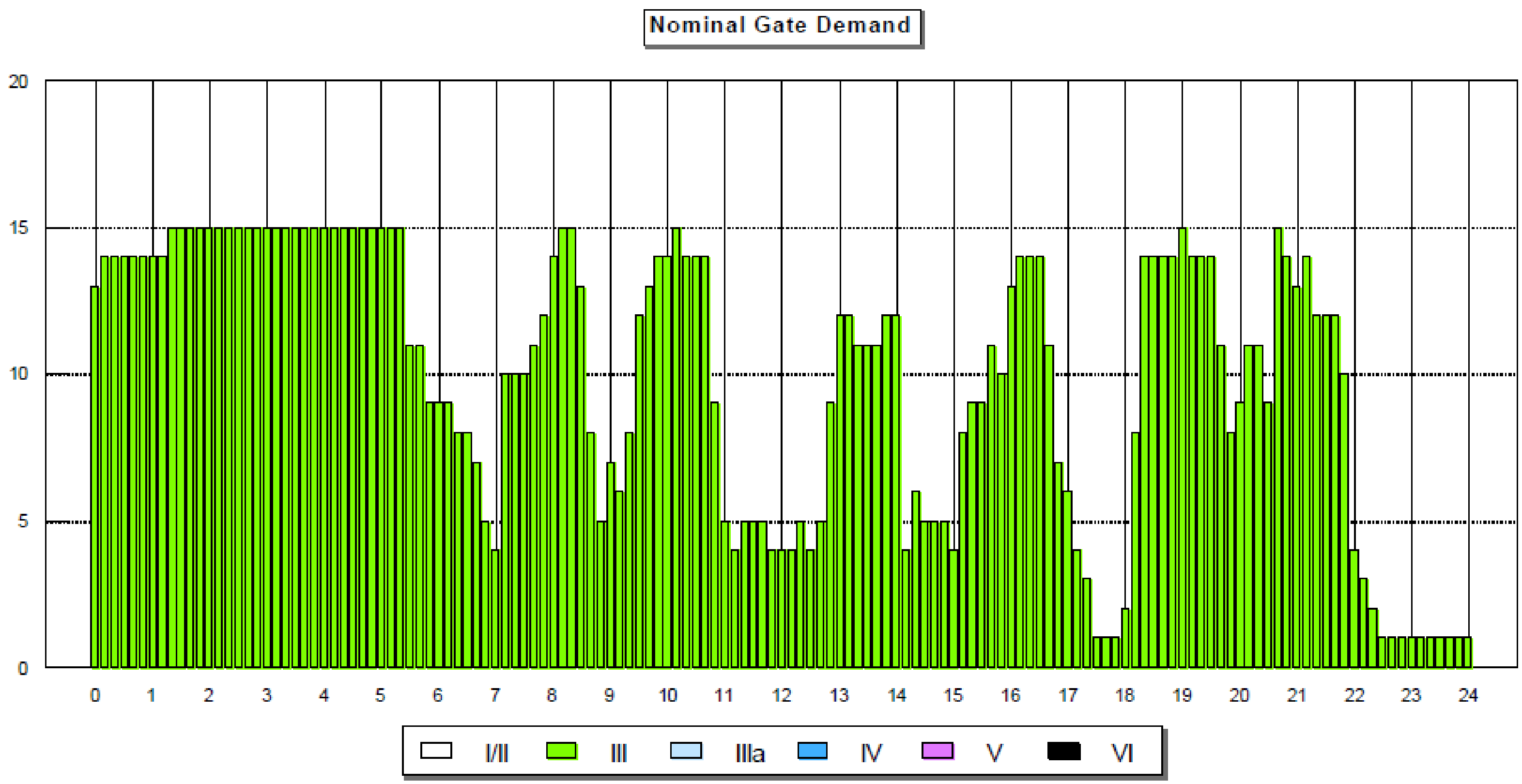
Source: Hirsh Associates, October 2020.

Figure 4.2-6: Terminal 2 Gate Demand (Active Gates and RON Positions)

Terminal 2 - Southwest **Weekday, July 2019**

Minimum Buffer Time: 20 minutes

RON Parking Positions Included



	I/II	III	IIIa	IV	V	VI	Combined
Maximum Number of Gates:	0	15	0	0	0	0	15
begins at:		120					120
Avg. Scheduled Time on Gate:	NA	93	NA	NA	NA	NA	93 minutes

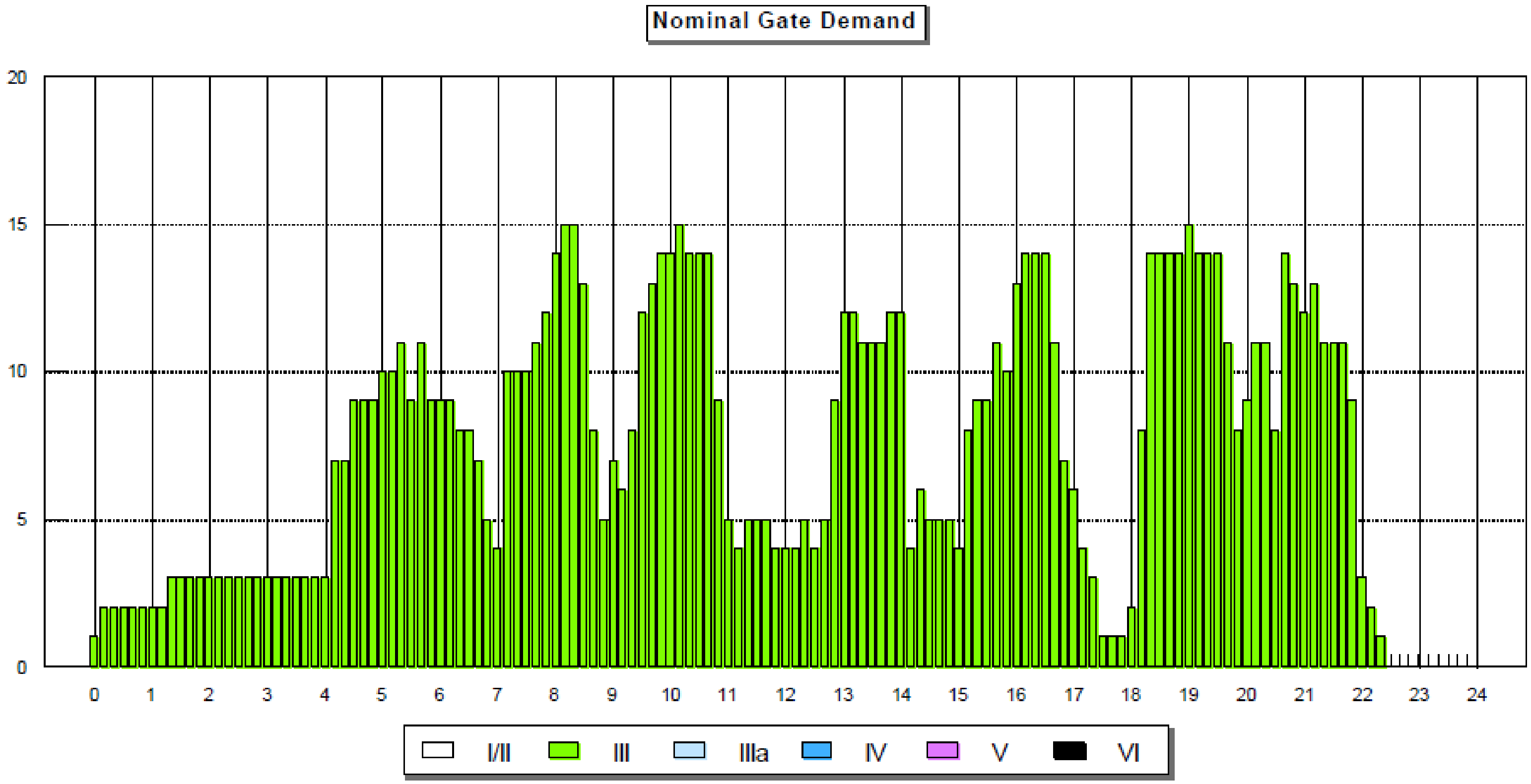
Source: Hirsh Associates, October 2020.

Figure 4.2-7: Terminal 2 Gate Demand (Active Gates Only)

Terminal 2 - Southwest Weekday, July 2019

Active Gates Shown

Minimum Buffer Time: 20 minutes
RON flights on gate: 30 to 90 minutes before departure time
30 to 90 minutes after arrival time



	I/II	III	IIIa	IV	V	VI	Combined
Maximum Number of Gates:	0	15	0	0	0	0	15
begins at:		810					810
Avg. Scheduled Time on Gate:	NA	63	NA	NA	NA	NA	63 minutes

Source: Hirsh Associates, October 2020.

The results of the DDFS analysis for each forecast period are presented in Table 4.2-1**.** The DDFSs for Terminal 1 indicate a reduction in gate demand for the Terminal 1 airlines in the near- and mid-terms, with a recovery to almost 2019 conditions by the end of the forecast period. Based on the projected 1.4 percent growth in passenger enplanements through the planning horizon, Southwest Airlines is projected to need two additional gates in the near- and mid-terms, with an additional two gates by the end of the forecast period.

As noted above, gates at STL are mostly "exclusive-use" with a few City-controlled, "common-use" gates. This means that the "raw" gate requirements of a DDFS have to be adjusted to reflect the Airport's leasing arrangements. Over the long term, leasing arrangements may change. Although future terms are unknown, full common-use gates are not considered a reasonable assumption for planning at this time. Thus, adjusted gates are referred to as "preferential" gates in **Table 4.2-2**, although other leasing arrangements may be used. Note that with the exception of the smaller ADG I and II gates, all other gates are ADG III narrowbodies. Any future widebody aircraft would be limited to the FIS gates. Gate use assumptions are:

- For Terminal 1, the raw gate requirements for smaller ADG I gates are used for the future requirements. This is considered reasonable since the ground-loaded gates can be flexibly used by different airlines. For the small RJs, the raw gates are also used due to the possibility that these could be replaced by larger wingspan aircraft as airline fleets change and can also use larger ADG III gates as they currently do.
- Terminal 1 narrowbody ADG III 'raw' DDFS demands were adjusted by a factor equal to the ratio of existing ADG III gates to the 2019 ADG II plus ADG III demand. Thus the preferential use factor is equal to: 25/(5 + 16) = 1.2.
- Terminal 2 gates were similarly adjusted to provide operational spare gates.

Table 4.2-2: Projected Gate Demand Based on Design Day Flight Schedules

Terminal 1

	Existing Gates In use	DDFS Gate Requirements 2019	2025	2030	2040
Small Commuter (Group I)	8	8	6	6	6
Small RJ/Medium Commuter (Group II)		5	4	4	5
Narrowbody/Large RJ (Group III)	25	16	15	14	17
Widebody (Group IV)					
B777/B787/A350 (Group V)					
Total Gates	33	29	25	24	28

	Preferential Use factor [1]	Preferential Gate Requirements 2019	2025	2030	2040
Small Commuter (Group I)	1.0	8	6	6	6
Small RJ/Medium Commuter (Group II)	1.0	5	4	4	5
Narrowbody/Large RJ (Group III)	1.2	20	18	17	21
Widebody (Group IV)					
B777/B787/A350 (Group V)					
Total Gates		33	28	27	32

Terminal 2

Gate demand based on WN activity
International gates are additional [3]

	Existing Gates In use	DDFS Gate Requirements 2019	2025	2030	2040
Small Commuter (Group I)					
Small RJ/Medium Commuter (Group II)					
Narrowbody/Large RJ (Group III)	17	15	17	17	19
Widebody (Group IV)					
B777/B787/A350 (Group V)					
Total Gates	17	15	17	17	19

	Spare gates factor [2]	Preferential Gate Requirements 2019	2025	2030	2040
Small Commuter (Group I)					
Small RJ/Medium Commuter (Group II)					
Narrowbody/Large RJ (Group III)	1.13	17	20	20	22
Widebody (Group IV)					
B777/B787/A350 (Group V)					
Total Gates		17	20	20	22

Notes -
[1] - T-1 preferential factor for ADG III based on combined ADG II and III 2019 demand compared to active ADG III gates.
[2] - T-2 spare gates factor based on 2019 demand compared to active gates.
[3] - International gates are assigned to T-2 for consistency with existing FIS location. Final location may be different. Additional gates are: 1, ADG III plus 1, ADG V.

Source: Hirsh Associates, October 2020.

4.2.3 PASSENGER TERMINAL FACILITIES PLANNING CRITERIA

Terminal facility requirements for an airport (the terminal program) are a function of the specific and unique characteristics of that airport. These include the design levels of passenger and aircraft activity, the number and type of airlines serving the airport, the operating requirements of the airlines and local factors such as the proportions of leisure vs. business travelers, locally originating passengers, etc.

TERMINAL FACILITIES AREAS

Unlike airfield facilities, the capacity of each element of a terminal facility can vary depending on the level of crowding and/or processing/waiting times, which are considered acceptable. In many cases, the degree of acceptability itself may also vary depending on the configuration of the terminal space and the level of amenity provided. Thus, the 'capacity' of a terminal can vary significantly.

LEVEL OF SERVICE

The term "World Class" is used to describe some airports around the world and by many other airports as an aspirational goal. What "World Class" actually means is subject to debate.

- In the 9th Edition of the I International Air Transport Association (IATA)'s *Airport Development Reference Manual* (ADRM), published in 2004, the term is defined as "top rated airports from world-wide passenger surveys". These airports "usually have airport layouts that allow for efficient airline operations and passenger terminal designs that are passenger friendly". The ADRM lists 20 key characteristics from the passenger and airline perspectives.
- The ADRM then lists a series of standards for maximum queuing times for major processes, minimum area per passengers for passenger queues and seating areas, percentages of passengers seated in various areas, and a number of airline operational metrics, such as wheel stop to last bag delivery and minimum connecting times.
- For terminal functional areas, such as queues or seating areas, the "World Class" standards generally corresponded to Level of Service (LOS) 'C'. Level of Service 'C' is recommended as the design objective, as it provides good service and comfort with acceptable delays at a reasonable cost. This applies to the design hour levels of activity. The same basic criteria are recommended in the ACRP Report 25, *Airport Passenger Terminal Planning and Design.*
- Beginning with the release of the ADRM (10th Edition, 2016), the term "World Class" does not appear. The various LOS metrics - from A (excellent) to F (unacceptable) were reduced to "Optimum", "Over-Design" and "Sub-Optimum". In most cases, the Optimum range corresponds to the former LOS 'C' areas. Maximum waiting times in some cases are shorter than the 9th Edition "World Class" (a higher LOS), and in other cases are longer (a lower LOS). The ADRM 9th Edition LOS metrics have been used where the 10th edition does not provide comparable metrics.

It should be noted that most time-based levels of service are outside the Airport's control in the U.S. Airlines, Transportation Security Administration (TSA), Customs and Border Protection (CBP) and others ultimately determine staffing levels and processes that affect a passenger's waiting time and experience, regardless of the number and size of facilities provided by the Airport.

PROGRAM RECOMMENDATIONS

The approach taken in developing terminal facilities requirements for STL was to review the plans and areas of the terminal, and discuss with airport staff, airline and other tenants how well the present facilities are functioning. These observations, coupled with calculations of area per passenger, per gate, or other determinant of demand, were compared to generally accepted industry planning factors (LOS 'C'). From these comparisons, a planning factor for each terminal component was determined and used to project facility requirements.

As noted in Section 4.2.1, Design Hour passengers are used for passenger processing to which LOS 'C' criteria are applied. Much of the design day (as well as most of the year) has less activity than the Design Hour. Thus, the effective LOS of a terminal designed for LOS 'C' will be at LOS 'B' or 'A' most of the time. **Table 4.2-3** and **Figures 4.2-8** and **4.2-9** illustrate this for Terminals 1 and 2 respectively, using ratios of areas previously published in the ADRM 9th Edition. If LOS 'C' areas are used for the peak hour, over 95 percent of the day, passenger activity in Terminal 1 would result in areas/passenger of LOS 'B' or 'A'. In Terminal 2, where there are multiple peaks, areas/passenger would still exceed LOS 'C' over 85 percent of the day.

The program areas developed were based on the utilization of existing facilities, and on projected trends. **Tables 4.2-4** and **4.2.6** present the program data in five columns, and results are color-coded to reflect the level of service, based on the ratio of existing to forecast required areas. The five columns included in the program are listed below:

- Existing Facilities in Use: These are the areas measured from architectural plans of the terminal, lease exhibits and the current functions as discussed with the users. STL is unusual, in that there are large sections of concourses that are currently 'mothballed'. While these areas are potentially available for future use, including them as part of the existing areas would distort the basis for the program. These areas may, however, be considered in alternatives development.

  Tables 4.2-4 and 4.2-6 only include active areas within the terminals.

- Base Year 2019 Activity: These areas represent the facilities which would be needed to support levels of passenger activity for the base planning year. These values may differ from existing conditions and either point out deficiencies in existing facilities or facilities with excess capacity. These differences help establish whether existing ratios of space per unit of demand are appropriate to use for planning.
- Recommended Facilities – 2025/2030/2040: These are the areas recommended to support each level of design hour passengers and the associated annual enplanements associated with the forecasts. The timing of the needed improvements would be based on the actual passenger growth rates.

Program areas were estimated separately for Terminal 1, Terminal 2 and for a single terminal accommodating all airlines. For most facilities, the single terminal program is the sum of the Terminal 1 and Terminal 2 areas. This is used where passenger or airline characteristics differ between the current terminals. For other facilities that would be non-airline specific, such as the security screening checkpoint (SSCP) or checked baggage screening - the combined design hour activity is used as the basis for calculations.

Table 4.2-3: Levels of Service when Designing to LOS C for Peak Hour

Example - Check-in Queue (using T-1 scheduled seats)

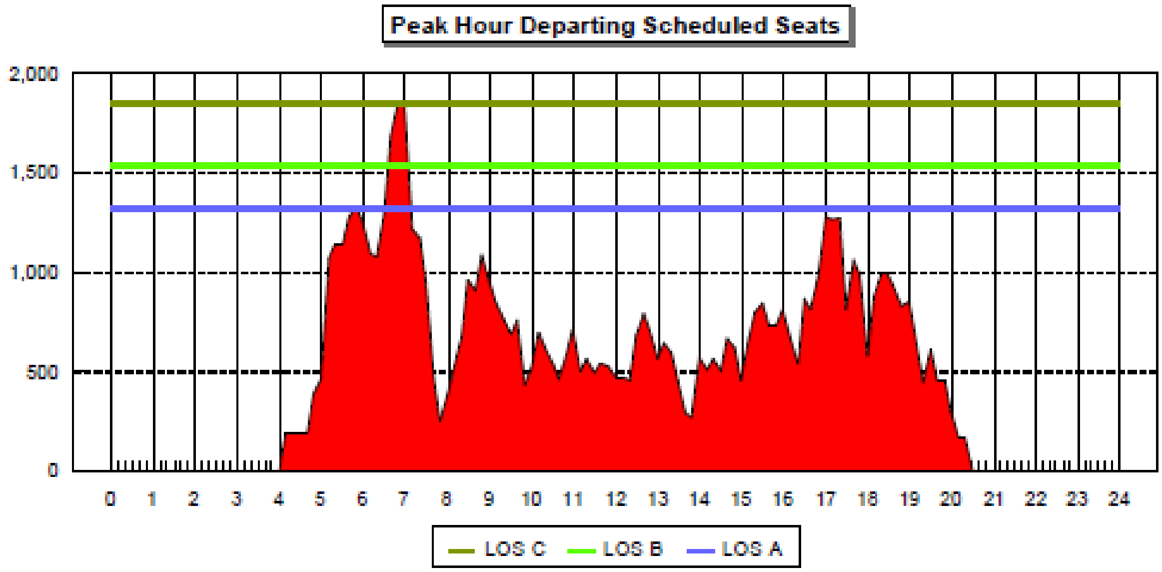
LOS C:		14	SF/pax
Design Hour Departing Pax		**1,850**	**pax**
Queuing area needed for LOS C =		25,900	SF
ADRM 9th ed. area per pax ratio for LOS B =		1.2	times LOS C
	=>	16.8	SF/pax
Same queuing area provides LOS B for		**1,540**	**pax**
ADRM 9th ed. area per paxratio for LOS A =		1.4	times LOS C
	=>	19.6	SF/pax
Same queuing area provides LOS A for		**1,320**	**pax**

Note:

LOS ratios are based on earlier editions of ADRM (pre-10th edition).

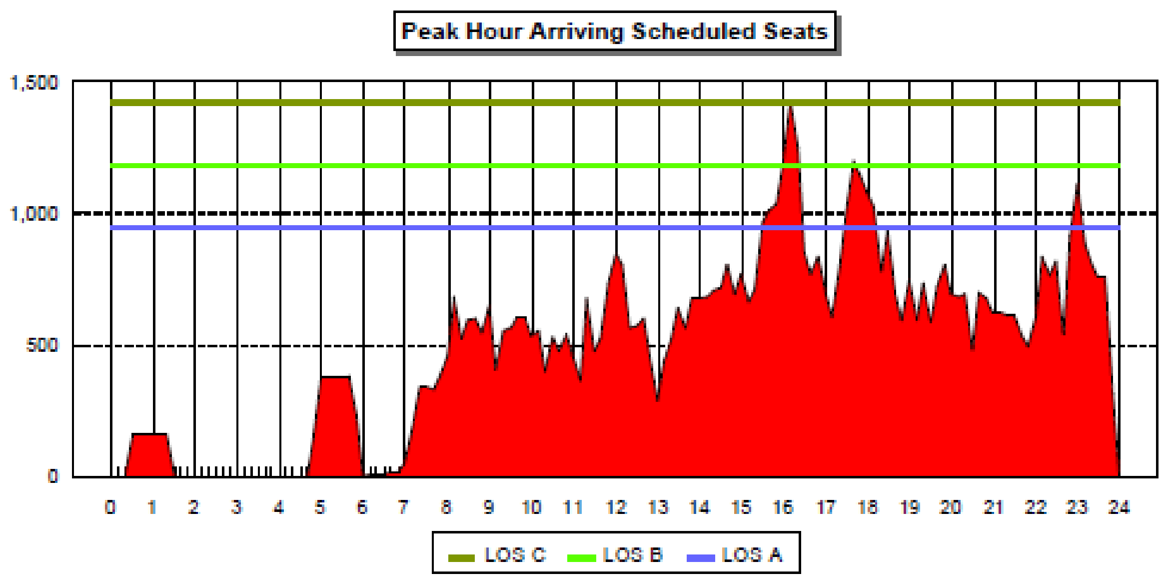
Source: Hirsh Associates, December 2020.

Figure 4.2-8: Terminal 1 - Level of Service if Facilities are Sized to LOS C for Peak Hour (Typical Weekday, July 2019)



If facilities are sized at LOS C for the peak hour:

Percentage of time at LOS C	3%		
Percentage of time at LOS B	1%	LOS area/pax =	1.2 x LOS C *
Percentage of time at LOS A	96%	LOS area/pax =	1.4 x LOS C *



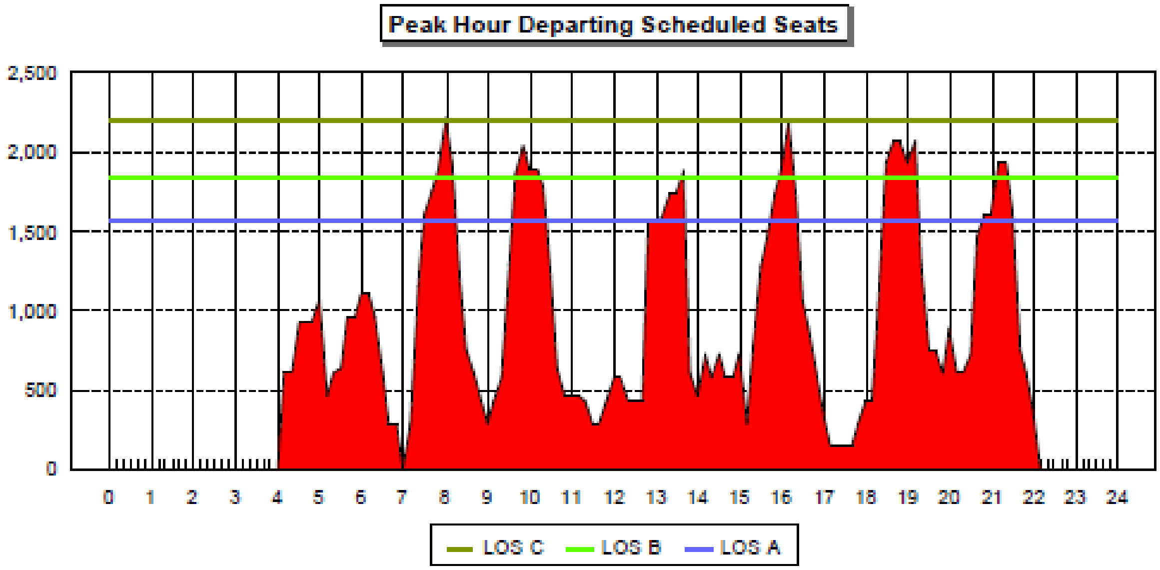
If facilities are sized at LOS C for the peak hour:

Percentage of time at LOS C	2%		
Percentage of time at LOS B	7%	LOS area/pax =	1.2 x LOS C *
Percentage of time at LOS A	91%	LOS area/pax =	1.5 x LOS C *

* - LOS area/pax ratios from IATA ADRM, 9th Edition

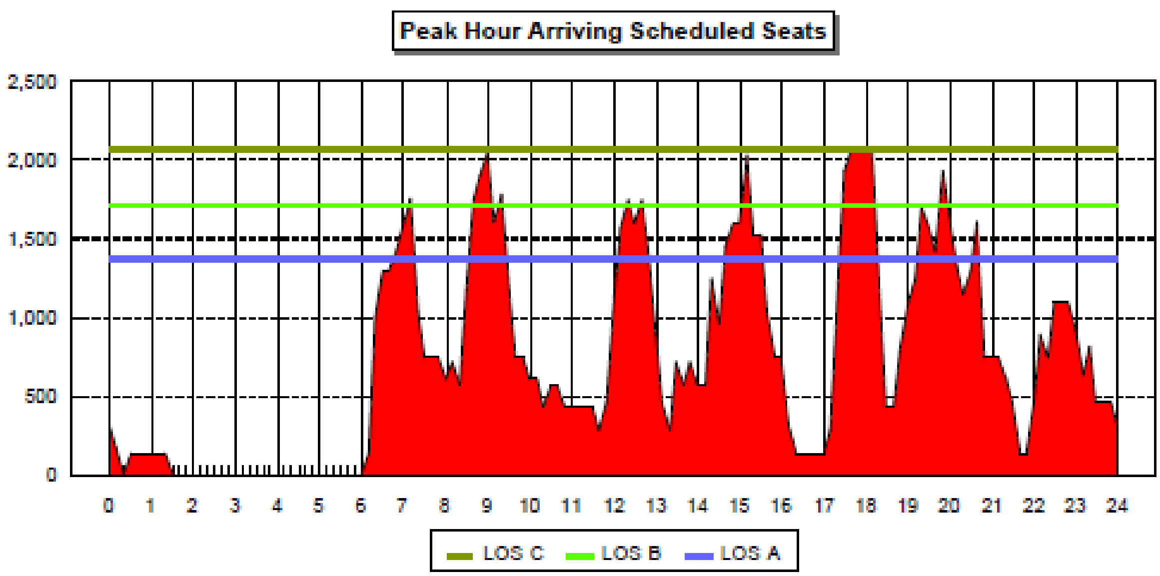
Sources: Hirsh Associates, October 2020.

Figure 4.2-9: Terminal 2 - Level of Service if Facilities are Sized to LOS C for Peak Hour (Typical Weekday, July 2019)



If facilities are sized at LOS C for the peak hour:

Percentage of time at LOS C	14%		
Percentage of time at LOS B	9%	LOS area/pax =	1.2 x LOS C *
Percentage of time at LOS A	77%	LOS area/pax =	1.4 x LOS C *



If facilities are sized at LOS C for the peak hour:

Percentage of time at LOS C	11%		
Percentage of time at LOS B	12%	LOS area/pax =	1.2 x LOS C *
Percentage of time at LOS A	77%	LOS area/pax =	1.5 x LOS C *

* - LOS area/pax ratios from IATA ADRM, 9th Edition

Sources: Hirsh Associates, October 2020.

Table 4.2-4: Terminal 1 Program Requirements

	Existing Facilities In Use	Recommended Facilities Base Year 2019	Forecast Year 2025	2030	2040	
Annual Enplanements		3,114,599	2,926,000	3,196,000	3,880,000	
Design Hour Passengers						
Design Hour Connecting %		0%	0%	0%	0%	
Enplaned		1,670	1,550	1,580	1,720	
Enplaned O&D		1,670	1,550	1,580	1,720	
Deplaned		1,280	1,170	1,150	1,310	
Deplaned O&D		1,280	1,170	1,150	1,310	
Total		2,030	1,870	1,850	2,190	
Meeter/Greeters per O&D Passenger		0.2	0.2	0.2	0.2	
GATES & HOLDROOMS						
Total Gates (Domestic & International):						
Small Commuter (Group I)	10	8	6	6	6	
Small RJ/Medium Commuter (Group II)		5	4	4	5	gates
Narrowbody/Large RJ (Group III)	26	20	18	17	21	gates
Widebody (Group IV)						gates
B777/B787/A350 (Group V)						gates
Total Gates	36	33	28	27	32	gates
Narrowbody Equivalent Gates (NBEG)	30.0	26.7	23.2	22.2	26.9	NBEG
Equivalent Aircraft (EQA)	29.6	24.8	22.0	20.9	25.7	EQA
International Arrivals Gates:						
Narrowbody/Large RJ (Group III)						gates
Widebody (Group IV)						gates
B777/B787/A350 (Group V)						gates
Total Gates	0	0	0	0	0	gates
Narrowbody Equivalent Gates (NBEG)	0.0	0.0	0.0	0.0	0.0	NBEG
Equivalent Aircraft (EQA)	0.0	0.0	0.0	0.0	0.0	EQA
Additional RON positions	15	10	10	10	12	positions
Holdrooms:						
Commuter Aircraft (Group I)		2,400	1,800	1,800	1,800	SF
Regional Aircraft (Group II)		5,800	4,600	4,600	5,800	SF
Narrowbody (Group III)		43,000	38,700	36,600	45,200	SF
Widebody (Group IV)		0	0	0	0	SF
B777/B787/A350 (Group V)		0	0	0	0	SF
Total Holdroom Area	48,727	48,800	43,300	41,200	51,000	SF
CBP Outbound Gate Interview Rooms		0	0	0	0	SF
Subtotal	48,727	48,800	43,300	41,200	51,000	SF

AIRLINE SPACE

Ticketing/Check-in Positions:						
Total Equivalent Check-in Positions	78	78	73	74	81	pos
Percentage Using Staffed Positions		28%	25%	20%	20%	
Conventional Staffed Positions	22	22	18	15	16	pos
Percentage Using Kiosks		55%	60%	60%	60%	
Self Service Kiosks	43	43	44	45	49	kiosks
Bag Drops	13	13	14	14	15	pos
Linear Positions	43	43	40	37	40	pos
Ticket/Check-in Counter - length	356	300	280	260	280	LF
Ticket/Check-in Counter - area	4,630	3,900	3,600	3,400	3,600	SF
ATO and Other Airline Offices	12,978	12,000	11,200	10,400	11,200	SF
Airline Operations	22,481	24,800	22,000	20,900	25,700	SF
Airline Clubs & 1st/Bus. Class Lounges	7,626	8,100	12,900	12,500	14,400	SF
Baggage Service Offices	2,385	3,000	2,600	2,500	3,100	SF
Baggage Handling:						
Estimated make-up capacity	61	67	59	56	69	carts
Baggage Make-up area	60,214	53,600	47,200	44,800	55,200	SF
Checked Baggage Screening - EDS units	3	3	3	3	3	units
Checked Baggage Screening - area	13,963	14,000	14,000	14,000	14,000	SF
Baggage Claim Off-load - domestic	22,522	6,000	6,000	6,000	6,000	SF
Baggage Claim Off-load - international		0	0	0	0	SF
Baggage Tug/cart Circulation	39,052	8,900	8,000	7,600	9,200	SF
Ramp Control Tower		0	500	500	500	SF
Airline Systems	inc ops.	1,200	1,100	1,000	1,300	SF
Subtotal	185,851	135,500	129,100	123,600	144,200	SF

DOMESTIC BAGGAGE CLAIM

Claim Frontage Required	-	470	430	420	480	LF
Claim Units	6	3	3	3	3	units
Claim Frontage Programmed	930	465	465	465	465	LF
Baggage Claim Area	29,170	18,600	18,600	18,600	18,600	SF
Oversized Baggage	428	900	900	900	900	SF
Subtotal	29,598	19,500	19,500	19,500	19,500	SF

CONCESSIONS

Ground Services/Information Counter	522	600	600	600	600	SF
Rental Car Counters	5,113	0	0	0	0	SF
Food/Beverage; Secure	21,070	16,800	15,800	17,300	21,000	SF
News/Gift/Retail; Secure	9,100	10,400	9,700	10,600	12,900	SF
Subtotal; Secure Concessions	30,170	27,200	25,500	27,900	33,900	SF
Food/Beverage; Non-Secure	16,215	1,900	1,800	1,900	2,300	SF
News/Gift/Retail; Non-Secure	4,653	1,200	1,100	1,200	1,400	SF
Subtotal; Non-Secure Concessions	20,868	3,100	2,900	3,100	3,700	SF
Duty Free	0	0	0	0	0	SF
Other Services	0	300	300	400	400	SF
USO	6,994	7,500	7,000	7,700	9,300	SF
Concession Support Area	20,644	7,700	7,200	7,900	9,500	SF
Subtotal	84,311	46,400	43,500	47,600	57,400	SF

PUBLIC SPACE & CIRCULATION

Ticket Lobby	18,118	18,800	17,500	16,300	17,500	SF
Security Screening (SSCP) Lanes	11	11	10	10	11	lanes
Checkpoint/Queue/Search Area	21,477	21,300	19,400	19,400	21,300	SF
Secure Circulation Corridor Width	18-33'	30	30	30	30	ft
Secure Circulation	72,950	57,300	49,800	47,600	57,700	SF
Sterile (Int'l Arrivals) Circulation		0	0	0	0	SF
Public Seating/Waiting/Domestic M/G Area	21,398	9,100	8,400	8,300	9,900	SF
International Meeter/Greeter Lobby		0	0	0	0	SF
Restrooms - Non-Secure Departures Level	1,297	2,600	2,400	2,500	2,700	SF
Restrooms - Non-Secure Arrivals Level	4,950		1,500	1,500	1,700	SF
Restrooms - Secure Locations	6,899	8,800	6,600	6,600	8,800	SF
Other Public Circulation	109,773	82,600	77,100	76,200	89,400	SF
Subtotal	256,862	181,700	165,200	162,100	191,500	SF

FEDERAL INSPECTION SERVICES

Design Capacity (passengers per hour)						
Primary Inspection:						kiosks
Global Entry Kiosks						kiosks
APC Kiosks						
CBP Officers for APC Verification & Triage						officers
Global Entry Officers						officers
APC Verification & Triage Officers						officers
Non-APC Inspection Officers						counters
Double Inspector Counters						SF
Counters, Kiosks, Queues and Exit Area						
						SF
CBP Command & Control Center (CCC)						SF
Public Restrooms						
Baggage Claim:						LF
Claim Frontage Required						
Average Claim Unit Size						units
Claim Units						LF
Claim Frontage Provided						SF
Claim Area						SF
Bag Trolley Area						SF
Exit Podium						SF
Exit Control Queue						
						SF
Unified Secondary Processing & Inspection						SF
CBP Secondary Operations & Support						SF
CBP Administration & Staff Offices						SF
CBP Support Spaces						
PHS/CDC offices						pos
FWS offices						LF
Transfer Baggage Re-check:						SF
Assisted Check-in Positions						SF
Counter Length						
Counter & Queuing Area						
FIS Circulation						
Subtotal	0	0	0	0	0	SF

OTHER AREAS						
Airport Administration/Operations	77,356	77,400	77,400	77,800	90,700	SF
TSA Offices & Support	11,327	7,000	6,500	6,500	7,000	SF
Other (USPS, chapel, etc.)	749	800	800	800	800	SF
Loading Docks & Receiving	0	5,000	5,000	5,000	5,000	SF
Service Animal Relief Areas	459	500	500	500	500	SF
Non-Public Circulation	33,014	27,000	26,200	26,000	30,200	SF
Subtotal	122,905	117,700	116,400	116,600	134,200	SF
Total Functional Area	776,981	598,400	560,300	551,800	648,800	SF
Mechanical/Electrical/Utilities	113,461	89,800	84,000	82,800	97,300	SF
Janitorial/Storage/Shops	8,234	6,000	5,600	5,500	6,500	SF
Structure/non-net areas	inc above	20,800	19,500	19,200	22,600	SF
TOTAL TERMINAL GROSS AREA	**898,676**	**715,000**	**669,400**	**659,300**	**775,200**	**SF**
Gross Terminal Area per gate:	30,000	26,800	28,900	29,700	28,800	SF/NBEG

Notes:

[1] - Color coding reflects ratio of existing areas to forecast required areas:

a. Green font: ratio ≥ 1.0, which corresponds to Level of Service (LOS) C or better (per pre-10th Edition of the *Airport Development Reference Manual)*

b. Orange font: 0.8 ≤ ratio <1.0, which corresponds to LOS D

c. Red font: ratio <0.8, which corresponds to worse than LOS D

Source: Hirsh Associates, December 2020.

Table 4.2-5: Terminal 2 Program Requirements

	Existing Facilities In Use	Recommended Facilities Base Year 2019	Forecast Year 2025	2030	2040	
Annual Enplanements		4,800,617	5,168,000	5,646,000	6,760,000	
Design Hour Passengers						
Design Hour Connecting %		37%	40%	40%	40%	
Enplaned		1,990	2,170	2,170	2,450	
Enplaned O&D		1,250	1,300	1,300	1,470	
Deplaned		1,860	1,970	1,990	2,450	
Deplaned O&D		1,170	1,180	1,190	1,470	
Total		2,980	3,730	3,730	3,980	
Meeter/Greeters per O&D Passenger		0.2	0.2	0.2	0.2	
GATES & HOLDROOMS						
Total Gates (Domestic & International):						
Small Commuter (Group I)						gates
Small RJ/Medium Commuter (Group II)						gates
Narrowbody/Large RJ (Group III)	18	18	21	21	23	gates
Widebody (Group IV)						gates
B777/B787/A350 (Group V)			1	1	1	gates
Total Gates	18	18	22	22	24	gates
Narrowbody Equivalent Gates (NBEG)	18.0	18.0	22.8	22.8	24.8	NBEG
Equivalent Aircraft (EQA)	21.6	21.6	28.0	28.0	30.4	EQA
International Arrivals Gates:						
Narrowbody/Large RJ (Group III)	3	3	2	2	2	gates
Widebody (Group IV)						gates
B777/B787/A350 (Group V)			1	1	1	gates
Total Gates	3	3	3	3	3	gates
Narrowbody Equivalent Gates (NBEG)	3.0	3.0	3.8	3.8	3.8	NBEG
Equivalent Aircraft (EQA)	3.0	3.0	4.8	4.8	4.8	EQA
Additional RON positions	4	0	0	0	0	positions
Holdrooms:						
Commuter Aircraft (Group I)		0	0	0	0	SF
Regional Aircraft (Group II)		0	0	0	0	SF
Narrowbody (Group III)		49,500	57,800	57,800	63,300	SF
Widebody (Group IV)		0	0	0	0	SF
B777/B787/A350 (Group V)		0	3,300	3,300	3,300	SF
Total Holdroom Area	42,381	49,500	61,100	61,100	66,600	SF
CBP Outbound Gate Interview Rooms		200	200	200	200	SF
Subtotal	42,381	49,700	61,300	61,300	66,800	SF

AIRLINE SPACE

Ticketing/Check-in Positions:						
Total Equivalent Check-in Positions	18	18	19	19	22	pos
Percentage Using Staffed Positions		25%	25%	25%	25%	
Conventional Staffed Positions	5	5	5	5	6	pos
Percentage Using Kiosks		60%	60%	60%	60%	
Self Service Kiosks	11	11	12	12	14	kiosks
Bag Drops	2	3	3	3	3	pos
Linear Positions	7	8	8	8	9	pos
Ticket/Check-in Counter - length	108	100	100	100	110	LF
Ticket/Check-in Counter - area	1,080	1,000	1,000	1,000	1,100	SF
ATO and Other Airline Offices	5,700	5,800	5,800	5,800	6,400	SF
Airline Operations	19,967	20,500	26,600	26,600	28,900	SF
Airline Clubs & 1st/Bus. Class Lounges	2,937	3,000	3,900	3,900	4,300	SF
Baggage Service Offices		1,100	1,400	1,400	1,500	SF
Baggage Handling:						
Estimated make-up capacity	26	54	70	70	76	carts
Baggage Make-up area	16,017	32,400	42,000	42,000	45,600	SF
Checked Baggage Screening - EDS units	3	3	3	3	3	units
Checked Baggage Screening - area	6,584	10,500	10,500	10,500	10,500	SF
Baggage Claim Off-load - domestic	3,755	6,000	6,000	6,000	8,000	SF
Baggage Claim Off-load - international	834	2,000	4,000	4,000	4,000	SF
Baggage Tug/cart Circulation	0	6,100	7,800	7,800	8,600	SF
Ramp Control Tower	0	0	500	500	500	SF
Airline Systems	inc ops.	1,000	1,300	1,300	1,400	SF
Subtotal	56,874	89,400	110,800	110,800	120,800	SF

DOMESTIC BAGGAGE CLAIM

Claim Frontage Required	-	520	520	530	650	LF
Claim Units	2	3	3	3	4	units
Claim Frontage Programmed	365	540	540	540	720	LF
Baggage Claim Area	10,028	21,600	21,600	21,600	28,800	SF
Oversized Baggage	20	1,100	1,100	1,100	1,400	SF
Subtotal	10,048	22,700	22,700	22,700	30,200	SF

CONCESSIONS

Ground Services/Information Counter	108	600	600	600	600	SF
Rental Car Counters	0	0	0	0	0	SF
Food/Beverage; Secure	21,075	25,900	27,900	30,500	36,500	SF
News/Gift/Retail; Secure	7,420	16,000	17,200	18,800	22,500	SF
Subtotal; Secure Concessions	28,495	41,900	45,100	49,300	59,000	SF
Food/Beverage; Non-Secure	800	2,900	3,100	3,400	4,100	SF
News/Gift/Retail; Non-Secure	0	1,800	1,900	2,100	2,500	SF
Subtotal; Non-Secure Concessions	800	4,700	5,000	5,500	6,600	SF
Duty Free	0	0	200	200	200	SF
Other Services	0	500	600	600	700	SF
USO	724	800	900	900	1,100	SF
Concession Support Area	2,897	11,800	12,700	13,900	16,600	SF
Subtotal	33,024	60,300	65,100	71,000	84,800	SF

PUBLIC SPACE & CIRCULATION

Ticket Lobby	6,421	6,300	6,300	6,300	6,900	SF	
Security Screening (SSCP) Lanes	7	7	7	7	8	lanes	
Checkpoint/Queue/Search Area	12,195	13,600	13,600	13,600	15,500	SF	
Secure Circulation Corridor Width	16-32'	30	30	30	30	ft	
Secure Circulation	62,097	77,200	97,800	97,800	106,400	SF	
Sterile (Int'l Arrivals) Circulation	6,424	6,400	8,200	8,200	8,200	SF	
Public Seating/Waiting/Domestic M/G Area	6,052	11,200	14,000	14,000	14,900	SF	
International Meeter/Greeter Lobby	1,100	1,300	1,900	1,900	1,900		0
Restrooms - Non-Secure Departures Level	753	3,100	3,400	3,400	3,800	SF	
Restrooms - Non-Secure Arrivals Level	1,345	2,500	2,600	2,600	3,200	SF	
Restrooms - Secure Locations	4,163	7,700	10,300	10,300	10,300	SF	
Other Public Circulation	20,268	76,200	89,900	91,300	102,600	SF	
Subtotal	120,818	199,200	241,700	242,100	266,800	SF	

FEDERAL INSPECTION SERVICES

Design Capacity (passengers per hour)	400	400	600	600	600	
Primary Inspection:						
Global Entry Kiosks	2	2	2	2	2	kiosks
APC Kiosks	0	9	13	13	13	kiosks
CBP Officers for APC Verification & Triage						
Global Entry Officers		1	1	1	1	officers
APC Verification & Triage Officers		4	5	5	5	officers
Non-APC Inspection Officers		1	1	1	1	officers
Double Inspector Counters	4	4	6	6	6	counters
Counters, Kiosks, Queues and Exit Area		5,300	7,900	7,900	7,900	SF
CBP Command & Control Center (CCC)		225	225	225	225	SF
Public Restrooms		700	800	800	800	SF
Baggage Claim:						
Claim Frontage Required		175	265	265	265	LF
Average Claim Unit Size		180	180	180	180	LF
Claim Units	1	1	2	2	2	units
Claim Frontage Provided	150	180	360	360	360	LF
Claim Area		8,100	16,200	16,200	16,200	SF
Bag Trolley Area		600	900	900	900	SF
Exit Podium		180	180	180	180	SF
Exit Control Queue		1,000	1,400	1,400	1,400	SF
Unified Secondary Processing & Inspection		5,600	6,100	6,100	6,100	SF
CBP Secondary Operations & Support		2,100	2,100	2,100	2,100	SF
CBP Administration & Staff Offices		1,300	1,400	1,400	1,400	SF
CBP Support Spaces		3,300	3,400	3,400	3,400	SF
PHS/CDC offices		310	310	310	310	SF
FWS offices		0	0	0	0	SF
Transfer Baggage Re-check:						
Assisted Check-in Positions	0	1	2	2	2	pos
Counter Length		5	10	10	10	LF
Counter & Queuing Area		300	500	500	500	SF
FIS Circulation		2,700	4,500	4,500	4,500	SF
Subtotal	28,850	33,500	48,300	48,300	48,300	SF

OTHER AREAS						
Airport Administration/Operations	1,625	1,600	1,600	1,600	1,600	SF
TSA Offices & Support	2,690	5,000	5,000	5,000	5,500	SF
Other (USPS, chapel, etc.)	257	300	300	300	300	SF
Loading Docks & Receiving	0	5,000	5,000	5,000	5,000	SF
Service Animal Relief Areas	165	200	200	200	200	SF
Non-Public Circulation	14,824	10,100	11,700	11,900	13,200	SF
Subtotal	19,561	22,200	23,800	24,000	25,800	SF
Total Functional Area	353,937	526,500	634,800	642,300	710,100	SF
Mechanical/Electrical/Utilities	49,612	79,000	95,200	96,300	106,500	SF
Janitorial/Storage/Shops	2,878	5,300	6,300	6,400	7,100	SF
Structure/non-net areas	inc above	18,300	22,100	22,400	24,700	SF
TOTAL TERMINAL GROSS AREA	**406,427**	**629,100**	**758,400**	**767,400**	**848,400**	**SF**
Gross Terminal Area per gate:	22,600	35,000	33,300	33,700	34,200	SF/NBEG

Notes:

[1] - Color coding reflects ratio of existing areas to forecast required areas:

a. Green font: ratio ≥ 1.0, which corresponds to Level of Service (LOS) C or better (per pre-10th Edition of the *Airport Development Reference Manual)*

b. Orange font: 0.8 ≤ ratio <1.0, which corresponds to LOS D

c. Red font: ratio <0.8, which corresponds to worse than LOS D

Source: Hirsh Associates, December 2020.

Table 4.2-6: Single Terminal Program Requirements

	Recommended Facilities				
	Base Year	Forecast Year			
	2019	2025	2030	2040	
Annual Enplanements	7,915,216	8,094,000	8,842,000	10,640,000	
Design Hour Passengers					
Design Hour Connecting %	25%	28%	28%	28%	
Enplaned	2,670	2,770	2,800	3,200	
Enplaned O&D	2,000	1,990	2,020	2,300	
Deplaned	2,930	3,010	2,920	3,090	
Deplaned O&D	2,200	2,170	2,100	2,220	
Total	4,150	4,480	4,630	5,450	
Meeter/Greeters per O&D Passenger	0.2	0.2	0.2	0.2	
GATES & HOLDROOMS					
Total Gates (Domestic & International):					
Small Commuter (Group I)	8	6	6	6	gates
Small RJ/Medium Commuter (Group II)	5	4	4	5	gates
Narrowbody/Large RJ (Group III)	38	39	38	44	gates
Widebody (Group IV)					gates
B777/B787/A350 (Group V)		1	1	1	gates
Total Gates	51	50	49	56	gates
Narrowbody Equivalent Gates (NBEG)	44.7	46.0	45.0	51.7	NBEG
Equivalent Aircraft (EQA)	46.4	50.0	48.9	56.1	EQA
International Arrivals Gates:					
Narrowbody/Large RJ (Group III)	3	2	2	2	gates
Widebody (Group IV)					gates
B777/B787/A350 (Group V)		1	1	1	gates
Total Gates	3	3	3	3	gates
Narrowbody Equivalent Gates (NBEG)	3.0	3.8	3.8	3.8	NBEG
Equivalent Aircraft (EQA)	3.0	4.8	4.8	4.8	EQA
Additional RON positions	10	10	10	12	positions
Holdrooms:					
Commuter Aircraft (Group I)	2,400	1,800	1,800	1,800	SF
Regional Aircraft (Group II)	5,800	4,600	4,600	5,800	SF
Narrowbody (Group III)	92,500	96,500	94,400	108,500	SF
Widebody (Group IV)	0	0	0	0	SF
B777/B787/A350 (Group V)	0	3,300	3,300	3,300	SF
Total Holdroom Area	98,300	104,400	102,300	117,600	SF
CBP Outbound Gate Interview Rooms	200	200	200	200	SF
Subtotal	98,500	104,600	102,500	117,800	SF

AIRLINE SPACE

Ticketing/Check-in Positions:					
Total Equivalent Check-in Positions	96	92	93	103	pos
Percentage Using Staffed Positions					
Conventional Staffed Positions	27	23	20	22	pos
Percentage Using Kiosks					
Self Service Kiosks	54	56	57	63	kiosks
Bag Drops	16	17	17	18	pos
Linear Positions	51	48	45	49	pos
Ticket/Check-in Counter - length	400	380	360	390	LF
Ticket/Check-in Counter - area	4,900	4,600	4,400	4,700	SF
ATO and Other Airline Offices	17,800	17,000	16,200	17,600	SF
Airline Operations	45,300	48,600	47,500	54,600	SF
Airline Clubs & 1st/Bus. Class Lounges	11,100	16,800	16,400	18,700	SF
Baggage Service Offices	4,100	4,000	3,900	4,600	SF
Baggage Handling:					
Estimated make-up capacity	116	125	122	140	carts
Baggage Make-up area	69,600	75,000	73,200	84,000	SF
Checked Baggage Screening - EDS units	3	3	4	4	units
Checked Baggage Screening - area	10,500	10,500	14,000	14,000	SF
Baggage Claim Off-load - domestic	12,000	12,000	10,000	12,000	SF
Baggage Claim Off-load - international	2,000	2,000	2,000	2,000	SF
Baggage Tug/cart Circulation	12,500	13,400	12,800	14,700	SF
Ramp Control Tower	0	500	500	500	SF
Airline Systems	2,300	2,400	2,400	2,700	SF
Subtotal	224,900	239,900	234,400	265,000	SF

DOMESTIC BAGGAGE CLAIM

Claim Frontage Required	970	960	930	980	LF
Claim Units	6	6	5	6	units
Claim Frontage Programmed	1,080	1,080	900	1,080	LF
Baggage Claim Area	43,200	43,200	36,000	43,200	SF
Oversized Baggage	2,200	2,200	1,800	2,200	SF
Subtotal	45,400	45,400	37,800	45,400	SF

CONCESSIONS

Ground Services/Information Counter	600	600	600	600	SF
Rental Car Counters	0	0	0	0	SF
Food/Beverage; Secure	42,700	43,700	47,700	57,500	SF
News/Gift/Retail; Secure	26,400	27,000	29,400	35,400	SF
Subtotal; Secure Concessions	69,100	70,700	77,100	92,900	SF
Food/Beverage; Non-Secure	4,700	4,900	5,300	6,400	SF
News/Gift/Retail; Non-Secure	2,900	3,000	3,300	3,900	SF
Subtotal; Non-Secure Concessions	7,600	7,900	8,600	10,300	SF
Duty Free	0	200	200	200	SF
Other Services	800	900	1,000	1,100	SF
USO	8,300	7,900	8,600	10,400	SF
Concession Support Area	19,400	19,900	21,700	26,100	SF
Subtotal	105,800	108,100	117,800	141,600	SF

PUBLIC SPACE & CIRCULATION

Ticket Lobby	25,100	23,800	22,600	24,400	SF
Security Screening (SSCP) Lanes	11	10	11	12	lanes
Checkpoint/Queue/Search Area	21,300	19,400	21,300	23,300	SF
Secure Circulation Corridor Width	45	45	45	45	ft
Secure Circulation	143,800	148,000	144,800	166,300	SF
Sterile (Int'l Arrivals) Circulation	6,400	8,200	8,200	8,200	SF
Public Seating/Waiting/Domestic M/G Area	15,600	16,800	17,400	20,400	SF
International Meeter/Greeter Lobby	1,300	1,900	1,900	1,900	SF
Restrooms - Non-Secure Departures Level	4,200	4,300	4,400	5,000	SF
Restrooms - Non-Secure Arrivals Level	3,900	4,000	3,900	4,100	SF
Restrooms - Secure Locations	15,500	18,100	18,100	20,600	SF
Other Public Circulation	144,700	151,000	149,700	172,800	SF
Subtotal	356,700	371,700	369,700	422,600	SF

FEDERAL INSPECTION SERVICES

Design Capacity (passengers per hour)	400	600	600	600	
Primary Inspection:					kiosks
Global Entry Kiosks	2	2	2	2	kiosks
APC Kiosks	9	13	13	13	
CBP Officers for APC Verification & Triage	0	0	0	0	officers
Global Entry Officers	1	1	1	1	officers
APC Verification & Triage Officers	4	5	5	5	officers
Non-APC Inspection Officers	1	1	1	1	counters
Double Inspector Counters	4	6	6	6	SF
Counters, Kiosks, Queues and Exit Area	5,300	7,900	7,900	7,900	
					SF
CBP Command & Control Center (CCC)	225	225	225	225	SF
Public Restrooms	700	800	800	800	
Baggage Claim:					LF
Claim Frontage Required	175	265	265	265	LF
Average Claim Unit Size	180	180	180	180	units
Claim Units	1	2	2	2	LF
Claim Frontage Provided	180	360	360	360	SF
Claim Area	8,100	16,200	16,200	16,200	SF
Bag Trolley Area	600	900	900	900	SF
Exit Podium	180	180	180	180	SF
Exit Control Queue	1,000	1,400	1,400	1,400	
					SF
Unified Secondary Processing & Inspection	5,600	6,100	6,100	6,100	SF
CBP Secondary Operations & Support	2,100	2,100	2,100	2,100	SF
CBP Administration & Staff Offices	1,300	1,400	1,400	1,400	SF
CBP Support Spaces	3,300	3,400	3,400	3,400	SF
PHS/CDC offices	310	310	310	310	SF
FWS offices	0	0	0	0	
Transfer Baggage Re-check:					pos
Assisted Check-in Positions	1	2	2	2	LF
Counter Length	5	10	10	10	SF
Counter & Queuing Area	300	500	500	500	SF
FIS Circulation	2,700	4,500	4,500	4,500	SF
Subtotal	33,500	48,300	48,300	48,300	SF

OTHER AREAS

Airport Administration/Operations	79,000	79,000	79,400	92,300	SF
TSA Offices & Support	7,000	6,500	7,500	8,000	SF
Other (USPS, chapel, etc.)	1,100	1,100	1,100	1,100	SF
Loading Docks & Receiving	10,000	10,000	10,000	10,000	SF
Service Animal Relief Areas	700	700	700	700	SF
Non-Public Circulation	36,200	36,800	37,000	42,400	SF
Subtotal	134,000	134,100	135,700	154,500	SF
Total Functional Area	1,097,100	1,156,500	1,148,500	1,312,800	SF
Mechanical/Electrical/Utilities	164,600	173,500	172,300	196,900	SF
Janitorial/Storage/Shops	11,000	11,600	11,500	13,100	SF
Structure/non-net areas	38,200	40,200	40,000	45,700	SF
TOTAL TERMINAL GROSS AREA	**1,310,900**	**1,381,800**	**1,372,300**	**1,568,500**	**SF**
Gross Terminal Area per gate:	29,300	30,000	30,500	30,300	SF/NBEG

Source: Hirsh Associates, October 2020.

It should be noted that the terminal space program represents a starting point for terminal planning. It is generally considered a minimum program needed to support the design hour levels of passenger activity. As such, it generally does not refer to any specific terminal concept or gate configuration. When a final terminal concept is chosen, the gross terminal area may differ from the square foot total presented in the tables. For example, the amount of secure and non-secure circulation may vary from the program due to the terminal configuration and location of the security checkpoint, whereas the amount of airline space should be relatively independent of the concept selected.

GATE METRICS

Comparisons between airports, or between alternative concepts, are frequently made on the basis of passengers per gate, or terminal area per gate. But these lack a consistent definition of the term "gate". To standardize the definition of "gate" when evaluating aircraft utilization and requirements, Hirsh Associates developed a statistic referred to as a “NarrowBody Equivalent Gate” (NBEG). The characteristics of the NBEG are summarized in **Table 4.2-7**.

Table 4.2-7: Narrowbody Equivalent Gate Index

AIRPLANE DESIGN GROUP	MAXIMUM WINGSPAN	TYPICAL AIRCRAFT	NBEG INDEX
I - Small Regional	<49'	Metro	0.4
II - Medium Regional	<79'	SF340, CRJ	0.7
III - Narrowbody/Large Regional	**<118'**	**A320, B737, DHC8, E175**	**1.0**
IIIa - B757 (winglets)	<135'	B757	1.1
IV - Widebody	<171'	B767, MD11	1.4
V - Jumbo	<214'	B777, B787, A330, A350	1.8

Note:
NBEG = NarrowBody Equivalent Gate
Source: Hirsh Associates.

This statistic is used to normalize the apron frontage demand and capacity to that of a typical narrowbody aircraft gate. The amount of space each aircraft requires is based on the *maximum* wingspan of aircraft in its respective aircraft group. FAA Airplane Design Groups (ADG) used to define runway/taxiway dimensional criteria were used to classify the aircraft. The “ADG IIIa” ADG was created by the Consultant to more accurately reflect the Boeing 757, which has a wider wingspan than ADG III, but is substantially less than a typical ADG IV aircraft.

In developing terminal facilities requirements, the apron frontage of the terminal, as expressed in NBEG is a good determinant for some facilities, such as secure circulation. Different terminal concepts can also be more easily to be compared by normalizing different gate mixes.

The concept of Equivalent Aircraft (EQA) is similar to that of NBEG; it is a way to look at the capacity of a gate. EQA, however, normalizes each gate based on the seating capacity of the aircraft which can be accommodated, as depicted in **Table 4.2-8**. In order to have a relationship with the physical parameters associated with the NBEG, the basis of EQA is also an ADG III narrowbody jet. Most aircraft in this class typically have 140-150 seats. This establishes a basis of 1.0 EQA = 145 seats. More recently, larger ADG III aircraft with 160-180 seats have become more common, but the original seat basis was retained to maintain consistency with historic data and trends. As with the concept of NBEG, smaller aircraft may use a gate, but the EQA capacity is based on the aircraft seating configuration typically in use:

Table 4.2-8: Equivalent Aircraft Index

AIRPLANE DESIGN GROUP	TYPICAL SEATS	TYPICAL AIRCRAFT	EQA INDEX
I - Small Regional	25	Metro	0.2
II - Medium Regional	50	Saab 340, Bombardier CRJ 200	0.4
III - Large Regional	90	Bombardier CRJ 900, Embraer ERJ 175	0.6
III - Narrowbody	**145**	**Airbus A320, Boeing 737, McDonnell-Douglas MD80**	**1.0**
IIIa - B757 (winglets)	185	Boeing 757	1.3
IV - Widebody	280	Boeing 767, McDonnell-Douglas MD11	1.9
V - Jumbo	400	Boeing 777, Boeing 787, Airbus A330, Airbus A350	2.8

Note:

EQA = Equivalent Aircraft

Source: Hirsh Associates.

For STL, two adjustments were made to reflect the fleet mixes of the terminals:

- ADG I small turboprops used at Terminal 1 have 10 or fewer seats, thus the EQA was reduced to 0.1
- ADG III narrowbodies at Terminal 1 are averaging 160 seats, thus the EQA was increased to 1.1. For Terminal 2, Southwest Airlines is expected to standardize on a 175-seat fleet, thus the EQA was set at 1.2.

While most terminal facility requirements are a function of design hour passenger volumes, some airline facilities are more closely related to the capacity of the aircraft. Thus, the EQA capacity of the terminal can represent a better indicator of demand for these facilities.

In the following program analysis, design hour passengers, NBEG and EQA were used as appropriate to estimate the demand for terminal facilities.

AIRCRAFT GATES AND HOLDROOMS

The total number of gates needed to support forecast activity is a critical element in determining the overall size and configuration of the terminal complex. The methodology used for total gates is described in Section 4.2.2.

GATE MIX

All the usable gates at STL have PLBs, except for those used by ADG I commuter aircraft. As noted, the current demand is mostly for ADG III gates, either for mainline narrowbody (NB) aircraft or larger regional jets (RJ). There are also a significant number of smaller RJs using larger capacity gates, which are expected to remain in the fleet for the near- to mid-term. Gate A8 and A10 are planned to be re-striped as standard NB gates in the near future. Based on the annual aircraft mix forecasts, most domestic gates are expected to be ADG III in the future.

The Airport has a number of larger capacity (Boeing 757 and ADG V) gates. At Terminal 1, Gate A10 is marked for Boeing 757 and Gate A18 is marked for a Boeing 767; however, both Gates A18 and A10 holdrooms are undersized for these aircraft. Gates C28 and C30 are marked for ADG V aircraft and have holdrooms capable of supporting those aircraft. At Terminal 2, Gate E29 is marked for ADG V aircraft, but blocks Gate E31 when in use.

Terminal 2 has three ADG III gates capable of international arrivals: E29, 31 and 33. Gates E29 and 31 are the primary Federal Inspection Service (FIS) gates. A Letter of Understanding (LOU) between Southwest Airlines and the STLAA states that Gate E33 will be made available for international flights if needed.

International arrivals gates, however, will need to accommodate widebody aircraft on a regular basis in the near term if the Airport's air service development objectives are met. Based on aircraft design trends, these gates should be capable of handling ADG V wingspans. At present, when a widebody aircraft parks at Gate E29, Gate E31 is not usable. Both holdrooms at Gates E29 and E31 are needed to accommodate an ADG V aircraft passenger load. In that situation, Gate E33 is still available for international narrowbody aircraft. Based on discussions with the Airport, at least one widebody (ADG V) gate should be available in the future, but the ramp and PLBs should be configured to serve two ADG III aircraft most of the time. For continuity, all international gates are included in the Terminal 2 program table. During alternatives development, these gates (and related FIS facilities) may be located in Terminal 1, even if Terminal 2 remains in operation.

REMAIN OVERNIGHT AIRCRAFT PARKING

In addition to active gates, parking often needs to be provided for additional Remain Overnight (RON) aircraft.

- Current Terminal 1 RON demands, in aggregate, do not exceed the number of gates in use by aircraft size. However, some of the larger airlines (American Airlines, Delta Airlines and United Airlines) routinely have RON aircraft that exceed their leased gates. Other airlines also occasionally have excess RONs. Based on the 2019 design day, this amounts to 10 additional RON parking positions. There are more than adequate numbers of remote parking pads and unused concourse locations for these aircraft.
- Southwest Airlines rarely exceeds its leased gates for RONs. There is a remote parking pad northeast of Terminal 2 (4 positions) and unused gates along Concourse D.

HOLDROOMS

Holdrooms, or gate lounges, are based on the mix of gates and the average seating capacity of each class of aircraft. The holdroom area consists of the passenger seating/lounge area, the airline's ticket lift podium and circulation. The amount of seating/lounge area is dependent on the LOS the Airport wishes to provide.

The LOS is based on the aircraft load factor, the percentage of passengers seated vs. standing, and the average area per seated or standing passenger.

The current holdrooms vary in size and configuration by terminal. In Terminal 1, the holdrooms are approximately 25 feet deep along the concourses, with some deeper holdrooms at the end of Concourse A and at bends on both Concourses A and C. In Terminal 2, they are approximately 30 feet deep for the main line of E gates. The holdroom for Gate E29/31 is up to 50 feet deep but is reduced in places along the international arrivals sterile corridor. The former Concourse D gates (E34, 36, 38 and 40) have narrower holdrooms of approximately 23 feet in depth.

With the exception of the main Terminal 2 gates, the other holdrooms are not considered to have adequate depths to allow different types of boarding queues or seating configurations. It is recommended for programming that holdrooms have a minimum usable depth of 30 feet.

Typically, holdrooms are planned for 80 percent aircraft loads with 50-80 percent of passengers seated and the balance standing. This was considered LOS C to B, and typically assumes a large amount of secure concessions area where many passengers may wait. For STL, 80 percent of passengers seated is recommended. This net of 64 percent of aircraft capacity compares favorably to the more recent IATA ADRM recommendation of 50-70 percent of holdroom occupants seated[4]. With 80 percent of design passengers seated, the remaining 20 percent are assumed to be either standing or elsewhere in the terminal, such as seating in nearby concessions until the flight begins the boarding process. The planning objective is to provide space for the full aircraft load, to avoid passengers waiting or queuing in the corridors. When holdrooms are paired, such as at STL, the amount of seating and standing area is typically reduced by 10 percent, except in hubbing situations.

It should be noted, however, that both airline systemwide and peak hour load factors are exceeding 80 percent in the U.S. and some airport planners are considering using higher aircraft load factors. Discussions with Southwest Airlines indicate that they are using a 90 percent load factor combined with 80 percent seated for holdroom design. This higher load factor is considered appropriate for Terminal 2 and was incorporated into the terminal program.

A 240 sq. ft. (8-foot wide) boarding/deplaning corridor was added to the seating/standing area, which assumes an average 30-foot deep holdroom. The corridor effectively acts as an extension of the loading bridge door. Each ticket lift podium position is allocated 5 feet for width, although many airlines use 3-4-foot-wide positions. The depth of the podium and back wall is typically 8 feet, and a 15-foot-deep queuing area is provided.

The average assumed aircraft seating capacities and holdroom sizes are shown in **Table 4.2-9**. For Terminal 2, the ‘non-paired’ holdroom area was used due to the hub-like nature of Southwest Airlines’ operations.

4 Note that the ADRM does not specify the load factor to use, so the “percentage of seated occupants” may be interpreted differently.

Table 4.2-9: Holdroom Program Parameters

Aircraft Size		Small Commuter [1] LOS C	Medium RJ LOS C	Narrowbody LOS C	Narrowbody WN	ADG V LOS C
# of Seats on Design Aircraft		10	75	160	175	250
Load Factor		80%	80%	80%	90%	80%
# of Design Passengers		**8**	**60**	**128**	**158**	**200**
Percent Seated		80%	80%	80%	80%	80%
Percent Standing		20%	20%	20%	20%	20%
Seated Area/Passenger (sq. ft.)		15	15	15	15	15
Standing Area/Passenger (sq. ft.)		10	10	10	10	10
Seated & Standing Area (sq. ft.)		**110**	**840**	**1,790**	**2,210**	**2,800**
Podium Width/Position (ft)	5.0					
Depth of Podium to back wall (ft)	8					
Podium Queue Depth (ft)	15					
Additional circ behind podium	7					
Area per Podium Position (sq. ft.)	**150**					
Number of Podium Positions		1	1	2	2	2
Total Podium and Queue Area (sq. ft.)		**75**	**150**	**300**	**300**	**300**
Boarding/ Egress Corridor Width (ft)	8					
Depth of Holdroom (ft)	30					
Corridor Area per Bridge (sq. ft.)	**240**					
Number of Bridges		1	1	1	1	1
Boarding Corridor Area (sq. ft.)		**120**	**240**	**240**	**240**	**240**
Single Total Holdroom Area (sq. ft.)		**305**	**1,230**	**2,330**	**2,750**	**3,340**
Area per holdroom if paired						
% reduction in seating/standing area	10%	**295**	**1,150**	**2,150**	**2,530**	**3,060**

Notes:

1 Small commuter holdrooms are grouped and have limited numbers of simultaneous departures, resulting in shared podiums and smaller boarding/egress corridors.

WN = Southwest Airlines

Source: Hirsh Associates, October 2020.

The current amount of holdroom area in Terminal 1 meets the requirements for 33 active gates. This is somewhat deceptive, since the holdroom area includes oversized holdrooms for the commuter operations, and the holdroom for Gate A9, which is now part of the Gate A15 holdroom. A similar situation occurs with Gates A17 and A19. As noted, most of the holdrooms are also narrower than recommended. In Terminal 2, the total amount of holdroom area is undersized by approximately 15 percent. Much of the shortfall is for the four gates originally on Concourse D, but designated as Gates E34-40 since 2008. These gates have a depth of 25 feet between window wall and public corridor.

The programmed areas also include a line item for CBP Outbound Interview rooms of 100 sq.ft. per two international gates. Existing CBP interview rooms are located opposite Gate E29 on the east side of the public corridor. These are part of a larger CBP space that also includes some CBP support functions and has secure stairwell access to the lower level holding cells.

AIRLINE SPACE

Airline space includes both exclusive leased areas (for example offices and operations) and joint use space (such as baggage claims). The airlines serving STL were contacted to determine how well their facilities met current levels of activity.

The amount of exclusive leased areas is generally proportional to the amount done in-house. Airline personnel provide "below the wing" services for Southwest Airlines, American Airlines, Delta Airlines, Cape Air, and Air Choice One. All others use third party "below the wing" handlers. Each airline area is configured differently, and functions such that airline offices and operations are not easily distinguished in some cases. Recommended facilities for each function were developed separately.

AIRLINE TICKETING AND CHECK-IN (ATO COUNTER)

The Airline Ticketing Office (ATO) counter traditionally has consisted of staffed agent positions. As airlines provide more self-service kiosks, the definition and configuration of check-in function has, and will continue to change. In order to estimate future ATO requirements, staffed positions and kiosks were combined as Total Equivalent Check-in Positions (ECP).

Ticketing/check-in positions are typically based on the number of design hour enplaning passengers, the number of design hour departing flights, the number of airlines, the time distribution of passengers arriving at the terminal, and the percentage of passengers checking in at the ticket counter vs. curbside check-in, using a self-service kiosk or electronically prior to arriving at the terminal. Most of this information was not directly available for all airlines. A planning factor was developed that reflects these characteristics to the extent known, current ATO counter and kiosk utilization (not necessarily leased positions), and understood excesses and shortfalls.

At present, all ATO counters and kiosks are exclusive use, categorized as summarized in **Table 4.2-10**.

Table 4.2-10: Airline Ticketing Office Counter Categories

	TERMINAL 1	TERMINAL 2
Staffed counters in use	22	5
Dedicated bag drop counters	13	2
Multifunction kiosks in-line with the ATO counter	8	0
Multifunction kiosks located within the check-in queue	18	11
Kiosks for boarding pass printing only (no checked bags)	17	0
Vacant counter positions	5	0

Note:

Five vacant ATO counters on the west side of the ticket lobby in Terminal 2 were not counted, because their queuing area was taken by the SSCP and the related offices used by others. Thus, the counters are not usable.

Source: Hirsh Associates, October 2020.

Please note that the five vacant ATO counters on the west side of the ticket lobby in Terminal 2 were not counted, because their queuing area was taken by the SSCP and the related offices used by others. Thus, the counters are not usable.

Some of the airlines are providing bag tag printers at the kiosks to allow self-tagging. This trend, along with increased use of kiosks and other check-in options, is expected to continue.

From airline discussions, less than 30 percent of Terminal 1 passengers, and only 25 percent of Terminal 2 passengers, use full-service staffed counters. The balance use kiosks or other self-service check-in options. The use of internet check-in, combined with self-tagging, has also increased in the past year, as some carriers increased the capability of kiosks. Based on industry trends, the percentage of kiosk use is expected to increase in the medium-term future to between 55 and 60 percent. This also requires an increase in bag drop counter positions.

The number of forecast ECPs was converted to conventional linear positions to establish the length of the ATO counter. Locations for kiosks are a combination of airline preference and the physical constraints of the ticket lobby. For STL, it was assumed that future kiosks and bag drop positions would be located in-line with the staffed counters at a similar ratio as today.

Most domestic carriers can use a 6-foot double counter plus a shared 30-inch bag well for an average of 4.25 feet per agent. Similar configurations are typically used for bag drops. There are also breaks in the ATO counter to allow personnel access to individual ATO office areas, and end counters typically without bag wells. This increases the average ATO counter length for planning to typically 5.5 linear feet (LF) per position.

In both Terminal 1 and Terminal 2, the ATO counter length per position is significantly greater than typical. This is due to a combination of older-style counter configurations and the removal of staffed counters within leased counter lines. The result is an average of over 8 LF per linear position in Terminal 1 and over 15 LF per position in Terminal 2. These ratios were reduced slightly for planning to recognize the constraints of the terminals and the evolving uses of the ATO counters.

The ATO counter depth is typically 10 feet from face of counter to back wall for domestic terminals to provide space for the counter, agent workspace, and a baggage conveyor parallel to the counter. This is the condition in Terminal 2. The existing counter depths average approximately 13 feet in Terminal 1 due to differences in counter module designs. Existing depths were assumed for programming.

AIRLINE OFFICES

Airline Offices include the ATO offices and other airline administrative spaces. At STL, like most airports, the ATO offices are located immediately behind, or adjacent to the ATO counter to provide support functions for the customer service agents. Typically, these are 30-35 feet deep along the length of the counter. At STL, these vary from 13-23 feet deep (Terminal 1) plus a narrow circulation corridor, to 28 feet deep (Terminal 2). Other offices may include functions such as the airline station manager. The amount of these offices and location (ATO, operations area, office location on a terminal concourse, etc.) is dependent on individual airline requirements and preferences, and space availability.

Discussions indicate that offices in the ATO area and elsewhere are undersized for many carriers. For planning purposes, the current ratio of offices per linear foot of ATO counter was increased.

AIRLINE OPERATIONS

Airline operations include all the support spaces for aircraft servicing, and aircraft crew related support spaces. The demand for airline operations areas is a function of the size and types of aircraft being operated and individual airline operating policies. Because many airlines do not identify their specific space requirements at this stage of planning and future airlines cannot be identified, a program area for operations is typically based on the number/size of gates (expressed as EQA) and airlines at an airport. There are also third-party ground handlers providing 'below the wing' services for some carriers. These ground handlers have consolidated support facilities outside of the terminal.

Discussions indicate that airline operations spaces are adequate for many carriers, but that some of these areas need to be reconfigured for better functionality. For planning purposes, the current ratios of operations spaces per EQA were increased.

AIRLINE CLUBS AND LOUNGES

Airlines typically provide membership clubs based on their level of activity at an airport, the number of club members living in or regularly traveling to the airport area and other marketing considerations.

Of the airlines serving STL, only American Airlines has a club at STL. It is considered adequate for 2019 activity. A non-airline membership club - Wingtips - is located in Terminal 2 to serve Southwest Airlines' passengers (and international carriers when they operated). The club is of adequate size for 2019 levels of activity. Club space demand is projected to increase slowly over time in proportion to annual activity levels. Current discussions with the carriers did not indicate the need for additional club locations. However, in the recent past, one airline expressed interest in a club. For programming, a new 4,000 sq. ft. club was added beginning in 2025.

BAGGAGE SERVICE OFFICES

Baggage service offices (BSOs) are typically required by airlines with sufficient activity to warrant staffing, and the four larger carriers (American Airlines, Delta Airlines, United Airlines and Southwest Airlines) have BSOs. Other airlines' late bags are presently stored in the ATO offices, which is inconvenient, but do not have sufficient activity to warrant a separate BSO. A small increase in the current ratios of BSO space was assumed to address existing shortfalls and provide storage/lock-up space for smaller airlines.

BAGGAGE MAKE-UP

Baggage make-up includes the make-up units or conveyors, the cart loading areas and baggage tug/cart (baggage train) maneuvering. The checked baggage inspection and outbound baggage systems are operated and maintained by an Airport contractor (Vanderlande). While the system is common use, each airline (or ground service provider) has its own assigned make-up units. There are five sloped bed make-up units in Terminal 1, and two units in Terminal 2. The capacities range from 8 to approximately 12 staged carts in Terminal 1 and 10 to 16 staged carts in Terminal 2. All of the make-up units allow for bag carts to be staged parallel to the make-up units. All are separated far enough to allow bag trains to bypass the units.

Baggage cart staging demand is a function of aircraft size (seat capacity) and the number of hours a flight is in the make-up process (typically 2 hours for a domestic flight). This has usually resulted in a demand for one cart per 50 aircraft seats, or 3-4 carts for a narrowbody flight. Not all of these carts are staged simultaneously, with filled carts being moved to a holding area or the gate area while empty carts are moved to the make-up unit. With the increased baggage fees and lower percentages of passengers with checked bags, the total number of bag carts has been declining for many airlines. Based on modeling of the make-up process at other domestic airports and applying this to the 2019 base schedules, a planning factor of 2.7 staged carts per EQA was assumed for Terminal 1, and 2.5 carts per EQA for Terminal 2.

The make-up area is dependent on the configuration of the make-up units. The Terminal 1 make-up units have some excess area as compared to typical configurations, while Terminal 2 is undersized with one unit only allowing staging on one side. Planning factors were adjusted to more typical values.

CHECKED BAGGAGE SCREENING

As a result of the Aviation and Transportation Security Act, all checked baggage is subject to screening for explosives. The Airport has a fully automated, in-line Checked Baggage Inspection System (CBIS) for screening and sorting outbound bags. The screening matrices in each terminal have three CTX-9800 Explosive Detection Systems (EDS) units. The rated capacity of each EDS unit was 740 bags/hour. Two of the EDS units were needed by design to meet the expected throughput requirements, while the third unit is a spare. In reality, all three units are running most of the time.

Bags that alarm in the EDS units (Level 1) are subject to on-screen resolution (Level 2) while within the baggage system. If a TSA screener cannot determine if the bag can be cleared, the bag is diverted to the Checked Bag Resolution Area (CBRA) where screeners using images from the EDS open the bag and check its contents with Explosives Trace Detection (ETD) (Level 3). There are 5 CBRA inspection tables in each terminal. Cleared bags are then re-inducted into the baggage system toward the make-up units. Oversized bags (either manually identified or measured by the CBIS as too long for the EDS units are sent directly to the CBRA for manual inspection.

It is reported that during peak conditions, certain portions of the sorting/screening system can become overloaded causing back-ups on the conveyors ("dieback") from some ATO counters in both terminals. This is reportedly due to a combination of exceeding Level 2/3 screening capacity and the configurations of the sortation systems.

Based on discussions with the airlines, an average of 0.6 checked bags per passenger is estimated during the peak months. Each EDS unit (CTX 9800) has a rated capacity to process 740 bags/hour but may not be achieving this due to other baggage system issues. According to TSA, the original design assumed a lower EDS throughput rate (600 bags/hour). This lower rate was used for planning, but three units (two active plus a spare) in each terminal would meet the projected forecast levels of activity for separated terminals. A consolidated terminal would need less than the combined demands of Terminal 1 and Terminal 2, due to the degree of overlap of the peak enplaning hours. The area per EDS unit would need to be increased to provide space to correct the noted sortation system issues.

BAGGAGE CLAIM OFF-LOAD

Baggage off-load includes: the portion of a flat plate, direct feed claim unit upon which the bags are placed, or the input conveyor for a sloped bed claim unit, the adjacent baggage train lane and work area, and a by-pass lane for baggage trains. A 75-foot off-load zone was assumed to allow a four-cart baggage train to be unloaded.

Terminal 1 has a very large area for baggage unloading, while Terminal 2 is much more constrained. International bag claim off-loading in Terminal 2 is in an exterior location.

BAGGAGE TRAIN CIRCULATION

A percentage of baggage handling space for baggage train circulation around and between the bag make-up and off-load areas is included for planning. Terminal 1 has a significant amount of circulation space with (mostly two-way) drive lanes between most of the make-up units, and extra by-pass lanes for the bag claim off-load conveyors. In contrast, Terminal 2 has no additional circulation.

Ten percent of baggage handling space is a typical planning factor, but for STL, 15 percent was used. This assumes that future terminal concepts incorporating Terminal 1 will require relatively less circulation, while expanding Terminal 2 should add circulation to improve operational efficiency. The final configuration of the terminals may require more or less space.

RAMP CONTROL TOWER

There is no ramp control tower at present. All aircraft pushbacks are coordinated by airline staff, as these occur in non-movement areas. ATCT staff coordinates pushbacks onto Taxilane C (Taxilane C is a taxilane from Charlie Pad east to Hotel Pad). An allowance was included for a small ramp control tower. The final size and location(s) would be determined when the concept is finalized.

AIRLINE SYSTEMS

An allowance of 5 percent of airline operations area was included in the terminal program to accommodate airline systems that may not be considered in the terminal's mechanical/electrical area estimates. These systems typically include computer and communications rooms, which have increased in size and complexity as more airline functions are automated. The allowance is not intended to cover large, centralized ground power motor/generators, or centralized pre-conditioned air systems.

DOMESTIC BAGGAGE CLAIM

There are eight sloped bed baggage claim units - six in Terminal 1 and two in Terminal 2.

- The claim units in Terminal 1 are arrayed in three pods, each containing two units. Public hallways separate each pod. Each claim unit have approximately 155 LF of claim frontage (i.e., where passengers can access the bags). The separation between the claim units within each pod is 24 feet, which is less than recommended (minimum of 30 feet, with a minimum of columns). The distance between the long sides of the claim units to the "positive claim" railings is approximately 20 feet in most places and is reduced in places by bag trolley racks. However, at the shorter ends of the claim units, there is only 10 feet to the railings, and less than 7 feet to the BSOs. This is considerably less than the 15-foot minimum recommendation. Although there is a large amount of bag claim area, especially if the hallways between the railings are included, the area does not meet recommended circulation standards. This is also partially due to the wide configuration of the claim units.
- The claims in Terminal 2 each have approximately 180 LF of claim frontage. The separation between the two units is approximately 29 feet. The distance between the long sides of the claim units to the "positive claim" railing or back wall is approximately 15-16 feet, but is reduced along the railing by bag trolley racks. Walls within the claim units (housing the feed conveyors) reduce visibility of bags on the claim units more than typically with sloped bed units.

Baggage claim requirements are based primarily on design hour deplaned passengers, the concentration of these arriving passengers within a 20-minute time period, and, to a lesser extent, checked bag per passenger ratios. Observations at most U.S. airports indicate that the majority of domestic passengers arrive at the baggage claim area before their bags are unloaded onto the claim units. At an airport such as STL, virtually 100 percent of the passengers are expected to be waiting prior to first bag delivery. The result is that the claim unit should be sized for the estimated number of passengers waiting for baggage, because most bags are claimed on the first revolution of the claim unit.

Based on current schedules, the peak 20 minutes represents 50 percent of the design hour activity. This is a fairly typical arrivals concentration at spoke airports, and also reflects the typically spread-out nature of Southwest Airlines arrival banks. The percentage of passengers who have checked baggage is estimated at 50 percent during the peak hours for Terminal 1, and 60 percent for Terminal 2. The terminal program demands are based on common use claim units.

The existing bag claim sizes are considered adequate for larger narrowbody aircraft, or multiple smaller flights. The baggage claim area is recommended to be 40 sq. ft. per foot of frontage to provide adequate queuing and circulation space with sloped bed claim units in typical configurations. A 30-foot separation between adjacent claim units is recommended.

An allowance for oversized baggage delivery was included. This would be for oversized baggage slides of adequate size for skis and other large checked items. There are two conveyors to deliver oversized baggage in Terminal 1, and only a small conveyor in Terminal 2, which is accessed by airline staff.

CONCESSIONS

Terminal concessions include all of the commercial, revenue-producing functions that serve the traveling public, and some services that may not directly produce revenue. Preliminary concessions programming in Tables 4.2-1 through 4.2.3 are mostly based on factors of square feet per 1,000 annual enplanements, which were adjusted to reflect understood conditions and discussions with the major concession operators.

Based on these planning factors, Terminal 1 has adequate secure-side concessions but the distribution between the concourses may not be ideal. Non-secure concessions are in excess of likely demand. Terminal 2 is the opposite, with significant area shortfalls for both secure and non-secure side concessions. More detailed concessions studies would be needed to define the best mix of concessions for each terminal.

GROUND SERVICES/INFORMATION COUNTERS

There are information counters on the arrivals level of both terminals staffed by volunteers. New terminal processors are assumed to have similar counters.

Rental car companies (RAC) have counters and offices in Terminal 1. However, these counters are not staffed, and are planned to be removed in January 2021. Signage on the counters directs customers to the RAC curb for pickup. Phones are located on the RAC counters for late night arrivals and those passengers without reservations. There are no RAC counters in Terminal 2 and customer pick-ups are arranged by telephone. It was assumed that RAC counters would not be provided in any terminal in the future.

FOOD AND BEVERAGE SERVICES

Food and beverage (F&B) concessions consist of a variety of sit-down and take-away locations. In Terminal 1, almost 60 percent of the F&B area is in the secure portion of the terminal.

In Terminal 2, all of the F&B is within the secure area, with the exception of a Starbucks.

In both terminals, approximately 90 percent of the food/beverage and retail concessions should be located inside security, which is desirable by most passengers. The planning ratio (in terms of square feet per

1,000 annual enplanements) has resulted in a decrease in F&B concessions demand in Terminal 1 for the base year, and an increase for Terminal 2. This is consistent with discussions held with the major F&B concessionaires.

Military trainee classes going to Fort Leonard Wood assemble in Terminal 1, where it is common to have 100 trainees on the non-secure side waiting for the final members to arrive and then all embark to the fort. This does increase the demand for non-secure concessions, especially F&B, but the 10% should be adequate (when combined with USO) to meet these demands if located properly.

NEWS/GIFT/SPECIALTY RETAIL

This category includes news, gift, retail, and specialty shops. A similar approach to developing a planning factor as F&B was used. It is also recommended that 90 percent of retail space be located within the secure area.

DUTY FREE RETAIL

Duty Free retail is available to departing passengers on international flights. There is no duty-free retail space in either terminal at present. This is understandable, since international service is currently limited to Caribbean destinations and U.S. citizens would not typically buy duty free goods when leaving on vacation.

If additional international service is added as expected by the Airport, non-U.S. passengers may provide a small market for duty free. A small area for duty free retail was included in the terminal program, but the demand would be highly dependent on the types of international service. This was assigned to Terminal 2, as the tentative location of additional international gates.

OTHER SERVICES

This category usually includes ATMs, vending, arcades, and other services. These were not readily identified from the terminal plans. A typical planning ratio was used.

UNITED SERVICES ORGANIZATION

The United Services Organization (USO) operates lounges in the arrivals area of both terminals, to provide hospitality for traveling service members and their families. Because of the large joint military training base at Fort Leonard Wood, large numbers of service members travel through STL every week. During the Christmas/New Year holiday, the base closes and "Green Day" occurs. During a 24-hour timespan, 5,000 to 6,000 personnel will pass through STL in a well-choreographed logistics exercise.

The 7,000 sq. ft. Terminal 1 USO facility has an effective capacity of approximately 190 people. On busy days, the demand exceeds this capacity and the USO staff see service members look in and then go elsewhere. Support spaces within the lounge (baggage storage, food storage, etc.) are reported to be adequate. A smaller USO lounge is located in Terminal 2 (approximately 700 sq. ft.). This is reported to be adequate for the people using it, since ground transportation to and from Fort Leonard Wood is handled from the Terminal 1 location.

A small increase in area for current conditions was added to Terminal 1. The areas in both terminals are projected to increase in proportion to design hour enplaned passengers.

CONCESSION SUPPORT

Concession support consists of storage areas, preparation kitchens, employee lockers and administrative offices. For the terminal program, 25 percent of the customer-serving areas was assumed to be used for concession support. It should be noted that the major concessionaires have warehouse/receiving buildings elsewhere on and off-Airport.

In Terminal 2, there is a need to install a large capacity service elevator from the support areas located at the east end of the Concourse E lower level to the concourse/gate level.

PUBLIC SPACES

Public spaces include most of the non-revenue producing areas of the terminal, including queuing areas, seating and waiting areas, restrooms, and circulation. Some of the public space elements are directly related to design hour passenger volumes, whereas others are functions of other facility requirements.

TICKET LOBBY

The ticket lobby includes ATO counter queuing area, self-service kiosks, and cross circulation:

- In Terminal 1, there two ticket lobby arrangements. At the ends, where United Airlines faces Frontier Airlines and Air Canada, and American Airlines faces smaller carriers, the separation is approximately 48-49 feet. At the far west end, the counters of Air Canada are only separated from the stairwell by 18 feet. The central counters (Delta Airlines and others) have approximately 53 feet from the face of the counter to the public seating area.
- In Terminal 2, there is approximately 48 feet from the ATO counter to the window wall and entry vestibules.

The minimum dimension from the face of the ticket counter to any obstruction to cross circulation in a conventional linear counter arrangement should be 45-50 feet for airports with traffic similar to STL. This provides 25-30 feet for queuing and kiosks and 20 feet for cross circulation, for a total of 45-50 feet. Terminal 2 falls just short of this, since the vestibule door sensor area should be out of the circulation zone.

In the case of opposing ATO counter configurations (Terminal 1 end counters), the distance between counters is recommended to be 70-80 feet, to provide the queuing for each set of counters and a 20-foot central circulation zone. Terminal 2 falls far short of this recommendation.

A 50-foot-deep ticket lobby for all airlines was assumed for programming purposes, which would provide flexibility for future alternative configurations.

SECURITY SCREENING CHECKPOINT

With the changes in security inspection procedures and equipment, processing rates have varied at most airports. The TSA has also continued to mandate new security screening equipment and checkpoint (SSCP) configurations. A SSCP lane is defined as the checked baggage X-ray and its associated divest tables and composure (pick-up) conveyors/rollers. A lane usually shares the passenger screening equipment with an adjacent lane.

- Terminal 1 has two SSCP locations. The checkpoint for Concourse A has four lanes, and the checkpoint for Concourse C has 7 lanes. This imbalance is due to previous passenger loads on the various concourses. There is no secure passenger path between the concourses to allow potential balancing of demands.

- The Terminal 2 SSCP is split into two sections, with 4 and 3 lanes. The smaller section is used by TSA Pre-check and Clear registered passengers.

The carry-on baggage X-rays have varying configurations in terms of the length of divest tables and composure (pick-up) conveyors/rollers. Lanes with shorter composure rollers can cause delays for the X-ray if bags and bins are not cleared out by passengers. The lanes for regular passenger screening have Advanced Imaging Technology (AIT) body scanners, which are slower than Walk Through Metal Detectors (WTMDs):

- Checkpoint A has one AIT
- Checkpoint C has two AITs
- Checkpoint E has one AIT

However, the limiting factor for processing rates is often the baggage X-ray. TSA has recently installed four CTX-type hand baggage screening lanes (1 at Checkpoint A and 3 at Checkpoint C). While these provide significantly better images to the TSA officers, throughput is currently slower than conventional bag X-ray units. Throughput rates are expected to improve and eventually equal the rate of conventional X-ray screening units.

Throughput rates measured by TSA in STL are normally (prior to 2020) 150 passengers/hour/lane for regular lanes, which are similar to those observed at other airports in recent years. Throughput rates for Pre-Check lanes were significantly higher (approximately 240 passengers/hour/lane). TSA reports that Pre-Check passengers range from 27 percent (Terminal 1) to 37 percent (Terminal 2), but the number of Pre-Check users is highly variable by time of day and flight. For terminal planning, all lanes were assumed to have the capacity of regular screening lanes. During design hours, a 10-minute wait time was assumed, but the queue area was sized to accommodate a 20-minute queue. Because Terminal 1 has separate SSCPs, an 'inefficiency' factor of 20 percent was added to increase the total number of lanes as compared to a single SSCP location. Terminal 2 is considered to have a single SSCP location. For a single terminal option, a single SSCP location is also assumed for efficiency.

The terminal program area includes the actual SSCP equipment, divesting/bag repacking areas and TSA support space required at the checkpoint. This can vary by equipment configuration. Current TSA configurations require up to 60 feet by 30 feet wide (per pair of lanes) for the equipment, plus additional space for document checking, trace detection, and passengers to re-pack their carry-ons. The terminal program assumes an 85-foot-deep zone to accommodate all these functions. Additional area for TSA support at the SSCP (5 percent) was included.

SECURE CIRCULATION

Secure circulation typically consists of the central corridor of the concourses and adjacent egress stairs. Existing corridor widths differ by terminal:

- The Terminal 1 corridor widths vary. In Concourse A, most of the corridor is approximately 25 feet wide. However, where some concessions have expanded into the corridor, the corridor width narrows to 18 feet.

- Concourse C has more variability. Most of the initial section (to Gate C9) is 20-22 feet wide, narrowing down to 18 feet where some concessions expanded into the corridor. The corridor is then mostly 25 feet wide until Gate C17, where it widens to 31 feet. After Gate C24, the corridor is 33 feet wide with moving walkways in the center.
- The Terminal 2 corridors also vary considerably in width. The main section of the corridor between Gates E12 and E18 is mostly 32 feet wide, with some concession seating along one wall. The corridor tapers to the east, narrowing to as little as 8 feet near Gate E6 and the adjacent concession. The corridor also tapers to the west in a similar manner. The corridors serving Gates E29 to E40 are mostly less than 20 feet wide, except for the long connector to the former Concourse D gates, which has a 30-foot-wide corridor with moving walkways along one side.

Terminal planning practice would recommend a 30-foot-wide clear corridor for double-loaded concourses without moving walkways, 45 feet with moving walkways and between 20-25 feet for a single-loaded corridor, depending on whether there are significant uses across from the holdrooms and the number of gates. Ancillary uses would be located outside of these corridors. For the main section of Terminal 2 where there are significant passenger movements in both directions, at least 30 feet should be provided, even though it is a single-loaded concourse. Both of the terminals' corridors can be considered to be under-sized.

The terminal program area is based on an area per equivalent concourse length determined by gates expressed as NBEG. The actual amount of secure circulation required will depend on the terminal configuration. For terminal programming, it was assumed that Terminal 1 would continue to have short double-loaded concourses. Terminal 2 is assumed to have single-loaded concourses, but with the full 30-foot width to accommodate hubbing activity and concessions.

A future single terminal may have many configurations. For programming purposes, it is assumed to have double-loaded concourses, but of a sufficient length to require moving walkways.

STERILE INTERNATIONAL ARRIVALS CIRCULATION

Arriving international passengers must be kept separate from other passengers, visitors or unauthorized airline employees until they have cleared all FIS inspections. This requires a separate corridor system from the aircraft gate to primary inspection. Terminal 2 has three international arrivals gates (E29, E31 and E33), which access an 8-10-foot-wide sterile corridor system.

Sterile corridors should be sized for single direction passenger flow, typically 10-15 feet wide depending on whether a moving walkway is required. Because departing passengers can use the same gates as international arrivals, control doors and monitoring of the corridor system is required to prevent mixing of arriving and departing passengers.

At this point in the planning process, it is assumed that international gates would be single-loaded, or on one side of a double-loaded concourse. The program area allowance assumes that the gates and FIS will be in reasonable proximity with each other, and that moving walkways would not be required.

PUBLIC SEATING

Public seating areas include general waiting areas near the ticket lobby, domestic baggage claim areas and concessions. These are typically in non-secure areas of the terminal. The bulk of the seating/waiting area would be located to provide an area for domestic meeters/greeters outside of security or near the baggage claim.

Airports typically provide seating for a portion of the design hour total passengers and their visitors. Due to security restrictions, the number of well-wishers at most airports have declined dramatically, and these ratios are estimated to be low. For terminal programming, it was assumed that non-secure seating would be provided for 10 percent of design hour total passengers, the well-wishers for the enplaning passengers, and the meeters/greeters of deplaning domestic design hour passengers.

A separate estimate was made for the international meeters/greeter lobby, which would be located at the exit from the FIS and sized for all the greeters of the design hour terminating international passengers.

RESTROOMS

Restrooms should have at least as many toilets for women as toilets and/or urinals (fixtures) for men. Newer building codes in some cities require 25-50 percent more fixtures for women than for men in buildings such as terminals. This is consistent with methodologies presented in ACRP publications[5] when a 50 percent male/50 percent female gender split is assumed.

Restroom locations at STL vary significantly in the numbers of fixtures and the ratios of male and female fixtures:

Terminal 1:

- Ticketing has only two small restrooms with equal numbers of fixtures.
- Non-secure areas before the SSCP have very large restrooms, but there are 50 percent more fixtures for men than women in the largest two locations, and an equal number in the smallest location.
- Concourse A has three relatively small restroom locations, with mostly more fixtures for men than women.
- Concourse C, having been built for a hub and to more recent standards, has four locations within the active gate section. All have more fixtures for women than men, with two locations having twice as many fixtures for women.

Terminal 2:

- Ticketing and bag claim each have a small restroom with mostly equal or slightly fewer fixtures for women.
- Concourse E has four restroom locations. The largest pair of restrooms in the central section of the terminal have twice as many fixtures for women than men. The smaller restrooms have equal numbers of fixtures.

Terminal 1 restrooms are generally more in need of expansion to meet recommended gender fixture ratios, but both terminals have locations where improvements should be made.

5 Airport Cooperative Research Program, Report 130, Guidebook for Airport Terminal Restroom Planning and Design.

The program area was divided between the main terminal locations (departures and arrivals levels) and the secure concourse area. The terminal factor is based on design hour passengers and their estimated visitors. The minimum number of toilets and/or urinals is recommended to be 10 for men and 12 for women in the secure locations. Because the main demand on secure restrooms is for arriving passengers, it is recommended that these be located to be convenient for passengers proceeding from gate to baggage claim. The planning factor is based on a restroom with 12 men's and 16 women's fixtures for every 8 EQA.

In addition to handicapped access toilets, sinks and urinals, it is recommended in transportation facilities such as airports that companion care restrooms be provided. These unisex restrooms allow an elderly or disabled person to be accompanied into a restroom by another person who assists the disabled person. Most of the STL restroom locations have a companion care restroom. The program restroom area includes a companion care restroom for each restroom module.

GENERAL PUBLIC CIRCULATION

Other public circulation includes the corridors, vertical circulation elements, and other architectural spaces which tie the public functional elements of the terminal together. Terminal 1 has a relatively high percentage of public circulation, while Terminal 2 has a minimal amount of public circulation.

The program area is based on a percentage of these functional areas: ticket lobby, domestic baggage claim, baggage service offices, holdrooms, concessions (excluding concession support area), airline clubs, and other public areas. For Terminal 1, 35 percent was used to reflect certain elements that would be expected to remain. For Terminal 2 and a single terminal, a more typical 30 percent was used.

The percentage is a first approximation and will also vary with the terminal configuration. The split between secure and non-secure (public) circulation is also a function of the terminal concept, however, in the table, the public circulation allowance was included as non-secure circulation.

FEDERAL INSPECTION SERVICES

Federal Inspection Services (FIS) facilities are required at all airports with international flights. The exception are most flights from Canada and a limited number of other airports with U.S. pre-clearance facilities. These passengers are treated the same as domestic arrivals. In Terminal 1, Air Canada's flights are pre-cleared and do not use the FIS.

The Customs and Border Protection (CBP) inspection process flow has changed, and continues to evolve, since the FIS in Terminal 2 was built. Thus, one challenge for FIS planning is to accommodate the current process flow while maintaining flexibility for future changes. The most recent revision of the *Airport Technical Design Standard - November 2017 (ATDS)* also introduced a different process flow: "baggage first". The STL FIS follows the "traditional" inspection flow.

CBP procedures require that all passengers be processed through the primary inspection counters. Self-service kiosks (Global Entry and Automated Passport Control or APCs), where available, can speed up the Primary Inspection process. Other secondary inspection, passenger and/or baggage, is based on more selective procedures, using computer-based lists of passengers, roving agents, designations of high-risk and low-risk flights, and other selection techniques. A "unified secondary inspection area", which incorporates both secondary passenger and baggage inspection, is typically located after baggage claim.

In the "traditional flow", such as at STL, kiosks and primary inspection counters are located first, followed by baggage claim and then the unified secondary inspection area. In the new "baggage first" flow, the kiosks are followed by baggage claim and then the primary inspection counters and unified secondary. It is understood that CBP is recommending the "baggage first" flow where possible. For the purposes of the terminal program and to be consistent with existing conditions, the "traditional flow" will be described. If a new, or expanded FIS is built, changing the inspection process flow will be considered. The areas involved are not expected to be significantly different.

The inspection process and passenger flow in the STL FIS is as follows:

- Passengers who are eligible for APCs or Global Entry kiosks can use these
- Primary inspection booths for all passengers
- Baggage claim
- Secondary inspection tables for baggage and interview areas for document related issues
- FIS exit control for passengers not requiring further inspection

PRIMARY INSPECTION

The current primary inspection process flow relies more heavily on different types of automation to accommodate higher passenger volumes with fewer CBP officers. The basic primary inspection process is as follows:

U.S. Citizens (USC), Legal Permanent Residents (LPR), and Canadian Citizens (CAN) can use automated processes:

- Global Entry (GE) kiosks: after using the kiosks, these passengers pass by an officer for verification of their receipt.
- Mobile Passport Control (MPC): these passengers use an app on a mobile phone to enter data prior to arriving at the FIS, then proceed to a CBP officer.
- Automated Passport Control (APC) kiosks: these passengers use a kiosk to enter data and have their photo taken for the receipt. Visitors to the U.S. with some types of passports (Canadian citizens, B1/B2/Visa Waiver Program) can also use the APC kiosks. Most APC users can go to an officer for verification of their electronic or printed receipt. The remaining passengers are directed to a triage officer to take care of issues that the automated systems flag.

STL has two Global Entry kiosks and CBP estimates that approximately 5 percent of passengers use GE. There are no APC kiosks, nor is MPC available at present. It was assumed that APC and MPC will become available with any expansion of the FIS. Because there is no data on APC/MPC usage, assumptions were made based on other airports with small FISs. A maximum wait time of 10 minutes was assumed for APC kiosks, with 0 wait time for Global Entry.

INTERNATIONAL BAGGAGE CLAIM

After primary inspection, passengers proceed to baggage claim, or directly to Exit Control if they do not have checked bags. The FIS has a single sloped bed claim unit with approximately 150 LF of claim frontage. This is suitable for single arrivals of most narrowbody aircraft. However, Frontier Airlines was operating higher capacity (230-seat Airbus 321) aircraft, which strained the capacity of the claim unit. In the near- to mid-term, larger 180 LF claim units are recommended to accommodate higher capacity narrowbody and wide-body aircraft.

SECONDARY INSPECTION

After baggage claim, passengers enter a queue for Exit Control. Based on notations on their primary inspection receipt, passengers either exit the FIS or are directed to secondary inspection. If a "baggage first" inspection flow is implemented, Exit Control is not required.

CBP uses a Unified Secondary where all passport and baggage inspection occurs. Secondary inspection has:

- A waiting area and interview rooms for passport related issues
- Agriculture inspection X-ray and counter for bags from originations that may contain food and other prohibited plant or animal products
- Customs inspection counter, X-ray and search rooms for inspection of bags for other items

Passengers connecting to domestic flights would re-check their bags after exiting the FIS. Typically, this occurs at a counter outside the FIS. Connecting passenger volumes are low at present, and a re-check counter is not provided. Connecting passengers must go to their domestic airline (in Terminal 1 or Terminal 2) and check their bags as originating passengers. To improve passenger service, a recheck counter was included in the terminal program.

CBP ADMINISTRATIVE AND SUPPORT AREAS

The total amount of space, as specified in the ATDS, is based on the rated capacity of the FIS. The CBP administrative and support spaces should be located within the sterile perimeter and be accessible from the primary and secondary processing areas.

Other government agencies may have offices within the FIS. These include Public Health Services/Centers for Disease Control (PHS/CDC), U.S. Fish & Wildlife Service (FWS), and Immigration & Customs Enforcement (ICE). PHS/CDC currently have an office at STL. USFWS is under contract to the Airport for wildlife control services. The agency has two full-time staff plus two pick-up trucks. FWS is presently using spare offices at the Auto Shop, but should be in separate facilities.

Other agencies may require offices in the future, but these would be relatively small (typically 100-150 sq. ft. each). These were not included in the terminal program at this time.

FIS CIRCULATION

FIS circulation is based on 15 percent of the inspection and baggage claim areas. Circulation within the administrative and support areas is included in those sub-totals. The actual amount of circulation would depend on the configuration of the FIS.

As noted above, CBP processes and procedures have been continually evolving, and official facilities guidance has lagged what is observed in the field. Estimating future FIS facilities requirements is thus more subject to variability than other passenger processes. The gross area of the FIS in the program table should be considered a general area for master planning, with less focus on the specifics (other than baggage claim) than other portions of the terminal program.

OTHER AREAS

AIRPORT ADMINISTRATION/OPERATIONS OFFICES

The Airport has administrative offices on the upper and lower levels of Terminal 1, as well as in a separate Airport Office Building. Terminal operations offices are in other locations, scattered throughout the apron level of both terminals. Many other maintenance and operations functions are located outside of the terminal. Section 4.7 describes in more detail these locations and functions.

As noted in Section 4.7, an expanded, combined Operations Control Center (OCC) and Emergency Operations Center (EOC) is under design, to be located in the former HMS Host support space on the apron level of Terminal 1. This was included in the existing area, since HMS Host returned the space to the Airport.

Existing offices include a mix of administration/operations required for terminal operations and some other functions which do not necessarily have to be in the terminal. The existing areas were increased as described in Section 4.7 but should be evaluated further by STL to determine the best use of terminal spaces.

TRANSPORTATION SECURITY ADMINISTRATION OFFICES

In addition to the passenger and baggage screening equipment and adjacent search areas, the Transportation Security Administration (TSA) occupies space for some supervisor's offices, training, agent break rooms, and storage. These are presently located in multiple locations in Terminal 1, Terminal 2 and on the upper level of Concourse C.

The terminal program for TSA space is limited to that needed to support the SSCP and checked baggage screening operations, and is based on the number of SSCP lanes and EDS units. Other TSA administrative spaces are assumed to continue to be located in lower cost, off-airport office buildings

LOADING DOCKS AND RECEIVING

A terminal should have a loading dock and receiving area to allow deliveries from the public roadway system, as well as removal of trash generated by terminal users. The TSA requires screening of deliveries for secure side concessions before these are moved into or through secure areas. Terminal 1 has a six-bay loading dock located under TSA Checkpoint A and a two-bay trash dock. These are both located on the secure side of the terminal. Terminal 2 has a seven-bay loading dock and two-bay trash dock located under the east edge of Concourse E. The loading dock is located on the secure side, but the trash compactors are accessible from the public roadways.

Concessions deliveries are presently received at a commissary building (Building #307) for Host and their sub-tenants, and at an off-airport facility for the Hudson Group. Smaller trucks then deliver food and goods to each terminal.

A single receiving area was assumed for each terminal. This would allow landside deliveries, holding areas, and TSA screening of goods before movement into each concessionaire's in-terminal storage/support spaces. The actual area would be dependent on terminal configurations. As noted in Section 4.7, a centralized receiving and distribution center may also be considered.

NON-PUBLIC CIRCULATION

Non-public circulation provides access to airline operations, airport administration areas, concession support, and other areas typically not used by the traveling public, as well as restrooms used by airport tenants and separate screening checkpoints for employees (if required).

Non-public circulation also includes elevators for concessions servicing. These should be sized and rated for freight of the type required by the various concessions. Non-public circulation should be located so as to provide delivery and trash removal to as many concessions as possible without requiring passage through public spaces. The program area is based on 20 percent of non-public functional areas.

MECHANICAL/ELECTRICAL/UTILITY

At the planning and programming stage, utilities areas are typically estimated as a percentage of the enclosed functional areas of a terminal. This will vary with the provision of central utility plant functions, either within the terminal or remotely, and in some cases, architectural design considerations, which may limit the use of rooftop equipment, etc.

The existing terminal mechanical/electrical systems in the two terminals are equal to approximately 14-15 percent of the functional area of the terminal. For planning purposes, a factor of 15 percent of functional areas was used. Most newer terminals are in the range of 10-12 percent of functional areas when there is a separate heating/cooling plant, which may be considered in developing terminal alternatives.

JANITORIAL/STORAGE/SHOPS

Janitorial, storage and shop space include the building maintenance functions, which are required to be within the terminal building. In addition to typical janitorial functions, space must be made available to store any specialized maintenance equipment for the terminal, such as lifts for high ceiling areas.

Maintenance and storage areas are located in multiple locations in the terminal. There are also a number of building maintenance facilities outside the terminal, as described in Section 4.7. The existing overall ratio of these spaces to the functional areas (1 percent) was used for planning purposes, since it falls within typical ranges when there are significant building support functions outside of the terminal.

STRUCTURE/NON-NET AREAS

Non-net areas are added to the recommended facility requirements to provide a better estimate of the total gross building footprint. Although the program areas are in terms of gross space, allowances must be made for exterior walls. It is also to be expected that buildings will have areas that are unusable or occupied by special structures. For planning, a 3 percent factor was used, which is typical of terminals with conventional designs.

4.2.4 SUMMARY OF TERMINAL REQUIREMENTS

- Terminal program recommendations were developed for three operational scenarios:
  - Terminal 1 (T-1) continuing to accommodate all airlines, except Southwest;
  - Terminal 2 (T-2) continuing to handle Southwest, with limited international activity in the existing FIS location; and

- A single terminal for all airlines.

- Because the Airport's forecasted growth in passengers and operations are primarily due to Southwest Airlines, Terminal 2 would need to expand if the current "two terminals" operational scenario continues.
- Summary of aircraft gates requirements:

	Existing	2040 Forecast
Terminal 1	36	32
Terminal 2	18	22+2
Single terminal	-N/A-	56

As the ALPU/MP analysis was being completed, based on new gates leases and new route announcements, it was collectively decided with STLAA that the required number of gates in 2040 would be increased to 62 NBEG gates, to ensure the ALPU/MP would not under-plan, Ultimately, the number of gates to be constructed will be refined in the design phase, based on airline negotiations and number of common use gates.

- Summary of RON/hardstand aircraft positions requirements:
  - Existing: 27 off-gate positions (in addition to 56 gates)
  - 2040: 18 off-gate positions (in addition to 62 gates), approximately 8 acres
- Summary of gross terminal area (sq. ft.) requirements:

	Existing	2040 Forecast
Terminal 1	898,700	775,200
Terminal 2	406,400	848,400
Single terminal	-N/A-	1,568,500

The changes in gross terminal areas address functional deficiencies, in addition to accommodating growth. Thus, although Terminal 1 has excess gross area for the forecast levels of activity, a number of facilities need to be increased to provide the desired level of service.

- Passenger processing:
  - Ticket lobbies in both terminals have insufficient circulation space in front of the counters.
  - Holdrooms in most locations have insufficient depth.
  - Concourse corridors (secure circulation) are too narrow in Concourses A, parts of Concourse C, and portions of Concourse E.
  - Domestic baggage claims in Terminal 1 have insufficient separation between claim units. Terminal 2 baggage claim has insufficient capacity.
  - International bag claim is undersized for the size aircraft in use.
  - No baggage re-check counter for international passengers connecting to domestic flights.
- Concessions:

  - Too much of the concessions in Terminal 1 are located on the non-secure side.
  - Terminal 2 concessions are undersized overall, and very limited on the non-secure side.
  - USO in Terminal 1 is undersized for peak periods.
- Airline operations:
  - ATO offices are generally undersized in both terminals.
  - Checked baggage screening systems are often overloaded during peak periods.
  - Baggage make-up is undersized in Terminal 2.

4.3 ACCESS AND TERMINAL AREA ROADWAYS

This section documents the roadway requirements developed as part of the ALPU. Requirements were developed for the following roadway elements:

- Airport roadway geometry
- Terminal roadway intersections
- Terminal curbside

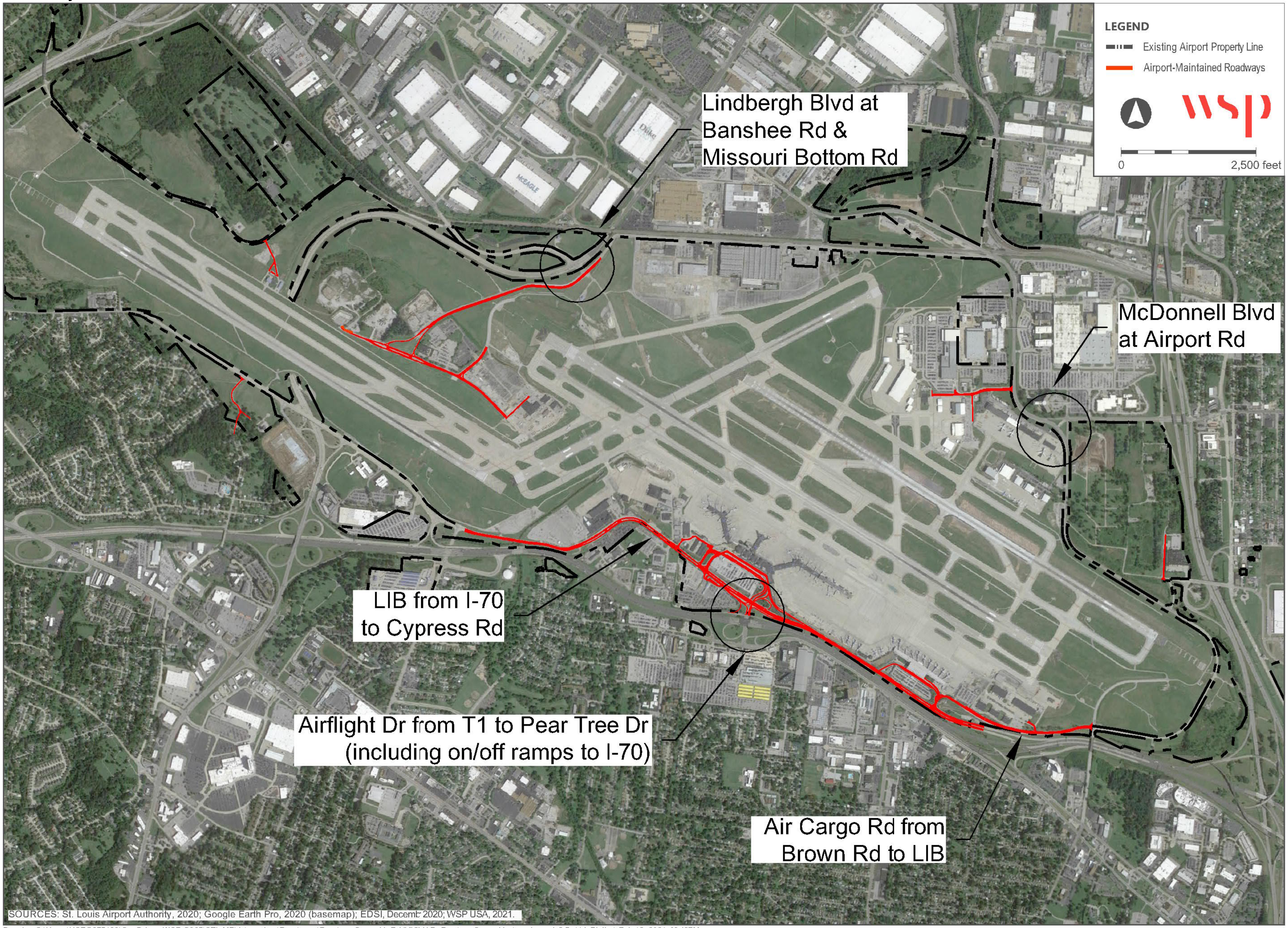
4.3.1 AIRPORT ROADWAY GEOMETRY

Existing conditions of the roadways around the Airport were evaluated to adequately identify insufficiencies and anticipate future needs of the Airport and its surrounding communities. To this end, several areas were specifically identified from a combination of future access scenarios, high-crash locations, and known geometric deficiencies. The areas studied are depicted on **Figure 4.3-1**. Three intersections and three roadways jumped out as primary candidates for assessment. Ramps were also evaluated individually. There were three airport access ramps and three interstate access ramps.

- Intersections:
  - Lindbergh Blvd., Banshee Rd. and Missouri Bottom Rd.
  - McDonnell Blvd. and Airport Rd.
  - I-70 eastbound exit (EBEX) and Pear Tree Dr.

FIGURE 4.3-1

Roadway Geometry Study Areas



Drawing: C:\Users\USEG675139\OneDrive - WSP O365\STL MP\4-Inventory\Roadways\Roadway Ownership Exhibits\ALP - Roadway Ownership.dwg Layout: 8.5x11-L Plotted: Feb 18, 2021, 03:48PM

- Roadways and Ramps:
  - Air Cargo Rd. between Lambert International Blvd. (LIB) and Brown Rd.
  - LIB between Cypress Rd. and I-70 ramp access.
  - Airflight Dr. between Terminal 1 to Pear Tree Dr. including I-70 ramp access.
  - Ramp C (Airflight Dr. to Ticketing Dr.)
  - Ramp D (Airflight Dr. to Baggage Dr.)
  - Ramp F (Airflight Dr. to LIB)
  - I-70 eastbound exit (EBEX) to Pear Tree Dr.
  - I-70 eastbound entrance loop ramp (EBEN Loop) from Airflight Dr.
  - I-70 Eastbound entrance directional ramp (EBEN Dir.) from Airflight Dr./Natural Bridge Rd.

TERMINAL ROADWAYS CRITERIA AND METHODOLOGY

To evaluate the roadway geometry, the criteria summarized in **Table 4.3-1** were tested.

Table 4.3-1: Geometry Criteria

CRITERIA	DESCRIPTION	SOURCES
Intersection Criteria		
Rt. Hand Radius of Return	Meet the minimum radius for turn vehicle.	MoDOT EPG; AASHTO Green Book
Turning Lane Width	Meet the minimum right turning lane width.	MoDOT EPG; AASHTO Green Book
Island Geometry	Meet minimum island dimensions.	MoDOT EPG; AASHTO Green Book
Shoulders	Meet shy width.	MoDOT EPG; AASHTO Green Book
Access Management	Meet minimum intersection and signal spacing.	MoDOT EPG;
Signal Disposition	Meet signal location and condition.	MoDOT EPG;
Americans with Disabilities Act Disposition	Meet min. widths, ramps, and access.	MoDOT EPG;
Roadway Criteria		
Horizontal Stopping Sight Distance	Meet minimum sight distance around curves.	AASHTO Green Book
Curve Radius for Non-Ramps	Meet minimum curve radius in non-ramp alignment.	AASHTO Green Book
Curve Length	Meet minimum alignment curve length.	MoDOT EPG
Ramp Operating Speed	Meet minimum speed to accelerate or decelerate safely.	MoDOT EPG; AASHTO Green Book
Speed Change Lane	Meet minimum length of accelerate or decelerate from interstate	MoDOT EPG; AASHTO Green Book
Degree of Convergence/Divergence	Meet maximum angle of attach of ramp approaching or deviating from the interstate.	MoDOT EPG;
Loop Ramp Radius	Meet minimum middle loop ramp radius.	MoDOT EPG; AASHTO Green Book
Vertical Clearance	Meet minimum clearance for bridges and overhead objects.	MoDOT EPG; AASHTO Green Book
Roadway Cross Section	Meet minimum lane and shoulder widths.	MoDOT EPG;
Americans with Disabilities Act Disposition	Meet minimum widths, ramps, and access.	MoDOT EPG;
Access Management	Meet minimum intersection and signal spacing.	MoDOT EPG; AASHTO Green Book

Notes:

MoDOT EPG = Missouri Department of Transportation *Engineering Policy Guide*

AASHTO = American Association of State Highway and Transportation Officials

Sources: Missouri Department of Transportation, *Engineering Policy Guide*, current edition; American Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets*, 2011 6th Edition; WSP USA, September 2020 (analysis).

Table 4.3-2 describes the methodology for each evaluation criteria.

Table 4.3-2: Criteria Methodology

CRITERIA	METHODOLOGY
Intersection Criteria	
Right-Hand Radius of Return	The radius of the right-hand turn lane was measured. Then it was compared to the minimum radius required for the specific design vehicle. AutoTURN was run against the client-supplied CADD files over aerial to verify. MoDOT EPG, Section 233.4.9 and AASHTO Green Book, Section 9.6.5 Table 9-18 and Figure 9-43 were used for criteria.
Turning Lane Width	The width of the right-hand turn lane was measured from the outside shoulder edge to the edge of the island face. Then it was compared to the minimum radius required for the specific design vehicle. AutoTURN was run against the client-supplied CADD files over aerial to verify. MoDOT EPG, Section 233.4.9 and AASHTO Green Book, Section 9.6.5 Table 9-18 and Figure 9-43 were used for criteria.
Island Geometry	The width, length, and area were approximated from measurements pulled from Google Earth. AASHTO Green Book Section 9.6.5 Table 9-18 and MoDOT EPG, Section 233.4.8 were used for criteria.
Shoulders	Once the AutoTURN for the design vehicle had been run, the inside and outside shy distance was measured. This was taken from the outside off-tracking line to the edge of island and the edge of shoulder. MoDOT EPG, Section 233.4.10 was used for criteria.
Access Management	The center-to-center distance between intersections was measured from Google Earth. MoDOT EPG, Section 940.5, 940.6, 234.2.1.1 MoDOT Access Control at Diamond Interchanges, Figure 1, AASHTO Green Book, Figure 10-68 were used for criteria.
Signal Disposition	The line of sight and distance from vehicle was measured from Google Earth. Other qualitative observations, such as mast condition, location, age, configuration etc. were noted. MoDOT EPG, Section 902.5 Figure 902.5.20 *Lateral and Longitudinal Location of Primary Signal Faces* were used for criteria.
Americans with Disabilities Act Disposition	Sidewalk width was measured from Google Earth. Other qualitative observations, such as rogue use, crosswalks, ramps, obstructions etc. are noted. MoDOT EPG, Sections 642.8-9 were used for criteria.
Roadway Criteria	
Horizontal Stopping Sight Distance	The inside radius measured from the CADD files over aerial was tested against the required horizontal offset for stopping sight distance. This also tested the minimum curve length and radius. AASHTO Green Book, Section 3.2 and Table 3-1 was used for criteria.
Curve Radius for Non-Ramps	The radius was measured from placing an approximate centerline curve in the CADD files over aerial. AASHTO Green Book, Section 3.3.5 Table 3-8 was used for criteria.
Curve Length	The length was approximated by drawing over the alignment in the client-supplied CADD files over aerial. MoDOT EPG, Section 230.1.3 was used for criteria.
Ramp Operating Speed	The speed for the loop ramps was determined by the radius of the curves and applying the speed enumerated in Section 234.2.1.8 and Table 2 of Section 234.5.1 of the MoDOT EPG. The directional ramp's operating speed was determined from the speed change lane length, and back calculating the speed from Table 10-3 of the AASTHO Green Book.
Speed Change Lane	The length of the speed change lane was measured from the visible end of the point of curve adjacent to the interstate, to the begin of taper at the end of the full lane width. Google Earth was used for the measurement. AASHTHO Green Book Tables 10-3 and

	10-5 and MoDOT Access Control at Diamond Interchanges, Figure 1 were used for criteria.
Degree of Convergence/Divergence	The radius of the approach curve to the interstate was drawn over the alignment in the client-supplied CADD files over aerial. The degree was then calculated. MoDOT Access Control at Diamond Interchanges, Figure 1 were used for criteria.
Loop Ramp Radius	The radius was approximated by drawing over the alignment in the client-supplied CADD files over aerial. Where the loop ramp was a compound curve, we used the middle curve. MoDOT EPG, Sections 234.2.1.8 and 325.5.1 were used for criteria.
Vertical Clearance	A visual qualitative analysis was conducted by "driving" down the roadways on Google Earth. Inadequate vertical clearance, either by warning sign or observation, were noted. MoDOT EPG, Section 751.1.2.6.1 was used for criteria.
Roadway Cross Section	The roadway cross sectional width of the travel lanes, turn lanes, and shoulder were measured at significant changes from Google Earth. MoDOT EPG, Sections 231.3 and 331.4 were used for criteria.
Americans with Disabilities Act Disposition	Sidewalk width was measured from Google Earth. Other qualitative observations, such as rogue use, crosswalks, ramps, obstructions etc. are noted. MoDOT EPG, Sections 642.8-9 were used for criteria.
Access Management	The center-to-center distance between intersections were measured from Google Earth. MoDOT EPG, Section 940.5, 940.6, 234.2.1.1, MoDOT Access Control at Diamond Interchanges, Figure 1, and AASHTO Green Book, Figure 10-68 were used for criteria.

Notes:

1. Design vehicle was selected based on a combination of the roadway classification, truck volume, and land use.
2. Roadway Classification was pulled from East-West Gateway classification maps.
3. Criteria parameters are based on Roadway Classification and design speed.

AASHTO = American Association of State Highway and Transportation Officials

CADD = Computer-aided design and Final Drafting

MoDOT EPG = Missouri Department of Transportation *Engineering Policy Guide*

Sources: Missouri Department of Transportation, *Engineering Policy Guide*, current edition; American Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets*, 2011 6th Edition; WSP USA, September 2020 (analysis).

TERMINAL ROADWAY EVALUATION RESULTS

This section summarizes the deficiencies found in the intersections, roadways, and ramps evaluated. Detailed spreadsheet analysis is provided in **Appendix 4C**.

INTERSECTION GEOMETRIC DEFICIENCIES

By and large, the three intersections evaluated, Missouri Bottoms Rd. & Banshee Rd./Lindbergh Blvd, Airport Rd. & McDonnell Blvd., and I-70 eastbound exit (EBEX) & Pear Tree Dr., passed most of the noted criteria in Table 4.3-1. The following deficiencies were found:

- Airport Rd. and McDonnell Blvd. fails for the design vehicle turning movement, as illustrated on **Figure 4.3-2**. The corner of concern is the northbound intersection leg of McDonnell Blvd. to eastbound Airport Rd. heading towards the interstate. These roadways are Principal Arterials and Major Collectors next to the interstate and justify a large design vehicle. While technically, the right-hand turning radius is standard, the turning lane width is not wide enough for a 73-foot-long interstate semi-trailer (WB-67 design). It is also obvious from Google Street View that significant off-tracking is taking place behind the existing curb. This intersection also fails the shoulder width for the four quadrants. The standard outside shoulder width should be 10 feet or at least a 2-foot shy distance from the curb line, per MoDOT EPG, Section 233.4.10 and Section 231.4.

Figure 4.3-2: Airport Rd. and McDonnell Blvd. Turning Movement

Sources: Google Earth, September 2020; WSP USA, September 2020 (annotations).

Additionally, the signal equipment is old and rusted, as shown on **Figure 4.3-3**. It is similar to a light standard configuration, rather than the modern post and mast system currently erected. The signals are employing an old shade and bulb combination.

Figure 4.3-3: Airport Rd. and McDonnell Blvd. Signal Equipment

Source: Google Street View, September 2020.

The intersection itself does not have Americans with Disabilities Act (ADA)/pedestrian features. This is a lost opportunity if the vacated subdivision to the northeast of the airfield is developed by the Airport. Any improvements in reconfiguring this intersection to meet standard compliance in the future should make provisions for or include pedestrian spaces.

- While it's not a feature of the criteria, it should be noted that the Pear Tree Dr. intersection with EBEX was overlaid to such a degree that the surrounding curbs have lost standard height.

ROADWAY AND RAMP GEOMETRIC DEFICIENCIES

The access ramps from Terminal 1 to Airflight/LIB are Ramps C, D and F. These ramps have few geometric flaws. Shy distance on the shoulders could make a more comfortable user experience, if it were extended from 1 to 2 feet. Since all the horizontal stopping sight distances are met, it is advisable to keep shoulders narrow to encourage traffic calming effects.

The interstate ramps are EBEX to Pear Tree Dr., EBEN Loop from Airflight Dr. to I-70, and EBEN Dir. from Airflight Dr./Natural Bridge Rd to I-70. While I-70 EBEX and EBEN Dir. have no geometric issues, EBEN Loop fails on the following counts:

- Based on its loop radius, the ramp's operational speed is 20 mph. From Table 1 of the Missouri Department of Transportation (MoDOT)'s *Engineering Policy Guide (EPG),* Section 234.5.1, the acceptable range of speed is 35-60 mph for a mainline interstate speed of 60 mph.
- The acceleration speed change lane is 480 feet long. According to AASHTO, Table 10-3, the lane length needs to be 1,100 feet for a ramp going from 20 mph to 60 mph. Accommodating this geometry would drastically change the look and function of this interchange.
- The degree of divergence should be no more than 6 degrees per MoDOT's *Access Control at Diamond Interchanges*, Figure 1. This entrance curve has a degree of 9.5.

These are significant geometric standard shortfalls for an interstate ramp.

The roadways analyzed were LIB, Air Cargo Dr., Pear Tree Dr., Airflight Dr., McDonnell Blvd., Airport Rd, and Banshee Rd. The following deficiencies were found:

- LIB's centerline curve adjacent to the Terminal 1 Cell Phone Lot does not meet horizontal sight distance. The fence and trees partially obscure the necessary stopping sight distance offset, as shown on **Figure 4.3-4**. In general, the length of alignment curves is too short relative to the current posted speed of 35 mph along the entire study area. This necessitates a minimum of 525' of curve length per MoDOT EPG, Section 230.1.3.

Figure 4.3-4: Insufficient Horizontal Sight Distance on Lambert International Blvd

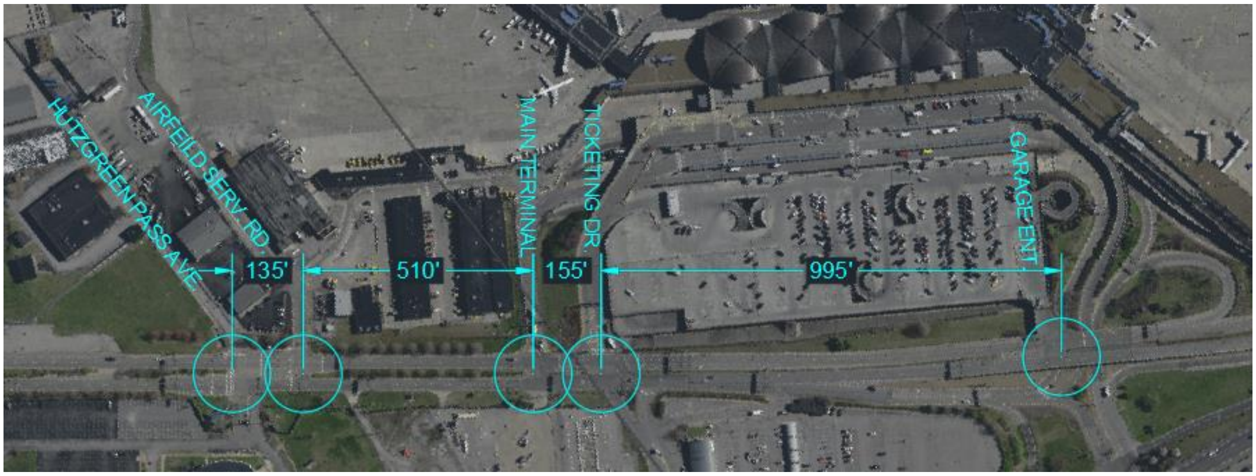
Notes:

1. Top image is from Google Street View.
2. Bottom image is plan view. Blue Hatching represents the calculated horizontal visible area.

Sources: Google Earth, September 2020; East West Gateway Aerial Imagery, 2015; WSP USA, September 2020 (annotations)

- The signalized intersections are spaced too closely in front of and west of Terminal 1, as shown on **Figure 4.3-5**. Section 940.6 of the MoDOT EPG allows for a minimum of ¼ mi. (1,320 feet) for signalized intersections. The most distance we get between these five signalized intersections is 995 feet between the Terminal 1 Parking Garage entrance and Ticketing Dr. exit.

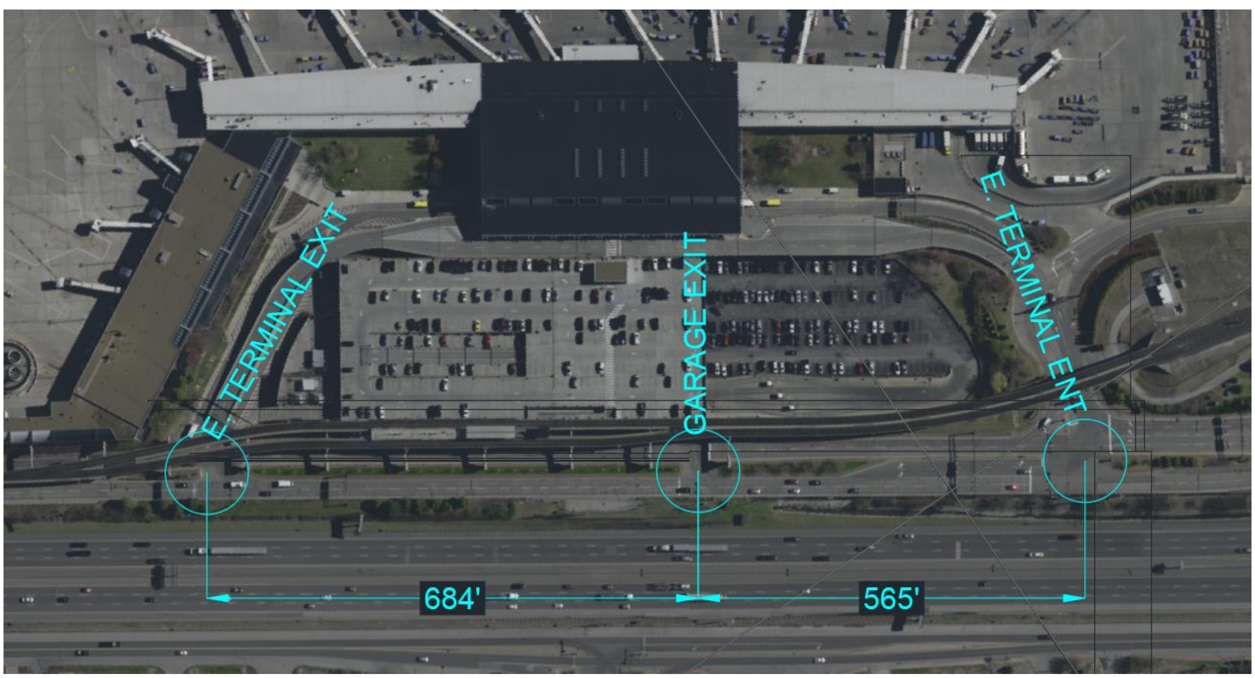
Figure 4.3-5: Signalized Intersections Spacing West of Terminal 1



Sources: East West Gateway Aerial Imagery, 2015; WSP USA, September 2020 (annotations).

- The signalized intersections are spaced too closely in front of and west of Terminal 1, as shown on **Figure 4.3-6**. Section 940.6 of the MoDOT EPG allows for a minimum of ¼ mi. (1,320 feet) for signalized intersections.

Figure 4.3-6: Signalized Intersections Spacing at Terminal 2



Sources: East West Gateway Aerial Imagery, 2015; WSP USA, September 2020 (annotations).

- Sidewalks are intermittently placed to the north and south of LIB, as shown on **Figure 4.3-7**. They are riddled with light standards, signal equipment, lack width adjacent to the roadway, and do not feature proper ADA ramps and detectable warnings.

Figure 4.3-7: Lambert Internal Blvd Sidewalks

Notes:

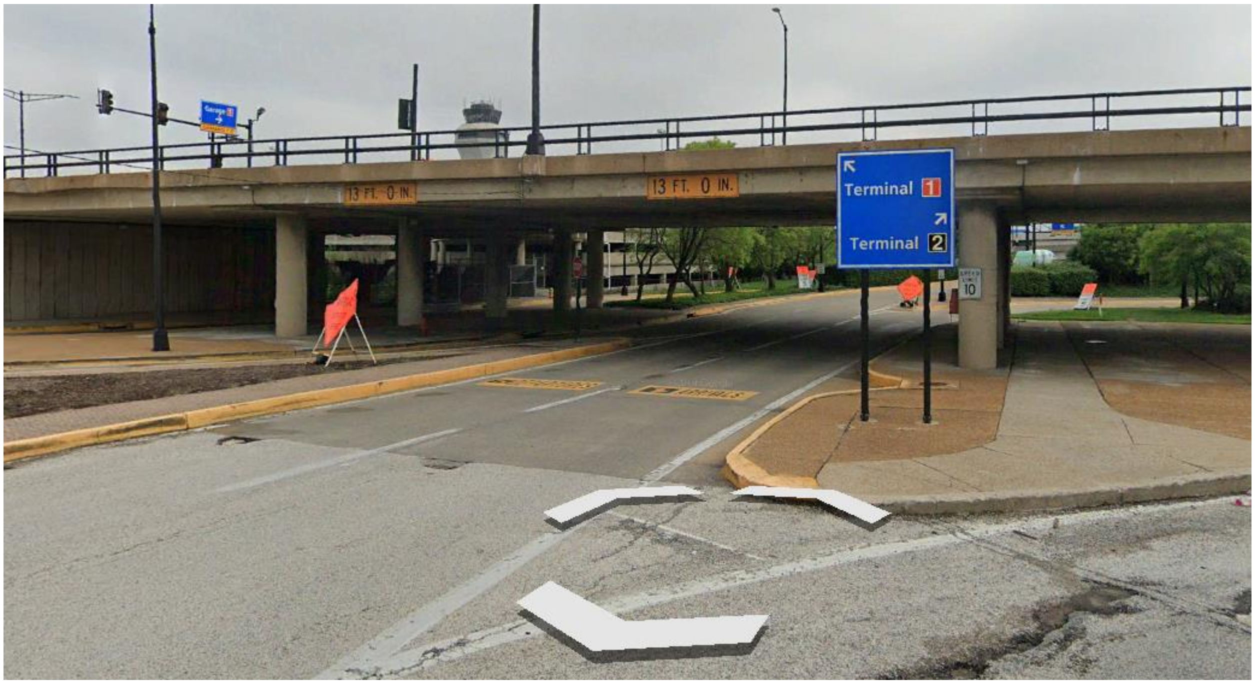
1. Top of figure is street view representative of sidewalk width obstructions.

2. Bottom of figure is street view representative example of substandard pedestrian protection and ADA ramps, and lack of detectable warnings.

Sources: Google Street View, September 2020; WSP USA, September 2020 (annotations).

- Airflight Dr. has substandard bridge clearance under I-70, as shown on **Figure 4.3-8**. MoDOT EPG, Section 751.1.2.6.1 requires a standard 14.5 feet of clearance for minor streets. The current clearance is 13 feet.

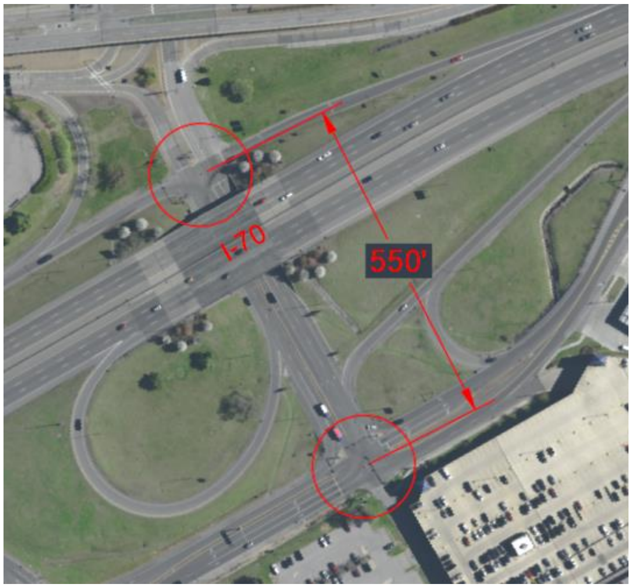
Figure 4.3-8: Airflight Dr. Substandard Bridge Clearance under I-70



Source: Google Street View, September 2020.

- The distance between the interchange ramp terminals is too short (they are too close together), as depicted in **Figure 4.3-9**. MoDOT *Access Control at Diamond Interchanges*, Figure 1, sets a minimum distance of 800 feet between the intersections, and the current distance is 550 feet.

Figure 4.3-9: Insufficient Interchange Ramp Separation



Sources: East West Gateway Aerial Imagery, 2015; WSP USA, September 2020 (annotations).

- Airport Rd. fails a few criteria, as shown on **Figure 4.3-10**. Its outside shoulders are non-existent. The East-West Gateway (EWG) qualifies this roadway as a Principal Arterial. Therefore, the standard outside shoulder width should be 10 feet, or at least a 2-foot shy distance from the curb line. Neither are provided.

  The signalized intersection spacing from the entrance to McDonnell Blvd. is only 250 feet, while the minimum access requirement is a minimum of ¼ mi. (1,320 feet) for signalized intersections, per Section 940.6 of the MoDOT *EPG*.

Figure 4.3-10: Airport Rd. Shoulder and Signalized Intersections Spacing Deficiencies

Notes:

1. Top image highlights the lack of shoulder or shy distance from curbs.
2. Bottom image shows substandard intersection distance along Airport Rd.

Sources: East West Gateway Aerial Imagery, 2015; WSP USA, September 2020 (annotations).

The remaining roadways pass other evaluated criteria.

SUMMARY OF ROADWAY GEOMETRY DEFICIENCIES

- Intersections:
  - Airport Rd. and McDonnell Blvd.:
    - Northbound intersection leg of McDonnell Blvd. to eastbound Airport Rd. heading towards the interstate: insufficient width of turning lane
    - Insufficient shoulder width for the four quadrants
    - Signal equipment is old and rusted
    - Intersection does not have ADA/pedestrian features
    - St. Louis County Highways has designated this intersection as a "hot spot" due to the annual volume of motor vehicle crashes.
  - Pear Tree Dr. intersection with EBEX: surrounding curbs have lost standard height
  - Missouri Bottom Rd./Banshee Rd. and Lindbergh Blvd. intersection has been designated by St. Louis County Highways as a "hot spot" due to the annual volume of motor vehicle crashes.
- Ramps:
  - EBEN Loop:
    - The ramp's operational speed is 20 mph (acceptable range of speed is 35-60 mph)
    - The acceleration speed change lane is 480 feet long (instead of 1,100 feet)
    - The degree of divergence is 9.5 (instead of 6 degrees maximum)
- Roadways:
  - Lambert International Blvd.:
    - The centerline curve adjacent to the Terminal 1 Cell Phone Lot does not meet horizontal sight distance (fence and trees partial obscuration).
    - The signalized intersections are spaced too closely in front of and west of Terminal 1 (maximum spacing provided is 995 feet, for a minimum requirement of 1,320 feet).
    - The signalized intersections are spaced too closely in front of Terminal 2 (maximum spacing provided is 684 feet, for a minimum requirement of 1,320 feet).
    - Sidewalks are intermittently placed to the north and south of LIB, they are riddled with light standards, signal equipment, lack width adjacent to the roadway, and do not feature proper ADA ramps and detectable warnings.
  - Airflight Dr.:
    - The 13-foot bridge clearance under I-70 does not meet 14.5-foot standard.
    - The 550-foot separation between the interchange ramp terminals along Airflight Dr. does not meet the minimum distance of 800 feet.

- Airport Rd.:
  - No outside shoulders (10-feet standard, or 2-foot shy distance from the curb line).
  - The 250-foot spacing between signalized intersections at the entrance to McDonnell Douglas and McDonnell Blvd. does not meet the minimum spacing of 1,320 feet.

4.3.2 ROADWAY INTERSECTIONS

A VISSIM model was developed for the roadway intersections adjacent to and serving STL, in order to determine the existing vehicle traffic operational conditions. VISSIM is a microsimulation modeling software package that serves as an effective tool in evaluating traffic conditions. The models were developed utilizing existing roadway and intersection configurations, recent intersection turning movement counts for peak traffic and air travel hours, and existing signal timing.

ANALYSIS METHODOLOGY

Existing (2019) and 2030/2040 No-Build traffic conditions were evaluated using the VISSIM software package for the morning and afternoon peak hours. VISSIM is a microscopic analysis program that utilizes traffic count data, driver behaviors, roadway geometrics and signal timing data to calculate travel times, vehicle delays, queue lengths and intersection capacity using methodologies outlined in the *Highway Capacity Manual* (HCM)[6], published by the Transportation Research Board.

The HCM uses six levels of service (LOS) to measure traffic flow with consideration to such factors as speed, delay, driver comfort and convenience. Intersection LOS is based on delay and the type of traffic control used. The LOS range from LOS A (Free Flow conditions) to LOS F (Fully Saturated conditions). LOS C is normally used for design purposes and represents a roadway utilizing 70 to 80 percent of its capacity; however, LOS D is often considered acceptable for peak period conditions in urban and suburban areas. Many factors go into the determination of LOS for a given highway, or intersection, including geometry, signal timing characteristics, traffic volumes, and other roadway features. LOS levels are described below:

- **LOS A**: Free flow conditions. Traffic flows at or above the posted speed limit. Motorists have complete mobility between lanes and there is a high level of comfort in driving.
- **LOS B**: Reasonably free flow conditions. While LOS A traffic speeds are maintained, there is more restricted maneuverability between lanes. Motorists generally still have a high level of comfort in navigating the traffic conditions.
- **LOS C**: Stable flow. With minor reductions in traffic speeds, maneuverability between lanes is more restricted and lane changes require high driver awareness. Experienced motorists remain comfortable with the driving task. Some delay occurs at intersections.
- **LOS D**: Approaching unstable flow. Traffic speeds decrease as traffic volume increases. Maneuverability between lanes is much more restricted and driver comfort is significantly

[6] Transportation Research Board, Highway Capacity Manual, 6th Edition, 2016.

decreased. Minor incidents are expected to create delays. Delay at intersections is beginning to become significant for drivers.

- **LOS E**: Unstable flow. Roadways are operating at capacity, with virtually no gaps between vehicles. Any disruption to traffic flow, including ramp merges or minor incidents will have shockwave effects on traffic and create significant delays. Intersections experience significant delay.
- **LOS F**: Overcapacity. "Stop-and-go" traffic results in high density of vehicles on the roadway. It results in very limited maneuverability between lanes, significantly reduced traffic speeds, and travel time cannot be predicted. Heavy queuing and delays occur at intersections.

The thresholds for intersection LOSs are summarized in **Table 4.3-3**.

Table 4.3-3: Intersection Level of Service Thresholds

	DELAY PER VEHICLE (SECONDS/VEHICLE)	
Level of Service (LOS)	**Signalized**	**Unsignalized**
A	<10	<10
B	10-20	10-15
C	20-35	15-25
D	35-55	25-35
E	55-80	35-50
F	>80	>50

Source: Transportation Research Board, *Highway Capacity Manual*, 6th Edition, 2016.

STUDY AREA

The intent of the modeling was to determine the existing conditions on the roadways serving the airport terminals. Although the Airport is in close proximity to I-70, conditions along the interstate were not considered to be critical for this analysis. The study area for the modeling, depicted in **Figure 4.3-11**, included the terminal curb areas, airport access roadways and adjacent I-70 interchanges. The interchanges included in this analysis included Cypress Road and Airflight Drive along with the south outer road (Pear Tree Drive/Natural Bridge Road). Lambert International Boulevard was modeled from Cypress Road to Air Cargo Drive.

Figure 4.3-11: Roadway Intersections Study Area (1 of 2)

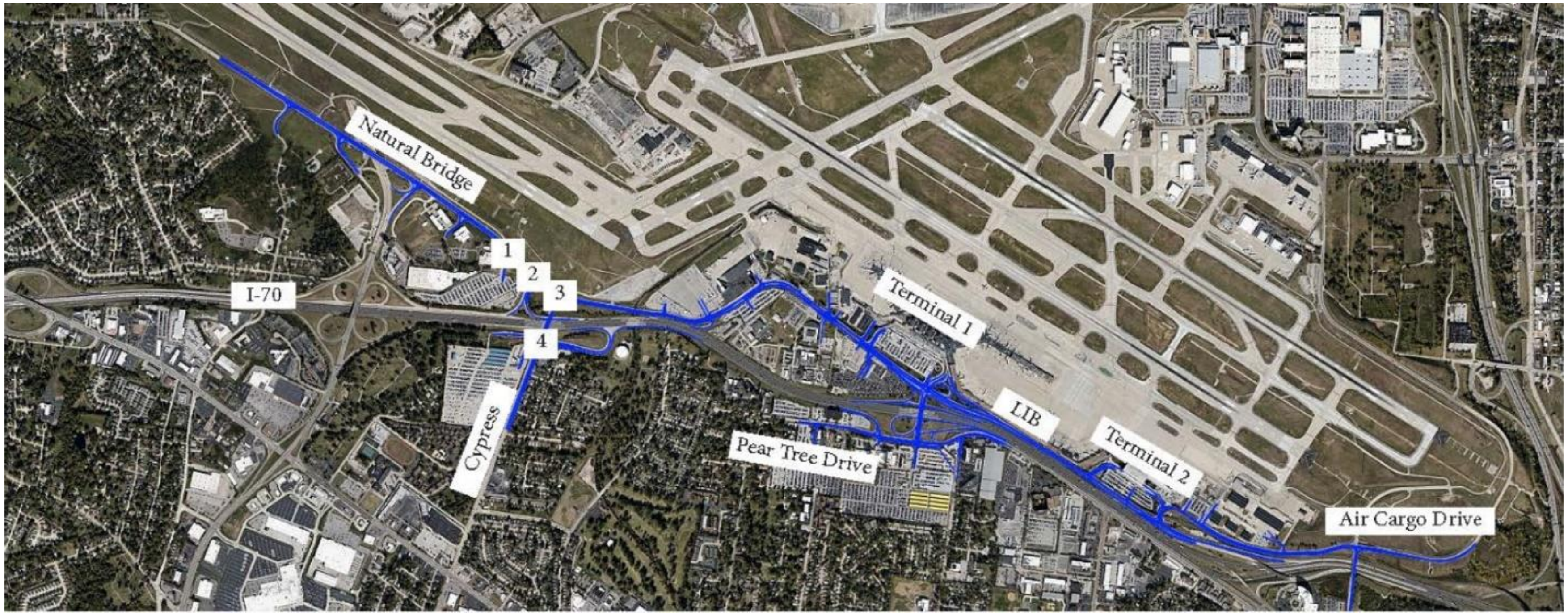
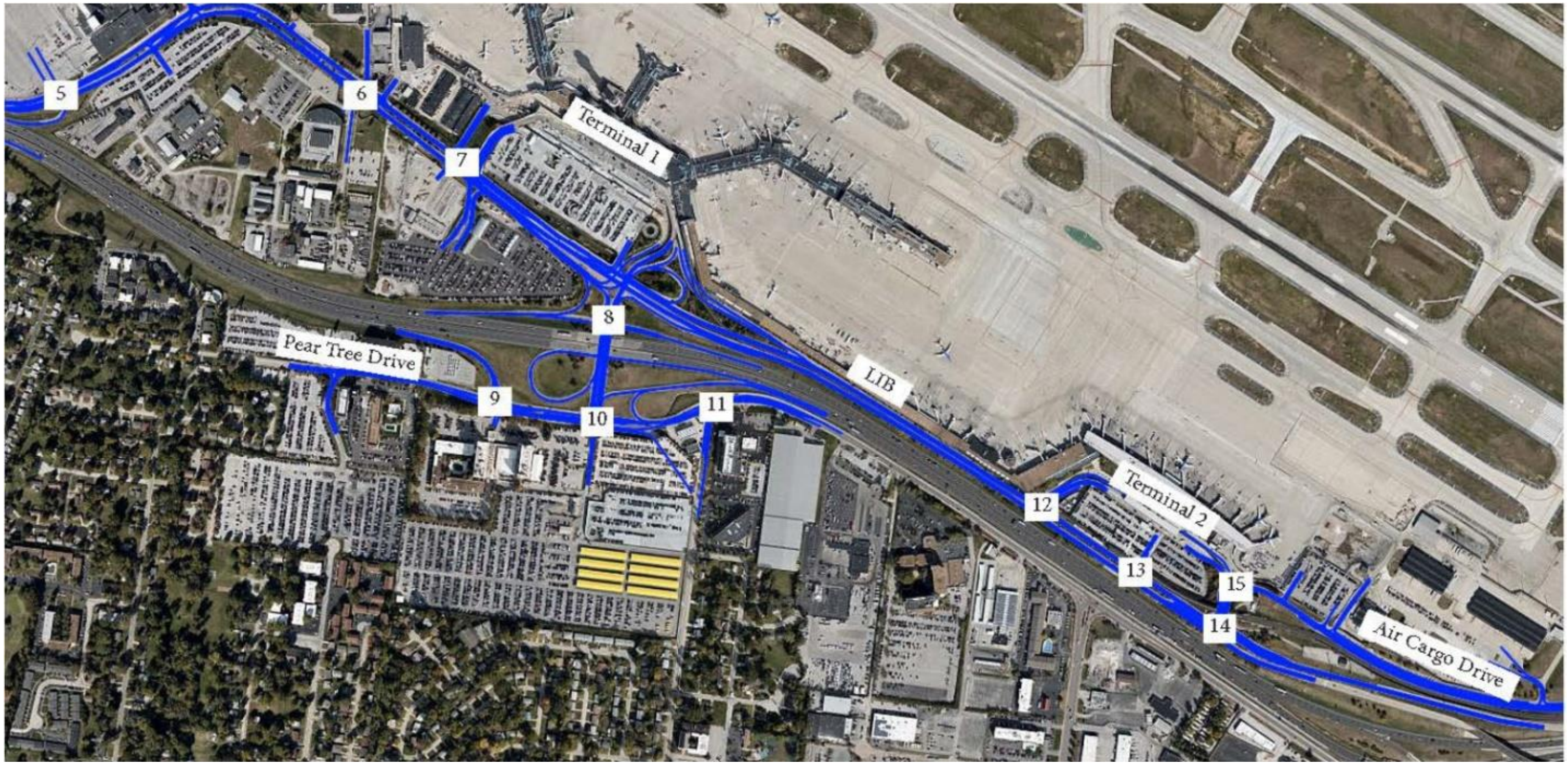


Figure 4.3-11: Roadway Intersections Study Area (2 of 2)



Note: Intersection numbers correspond to numbers in this section's tables.

Sources: Google Earth, 2020 (aerial image); WSP USA, September 2020 (analysis).

TRAFFIC VOLUMES

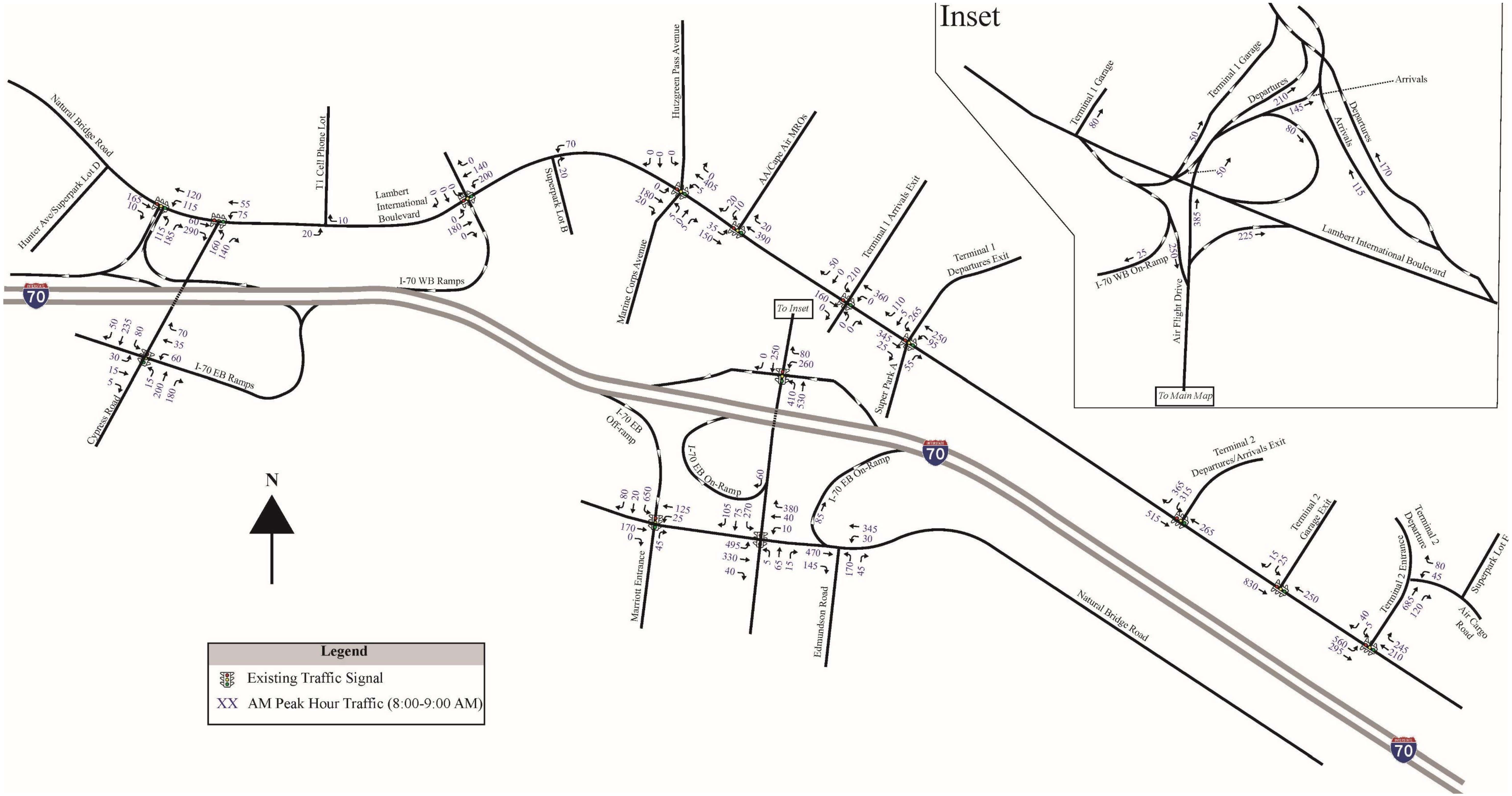
Existing (2019) conditions and No-Build conditions for 2030 and 2040 were analyzed for the Airport's morning peak hour (8:00 am-9:00 am) and the afternoon peak hour (4:30 pm-5:30 pm). Intersection turning movement counts and mainline traffic volumes were collected on Lambert International Boulevard (LIB) in October and November 2017, as part of the *Lambert Traffic Management Enhancement Project*. Peak hours were determined by evaluating the traffic count data for intersections directly serving the Airport terminals. Therefore, the peak hour volumes used for the Existing (2019) conditions analysis represent the highest traffic volumes that occur at the Airport. Using this count data, a heavy truck percentage was calculated and includes shuttle busses serving the Airport. An 18 percent heavy truck factor was used for both the morning and afternoon peak hours. A 1.2% annual growth rate was used in order to project volumes for years 2030 and 2040, to evaluate future No-Build conditions. For Existing (2019) conditions near Terminal 1, the average daily traffic (ADT) on LIB is approximately 12,000 vehicles per day, with a peak hourly volume of 900 vehicles per hour. Near Terminal 2, the ADT on LIB is approximately 22,000 vehicles per day with a peak hourly volume of 1,500 vehicles per hour. The morning and afternoon peak hour volumes are shown in **Figure 4.3-12** and **Figure 4.3-13**, respectively. The morning and afternoon 2030 No-Build peak hour volumes are shown in **Figure 4.3-14** and **Figure 4.3.15**, respectively. The morning and afternoon 2040 No-Build peak hour volumes are shown in **Figure 4.3-16** and **Figure 4.3.17**, respectively.

CALIBRATION

One of the key reasons for using VISSIM was the ability to simulate vehicles along the arrival and departure curbs at each terminal and the surrounding roadway network. During peak conditions, queuing along the curbs may lead to excessive delays for drivers traveling to/from the Airport, with queues extending into the surrounding roadway network. In addition, VISSIM was used to assess the relative effectiveness of the overall roadway alternatives in accommodating traffic growth.

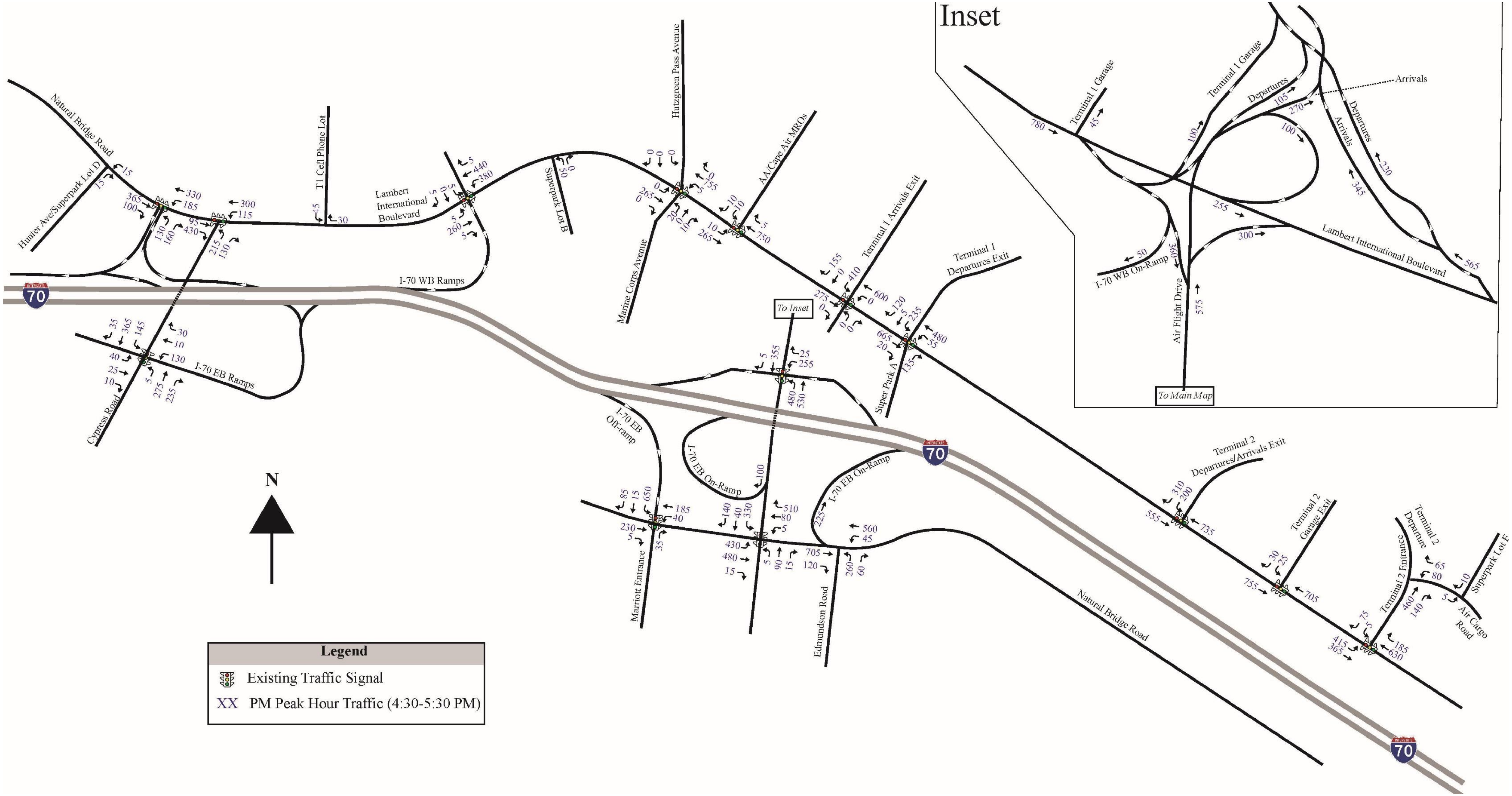
Using historical traffic volume data, current signal timing data and existing roadway geometrics, an existing conditions model was developed for the two peak hours analyzed (Morning Peak and Afternoon Peak). Each model was calibrated based on observational data and was coordinated with airport personnel to confirm the simulated conditions matched closely with actual field conditions. Observational data included extensive observations of passenger vehicle and shuttle bus dwell times at each terminal arrival and departure curb. The observed dwell times were also compared to data from other large airports for validation.

Figure 4.3-12: Morning Peak Hour Traffic Volumes – Existing (2019)



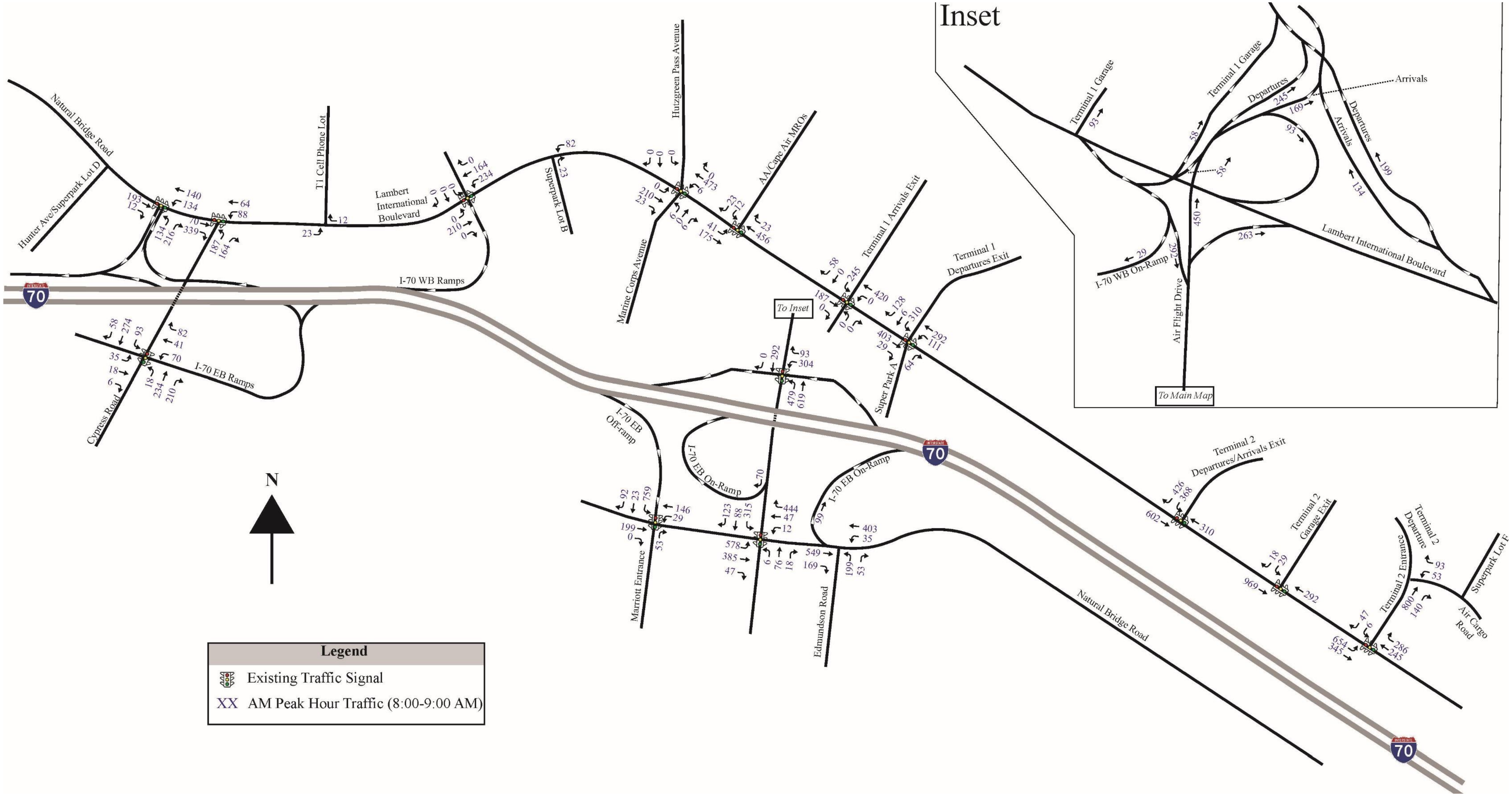
Sources: Lambert Traffic Management Enhancement Project, 2017; WSP USA, October 2020 (analysis).

Figure 4.3-13: Afternoon Peak Hour Traffic Volumes – Existing (2019)



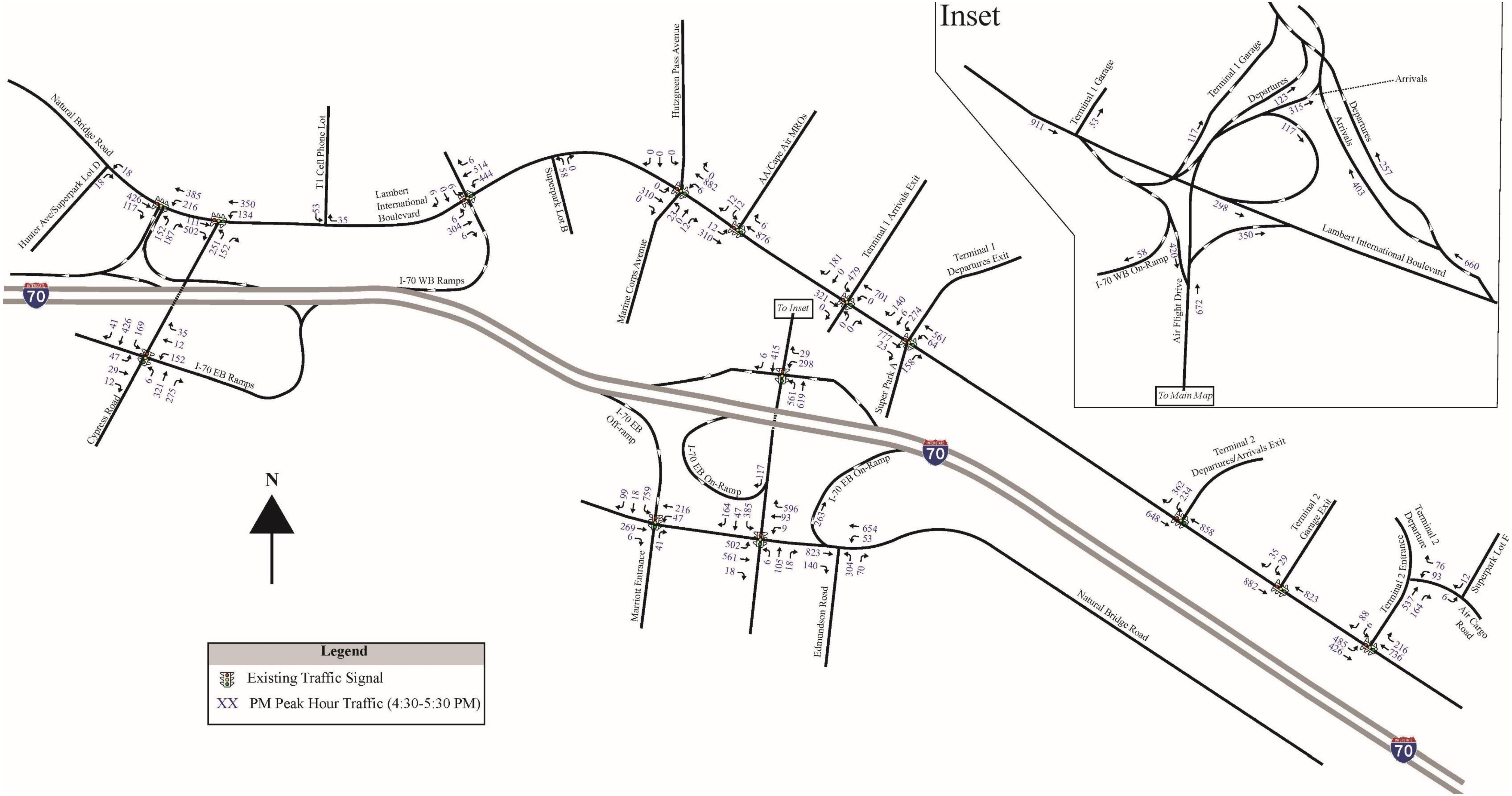
Sources: Lambert Traffic Management Enhancement Project, 2017; WSP USA, October 2020 (analysis).

Figure 4.3-14: Morning Peak Hour Traffic Volumes – 2030 No Build



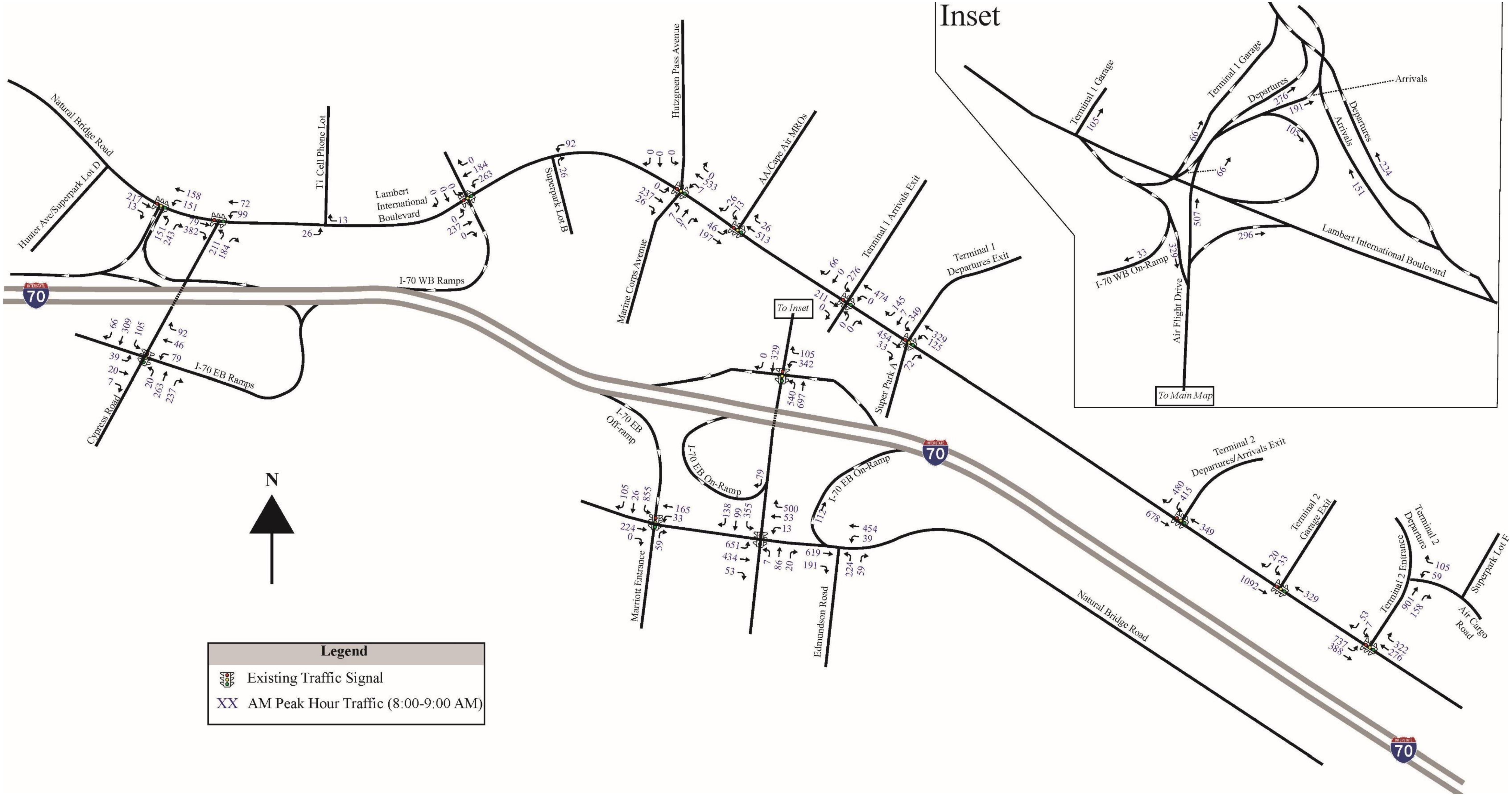
Sources: Lambert Traffic Management Enhancement Project, 2017; WSP USA, October 2020 (analysis).

Figure 4.3-15: Afternoon Peak Hour Traffic Volumes – 2030 No Build



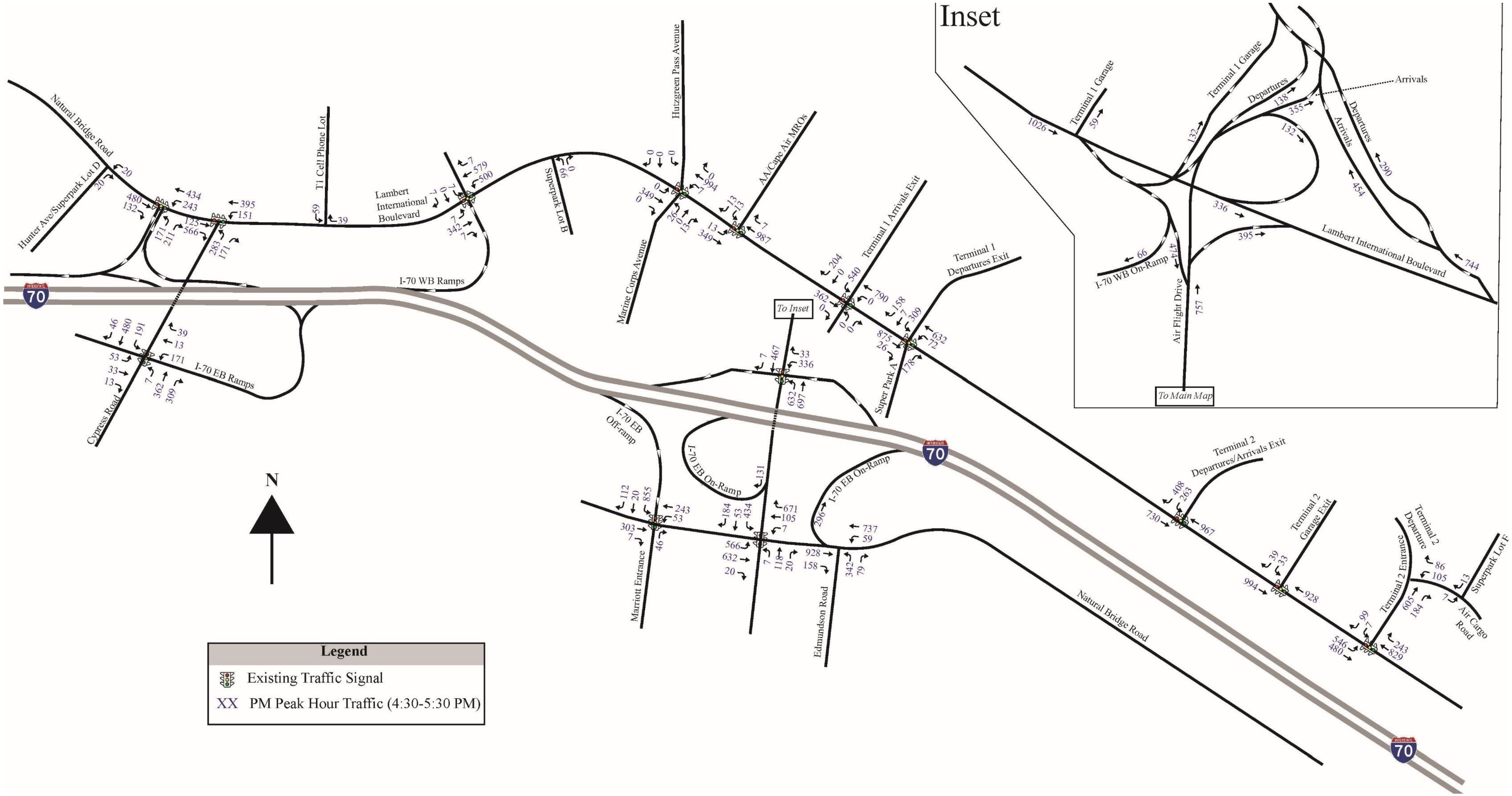
Sources: Lambert Traffic Management Enhancement Project, 2017; WSP USA, October 2020 (analysis).

Figure 4.3-16: Morning Peak Hour Traffic Volumes – 2040 No Build



Sources: Lambert Traffic Management Enhancement Project, 2017; WSP USA, October 2020 (analysis).

Figure 4.3-17: Morning Peak Hour Traffic Volumes – 2040 No Build



Sources: Lambert Traffic Management Enhancement Project, 2017; WSP USA, October 2020 (analysis).

EXISTING ROADWAY/INTERSECTION AND SIGNAL NETWORK

The airport terminals are accessible by vehicle via signalized intersections and directional ramps. Terminal 1 is accessible via directional ramps from Air Flight Drive and from LIB. In addition, the Terminal 1 parking garage is accessible via an unsignalized entrance on LIB. Vehicles exit Terminal 1 via two signalized intersections on LIB. Terminal 2 is accessible via a signalized intersection on Air Cargo Drive, in close proximity to LIB. Vehicles exit Terminal 2 via a signalized intersection on LIB and a signalized garage exit on LIB. STLAA operates and maintains the signalized intersections along LIB. The signalized intersections along LIB operate in coordination throughout the day, and are controlled via an advanced transportation management system (ATMS) located at the Airport Office Building. STLAA's signalized intersections include an on-ramp to I-70 west of Parking Lot B. In addition, there are two signalized interchanges that serve airport traffic along I-70 at Cypress Road and at Air Flight Drive. These interchanges and signalized intersections are operated and maintained by MoDOT and are controlled via an ATMS located at MoDOT's Transportation Management Center.

CUT-THROUGH TRAFFIC EVALUATION

The Existing (2019) traffic volumes and roadway network were used to evaluate the amount of cut-through traffic traveling on LIB past the Airport. Due to the limited origins and destinations on LIB (Natural Bridge Rd) west of the airport and Air Cargo Drive east of the airport, there is very limited cut-through traffic during normal conditions. However, there is a potential for a considerable amount of cut-through traffic during major incidents on I-70, since LIB has multiple direct access points to and from I-70. The Airport and the Missouri Department of Transportation do not promote LIB as an alternative during incident-related closures of I-70, however, there is limited ability in order to prevent incident-related detour traffic. For this analysis of normal conditions, it is assumed that cut-through traffic is minimal and insignificant.

AIRPORT ROADWAY ANALYSIS RESULTS

EXISTING (2019) CONDITIONS

Morning Peak Hour

Near Terminal 1, the ADT on Lambert International Boulevard is approximately 12,000 vehicles per day, with morning peak hourly volumes of 200 vehicles per hour (vph) eastbound and 400 vph westbound. Near Terminal 2, the ADT on Lambert International Boulevard is approximately 22,000 vehicles per day, with morning peak hourly volumes of 600 vph eastbound and 725 vph westbound.

The intersection volume, delay and LOS are summarized in **Table 4.3-4**. Each intersection operates at a LOS C or better during the morning peak hour. The LOS and low delay can be attributed to the relatively low cycle length (95 seconds) that each signal operates throughout the day. The signal timing was recently optimized as part of a traffic enhancement project and provides for efficient intersection operation. Furthermore, the majority of individual intersection movements operate at acceptable LOS throughout the day, and no movement is over capacity, as shown in **Table 4D-1**. Average queue lengths were evaluated to determine if any movement has excessive queueing or extends beyond provided storage bays. As shown in Table 4D-1, there is no excessive queueing during the morning peak hour in the study area.

Table 4.3-4: Intersection Level of Service – Morning Peak Hour – Existing (2019)

INTERSECTION		VOLUME (VEHICLES)	DELAY (SEC)	LOS
1	Hunter Ave & Natural Bridge Rd	402	0.1	A
2	Natural Bridge Rd & I-70 WB Ramps	689	7.8	A
3	Lambert Intl Blvd & Cypress	779	4.6	A
4	Cypress Rd & I-70 EB Ramps	971	8.4	A
5	Lambert Intl Blvd & I-70 WB On Ramp	513	1.3	A
6	Lambert Intl Blvd & American Airlines/Cape Air MROs	633	3.7	A
7	Lambert Intl Blvd & Terminal 1 Exit	1,181	30.0	C
8	Air Flight Dr & I-70 Ramps	1,551	13.2	B
9	Pear Tree Dr & I-70 EB Off Ramp	1,125	14.4	B
10	Pear Tree Dr & Air Flight Dr	1,856	20.4	C
11	Natural Bridge & Edmundson	1,224	10.1	B
12	Lambert Intl Blvd & Terminal 2 Exit	1,392	18.1	B
13	Lambert Intl Blvd & Terminal 2 Garage Exit	1,045	3.1	A
14	Lambert Intl Blvd & Terminal 2 Entrance	1,278	20.4	C
15	Air Cargo Dr & Terminal 2	989	8.8	A

Notes:
EB - eastbound
LOS – level of service
MRO – Maintenance, Repair and Overhaul Facility
SEC – seconds
WB - westbound

Sources: Lambert Traffic Management Enhancement Project, 2017; WSP USA, September 2020 (analysis).

Afternoon Peak Hour

Near Terminal 1, the ADT on Lambert International Boulevard is approximately 12,000 vehicles per day, with afternoon peak hourly volumes of 350 vph eastbound and 650 vph westbound. Near Terminal 2, the ADT on Lambert International Boulevard is approximately 22,000 vehicles per day, with afternoon peak hourly volumes of 650 vph eastbound and 875 vph westbound.

The intersection volume, delay and LOS are summarized in **Table 4.3-5**. Each intersection operates at a LOS C or better during the afternoon peak hour. The LOS and low delay can be attributed to the relatively low cycle length (95 seconds) that each signal operates throughout the day. The signal timing was recently optimized as part of a traffic enhancement project and provides for efficient intersection operation. In addition, improvements were recently implemented at Terminal 2 to reduce queueing for arrivals and departures traffic, along with an extension of the eastbound left turn storage bay at LIB & Terminal 2 Entrance to prevent blockage of the mainline through movement. Furthermore, the majority of individual intersection movements operate at acceptable LOS throughout the day and no movement is over capacity, as shown in **Table 4D-2** in **Appendix 4D**. Average queue lengths were evaluated to determine if any movement has excessive queueing or extends beyond provided storage bays. As shown in Table 4D-2, there is no excessive queueing during the afternoon peak hour in the study area.

Table 4.3-5: Intersection Level of Service – Afternoon Peak Hour – Existing (2019)

	INTERSECTION	VOLUME	DELAY (SEC)	LOS
1	Hunter Ave & Natural Bridge Rd	920	0.3	A
2	Natural Bridge Rd & I-70 WB Ramps	1,261	9.9	A
3	Lambert Intl Blvd & Cypress	1,275	7.4	A
4	Cypress Rd & I-70 EB Ramps	1,304	14.6	B
5	Lambert Intl Blvd & I-70 WB On Ramp	1,092	2.4	A
6	Lambert Intl Blvd & American Airlines/Cape Air MROs	1,049	4.2	A
7	Lambert Intl Blvd & Terminal 1 Exit	1,849	28.8	C
8	Air Flight Dr & I-70 Ramps	1,687	16.2	B
9	Pear Tree Dr & I-70 EB Off Ramp	1,262	18.3	B
10	Pear Tree Dr & Air Flight Dr	2,165	25.9	C
11	Natural Bridge & Edmundson	1,759	19.2	B
12	Lambert Intl Blvd & Terminal 2 Exit	1,824	14.1	B
13	Lambert Intl Blvd & Terminal 2 Garage Exit	1,535	2.8	A
14	Lambert Intl Blvd & Terminal 2 Entrance	1,692	18.0	B
15	Air Cargo Dr & Terminal 2	890	10.7	B

Notes:
EB - eastbound
LOS – level of service
MRO – Maintenance, Repair and Overhaul Facility
SEC – seconds
WB - westbound

Sources: Lambert Traffic Management Enhancement Project, 2017; WSP USA, September 2020 (analysis).

FUTURE CONDITIONS (2030 NO-BUILD)

Morning Peak Hour

The intersection volume, delay and LOS are summarized in **Table 4.3-6**. Each intersection operates at a LOS C or better during the AM peak hour for the 2030 No-Build condition. As shown, there is only a minor increase in delay at the intersection level, with LOS remaining at acceptable levels. Furthermore, most individual intersection movements operate at acceptable LOS throughout the day, with no movements degrading lower than LOS D compared to Existing (2019) conditions, as shown in **Table 4D-3** in Appendix 4D. Average queue lengths were evaluated to determine if any movement has excessive queueing or extends beyond provided storage bays. As shown in Table 4D-3, there is no excessive queueing during the morning peak hour in the study area.

Table 4.3-6: Morning Intersection Level of Service – 2030 No-Build

	INTERSECTION	VOLUME	DELAY (SEC)	LOS
1	Hunter Ave & Natural Bridge Rd	434	0.1	A
2	Natural Bridge Rd & I-70 WB Ramps	745	8.3	A
3	Lambert Intl Blvd & Cypress	841	5.4	A
4	Cypress Rd & I-70 EB Ramps	1,052	9.1	A
5	Lambert Intl Blvd & I-70 WB On Ramp	556	1.4	A
6	Lambert Intl Blvd & American Airlines/Cape Air MROs	686	4.2	A
7	Lambert Intl Blvd & Terminal 1 Exit	1,279	29.6	C
8	Air Flight Dr & I-70 Ramps	1,678	15.2	B
9	Pear Tree Dr & I-70 EB Off Ramp	1,222	14.7	B
10	Pear Tree Dr & Air Flight Dr	2,011	21.3	C
11	Natural Bridge & Edmundson	1,324	10.4	B
12	Lambert Intl Blvd & Terminal 2 Exit	1,506	18.1	B
13	Lambert Intl Blvd & Terminal 2 Garage Exit	1,133	3.7	A
14	Lambert Intl Blvd & Terminal 2 Entrance	1,383	24.0	C
15	Air Cargo Dr & Terminal 2	1,071	8.9	A

Notes:
EB - eastbound
LOS – level of service
MRO – Maintenance, Repair and Overhaul Facility
SEC – seconds
WB - westbound

Sources: Lambert Traffic Management Enhancement Project, 2017; WSP USA, September 2020 (analysis).

Afternoon Peak Hour

The intersection volume, delay and LOS are summarized in **Table 4.3-7**. Each intersection operates at a LOS C or better during the PM peak hour for the 2030 No-Build condition. As shown, there is only a minor increase in delay at the intersection level, with LOS remaining at acceptable levels. Furthermore, most individual intersection movements operate at acceptable LOS throughout the day, as shown in **Table 4D-4** in Appendix 4D.

Table 4.3-7: Afternoon Intersection Level of Service – 2030 No-Build

INTERSECTION		VOLUME	DELAY (SEC)	LOS
1	Hunter Ave & Natural Bridge Rd	995	0.4	A
2	Natural Bridge Rd & I-70 WB Ramps	1,363	11.0	B
3	Lambert Intl Blvd & Cypress	1,381	8.6	A
4	Cypress Rd & I-70 EB Ramps	1,414	17.0	B
5	Lambert Intl Blvd & I-70 WB On Ramp	1,186	3.2	A
6	Lambert Intl Blvd & American Airlines/Cape Air MROs	1,138	4.4	A
7	Lambert Intl Blvd & Terminal 1 Exit	2,004	30.4	C
8	Air Flight Dr & I-70 Ramps	1,810	20.2	C
9	Pear Tree Dr & I-70 EB Off Ramp	1,366	20.7	D
10	Pear Tree Dr & Air Flight Dr	2,330	32.2	D
11	Natural Bridge & Edmundson	1,887	31.8	D
12	Lambert Intl Blvd & Terminal 2 Exit	1,972	14.1	B
13	Lambert Intl Blvd & Terminal 2 Garage Exit	1,660	2.9	A
14	Lambert Intl Blvd & Terminal 2 Entrance	1,831	20.4	C
15	Air Cargo Dr & Terminal 2	964	11.4	B

Notes:
EB - eastbound
LOS – level of service
MRO – Maintenance, Repair and Overhaul Facility
SEC – seconds
WB - westbound

Sources: Lambert Traffic Management Enhancement Project, 2017; WSP USA, September 2020 (analysis).

The northbound through and right turn movements at Cypress and I-70 EB Ramp intersection degrade to LOS F, with 110.4 and 111.7 seconds of delay, respectively. In addition, the maximum queue lengths for these movements increase approximately 300 feet compared to Existing (2019) conditions. Average queue lengths for the remaining movements were evaluated to determine if any movement has excessive queueing or extends beyond provided storage bays. As shown in Table 4D-4, there are no other excessive queueing issues during the PM peak hour in the study area.

FUTURE CONDITIONS (2040 NO-BUILD)

Morning Peak Hour

The intersection volume, delay and LOS are summarized in **Table 4.3-8**. Each intersection operates at a LOS C or better during the AM peak hour for the 2040 No-Build condition.

Table 4.3-8: Morning Intersection Level of Service – 2040 No-Build

INTERSECTION		VOLUME	DELAY (SEC)	LOS
1	Hunter Ave & Natural Bridge Rd	466	0.1	A
2	Natural Bridge Rd & I-70 WB Ramps	798	9.0	A
3	Lambert Intl Blvd & Cypress	901	5.2	A
4	Cypress Rd & I-70 EB Ramps	1,126	9.9	A
5	Lambert Intl Blvd & I-70 WB On Ramp	595	1.6	A
6	Lambert Intl Blvd & American Airlines/Cape Air MROs	736	4.9	A
7	Lambert Intl Blvd & Terminal 1 Exit	1,371	30.2	C
8	Air Flight Dr & I-70 Ramps	1,791	17.3	B
9	Pear Tree Dr & I-70 EB Off Ramp	1,302	15.3	B
10	Pear Tree Dr & Air Flight Dr	2,145	22.6	C
11	Natural Bridge & Edmundson	1,417	11.3	B
12	Lambert Intl Blvd & Terminal 2 Exit	1,612	18.5	B
13	Lambert Intl Blvd & Terminal 2 Garage Exit	1,214	3.6	A
14	Lambert Intl Blvd & Terminal 2 Entrance	1,481	26..1	C
15	Air Cargo Dr & Terminal 2	1,147	9.0	A

Notes:
EB - eastbound
LOS – level of service
MRO – Maintenance, Repair and Overhaul Facility
SEC – seconds
WB - westbound

Sources: Lambert Traffic Management Enhancement Project, 2017; WSP USA, September 2020 (analysis).

As shown in **Table 4D-5** in Appendix 4D, there is only a minor increase in delay over 2030 No-Build conditions at the intersection level, with most LOSs remaining at acceptable levels. The northbound movements at Pear Tree Dr & Air Flight Dr degrade to LOS E. Average queue lengths for movements were evaluated to determine if any movement has excessive queueing or extends beyond provided storage bays. While average queue lengths would be expected to remain at acceptable levels, the maximum queue lengths during the peak hour would exceed storage bays and acceptable levels at numerous locations across the study area, as shown in Table 4D-5.

Afternoon Peak Hour

The intersection volume, delay and LOS are summarized in **Table 4.3-9**. Each intersection operates at a LOS D or better during the PM peak hour for the 2040 No-Build condition. As shown in **Table 4D-6** in Appendix 4D, there is a minor increase in delay at the intersection level, with a majority of LOS remaining at acceptable levels. The northbound movements at Pear Tree Dr & Air Flight Dr degrade to LOS F, compared to from 2030 No-Build conditions. Average queue lengths for movements were evaluated to determine if any movement has excessive queueing or extends beyond provided storage bays. While average queue lengths would be expected to remain at acceptable levels, the maximum queue lengths during the peak hour would exceed storage bays and acceptable levels at numerous locations across the study area, as shown in Table 4D-6.

Table 4.3-9: Afternoon Intersection Level of Service – 2040 No-Build

	INTERSECTION	VOLUME	DELAY (SEC)	LOS
1	Hunter Ave & Natural Bridge Rd	1,064	0.4	A
2	Natural Bridge Rd & I-70 WB Ramps	1,461	12.4	B
3	Lambert Intl Blvd & Cypress	1,476	9.6	A
4	Cypress Rd & I-70 EB Ramps	1,514	19.4	B
5	Lambert Intl Blvd & I-70 WB On Ramp	1,267	3.8	A
6	Lambert Intl Blvd & American Airlines/Cape Air MROs	1,216	4.9	A
7	Lambert Intl Blvd & Terminal 1 Exit	2,139	31.1	C
8	Air Flight Dr & I-70 Ramps	1,881	26.5	C
9	Pear Tree Dr & I-70 EB Off Ramp	1,451	35.2	D
10	Pear Tree Dr & Air Flight Dr	2,423	44.1	D
11	Natural Bridge & Edmundson	1,918	37.9	D
12	Lambert Intl Blvd & Terminal 2 Exit	2,096	14.7	B
13	Lambert Intl Blvd & Terminal 2 Garage Exit	1,759	3.1	A
14	Lambert Intl Blvd & Terminal 2 Entrance	1,946	21.8	C
15	Air Cargo Dr & Terminal 2	1,023	11.9	B

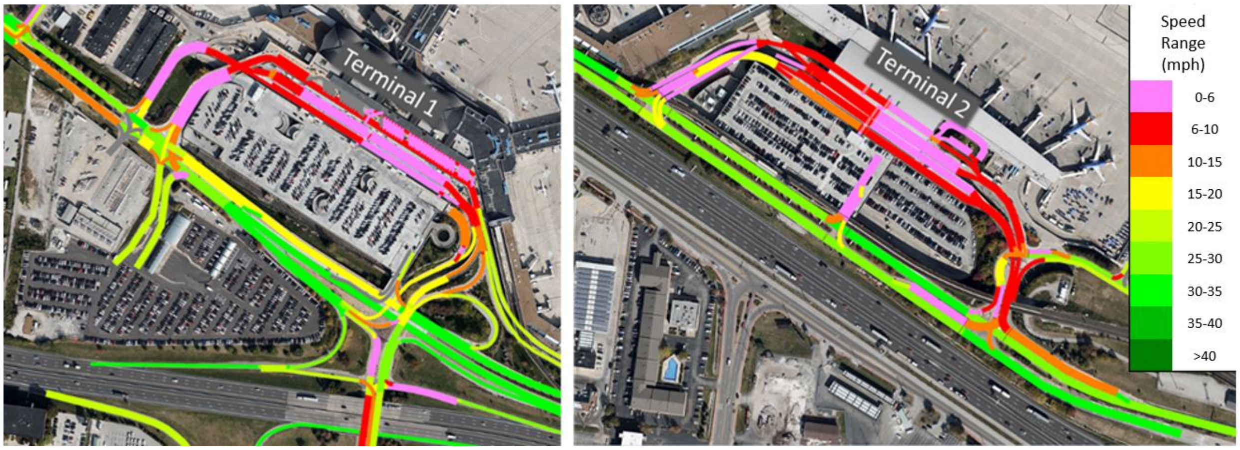
Notes:
EB - eastbound
LOS – level of service
MRO – Maintenance, Repair and Overhaul Facility
SEC – seconds
WB - westbound

Sources: Lambert Traffic Management Enhancement Project, 2017; WSP USA, September 2020 (analysis).

TERMINAL ROADWAY ANALYSIS RESULTS

Figure 4.3.18 depicts screen shots of VISSIM showing congestion during the Afternoon Peak at each terminal.

Figure 4.3.18: Afternoon Peak - Terminals 1 and 2 VISSIM Speed Heat Maps



Source: WSP USA, 2022.

SUMMARY OF ROADWAY FACILITY REQUIREMENTS

- Existing (2019) Morning and Afternoon Peak Hours:
  - Each intersection operates at a LOS C or better during the morning and afternoon peak hours.
  - Most individual intersection movements operate at acceptable LOS throughout the day, and no movement is over capacity.
- 2030 Morning Peak Hour:
  - Each intersection operates at a LOS C or better during the morning peak hour.
  - Most individual intersection movements operate at acceptable LOS throughout the day, with no movements degrading lower than LOS D.
- 2030 Afternoon Peak Hour:
  - Each intersection operates at a LOS C or better during the afternoon peak hour.
  - Most individual intersection movements operate at acceptable LOS throughout the day. The northbound through and right turn movements at Cypress and I-70 EB Ramp intersection degrade to LOS F.
- 2040 Morning Peak Hour:
  - Each intersection operates at a LOS C or better during the morning peak hour.
  - Most individual intersection movements operate at acceptable LOS throughout the day. The northbound movements at Pear Tree Dr & Air Flight Dr degrade to LOS E.
- 2040 Afternoon Peak Hour:
  - Each intersection operates at a LOS D or better during the afternoon peak hour.
  - Most individual intersection movements operate at acceptable LOS throughout the day, and no movement is over capacity

Table 4.3-10 summarizes overall intersection levels of service.

Table 4.3-10: Summary of Intersection Level of Service

		MORNING PEAK HOUR						AFTERNOON PEAK HOUR					
		Existing (2019)		2030 – No Build		2040 – No Build		Existing (2019)		2030 – No Build		2040 – No Build	
INTERSECTION		VOLUME	LOS	VOLUME	LOS	VOLUME	LOS	VOLUME	LOS	VOLUME	LOS	VOLUME	LOS
1	Hunter Ave & Natural Bridge Rd	402	A	434	A	466	A	920	A	995	**A**	1,064	A
2	Natural Bridge Rd & I-70 WB Ramps	689	A	745	A	798	A	1,261	A	1,363	B	1,461	B
3	Lambert Intl Blvd & Cypress	779	A	841	A	901	A	1,275	A	1,381	A	1,476	A
4	Cypress Rd & I-70 EB Ramps	971	A	1,052	A	1,126	A	1,304	B	1,414	B	1,514	B
5	Lambert Intl Blvd & I-70 WB On Ramp	513	A	556	A	595	A	1,092	A	1,186	A	1,267	A
6	Lambert Intl Blvd & American Airlines/Cape Air MROs	633	A	686	A	736	A	1,049	A	1,138	A	1,216	A
7	Lambert Intl Blvd & Terminal 1 Exit	1,181	C	1,279	C	1,371	C	1,849	C	2,004	C	2,139	C
8	Air Flight Dr & I-70 Ramps	1,551	B	1,678	B	1,791	B	1,687	B	1,810	C	1,881	C
9	Pear Tree Dr & I-70 EB Off	1,125	B	1,222	B	1,302	B	1,262	B	1,366	C	1,451	D
10	Pear Tree Dr & Air Flight Dr	1,856	C	2,011	C	2,145	C	2,165	C	2,330	C	2,423	D
11	Natural Bridge & Edmundson	1,224	B	1,324	B	1,417	B	1,759	B	1,887	C	1,918	D
12	Lambert Intl Blvd & Terminal 2	1,392	B	1,506	B	1,612	B	1,824	B	1,972	B	2,096	B
13	Lambert Intl Blvd & Terminal 2 Garage Exit	1,045	A	1,133	A	1,214	A	1,535	A	1,660	A	1,759	A
14	Lambert Intl Blvd & Terminal 2	1,278	C	1,383	C	1,481	C	1,692	B	1,831	C	1,946	C
15	Air Cargo Dr & Terminal 2	989	A	1,071	A	1,147	A	890	B	964	B	1,023	B

Notes:

EB - eastbound

LOS – level of service

MRO – Maintenance, Repair and Overhaul Facilities

Volume = number of vehicles

SEC – seconds

WB - westbound

Sources: Lambert Traffic Management Enhancement Project, 2017; WSP USA, September 2020 (analysis).

4.3.3 TERMINAL CURBSIDE

The terminal curbs provide the interface between non-parked vehicles and the terminal. The curb consists of both pedestrian facilities (sidewalk) and vehicle facilities (pick-up/drop-off lanes and through-traffic lanes).

4.3.3.1. EXISTING CURB CONFIGURATIONS

Most of the terminal curbs at both terminals have fewer lanes than typically recommended. For curbs being used by the public for drop-off and/or pickup (including TNCs), four lanes are recommended. This allows double parking at the curb, a maneuvering lane, and a lane for through traffic. For curbs used exclusively by commercial vehicles (shuttles, buses, etc.) three lanes are recommended. This assumes assigned curb locations (such as at STL) and brief stops when double parked.

Curbs serving Terminal 1 are configured as follows:

- The upper-level departures curb has an atypical configuration consisting of two through/bypass lanes, 39 pull-through spaces and an exit lane. Private vehicles and many commercial vehicles drop off departing passengers at this curb. TNCs also pick up on the upper-level departures curb. The roadway is located over a portion of the baggage claim area of the terminal.
- The lower-level inner arrivals curb consists of three lanes. It is divided into zones for private vehicles, hotel shuttles, TNCs, and on-Airport parking shuttles.
- The lower-level outer arrivals curb has two lanes. The curb is used for rental car and off-Airport parking shuttles.

Terminal 2 curbs are configured slightly differently than at Terminal 1:

- The upper-level departures curb was converted from the Terminal 1-style configuration to a conventional four-lane curb directly in front of the terminal functioning as described above. It is used by private vehicles and some commercial modes (taxis, limos, etc.). There is a separate drop-off area for commercial shuttles on the lower-level curb.
- The lower inner arrivals curb mostly consists of two lanes, divided into zones for hotel shuttles, rental car shuttles, and on-Airport parking shuttles. A separate area has pick-up spaces for terminal shuttles and off-Airport parking shuttles.
- The lower-level outer arrivals curb has two lanes for curb use and a third lane dedicated to garage entry. The curb is used for TNCs and private vehicles.

At both terminals, taxis and limos/black cars pick up passengers in the garages at designated locations.

STLAA has historically elected not to install pedestrian sidewalks or bike lanes due to roadway and other constraints.

4.3.3.2 CURB LENGTH REQUIREMENTS

The preferred approach to develop terminal curb requirements is to do activity surveys during busy travel periods.

- Surveys would include counts of vehicles and dwell times, reported separately by major vehicle type. Counts would be done in 15-minute intervals to establish peaking within busy hours.
- Actual passenger enplanements and deplanements for those days would be obtained from the airlines. If actual counts cannot be obtained, estimates can be made based on scheduled seats and agreed busy day load factors.
- From this data, peak hour curb demands can be calculated, and factors relating curb frontage to peak hour passengers developed. These factors can then be applied to design hours in the forecast years.

Unfortunately, these types of surveys could not be conducted due to the reduced traffic loads during the COVID-19 pandemic, nor data made available to the planning team.

AVAILABLE DATA

The available information is as follows:

- Vehicle classification counts were conducted for departures and arrivals as part of two separate studies:
  - *Terminal 2 Transportation Study,* CBB, October 2018: counts conducted at Terminal 2 in June 2018.
  - *Vendor Due Diligence Report*, Ricondo, December 2019: counts conducted at Terminal 1 in January 2019.

  The 2019 study divided some of the types finer than the 2018 study, but for forecast purposes, they can be equated. There are some differences, but an average of the observations can be used to estimate the modal splits.
- The 2019 study reported counts in 15-minute intervals for two hours at departures and 90 minutes for arrivals on a weekday. The 15-minute volume concentration relative to hourly volumes can be determined for Terminal 1. The peak 15-minute volumes were in the range of 28-33 percent of the average hour, which is typical. Departures were counted in the morning, and arrivals in the afternoon.
- The 2018 study reported counts in aggregate for three hours on a Thursday morning, and three hours on a Sunday afternoon. The arrivals curb counts for the Thursday morning may not be typical of normal arrivals peaks. The best estimates for Terminal 2 counts are averages of the three hours.
- Curb lengths (and number of pull-through departures spaces) for Terminal 1 can be measured from Google Earth photos. The Terminal 2 lower-level arrivals curb is under the upper-level departures roadway, and STLAA data sources were used for measurements.

As noted, the commercial vehicle types have assigned pick-up/drop-off zones on the lower arrivals levels of both terminals. Thus, the amount of curb length required from these users is independent of the actual vehicle volume. The Terminal 2 curbs were recently reconfigured with new signage, providing a basis for the number of curb spaces for each commercial vehicle type. Assigned curb spaces on the lower-level arrivals curbs apply to the following mode types:

- Rental Car shuttles: 1 per on-Airport company (6) plus 2 for other companies

- On-Airport Parking shuttles (including employees): per lot location (5)
- Terminal shuttle buses (2)
- Off-Airport parking shuttles (4). These would be demand-based for planning.
- Hotel shuttles (2). These would be demand-based for planning.

TNCs are supposed to pick-up and drop-off at designated curb zones (Terminal 1 upper-level departures curb and Terminal 2 lower-level arrivals curb). It is often difficult, however, to determine if a vehicle is private or a TNC when dropping off on a departures curb.

To allow as much of an "apples to apples" comparison of curb survey data taken at Terminal 1 and Terminal 2, the separate counts for Terminal 1 (private, TNC, limos and taxis) are grouped to compare to the counts for cars at Terminal 2.

CURB FACTOR CALCULATION APPROACH

Based on the above data limitations, the following approach was used:

- The vehicle counts were not reported with related terminal activity. Complicating this further are the dates the counts were taken. An off-peak month for Terminal 1 and a busy month, but a year earlier, for Terminal 2.
  - The peak hours for passenger activity (seats) from the July 2019 Design Day Flight Schedules (DDFS) with a 90 percent load factor that was previously assumed for other "existing conditions" terminal facilities were used. This establishes the 2019 Design Hour passengers.
  - July 2019 monthly enplanement data was established as the basis = 1.0. The ratio of monthly enplanements for January 2019 (Terminal 1) and June 2018 (Terminal 2) compared to July 2019 was used to estimate the peak hour passengers during the 2018 and 2019 studies survey periods. For example, during the survey month of January 2019, passenger enplanements were 546,549, as compared to 739,288 enplanements in the July 2019 base year, or a factor of 0.739. This factor can then be applied to the departures and arrivals peak hour passengers for the Design Month to estimate the passengers corresponding to the curb survey times.

  Table 4.3-11 summarizes the estimated number of peak hour passengers for the survey periods.
- The vehicle hourly average counts from the 2018 and 2019 studies were compared to the estimated peak hour passengers. This resulted in factors of vehicles to design hour passengers for each terminal. Factors were developed separately for arrivals and departures, and for each vehicle class that does not have a fixed number of curb spaces.

  Table 4.3-12 summarizes the estimated number of vehicles per design hour passenger.

Table 4.3-11: Estimated Number of Peak Hour Passengers

Design Month - July 2019		
Total enplanements	739,288	
Curb Survey Month Enplanements		
T-1 - January 2019 total enplanements	546,549	
= T-1 adjustment factor	0.739	
T-2 - June 2018 total enplanements	731,211	
= T-2 adjustment factor	0.989	
Terminal 1 Passengers for Survey Counts		
Departures Level Roadway		
Design Month early morning departures peak	1,851	seats
@ 90% L.F. =	1,670	passengers
Adjusted to Survey Month	**1,230**	passengers
Arrivals Level Roadway		
Design Month early afternoon arrivals peak	672	seats
@ 90% L.F. =	600	passengers
Adjusted to Survey Month	**440**	passengers
Terminal 2 Passengers for Survey Counts		
Departures Level Roadway		
Design Month early morning departures peak	2,209	seats
@ 90% L.F. =	1,990	passengers
O&D passengers @ 62% [1]	1,230	passengers
Adjusted to Survey Month	**1,220**	passengers
Design Month mid-day departures peak	1,876	seats
@ 90% L.F. =	1,690	passengers
O&D passengers @ 62%	1,050	passengers
Adjusted to Survey Month	**1,040**	passengers
Arrivals Level Roadway		
Design Month early morning arrivals peak	2,034	seats
@ 90% L.F. =	1,830	passengers
O&D passengers @ 62%	1,130	passengers
Adjusted to Survey Month	**1,120**	passengers
Design Month mid-day arrivals peak	1,733	seats
@ 90% L.F. =	1,560	passengers
O&D passengers @ 62%	970	passengers
Adjusted to Survey Month	**960**	passengers

[1] - Terminal 2 O&D percentage for July 2019, source: STLAA

Source: Hirsh Associates, December 2020.

Table 4.3-12: Estimated Number of Vehicles per Design Hour Passengers

Terminal 2 - June 2018

Thursday - 0700 - 1000	Departures	Arrivals	
Cars	665	633	
Hourly average	222	211	cars
Adjusted design hour passengers	1,220	1,040	passengers
= vehicles per design hour passenger	**0.18**	**0.20**	cars/passenger
Off-Airport Parking shuttles	141	134	
Hotel shuttles	39	42	
Total -	180	176	shuttles
Hourly average	60	59	shuttles
Adjusted design hour passengers	1,220	1,040	passengers
= vehicles per design hour passenger	**0.05**	**0.06**	shuttles/passenger

Sunday - 1200 - 1500	Departures	Arrivals	
Cars	1,015	834	
Hourly average	338	278	cars
Adjusted design hour passengers	1,120	960	passengers
= vehicles per design hour passenger	**0.30**	**0.29**	cars/passenger
Off-Airport Parking shuttles	133	151	
Hotel shuttles	24	55	
Total -	157	206	shuttles
Hourly average	52	69	shuttles
Adjusted design hour passengers	1,120	960	passengers
= vehicles per design hour passenger	**0.05**	**0.07**	shuttles/passenger

Source: Hirsh Associates, December 2020.

- Vehicle dwell times were not reported for either terminal in either study. Typical dwell times were used in place of actual data. These came from other airport surveys:
  - WSP conducted curb activity surveys at San Antonio International Airport (SAT) in June 2018. These surveys were considered appropriate for Terminal 1.
  - Corgan did a review of CBB's plans for Terminal 2 and utilized dwell times from their observations at Dallas Love Field (DAL) for private cars, TNCs and taxis. These were considered appropriate for Terminal 2.
  - Dwell times for shuttles without assigned spaces (hotels, off-airport parking lots, etc.) were taken from the SAT surveys.
- Using this data, curb length requirements were estimated for 2019 Design Day conditions. **Table 4.3-13** summarizes the terminal curb planning factors.
- Terminal 1 has the unusual departures configuration of pull-thru spaces for most vehicles. Terminal 2 has been re-configured to a conventional configuration of four lanes which can provide more effective capacity during peak hours: LOS C in peak hours (10-30% double parking). A similar four lane, conventional configuration for Terminal 1 has been assumed for planning where the private vehicles operate. For commercial vehicle curbs, a three-lane configuration without double parking has been assumed.

RESULTS

These curb factors were applied to each terminal and for a potential single terminal. For the single terminal, factors from Terminal 1 were used for the variable demand curbs. For all forecast years, the arriving commercial curb includes 15 assigned shuttle spaces (35 feet in length each). **Table 4.3-14** summarizes curb length requirements, color coded to reflect the Level of Service (LOS) based on the ratio of existing to forecast required lengths.

Table 4.3-14 indicates that the Terminal 2 arrivals curb has adequate lengths. However, this assumes that there are an adequate number of lanes: four for the public curb and three for the commercial curb, to provide acceptable levels of service (LOS C). In reality, the inner commercial curb only has two lanes, which is marginal for busy period operations. The outer public curb has two lanes for active use, with a third lane dedicated to garage access. While this lane is often used for bypass traffic for most of its length, it chokes down at the end of the curb. Even if garage access is closed, a three-lane public curb is not optimal for a high-volume curb such as Terminal 2. Thus, the seemingly adequate arrivals curb lengths for Terminal 2 in the table overstate the landside capacity.

Terminal 1 also only has three lanes for public arrivals (as well as some commercial vehicles), and an outer curb of only two lanes for some commercial vehicles. As with Terminal 2, these configurations do not achieve acceptable LOS.

Table 4.3-13: Terminal Curb Planning Factors

Terminal 1 - Departures

2019 Design Day

Departures peak hour	1,851	seats
@ 90% L.F. =	1,670	passengers
O&D passengers @ 100%	1,670	passengers

Vehicle Type	Vehicles per passenger	Design Hour Vehicles	Peak 15 Minutes 30%	Vehicle Dwell Time (min.)	Peak 15 Min. Demand in Minutes	Vehicle Length (ft)	Peak 15 Min. Demand (ft)
Private Vehicles, TNCs & taxis	0.24	401	120	2.1	252	25	425
Shuttles	0.05	84	25	1.5	38	35	105
Total		485	145				530

Required LOS 'C' Curbfront from: 410 ft to: 480 ft

Departures Curb Planning Factor:

Design Hour Pax	1,670	enplaned pax
LOS 'C' curbfront	480	LF
=>	**0.29**	**LF/design hour enplaned pax**

Terminal 1 - Arrivals

2019 Design Day

Arrivals peak hour	1,421	seats
@ 90% L.F. =	1,280	passengers
O&D passengers @ 100%	1,280	passengers

Vehicle Type	Vehicles per passenger	Design Hour Vehicles	Peak 15 Minutes 30%	Vehicle Dwell Time (min.)	Peak 15 Min. Demand in Minutes	Vehicle Length (ft)	Peak 15 Min. Demand (ft)
Private Vehicles, TNCs & taxis	0.40	512	154	1.8	277	25	450
Total		512	154				450

Required LOS 'C' Curbfront from: 350 ft to: 410 ft

Arrivals Public Curb Planning Factor:

Design Hour Pax	1,280	enplaned pax
LOS 'C' curbfront	410	LF
=>	**0.32**	**LF/design hour enplaned pax**

Vehicle Type	Vehicles per passenger	Design Hour Vehicles	Peak 15 Minutes 30%	Vehicle Dwell Time (min.)	Peak 15 Min. Demand in Minutes	Vehicle Length (ft)	Peak 15 Min. Demand (ft)
Shuttles	0.05	64	19	1.6	30	35	70
Total		64	19				70

Required LOS 'C' Curbfront from: 70 ft to: 80 ft

single parking allowed

Arrivals Commercial Curb Planning Factor:

Design Hour Pax	1,280	enplaned pax
LOS 'C' curbfront	80	LF
=>	**0.06**	**LF/design hour enplaned pax**

Terminal 2 - Departures

2019 Design Day

Departures peak hour	2,209	seats
@ 90% L.F. =	1,990	passengers
O&D passengers @ 62%	1,230	passengers

Vehicle Type	Vehicles per passenger	Design Hour Vehicles	Peak 15 Minutes 30%	Vehicle Dwell Time (min.)	Peak 15 Min. Demand in Minutes	Vehicle Length (ft)	Peak 15 Min. Demand (ft)
Private Vehicles, TNCs & taxis	0.24	296	89	1.8	160	25	275
Shuttles	0.05	62	19	1.5	29	35	70
Total		358	108				345

Required LOS 'C' Curbfront from: 270 ft to: 310 ft

Departures Curb Planning Factor:

Design Hour Pax	1,230	enplaned pax
LOS 'C' curbfront	310	LF
=>	**0.25**	**LF/design hour enplaned pax**

Terminal 2 - Arrivals

2019 Design Day

Arrivals peak hour	2,066	seats
@ 90% L.F. =	1,860	passengers
O&D passengers @ 62%	1,150	passengers

Vehicle Type	Vehicles per passenger	Design Hour Vehicles	Peak 15 Minutes 30%	Vehicle Dwell Time (min.)	Peak 15 Min. Demand in Minutes	Vehicle Length (ft)	Peak 15 Min. Demand (ft)
Private Vehicles, TNCs & taxis	0.40	512	154	1.8	277	25	450
Total		512	154				450

Required LOS 'C' Curbfront from: 350 ft to: 410 ft

Arrivals Public Curb Planning Factor:

Design Hour Pax	1,150	enplaned pax
LOS 'C' curbfront	410	LF
=>	**0.36**	**LF/design hour enplaned pax**

Vehicle Type	Vehicles per passenger	Design Hour Vehicles	Peak 15 Minutes 30%	Vehicle Dwell Time (min.)	Peak 15 Min. Demand in Minutes	Vehicle Length (ft)	Peak 15 Min. Demand (ft)
Shuttles	0.05	64	19	1.6	30	35	70
Total		64	19				70

Required LOS 'C' Curbfront from: 70 ft to: 80 ft

single parking allowed

Arrivals Commercial Curb Planning Factor:

Design Hour Pax	1,150	enplaned pax
LOS 'C' curbfront	80	LF
=>	**0.07**	**LF/design hour enplaned pax**

Source: Hirsh Associates, December 2020.

Table 4.3-14: Terminal Curb Length Requirements

	Existing Facilities In Use	Recommended Facilities: Base Year 2019	Forecast Year 2025	Forecast Year 2030	Forecast Year 2040	
Terminal 1						
Design Hour O&D Passengers						
Enplaned		1,670	1,550	1,580	1,720	
Deplaned		1,280	1,170	1,150	1,310	
Terminal Curbs [1,4]						
Departing Curb [2]	830	480	450	460	500	LF
Arriving Public Curb [2]	240	410	370	370	420	LF
Arriving Commercial Curb [3]	1,180	600	600	590	600	LF
Terminal 2						
Design Hour O&D Passengers						
Enplaned		1,250	1,300	1,300	1,470	
Deplaned		1,170	1,180	1,190	1,470	
Terminal Curbs [1,4]						
Departing Curb [2]	410	310	330	330	370	LF
Arriving Public Curb [2]	460	410	410	420	510	LF
Arriving Commercial Curb [3]	730	610	610	610	630	LF
Single Terminal						
Design Hour O&D Passengers						
Enplaned		2,000	1,990	2,020	2,300	
Deplaned		2,200	2,170	2,100	2,220	
Terminal Curbs [1]						
Departing Curb [2]	na	580	580	590	670	LF
Arriving Public Curb [2]	na	770	760	740	780	LF
Arriving Commercial Curb [3]	na	680	680	670	680	LF

Notes:

1 - Cross walks (typical 15'-20' each) would be in addition depending on configuration.

2 - Assumes a 4 lane curbside roadway where double parking is allowed - ACRP 40.

3 - Arriving Commercial curb includes 15 assigned shuttle spaces @ 35' each.
Assumes a 3 lane roadway with a single parking curb - ACRP 40.

4 - Existing curb lengths indicate that the Terminal 2 arrivals curbs have adequate lengths. However, this assumes that there are an adequate number of lanes: 4 for the public curb and 3 for the commercial curb to provide acceptable levels of service (LOS C). In reality, the inner commercial curb only has 2 lanes which is marginal for busy period operations. The outer public curb has 2 lanes for active use with a third lane dedicated to garage access. While this lane is often used for bypass traffic for most of its length, it chokes down at the end of the curb. Even if garage access is closed, a three lane public curb is not optimal for a high volume curb such as Terminal 2. Thus, the seemingly adequate arrivals curbs for Terminal 2 in the table overstate the landside capacity.
Terminal 1 also only has 3 lanes for public arrivals (as well as some commercial vehicles), and an outer curb of only 2 lanes for some commercial vehicles. As with Terminal 2, these configurations do not achieve acceptable LOS.

Source: Hirsh Associates, October 2021.

SUMMARY OF TERMINAL CURBSIDE REQUIREMENTS

- Curb length for departing passengers would be adequate at both terminals if Terminal 1 is reconfigured to a conventional four-lane curb, similar to recent improvements at Terminal 2.
- The arriving public vehicle curb length is undersized at Terminal 1 for current levels of activity and would become undersized at Terminal 2 by the end of the planning period. However, there are an insufficient number of lanes at both terminals to allow efficient vehicle maneuvering, and to be able to use the length to its full capacity.
- There is sufficient curb length for commercial vehicles on the arrivals levels of both terminals. However, there is an insufficient number of lanes at both terminals to allow efficient vehicle maneuvering, and to be able to use the length to its full capacity.

4.3.4 SUMMARY OF ACCESS AND TERMINAL AREA ROADWAYS REQUIREMENTS

- Roadway geometry:
  - Intersections:
    - Airport Rd. and McDonnell Blvd.:
      (a) Northbound intersection leg of McDonnell Blvd. to eastbound Airport Rd. heading towards the interstate: insufficient width of turning lane
      (b) Insufficient shoulder width for the four quadrants
      (c) Signal equipment is old and rusted
      (d) Intersection does not have ADA/pedestrian features
      (e) St. Louis County Highways has designated this intersection as a “hot spot” due to the annual volume of motor vehicle crashes.
    - Pear Tree Dr. intersection with EBEX: surrounding curbs have lost standard height
    - Missouri Bottom Rd./Banshee Rd. and Lindbergh Blvd. intersection has been designated by St. Louis County Highways as a “hot spot” due to the annual volume of motor vehicle crashes.
  - Ramps:
    - EBEN Loop:
      (a) The ramp’s operational speed is 20 mph (acceptable range of speed is 35-60 mph)
      (b) The acceleration speed change lane is 480 feet long (instead of 1,100 feet)
      (c) The degree of divergence is 9.5 (instead of 6 degrees maximum)
  - Roadways:
    - Lambert International Blvd.:
      (a) The centerline curve adjacent to the Terminal 1 Cell Phone Lot does not meet horizontal sight distance (fence and trees partial obscuration).

(b) The signalized intersections are spaced too closely in front of and west of Terminal 1 (maximum spacing provided is 995 feet, for a minimum requirement of 1,320 feet).

(c) The signalized intersections are spaced too closely in front of Terminal 2 (maximum spacing provided is 684 feet, for a minimum requirement of 1,320 feet).

(d) Sidewalks are intermittently placed to the north and south of LIB, they are riddled with light standards, signal equipment, lack width adjacent to the roadway, and do not feature proper ADA ramps and detectable warnings.

- Airflight Dr.:

(a) The 13-foot bridge clearance under I-70 does not meet 14.5-foot standard.

(b) The 550-foot separation between the interchange ramp terminals along Airflight Dr. does not meet the minimum distance of 800 feet.

- Airport Rd.:

(a) No outside shoulders (10-feet standard, or 2-foot shy distance from the curb line).

(b) The 250-foot spacing between signalized intersections at the entrance to McDonnell Douglas and McDonnell Blvd. does not meet the minimum spacing of 1,320 feet.

- Roadway intersections:
  - 2030:
    - Morning Peak Hour: Most individual intersection movements operate at acceptable LOS throughout the day, with no movements degrading lower than LOS D.
    - Afternoon Peak Hour: The northbound through and right turn movements at Cypress and I-70 EB Ramp intersection degrade to LOS F.
  - 2040:
    - Morning Peak Hour: The northbound movements at Pear Tree Dr & Air Flight Dr degrade to LOS E.
    - Afternoon Peak Hour: Each intersection operates at a LOS D or better during the afternoon peak hour.
- Terminal curbsides:
  - Curb length for departing passengers would be adequate at both terminals if Terminal 1 is reconfigured to a conventional 4-lane curb, similar to recent improvements at Terminal 2.
  - The arriving public vehicle curb length is undersized at Terminal 1 for current levels of activity and would become undersized at Terminal 2 by the end of the planning period. However, there are an insufficient number of lanes at both terminals to allow efficient vehicle maneuvering, and to be able to use the length to its full capacity.
  - There is sufficient curb length for commercial vehicles on the arrivals levels of both terminals. However, there is an insufficient number of lanes at both terminals to allow efficient vehicle maneuvering, and to be able to use the length to its full capacity.

4.4 GROUND TRANSPORTATION CENTER

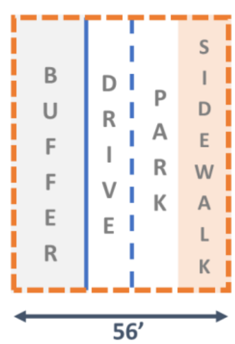
A Ground Transportation Center (GTC) can extend the available capacity of the existing roadways and curbsides in the terminal area. There is no GTC at STL today. STL staff expressed interest in moving some transportation modes from the terminal curbside to a GTC, to alleviate roadway and curbside congestion. At STL, a GTC would accommodate taxi/TNC pick-ups, hotel/rental car/parking shuttles, buses, limos, and shared ride vans.

Sizing requirements for a GTC are driven by flexible factors such as passenger enplanements, type of user, and dwell time. As shown in **Table 4.4-1**, the number of spaces needs were assessed for each mode of transportation, and a vehicle length identified for each. From there, total required curb length was determined. Approximately 3,115 linear feet of curb are anticipated to be required for the STL GTC.

Table 4.4-1: Ground Transportation Center Curb Requirement

MODE	EXISTING (T1 AND T2)	2040 NEEDS	VEHICLE LENGTH (FT)	REQUIRE CURB LENGTH (FT)
TNC	30	40	25	1,000
Taxi	15	15	25	375
Limo	10	8	35	280
On-airport parking shuttles	11	6	35	210
Off-airport parking shuttles	13	8	35	280
RAC shuttles	18	12	35	420
Hotel shuttles	5	6	35	210
Shared ride vans		2	35	70
Scheduled buses		2	60	120
Charter buses	2	3	50	150
				3,115

Source: WSP USA, 2022.



A building size ratio of 56 sq. ft. per linear foot of required curbside was calculated. It accounts for a 13-ft. sidewalk, 12-ft. parking lane, 12-ft. driving lane, and an extra 50 percent for circulation. This ratio was applied to the required curb length of 3,115 ft, for a proposed GTC size is approximately 175,000 sq. ft.

It should be noted that should a GTC be constructed at STL, the three commercial arrival lanes planned for the terminal curbside lower lane can be eliminated, as these vehicles would be accommodated in the GTC.

4.5 AUTOMOBILE PARKING FACILITIES

As passenger travel increases at STL, the demand for short-term and long-term parking is anticipated to also increase. Estimating future parking demand provides a basis for planning additional parking supply and dedicating the needed funding to construct the parking infrastructure.

Parking supply at STL consists of airport-operated and privately-operated public parking facilities, as well as commercial staging lots for taxis and TNCs. Employees park in the public parking facilities.

General automobile parking concerns are:

- Parking garages ingress/egress points
- Revenue opportunities to off-airport lots
- Insufficient supply at Terminal 2
- Insufficient mix of products that cater to consumer desires
- Locations of parking facility too distant from terminals

4.5.1 PUBLIC PARKING

EXISTING PUBLIC PARKING UTILIZATION

IDENTIFICATION OF PEAK MONTH AND PEAK DAY

The identification of the existing peak parking utilization of the Airport-operated facilities overall and at each location was based on the analysis and evaluation of historical 2018 and 2019 daily parking transaction data. The data was obtained via the Airport Parking Access and Revenue Control System (PARCS) for a period of 24 consecutive months, from January 2018 through December 2019.

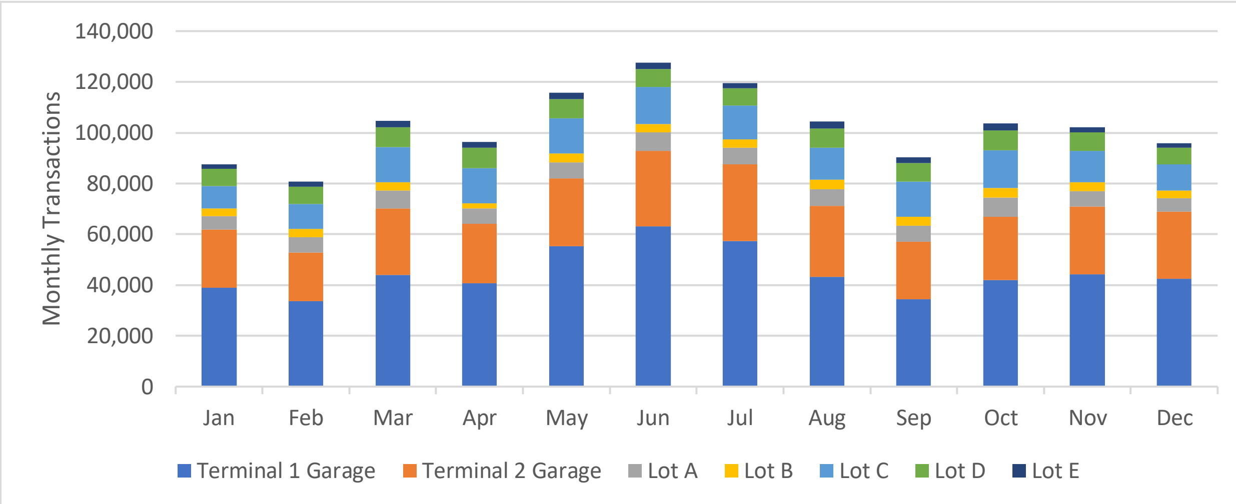
The two years of data were reviewed to first identify the peak day and month of operation by location. A monthly average number of transactions was calculated using the two years of data. **Figure 4.4-1** illustrates the average monthly parking transactions for 2018 and 2019.

June averaged the highest number of transactions, with July second and May third.

Figure 4.4-**Figure 4.4-2** shows the average parking transactions for each day of the week for 2018 and 2019. Thursday represents the busiest weekday, which is slightly higher than Friday, followed by Sunday as the busiest weekend day.

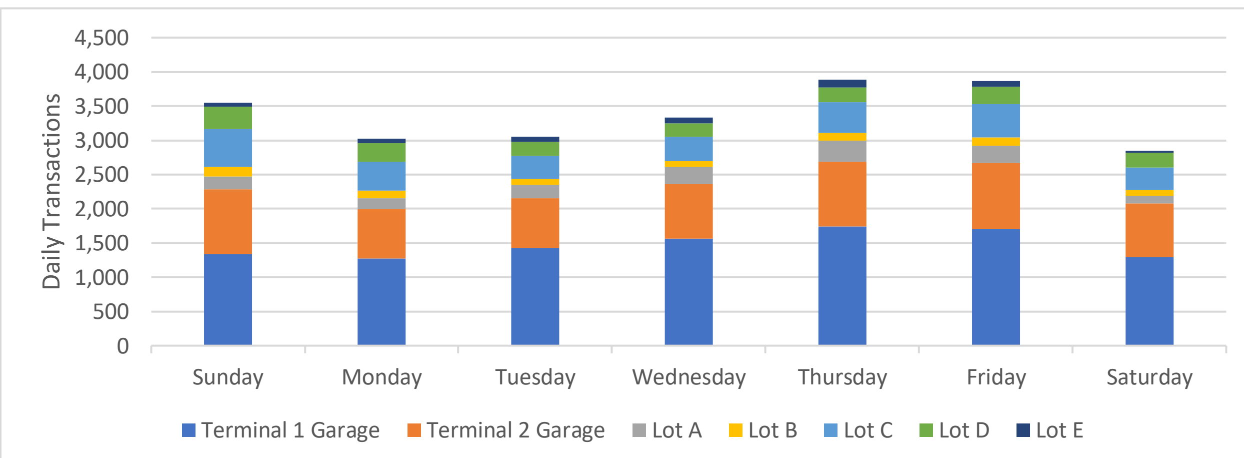
Based on the information shown in Figure 4.4-1 and Figure 4.4-2, the parking analysis focused on data recorded during the month of June and data recorded on Thursdays, as the peak month and day of the year, respectively.

Figure 4.4-1: Average Monthly Parking Transactions (2018 and 2019)



Sources: St. Louis Lambert International Airport, Airport Parking Access and Revenue Control System, 2018-2019 (transaction data); WSP USA, October 202 (analysis).

Figure 4.4-2: Average Daily Parking Transactions (2018 and 2019)



Sources: St. Louis Lambert International Airport, Airport Parking Access and Revenue Control System, 2018-2019 (transaction data); WSP USA, October 2020 (analysis).

PARKING DATA EVALUATION AND ANALYSIS

Hourly parking transaction data is needed to calculate parking utilization by the hour at each facility, and to identify when the peak utilization occurs by facility and overall. Two sets of data are provided.

- Data Set 1: Transactions by entry and exit were provided for each facility in hourly intervals; and
- Data Set 2: Daily parking transaction for year 2018 and 2019 from Airport PARCS.

Profiles were created for the 24-hour entry and exit transaction data for each facility to estimate the parking occupancy and peak utilization from Data Set 1. Based on the raw data review, it was noted that the exit transaction data was unreasonably low (indicating some exits were not counted accurately compared with the daily parking transactions from PARCS). For example, Terminal 1 Garage, Terminal 2 Garage, and Lot C display a substantial difference when comparing Data Set 1 and Data Set 2, as shown in **Table 4.4-1**.

Table 4.4-1: Exiting Daily Vehicular Data Comparisons (June 14, 2018)

FACILITY	DATA SET 1 24-HOUR EXIT TRANSACTION DATA*	DATA SET 2 DAILY REVENUE TRANSACTION DATA	DIFFERENCE
Terminal 1 Garage	165	1,905	1740
Terminal 2 Garage	698	1,173	475
Lot A	200	364	164
Lot B	86	109	23
Lot C	323	592	269
Lot D	213	209	-4
Lot E	233	136	-97

Sources: St. Louis Lambert International Airport, Airport Parking Access and Revenue Control System, 2018-2019 (transaction data); WSP USA, October 2020 (analysis).

As a result of the limitations of the available data and the inability to collect current data due to the ongoing pandemic and subsequent reduction in travel, a methodology was developed utilizing available reasonable data and applied assumptions. The following assumptions were developed to estimate parking occupancy and peak utilization of the facilities.

- Profiles were created for the 24-hour entry and exit transaction data for each facility based on Data Set 1.
- The exit profile data is unrealistically low. The profile from each facility is adjusted based on the daily transaction (Data Set 2) extracted from PARCS.
- Terminal 1 Garage and Lot A are connected, and share exits. As such, the two facilities were combined and analyzed as one facility. In addition, it is noted that the Terminal 1 Garage arrival curb was closed for a portion of year 2019 for resurfacing and Yellow Level parking was used as a temporary pickup curb for private vehicles. It is assumed that the usage of these parking spaces for temporary pickup location did not impact the occupancy, as the demand does not exceed the total supply for Terminal 1 Garage and Lot A.
- Terminal 2 Garage is closed once the facility is full. As such, we assumed the maximum occupancy occurred when the calculated utilization equaled the total parking spaces supplied. Due to the closure of the facility when it is full, the demand was capped at capacity, and it is assumed that the overflow was re-distributed to the other On-Airport parking facilities where spaces are available. As such, by capping the demand at Terminal 2, the methodology is assuming the additional demand at this facility is captured in the other On-Airport facilities.

In addition to the above assumptions, airport staff provided an observation count of parked vehicles at 3 a.m. on dates in the peak days and months (June and October on Thursdays and Sundays) at each facility, to use as a baseline to calculate hourly parking occupancy using the entry and exit transactions. The data shows June 14, 2018 and June 13, 2019 are the peak day of the peak month in 2018 and 2019.

The 3 a.m. parking occupancy observation count by date is provided in **Table 4.4-2**. As shown, the maximum total observed parked vehicles at 3 a.m. were 6,900, which represents over 75 percent of the total parking supply (9,001 spaces). This indicates a significant amount of parking spaces are occupied overnight during peak travel months.

Table 4.4-2: 3 a.m. Parking Observation Counts

DATE	TERMINAL 1 GARAGE	TERMINAL 2 GARAGE	LOT A	LOT B	LOT C	LOT D	LOT E	TOTAL
Thursday, June 14, 2018	1,185	754	713	436	2,181	1,202	181	6,652
Sunday, June 17, 2018	525	590	341	408	1,983	1,171	76	5,094
Thursday, October 18, 2018	1238	722	729	427	1,696	1,209	163	6,184
Sunday, October 21, 2018	641	801	411	424	1,895	1,172	126	5,470
Thursday, June 13, 2019	1,180	732	722	425	2,415	1,230	196	6,900
Sunday, June 16, 2019	537	585	371	41	1,974	1,193	65	4,766
Thursday, October 17, 2019	1,366	780	676	429	1,868	1,151	190	6,460
Sunday, October 20, 2019	649	818	421	423	2,025	1,156	116	5,608

Sources: St. Louis Lambert International Airport, Parking Oservations, 2018-2019; WSP USA, October 2020 (analysis).

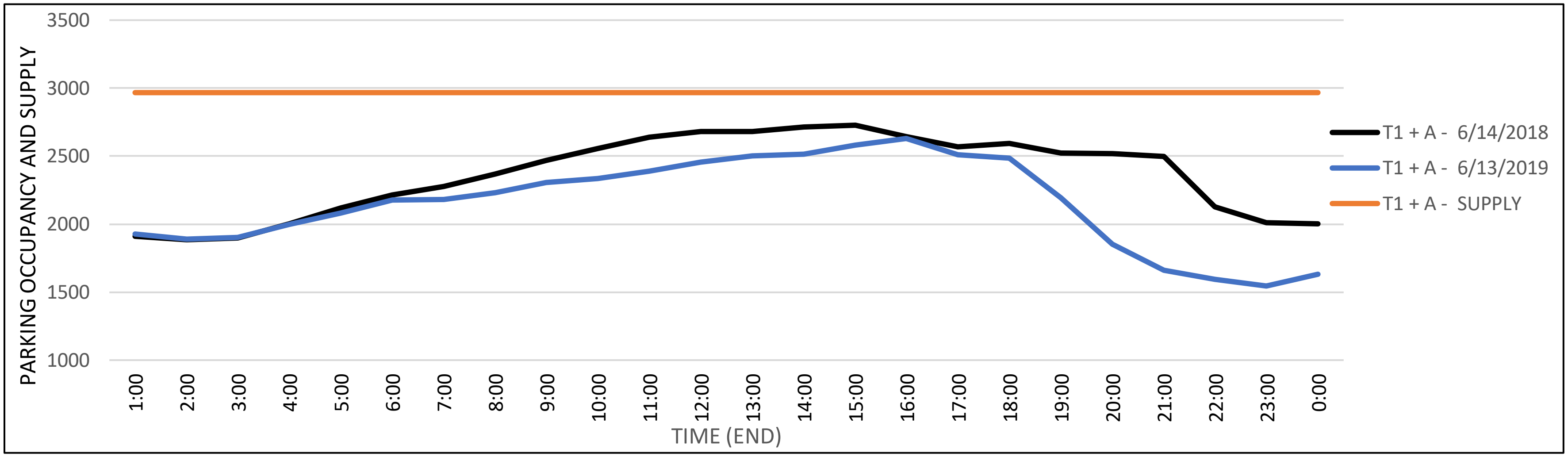
The June 14, 2018 and June 13, 2019 parking profiles were developed superimposing the 3 a.m. data with the facilities net entry/exit data provided, for the peak 2018 and 2019 parking demand. **Figures 4.4-3** through **4.4-9** show parking occupancy and supply profiles for each facility.

As shown in Figures 4.4-3 through 4.4-9, the overall public parking occupancy is below the supply provided by the seven parking facilities based on the June 2018 and June 2019 data.

However, the following are noted:

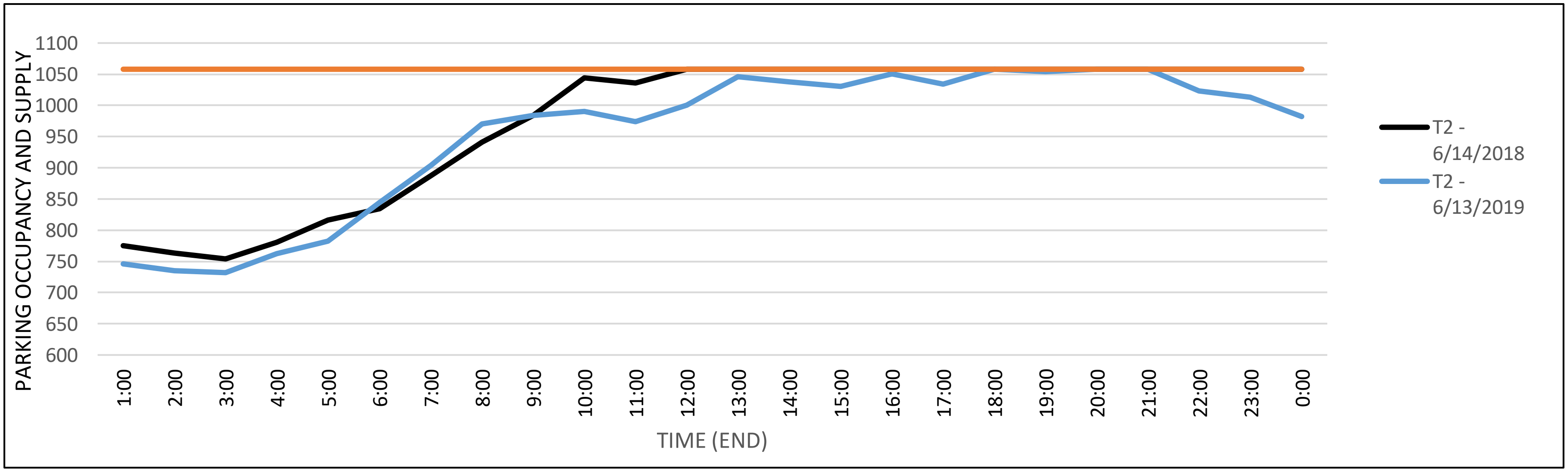
- Terminal 1 Garage, Lot A and Lot C are operating under capacity during the peak parking period.
- Terminal 2 Garage is full around noon on June 14, 2018 and at 6 p.m. on June 13, 2019. Vehicles trying to use this facility, when full and closed, were re-distributed to other On-Airport parking facilities where spaces are available.
- Lot B is at capacity between 8 a.m. to 10 a.m., and occupancy reduced during the rest of the day.
- Lot D is over capacity starting at 4 a.m., for the remainder of the day.
- Lot E is at or over capacity starting at 1 p.m.

Figure 4.4-3: Peak Month Terminal 1 and Lot A Parking Occupancy Profile



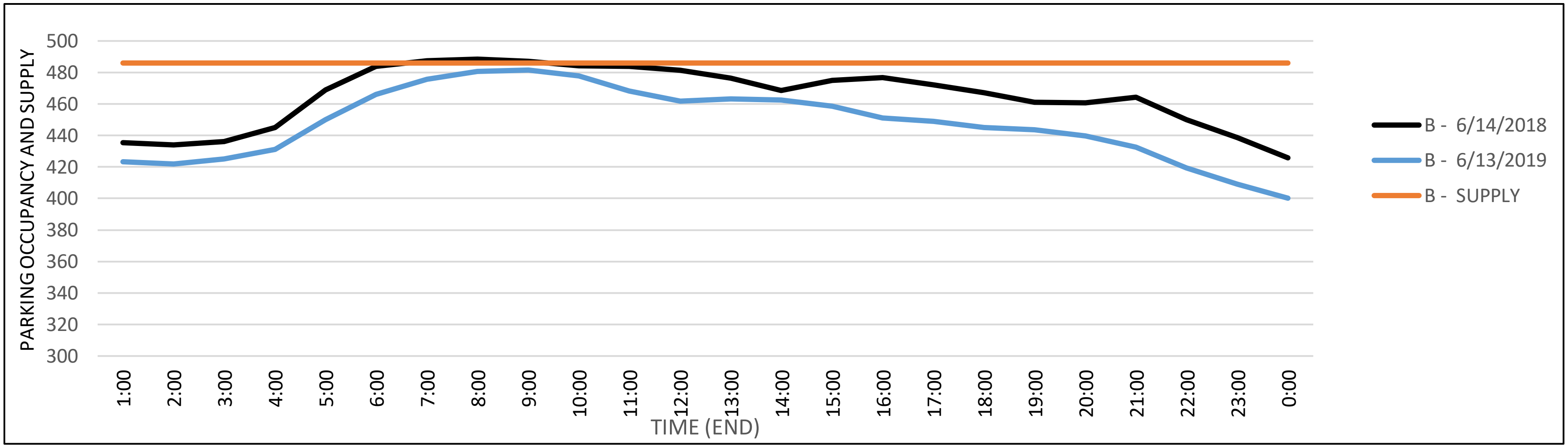
Sources: St. Louis Lambert International Airport, Airport Parking Access and Revenue Control System, 2018-2019 (transaction data); WSP USA, October 2020 (analysis).

Figure 4.4-4: Peak Month Terminal 2 Parking Occupancy Profile



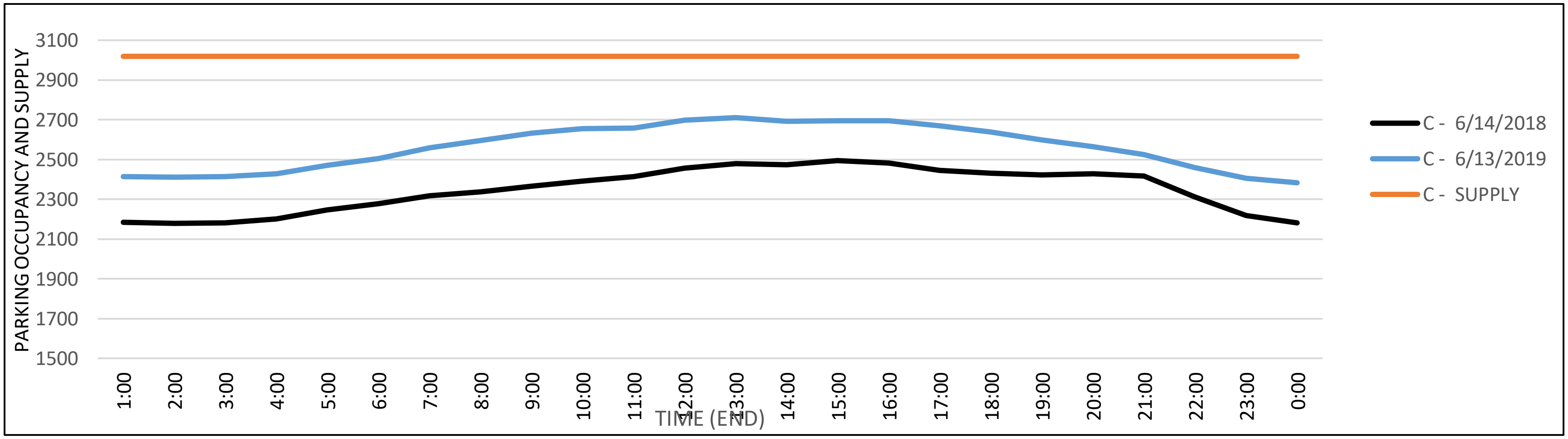
Sources: St. Louis Lambert International Airport, Airport Parking Access and Revenue Control System, 2018-2019 (transaction data); WSP USA, October 2020 (analysis).

Figure 4.4-5: Peak Month Lot B Parking Occupancy Profile



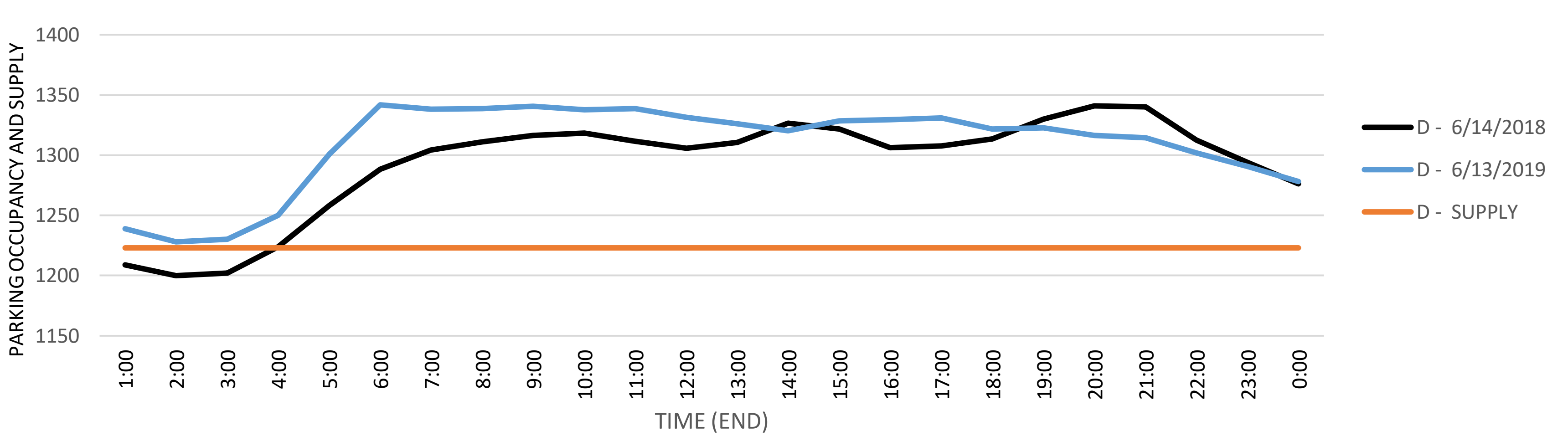
Sources: St. Louis Lambert International Airport, Airport Parking Access and Revenue Control System, 2018-2019 (transaction data); WSP USA, October 2020 (analysis).

Figure 4.4-6: Peak Month Lot C Parking Occupancy Profile



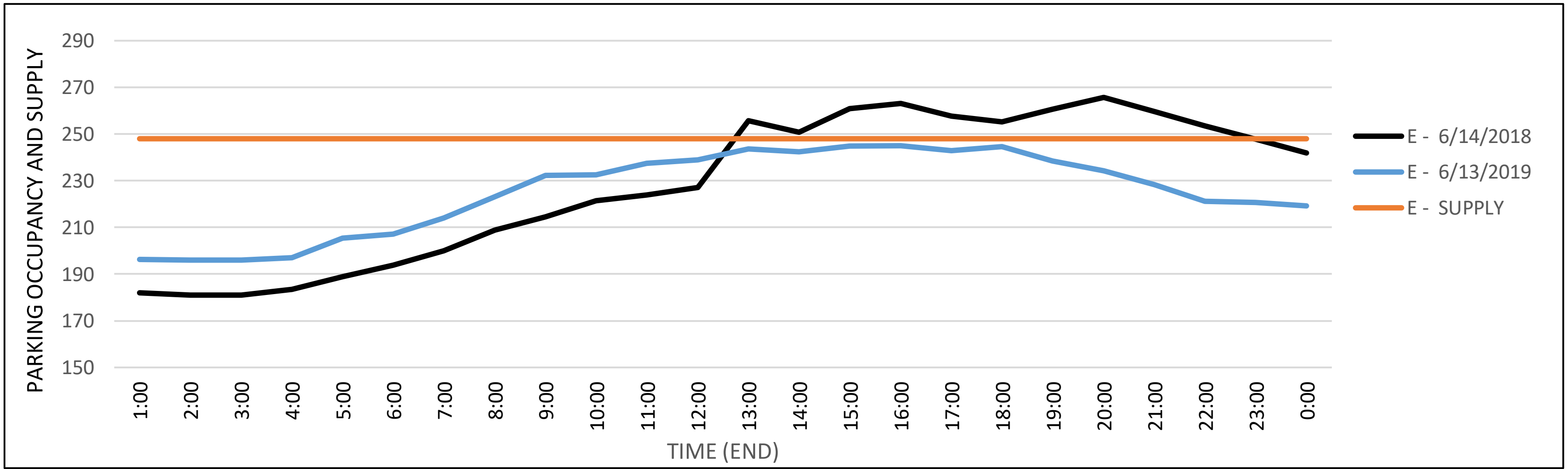
Sources: St. Louis Lambert International Airport, Airport Parking Access and Revenue Control System, 2018-2019 (transaction data); WSP USA, October 2020 (analysis).

Figure 4.4-7: Peak Month Lot D Parking Occupancy Profile



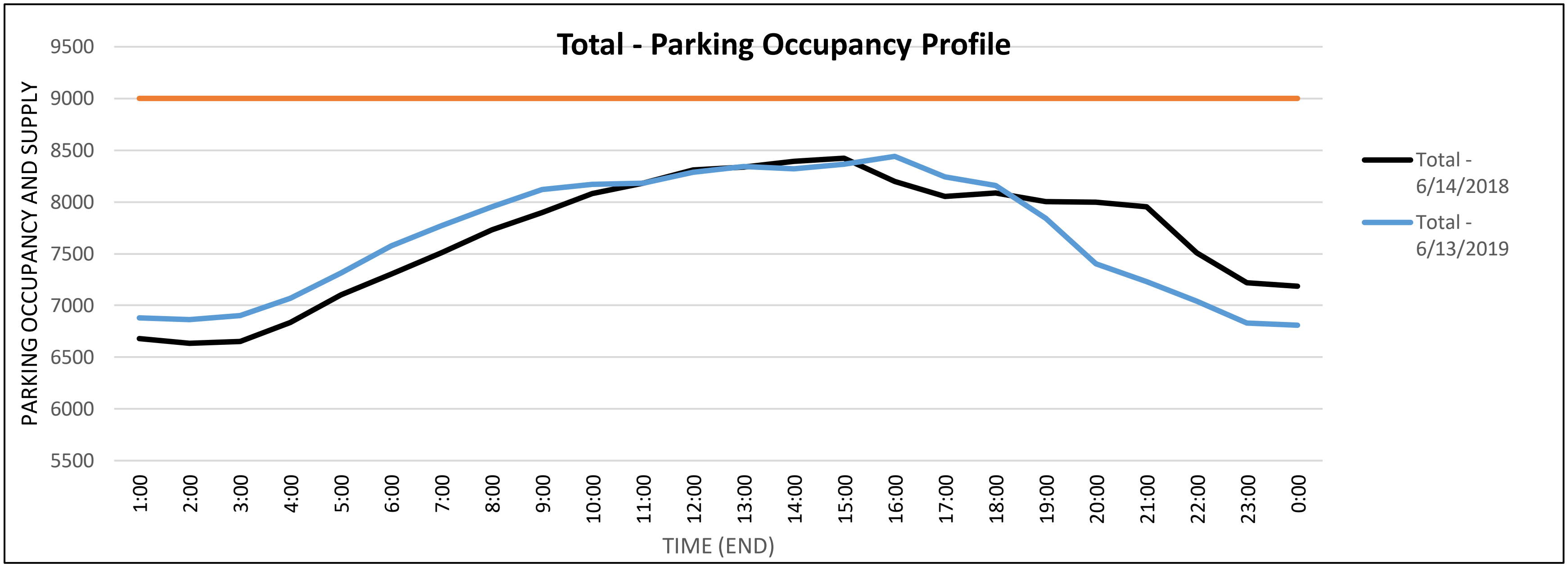
Sources: St. Louis Lambert International Airport, Airport Parking Access and Revenue Control System, 2018-2019 (transaction data); WSP USA, October 2020 (analysis).

Figure 4.4-8: Peak Month Lot E Parking Occupancy Profile



Sources: St. Louis Lambert International Airport, Airport Parking Access and Revenue Control System, 2018-2019 (transaction data); WSP USA, October 2020 (analysis).

Figure 4.4-9: Peak Month Total Parking facilities Occupancy Profile



Sources: St. Louis Lambert International Airport, Airport Parking Access and Revenue Control System, 2018-2019 (transaction data); WSP USA, October 2020 (analysis).

The minimum, maximum and average peak parking occupancy from the June 14, 2018 and June 13, 2019 data presented in Figures 4.4-3 through 4.4-9 are summarized in **Table 4.4-3**. The average of the 2018 and 2019 peak hour parking occupancy is used to establish the baseline year 2019 parking demand estimate.

Table 4.4-3: Existing 2019 Parking Occupancy and Average Utilization

	TERMINAL 1 GARAGE AND LOT A	TERMINAL 2 GARAGE	LOT B	LOT C	LOT D	LOT E	TOTAL
Parking Supply							
Total	2,967	1058	486	3,019	1,223	248	9,001
Restricted	40	22	9	57	23	7	127
Parking Demand							
Minimum	2,630	1,058	482	2,495	1,341	245	8,423
Maximum	2,728	1,058	488	2,711	1,342	266	8,441
Average	2,679	1,058	485	2,603	1,341	255	8,432
Parking Surplus/Deficit							
Minimum	337	0	4	524	-118	3	578
Maximum	239	0	-2	308	-119	-18	560
Average	288	0	1	416	-118	-7	569
Parking Utilization							
Minimum	89%	100%	99%	83%	110%	99%	94%
Maximum	92%	100%	101%	90%	110%	107%	94%
Average Utilization	90%	100%	100%	86%	110%	103%	94%

Sources: St. Louis Lambert International Airport, Airport Parking Access and Revenue Control System, 2018-2019 (transaction data); WSP USA, October 2020 (analysis).

From Table 4.4-3, the following observations were made:

- Terminal 1 Garage and Lot A were combined and are nearing capacity, but do not exceed it. Terminal 1 Garage may be full, but since both facilities were combined, separate results are not available. It was noted that for portion of year 2019, Terminal 1 arrival curb was closed for resurfacing and the yellow level parking garage was used as a surrogate pickup curb for private vehicles. It is assumed that the temporary use of these spaces for pick up would not impact the demand calculation as the peak hour garage parking demand profiles doesn't show the combined Terminal 1 Garage and Lot A facilities are not over capacity by 2019.
- Lot C is also approaching capacity at about 86 percent utilization.

- Terminal 2 Garage reaches capacity at around noon and the facility is closed when full. It is assumed that vehicles trying to use this facility, when full and closed, are re-distributed to other On-Airport parking facilities where spaces are available. Hence, the overall demand is captured in the overall On-Airport parking facilities.
- Lot B reaches capacity at about 8 a.m.
- Lot D and Lot E are operating over capacity, indicating parked vehicles in non-compliant areas; and
- The parking analysis indicates that the overall peak parking utilization at the public facilities at the Airport (8,432 spaces) was at or near capacity, at 94 percent utilization during 2019.

FUTURE PUBLIC PARKING DEMAND

The multivariate time series regression model, along with the long-term projections for the key demand drivers, determines the long-term growth rates in STL enplanements after full recovery from the downturn caused by the COVID-19 pandemic and economic recession.

The following three scenarios were developed for future passenger forecast:

- Scenario 1: three-year recovery
- Scenario 2: five-year recovery
- Scenario 3: nine-year recovery

The projected passenger volumes for the three scenarios are presented in **Table 4.4-4**.

Table 4.4-4: Airport Commercial Passenger Forecast Under Three Scenarios

YEAR	SCENARIO 1	SCENARIO 2	SCENARIO 3
2019	7,915,216	7,915,216	7,915,216
2024	7,979,645	6,967,636	5,698,994
2030	8,842,483	8,622,476	7,948,580
2035	9,690,406	9,449,302	8,710,784
2040	10,639,736	10,323,905	9,517,032

Source: Unison, St. Louis Lambert Airport Layout Plan Update, Aviation Activity Analyses and Forecast Report, August 06, 2020.

Detailed description and methodology of the scenarios are presented in the *Forecast of Aviation Activity* section.

The Airport sponsor has designated Scenario 1 – Three-Year Recovery as the preferred planning scenario. Recognizing uncertainty, the Airport sponsor maintains that it is a better strategy to plan for the most aggressive recovery scenario while maintaining the flexibility to delay the timing of the implementation of capital projects to be identified in this ALPU should aviation demand recovery turn out slower and more aligned with the slower recovery scenarios.

To be consistent with the preferred planning scenario, the Scenario 1 passenger forecast was used to estimate the future parking demand for each facility.

Privately managed parking lots that are located off-Airport were not available for data collection to estimate the airport passenger parking occupancy. Airport-operated public parking supply (9,000 spaces) is about 47 percent of the total parking spaces, including competing car park operators (privately-operated parking facilities – 10,000 spaces excluding the two hotel parking lots). As such, in the absence of real occupancy data and future market share study, future demand and supply analyses **assume no changes** in parking management, operation and pricing and privately-operated facilities (competing car park operators), which currently provide 53 percent of all public parking capacity, maintain current market share.

The parking growth factor for each future horizon year was established based on the ratio of future passenger forecast to existing 2019 passengers, as presented in **Table 4.4-5**. The growth factor shown in Table 4.4-5 was then applied to the existing 2019 demand. The resulting parking demand is presented in **Table 4.4-6** and **Figure 4.4-10**.

Table 4.4-5: Parking Growth Factor Based on Future Passenger Projection

	2019	2024	2030	2035	2040
Growth Factor	1.000	1.008	1.117	1.224	1.344

Sources: Unison, St. Louis Lambert Airport Layout Plan Update, Aviation Activity Analyses and Forecast Report, August 06, 2020; WSP USA, October 2020 (analysis).

Table 4.4-6: Future Parking Demand by Facility

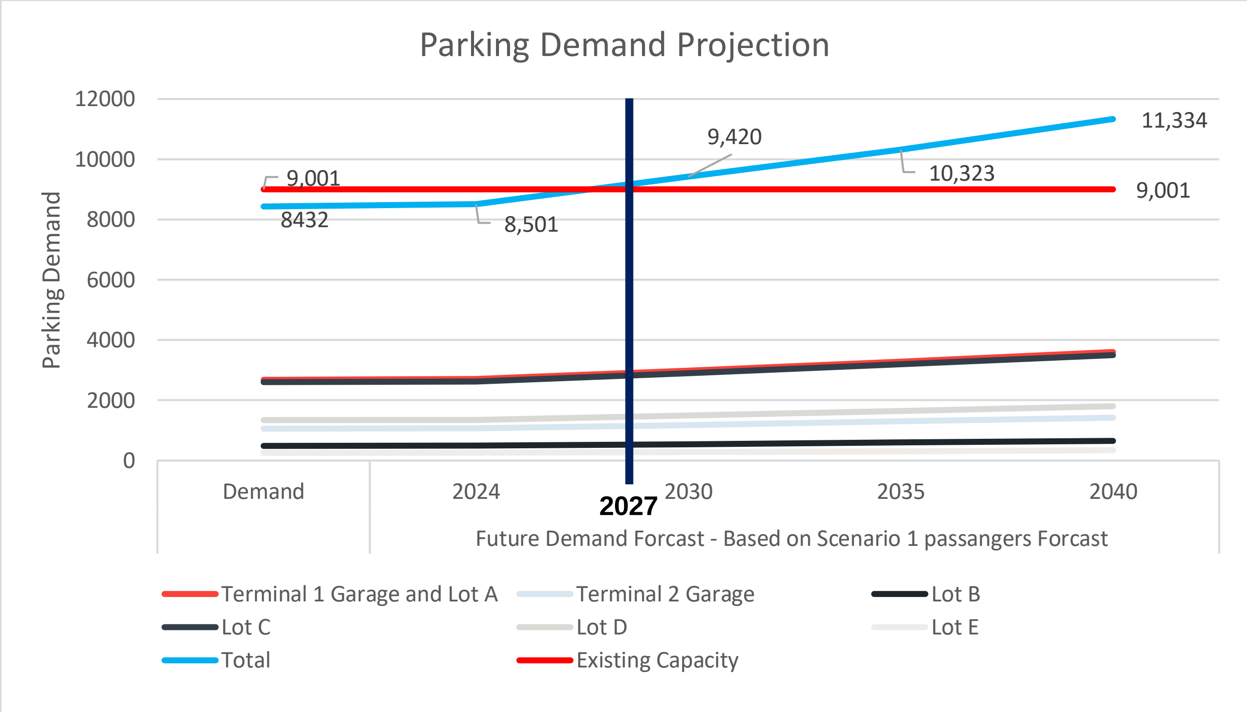
YEAR	TERMINAL 1 GARAGE AND LOT A	TERMINAL 2 GARAGE	LOT B	LOT C	LOT D	LOT E	TOTAL
	Supply						
2019	2,967	1,058	486	3,019	1,223	248	9,001
	Demand						
2019	2,679	1,058	485	2,603	1,341	255	8,432
2024	2,700	1,067	489	2,624	1,352	257	8,501
2030	2,992	1,182	542	2,908	1,498	285	9,420
2035	3,279	1,295	594	3,186	1,642	313	10,323
2040	3,601	1,422	652	3,498	1,803	343	11,334
	Year Demand Meets Supply*						
	2029	2019	2019	2032	2019	2019	2027

Note:

* Future year when demand exceeds supply

Source: WSP USA, October 2020 (analysis).

Figure 4.4-10: Future Parking Demand and Supply



Source: WSP USA, October 2020 (analysis).

As shown in Figure 4.4-10, the total Airport-operated parking demand is anticipated to exceed existing capacity in 2027. However, as shown in Table 4.4-6, Terminal 2 Garage, Lot B, and Lot E are already operating over capacity (2019 demand). Terminal 1 Garage and Lot A are forecasted to reach capacity by 2029, and Lot C by 2032.

By 2040, overall parking demand exceeds supply by 25 percent if no additional spaces are provided. The demand calculation provided in Table 4.4-6 is based on the parking profile data considering the peak month of the year and cumulative peak hour (worst case). The parking analyses shows the overall 9,000 available spaces are 94 percent utilized during the peak hour on a peak month – though some facilities are over capacity. i.e., the 2019 supply satisfies the demand. Note that even though the overall parking demand is satisfied by the available capacity, some of the facilities are at or over capacity (Terminal 2 garage, Lot D and Lot E) on a peak hour which lead to re-distribution of traffic to the other On-site facilities. As such, the parking requirements calculated herein is the minimum to satisfy overall parking demand. Additional parking may be recommended to satisfy individual facilities for customer convenience.

4.5.2 EMPLOYEE PARKING

There are no dedicated employee car parking lots at the Airport, and employees are directed to take public transit or use passenger parking facilities.

The typical peak parking demand for employees generally occurs in the midday period when the morning and afternoon shift workers overlap. On a typical busy day, there are 150 employees parked in Lot C and 164 employees parked in the Terminal 1 Garage Red Level at the peak time (2019 demand).

The total existing parking demand at the Lot C and Terminal 1 Garage locations is 314 spaces. The future employee parking demand was determined based on the future commercial passengers forecast proportion with the existing 2019 commercial passengers.

The employee parking demand for future horizon years is presented in **Table 4.4-7**. Since there is no dedicated parking for employees, the employee parking demand estimate is part of the overall parking demand estimate.

Table 4.4-7: Future Employee Parking Demand by Facility

YEAR	LOT C	TERMINAL 1 GARAGE	TOTAL EMPLOYEE PARKING
2019 (Actual)	150	164	314
2024	151	165	317
2030	168	183	351
2035	184	201	384
2040	202	220	422

Source: WSP USA, October 2020 (analysis).

4.5.3 COMMERCIAL VEHICLES STAGING LOTS

Commercial vehicles staging lots consists of TNCs and taxis. Commercial vehicle staging lots are located south of the Airport, generally along I-70 (taxis), and at the northeast corner of Lot C (TNCs).

TNCs use the roadway network like other vehicles and don't have set schedules or routes. TNC spaces for picking up arriving passengers are located at Terminal 1, Door Exit 6 (upper departure level). In Terminal 2, TNC and private vehicle passenger pick-up occurs on the lower level (arrivals) outer curbside.

Both terminals share similar curbside layouts and configurations with grade separated departure and arrival curbs. Specifics about each curbside were obtained through field visits. TNCs are accessed via passengers requesting service on their smartphones and meeting drivers outside the terminals. TNC are now allowed to drop-off and pick-up immediately at the curb following the drop with an allowed three minute grace period. There are 50 TNCs pick-up staging spaces available at the Super Park C Lot admin building free of charge.

There are two taxicab staging lots, one for each terminal; the staging lots can accommodate 82 taxi cabs in the Pear Tree lot (45,000 sq. ft.) for Terminal 1 and 24 taxicabs in the Air Cargo Road lot (14,000 sq. ft.) for Terminal 2. Passenger pick-up occurs inside the parking garages, with six to eight spaces allocated to taxicabs.

The staging lot demand for the current conditions is estimated from the busiest travel hour observed in 2018. **Table 4.4-8** shows the estimated supply and demand of the busiest travel hour at the Airport for the Taxi and TNC staging lots. The future Taxi and TNC parking demand are determined based on the proportion of future commercial passengers forecast with the existing 2019 commercial passengers and applying the growth factors established in Table 4.4-5.

Taxi staging areas for Terminal 1 are expected to satisfy the future demand up to 2035; demand will exceed capacity by 2040.The demand for Terminal 2 taxi staging areas and TNC staging continues to exceed the current supply, which will require 55 spaces for Terminal 2 taxi staging and 110 spaces for TNC staging during the peak demand. It is also noted that TNC vehicles on the surrounding roads – Pear Tree Drive and Natural Bridge Road – are also joining the TNC queue in addition to the TNC Lot C, which currently supplies only 50 spaces. It is recommended to monitor these locations and consider providing additional staging spaces when demand exceeds supply in all locations.

Table 4.4-8: Future Taxi and TNC Lot Demand and Supply

YEAR	TAXI TERMINAL 1 STAGING LOT HOURLY DEMAND	TAXI TERMINAL 2 STAGING LOT HOURLY DEMAND	TNC HOLD LOT HOURLY DEMAND
	Supply		
2019	82	24	50**
	Demand		
2019*	65	41	81
2024	66	41	82
2030	73	46	90
2035	**80**	**50**	99
2040	**87**	**55**	109

Notes:

TNC – Transportation Network Company

* Estimating parking demand based on peak hour – Observed 2018 and 2019

** TNC vehicles in the surrounding roads – Pearl Tree Drive and Natural Bridge Road – are also joining the TNC queue in addition to the TNC Lot C staging. As such, supply may be higher.

Sources: St. Louis Airport Authority, October 2020 (observations); Ricondo & Associates, Inc., *St. Louis Lambert International Airport, Vendor Due Diligence Report – FINAL DRAFT*, December 2019; WSP USA, October 2020 (analysis).

4.5.4 CELL PHONE LOT

Existing cell lots at Terminal 1 and Terminal 2 total 242 spaces (182 spaces at Terminal 1 and 60 spaces at Terminal 2). The Terminal 1 lot is oversized, even for pre-pandemic use, while the Terminal 2 lot is undersized for existing activity. The Terminal 2 lot routinely experiences overflow during the late afternoon and early evening arrival banks. The Terminal 2 lot capacity is also exacerbated by Uber/Lyft drivers that have been observed to occupy the lot.

Existing cell lots sizing is larger than the standard 300 sq. ft. per space. Terminal 1 and Terminal 2 cell lots combined occupy an area approximately 2.6 acres for a combined 230 spaces, resulting in an average 465 sq. ft. per space.

Upon relocating the TNC staging lots closer to the proposed consolidated terminal, TNC drivers are no longer expected to use the cell lot.

Combined, the two cell phone lots at STL cover an area approximately 2.6 acres, and can accommodate approximately 242 vehicles.

No count of the peak lot occupancy was conducted as a result of the COVID pandemic. An area approximately 1.5 acres in size (equivalent to approximately 215 parking spaces) is anticipated to be adequate for a cell phone lot serving the consolidated terminal.

4.5.5 SUMMARY OF PARKING FACILITY REQUIREMENTS

- Public Parking:
  - 2019 available/needed: 9,001 spaces/8,432 spaces (94 percent utilization)
  - 2040 needed: 11,334 spaces
- Employee Parking:
  - 2019: 314 spaces
  - 2040: additional 106 spaces (for a total of 420 spaces)
- Taxi Staging Lots:
  - Terminal 1:
    - 2019 available/needed: 82 spaces/65 spaces
    - 2040 needed: additional 5 spaces (for a total of 87 spaces)
  - Terminal 2:
    - 2019 available/needed: 24 spaces/41 spaces
    - 2040 needed: additional 31 spaces (for a total of 55 spaces)
- TNC staging lot:
  - 2019 available/needed: 50 spaces/81 spaces
  - 2040 needed: additional 80 spaces (for a total of 109 spaces)
- Cell phone lot:
  - 2019 available: 230 spaces (2.5 acres)
  - 2040 available: 215 spaces (1.5 acres)

4.6 RENTAL CAR FACILITIES

Three rental car companies (also referred to as Rent-A-Car or RAC) operate eight brands, located off-Airport: Avis, Budget, Enterprise, National, Alamo, Hertz, Dollar and Thrifty.

The following rental car facility components were assessed to determine RAC needs over the planning horizon:

- Customer service area
- Ready/return spaces
- Service sites:
  - Fueling positions
  - Wash bays
  - Vehicle light maintenance bays (including administrative areas and employee parking)
- Vehicle storage areas (including stacking/staging and overflow spaces)

4.6.1 METHODOLOGY

RAC operators were asked to fill out a survey requesting hourly transaction information, size, configuration, use of their existing facilities and anticipated short-term needs. The rental car facility requirements were developed based on the survey results. Existing (2019, pre-COVID) and 2025 requirements were obtained from survey responses. For planning years 2030 and 2040, it was assumed that rental car activity would grow at the same rate as passenger enplanements. Therefore, 2025 requirements were grown based on the baseline forecast scenario (Scenario 1) for planning years 2030 and 2040.

Avis/Budget, Enterprise (including Enterprise, National and Alamo) and Hertz returned completed surveys. Dollar and Thrifty did not return surveys; combined, these two operators represent approximately 12 percent of the total rental car facilities acreage. As a result, aggregate requirements for Enterprise, Avis Budget and Hertz were increased to account for Dollar and Thrifty facility requirements.

4.6.2 EXISTING FACILITY CONSTRAINTS

RAC operators were also given open ended questions pertaining to their existing constraints and growth potential. Some of the existing constraints identified include:

- Shortage in ready/return spaces and vehicle storage
- Inability to expand lot sizes to meet needs (especially for vehicle storage), unless expand vertically. Would be in favor of a consolidated rental car facility (ConRAC).
- Location of RAC facilities are difficult to find, mostly due to in adequate wayfinding signage.

An estimate of growth potential on existing RAC sites was also requested, and ranges from none to 15 percent growth.

4.6.3 RENTAL CAR COMPONENTS REQUIREMENTS

Table 4.5-1 summarizes the aggregated requirements for all rental car companies operating at STL, for each facility component.

The RAC operators identified current deficiencies in ready/return and storage spaces, as well as service site areas. Current customer service counters are adequate.

Table 4.5-1: Aggregated Rental Car Facilities Requirements by Component

FACILITY COMPONENT	EXISTING FACILITIES (2019)	REQUIRED			
		2019	2025	2030	2040
Customer Service Area					
Customer Service Counters	47	47	52	56	64
Ready/Return Spaces					
Ready Spaces	1,188	1,439	2,130	2,284	2,624
Return Spaces	1,096	1,512	1,998	2,142	2,461
Service Sites					
Fueling Positions	39	45	61	66	76
Wash Bays	8	9	11	12	14
Light Maintenance Bays (in SF) [1/]	87,622	135,406	138,243	150,270	161,087
Vehicle Storage Spaces					
Staging/Stacking/Onsite Vehicle Storage Spaces	4,194	4,421	5,391	5,779	6,641

Note:

SF – Square Feet

1/ Includes administrative areas and employee parking.

Sources: Rental Car Operators, 2020 (survey responses); WSP USA, August 2020 (analysis).

4.6.4 RENTAL CAR FACILITY FOOTPRINT REQUIREMENTS

Table 4.5-2 summarizes the overall footprint required to accommodate airport rental car operations, in acres. Industry standards were applied to individual facility components (e.g., 300 sq. ft. per customer service position) to determine space requirements. An allowance for circulation space was then added to the calculated space requirements of each facility component (20-25 percent). Lastly, an allowance for landscaping and circulation (15 percent) was added to the overall space program, to account for water detention needs and site access (road/rail).

The footprint requirements are provided for both surface facilities and a ConRAC. The ConRAC requirements are assumed to be 10 percent lower than the surface requirements, due to efficiencies associated with a multi-level facility. It should also be noted that the ConRAC acreage requirement shown in Table 4.5-2 includes the surface area of each level of a multi-level facility (i.e., the surface footprint would be less than shown in the table, based on the number of levels of the ConRAC).

Table 4.5-2: Summary of Rental Car Facility Footprint Requirements (in Acres)

	EXISTING (2019)	REQUIRED [3/]			
		2019	2025	2030	2040
Existing Surface Rental Car Facilities	42				
Required Surface Rental Car Facilities		57	73	79	90
Required ConRAC Facilities [1/ 2/]		51	66	71	81

Notes:

ConRAC – Consolidated Rental Car

1/ The ConRAC requirements are 10 percent lower than the surface requirements, due to efficiencies associated with a multi-level facility.

2/ The surface footprint of a ConRAC facility would be less than the acreage provided in the table, depending on the number of levels in the ConRAC.

3/ A 15 percent allowance was added for landscaping and circulation (rail/roadway access).

Sources: Rental Car Operators, 2020 (survey responses); WSP USA, August 2020 (analysis).

4.6.5 GENERAL INDUSTRY COMMENTS

Several factors affecting the RAC industry may impact the requirements for RAC facilities:

- Uncertainty in the RAC industry (Hertz bankruptcy, TNCs/automated vehicles)
- COVID-19 may cause further consolidation, resulting in fewer RAC operators in the industry
- TNCs have already started causing reduction in RAC use

4.6.6 CONSOLIDATED RENTAL CAR FACILITIES BENCHMARKING

Table 4.5-3 summarizes the characteristics of recent or under construction ConRAC facilities in the U.S., as a benchmark.

Table 4.5-3: Consolidated Rental Car Facility Benchmarking

AIRPORT	OPENING DATE	# OF LEVELS	PARKING SPACES				NO. OF RENTAL COMPANIES	CUSTOMER SERVICE (SF)	SERVICE AREAS		ACREAGE	PUBLIC PARKING (SPACES)	COST ($M)
			READY/ RETURN	STORAGE	TOTAL	TOTAL GARAGE (SF)			FUELING POSITIONS	WASH BAYS			
STL	**N/A**	**N/A**	**5,000**	**6,600**	**11,600**	**TBD**	**8?**	**24,000**	**76**	**14**	**TBD**	**TBD**	**TBD**
LAX	2023	5	7,600	10,000	17,600	6,400,000	11	NA	NA	NA	NA	2,900	2,000
EWR	2023	6	3,380	-	3,380	2,700,000	10	NA	54	15	19	2,925	500
HNL	2022	5	2,250	-	2,250	1,800,000	13	35,000	64	16	22	NA	353
CVG	2021	5					11				12		171
SAT	2018	7	2,040	1,060	3,100	1,800,000	13	40,848	54	NA	13	1349	165
TPA	2018	4	3,650	-	3,650	2,440,000	14	74,000	148	25	50	NA	730
ORD	2018	5	4,200	-	4,200	2,500,000	15	75,000	12	15	33	2,700	414
SAN	2016	3	2,830	-	2,830	2,063,718	19	25,000	72	15	21	NA	317
AUS	2016	4	1,876	-	1,876	1,300,000	11	24,000	48	12	15	758	155
BOS	2013	4	3,200	-	3,200	1,200,000	8	113,000	NA	NA	49	overflow	310
SEA	2012	5	4,000	-	4,000	2,100,000	12	60,000	88	18	23	3,200	419
BNA	2011	3	2,400	-	2,400	1,300,000	10	NA	54	10	NA	NA	75
MIA	2010	4	6,600	-	6,600	3,400,000	16	120,000	120	36	20	NA	410
MCI	2007	2	-	-	8,000		10	135,000			72		90

Notes:

N/A = not applicable

TBD = to be determined

Sources: Various media articles; WSP USA, August 2020 (analysis).

4.7 AIR CARGO FACILITIES

There are three main types of cargo facilities at STL:

- Integrator facilities serving larger integrated express operators, including Southern Air (operating for DHL), Federal Express (FedEx) and United Parcel Service (UPS). These facilities typically handle small parcels transported between aircraft, or between aircraft and trucks, going through the cargo facility. Additionally, UPS offers second day heavy lift cargo service. As Amazon Air continues to move into becoming an integrator, cargo handling facilities providing cargo services for Amazon Air will be combined with integrator facilities. Integrator facilities require a warehouse to store and sort air cargo, aircraft parking, truck docks and employee parking. Integrator facilities at STL are located at the St. Louis Air Cargo area, north of the airfield, off McDonnell Boulevard.
- Belly cargo facilities are used by carriers that use the belly compartment of passenger aircraft to provide cargo services. Cargo is typically moved by using carts or trucks to and from aircraft, and facilities typically require truck docks and employee parking. As of December 2019, the following airlines carried belly cargo to/from STL: Alaska Air, America Airlines, Delta Airlines, Southwest Airlines and United Airlines, in addition to the affiliates of mainline carriers, such as PSA, Republic Airways and Skywest Airlines. Belly cargo facilities are located in the Cargo City area, east of Terminal 2.
- Freight facilities accommodate all-cargo carriers and cargo handling operators moving freight that is typically containerized or palletized. Freight facilities require truck docks, apron parking area, and building used for storing and staging of cargo. During the calendar years 2018 and 2019, all-cargo carriers operating at STL included ABX Air, Charters (ATS), IFL Group, Interjet West, USA Jet and Active Aero. However, as of 2019, only ABX Air was operating at STL and was contracted out to operate flights for Amazon Air. Therefore, cargo handling facilities providing cargo services for Amazon Air will be combined with integrator facilities.

STL's air cargo activity is forecast at a regional level by applying the annual growth rates from the Freight Analysis Framework (FAF) database for the St. Louis MO-IL FAF Zone to the estimated air cargo tonnage at STL. Scenario 1, designated as the preferred planning scenario for air cargo activity, is based on the FAF high-range projections in which STL's total air cargo recovers to pre-COVID-19 levels in 2024 and grows at an annual average rate of 1.6 percent through 2040. Integrator and all-cargo carriers maintain a combined share of over 80 percent of air cargo traffic at STL.

The air cargo forecast is categorized by mode of cargo tonnage which consist of 1) passenger carriers; and 2) all-cargo carriers, which include the integrator express carriers. Using air cargo inventory information and air cargo forecast activity, requirements for air cargo facilities are derived for the anticipated aircraft fleet and planning period.

Future air cargo planning revolves around two key aspects of cargo activity: spatial needs for the movement and storage of air cargo aircraft, trucks and GSE and space for handling and storing air cargo, such as warehouse buildings. As such, air cargo functional areas can be defined as follows:

- Landside: mainly for truck operations and access to loading docks and parking lots

- Cargo building: warehouse where cargo is handled, sorted and stored, and where offices are located
- Apron: aircraft ramp or paved airside area for the movement and parking of aircraft, and GSE vehicle operations and parking

Additionally, regional competition plays a role in STL's air cargo activity. In fact, leakage of air cargo to other neighboring airports in the Midwest poses an issue as freight forwarded located off-airport property, assemble and transport cargo to the international gateway Chicago O'Hare International Airport (ORD) for air shipment.

Future requirements were assessed based on surveys of the air cargo operators and the utilization ratios provided by *ACRP Report 143*, *Air Cargo Facility Planning and Development*[7].

4.7.1 BELLY CARGO

Belly Cargo activity takes place within Cargo City, east of Terminal 2. Air General provides belly cargo ground handling support for American Airlines, United Airlines, Delta Airlines and Alaska Air, as well as handling storage, staging, and maintenance for GSE. Southwest Airlines utilizes the Cargo City 4 building for belly cargo operations, and the Cargo City 3 and Cargo City 4 buildings for outdoor equipment storage space.

According to the ACI-NA[8] airport grouping, STL is a small airport since its annual volume of cargo is less than 100,000 metric tons. Therefore, the viable tug driving time between belly cargo area and the passenger terminal should be between 1 to 5 minutes. Belly Cargo facilities are primarily located in the Cargo City area, which meets the viable tug driving time requirements.

ACRP Report 143 identified a method for determining facility requirements for air cargo facilities using Annual Tonnage per Area Ratio (TAR). The TAR is defined by total annual tons of freight per square foot of cargo floor space, with higher values indicating a highly efficient operation and lower values indicating less efficient facilities. *ACRP Report 143* cites a belly cargo utilization ratio of 0.64 and a GSE storage utilization ratio of 0.36 for planning belly cargo facilities.

Overall utilization for belly cargo building facilities was calculated to be between 0.54 and 0.58 based on historical belly cargo tonnage. The higher the utilization rate, the more cargo is handled and moves through the building space. To assess whether the existing facility can accommodate projected belly cargo demand, the overall utilization for each forecast scenario was calculated through the planning horizon. **Table 4.6-1** shows the overall utilization across all scenarios, which ranges between 0.34 to 0.62 between years 2020-2030. Since the utilization rate is below the industry planning standard of 0.64, existing belly cargo facility building areas are expected to be adequate over the next 10-year period. However, by 2040, the utilization rate ranges between 0.68 and 0.74, and therefore, additional building area of 3,810 sq. ft. under Scenario 1 will be needed to accommodate belly cargo projected demand.

[7] Airport Cooperative Research Program, Report 143 - Guidebook for Air Cargo Facility Planning and Development, [2015], http://www.trb.org/Main/Blurbs/173274.aspx

[8] The 2002 Airports Council International–North America Air Cargo Facility and Security Survey separated airports into three groups, which the research team followed.

GSE storage space is used to park and stage GSE when it is not in use. Overall utilization for belly cargo GSE storage was calculated to be between 0.26 and 0.28, based on historical belly cargo tonnage. The overall utilization for each forecast scenario was calculated through the planning horizon. Table 4.6-1 shows the overall utilization for Forecast Scenario 1, which ranges between 0.18 to 0.36 between years 2020-2040. Since the utilization rate is below the industry planning standard of 0.36, existing belly cargo GSE storage spaces are expected to be adequate through the planning horizon.

Table 4.6-1: Belly Cargo Facility Utilization

	HISTORICAL		FORECAST				
	2018	2019	2020	2021	2025	2030	2040
Belly Cargo Annual Tons	12,454	13,492					
Existing Building Area (sq ft)	23,260	23,260					
Building Utilization (tons/sq ft)	0.54	0.58					
Existing GSE Storage Area (sq ft)	47,805	47,805					
GSE Utilization (tons/sq ft)	0.26	0.28					
Scenario 1 - Projected Annual Tons			11,503	8,836	13,245	14,470	17,325
Projected Building Utilization Rate (tons/ sq. ft.)			0.49	0.38	0.57	0.62	0.74
Additional Belly Cargo building needed (sq. ft.) 1/			**-**	**-**	**-**	**-**	**3,810**
Projected GSE Utilization Rate (tons/ sq. ft.)			0.24	0.18	0.28	0.30	0.36

Notes:

Years represent Airport sponsors' fiscal year ending in June.

1/ Additional belly cargo building area are derived from the industry standard utilization ratio of 0.64.

Sources: WSP USA, September 2020 (analysis).

The Southwest Airlines Cargo City 4 building has nine truck docks, while Air General has eight docks at Cargo City 2. Using the truck dock and door ratios from *ACRP Report 143*, requiring one truck door for every 1,500 sq. ft. of space for cargo buildings less than 50,000 sq. ft., one additional freight truck dock is needed by 2040 to satisfy the requirements of 18 doors and docks in total by 2040 under Scenario 1.

Currently, employee parking at Cargo City is shared by all tenants. As the facility utilization and the belly cargo throughput increase over the planning horizon, the number of employees will also increase. Survey response from Southwest Airlines indicated that additional auto parking space is needed in the next 5 years. Since multiple tenants occupy Cargo City and share the parking lot, it is unclear how many of these tenant employees who are parking in the same lot are involved in cargo operations. However, based on the survey responses, additional parking will be needed with the growth of cargo activity in this area. The industry planning factor for truck/trailer parking, maneuvering, and auto parking is 110 percent of the calculated building space requirement for belly cargo building. Therefore, approximately 29,777 sq. ft. of truck/trailer parking space will be needed by 2040.

4.7.2 INTEGRATORS

Integrator carriers FedEx and UPS operate out of St. Louis Air Cargo, located north of the airfield, off McDonnell Boulevard. Majestic Terminal Services also operates out of St. Louis Air Cargo and provides ground handling and cargo sorting for Amazon Air, including breaking down freight from inbound flights and loading and offloading cargo from aircraft. Lastly, Worldwide Flight Services (WFS) provides cargo ground handling service and storage, staging and maintenance of ground support equipment for DHL, UPS, and USPS in Cargo City 2. DHL also operates from the ramp at the H Pad, located northeast of Terminal 2.

Since most of these operators are either integrator carriers or provide services for integrator carriers, the utilization ratios for express integrators are used to derive air cargo facility requirements. Per *ACRP Report 143*, typical building and apron utilization ratios for express integrators are 0.92 tons per square foot and 0.19 tons per square foot, respectively. **Table 4.6-2** summarizes integrator facility utilization ratios.

Table 4.6-2: Integrator Facility Utilization

	HISTORICAL		FORECAST				
	2018	2019	2020	2021	2025	2030	2040
Historical - Integrator							
Integrator Tons	60,355	61,894					
Existing Integrator Building Area (sq. ft.) 1/	147,073	147,073					
Building Utilization (Tons/sq. ft.)	0.41	0.42					
Existing Integrator Apron Area (sq. ft.) 2/	756,673	756,673					
Apron Utilization (Tons/sq. ft.)	0.08	0.08					
Scenario 1 Air Cargo Forecast							
Integrator Tons			71,482	54,908	67,193	72,026	84,245
Building Utilization (Tons/sq. ft.)			0.49	0.37	0.46	0.49	0.57
Apron Utilization (Tons/sq. ft.)			0.09	0.07	0.09	0.10	0.11

Notes:

Years represent Airport sponsors' fiscal year ending in June.

1/ Cargo integrator total building areas is calculated from building spaces occupied by FedEx, UPS, Majestic in St. Louis Air Cargo area and WFS in Cargo City 2.

2/ Cargo integrator total ramp area includes 177,700 sq. ft. ramp area at the H Pad, northeast of Terminal 2.

Sources: WSP USA, September 2020 (analysis).

BUILDING AND APRON REQUIREMENTS

The analysis shows that building and apron utilization at STL ranges between 0.37-0.57 and between 0.07-0.11, respectively, which are below the industry standards. Therefore, based on the industry utilization ratios, no additional integrator facilities will be needed for the planning horizon.

However, existing tenants indicated that an additional 13,000 sq. ft. of cargo building space would be needed in the next five years. **Table 4.6-3** summarizes integrator building and apron requirements.

Table 4.6-3: Air Cargo Building Requirements

	2020	2021	2025	2030	2040
Cargo Integrator Tons	71,482	54,908	67,193	72,026	84,245
Existing Cargo Buildings (Sq. Ft)	147,000				
Requirements per ACRP Report 143 (Sq. Ft.) 1/	77,698	59,683	73,036	78,289	91,571
Requirements per Tenants' Input (Sq. Ft)	157,000		160,000		160,000
Most Demanding Requirement (Sq. Ft.)	157,000	157,000	160,000	160,000	160,000
Most Demanding Requirements (Acres)	**3.6**	**3.6**	**3.7**	**3.7**	**3.7**

Notes:

Years represent Airport sponsors' fiscal year ending in June.

1/ Building requirements are calculated based on a space utilization of 0.92 annual tons per square foot for domestic cargo for integrated express carriers.

Sources: Airport Cooperative Research Program Report 143; WSP USA, February 2021 (analysis).

Table 4.6-4 summarizes facility requirements for cargo ramp and GSE storage for integrators based on representative values of 0.19 U.S. ton per square foot per year for aircraft parking and 0.57 U.S. ton per square foot for GSE storage, per *ACRP Report 143*. The analysis shows the minimum area required for GSE storage and cargo aircraft parking for the projected cargo tonnage. Although the combined available apron area exceeds apron facility requirements, space layout optimization may be needed to maximize space use for GSE equipment and aircraft parking.

Table 4.6-4: Air Cargo Apron Requirements

		2020	2021	2025	2030	2040
Cargo Integrator Tons		71,482	54,908	67,193	72,026	84,245
Existing	St Louis Cargo Total Apron (sq. ft.)	560,173				
	Cargo City Total Apron (sq. ft.)	196,500				
	Total Apron Available	**756,673**				
Requirements per ACRP Report 143	Cargo Ramp Required (0.19 annual tons per square foot)	376,221	288,989	353,647	379,084	443,395
	GSE Storage (0.57 annual tons per square foot)	125,407	96,330	117,882	126,361	147,798
	Total Apron Required	**501,628**	**385,319**	**471,530**	**505,446**	**591,193**
Requirements per Tenants' Input	Total Apron Required	756,673	756,673	756,673	756,673	756,673
Most Demanding Requirement (Sq. Ft.)		756,673	756,673	756,673	756,673	756,673
Most Demanding Requirements (Acres)		**17.4**	**17.4**	**17.4**	**17.4**	**17.4**

Notes:

Years represent Airport sponsors' fiscal year ending in June.

1/ Cargo integrator total apron areas are calculated from apron spaces occupied by FedEx, UPS, Majestic in St. Louis Air Cargo area and WFS in Cargo City 2 and H-Pad northeast of Terminal 2.

Sources: Airport Cooperative Research Program Report 143; WSP USA, February 2021 (analysis).

TRUCK DOCK AND PARKING REQUIREMENTS

Truck dock and parking requirements are derived based on the total building size. For a total existing building space of 147,073 sq. ft., parking space is based on a factor of 1.2 warehouse to truck parking ratio, resulting in 176,488 sq. ft. needed. Additionally, per *ACRP Report 143*, cargo buildings with a footprint of 147,073 sq. ft. require one truck door for every 2,900 sq. ft. of space. Therefore, 51 truck docks in total are required.

In total, there are 67 truck docks in the St. Louis Air Cargo area and 7 additional docks for WFS in Cargo City 2. Therefore, the number of truck docks is projected to remain adequate to handle projected air cargo tonnage. However, WFS indicated the warehouse doors on the back side are narrow, which is an existing constraint at their current facility.

Total landside parking for cargo facilities within the St. Louis Air Cargo area and Cargo City 2 is 392,250 sq. ft. which includes a truck parking area of 249,500 sq. ft. and a total vehicle parking area of 142,750 sq. ft. Per ACRP Report 143 parking requirements, landside parking is adequate for the planning horizon. However, existing tenants indicated that due to major construction changes, tractor and employee available parking space is not adequate and an additional 20 trailer spaces are needed in the near-term with a total of 30 additional trailer spaces needed by 2040. Other tenants' survey responses mentioned 20 percent additional parking needed in the next five years in Cargo City in addition to crack repairs to the shared parking lot, while 40 additional employee parking spaces are needed by 2040 in the St. Louis Cargo area.

As mentioned in section 4.6.1, parking is shared in Cargo City by multiple tenants and additional parking is needed to meet future demand. **Table 4.6-5** summarizes integrator landside requirements.

Table 4.6-5: Cargo Landside (Truck Dock and Parking) Requirements

	2020	2021	2025	2030	2040
Cargo Integrator Tons	71,482	54,908	67,193	72,026	84,245
Existing Landside Areas	392,250				
Air Cargo Building Requirements (Sq. Ft.)	157,000	157,000	160,000	160,000	160,000
Requirements per ACRP Report 143 (Sq. Ft.) 1/	188,400	188,400	192,000	192,000	192,000
Requirements per Tenants' Input (Sq. Ft.) 2/	414,250	414,250	415,450 3/	415,450	438,450
Most Demanding Requirement (Sq. Ft.)	414,250	414,250	415,450	415,450	438,450
Most Demanding Requirements (Acres)	9.5	9.5	9.5	9.5	10.1

Notes:

Years represent Airport sponsors' fiscal year ending in June.

1/ Per ACRP Report 143, parking space is based on a factor of 1.2 warehouse to truck parking ratio.

2/ Future parking requirements are calculated assuming 300 sq. ft. per vehicle parking space and 1,100 sq. ft. per tractor trailer space.

3/ Vehicle parking requirements for 2025 are based on tenant survey response indicating a need for 20 percent additional parking in Cargo City area, equivalent to 4 parking spaces.

Sources: Airport Cooperative Research Program Report 143; WSP USA, February 2021 (analysis).

OVERALL INTERGRATOR CARGO SITE REQUIREMENTS

Table 4.6-6 summarizes overall cargo integrator site requirements, based on the most demanding requirements of either ACRP Report 143 or tenant inputs.

Additionally, STLAA staff requested a 10-acre allowance for potential new entrants be included.

Table 4.6-6: Overall Air Cargo Site Requirements (in Acres)

		EXISTING	REQUIREMENTS (ACRES)			
		2020	**2020**	**2025**	**2030**	**2040**
Existing Tenants	Building/Warehouse	3.4	3.6	3.7	3.7	3.7
	Apron	17.4	17.4	17.4	17.4	17.4
	Landside	9.0	9.5	9.5	9.5	10.1
	Total Site	**29.8**	**30.5**	**30.6**	**30.6**	**31.1**
New Entrant		-	-	-	-	10
Total Cargo Requirements		**29.8**	**31**	**31**	**31**	**41**

Note: projected totals are rounded.

Sources: Airport Cooperative Research Program Report 143; WSP USA, February 2021 (analysis).

4.7.3 SUMMARY OF AIR CARGO FACILITIES REQUIREMENTS

- Belly Cargo:
  - Building space:
    - Existing: 23,260 sq. ft.
    - 2040: additional 3,810 sq. ft. (total of 27,070 sq. ft.)
  - Truck loading docks:
    - Existing: 17
    - 2040: 1 additional truck dock (total of 18)
  - GSE storage:
    - Existing: 47,805 sq. ft.
    - 2040: Total of 47,805 sq. ft.
  - Employee parking:
    - Existing: adequate
    - 2040: Total of 29,777 sq. ft.
- Cargo Integrators:
  - Building space:
    - Existing: 147,073 sq. ft.
    - 2040: additional 12,667 sq. ft. (total of 160,000 sq. ft.)

- Apron: Space layout optimization may be needed to maximize space use for GSE equipment and aircraft parking
- Landside parking:
  - Existing: additional 22,000 sq. ft. trailer space (equivalent to 20 trailer spaces) for a total of 414,250 sq. ft.
  - 2040: additional 13,200 sq. ft. employee parking and 11,000 sq. ft. tractor parking for a total landside parking of 438,450 sq. ft.
- Overall Site:
  - Existing: approximately 30 acres
  - 2020 required: additional 1 acre (total of 31 acres)
  - 2040 required: additional 10 acres for new entrant (total of 41 acres)

4.8 AIRPORT SUPPORT FACILITIES

Airport support facilities include buildings and other structures that serve secondary roles in the operation of the Airport to ensure efficient and safe operations. The purpose of airport support facilities ranges from administration to fuel storage to emergency response services. The following sections describe the existing and future facility requirements for the various STL airport support facilities based on the information provided through maps, tenant surveys, STLAA staff and passenger and operations forecasts.

4.8.1 AIRPORT ADMINISTRATION

Airport Administration facilities are split between the Airport Office Building (AOB) and Terminal 1. The AOB houses 23 employees from the Planning Development Department, including Engineering and Environmental Health and Safety, as well as employee training activities. Terminal 1 houses 82 employees fulfilling airport administration functions from Airport executives, Finance and Administration, Properties, Legal, Public Relations, Information Technology (IT), Human Resources, Air Service Development, and Employee Training.

Airport Administration facility requirements were derived using the total aircraft operations growth rate, which includes commercial, noncommercial and air taxi operations.

The total aircraft operation forecast under Scenario 1, based on a 3-year recovery, shows a decline in commercial operations for the short-term forecast in 2025, followed by a recovery for the medium- and long-term forecasts in 2030 and 2040, respectively. As a result, facility requirements are based on the growth rate in total aircraft operations that is relevant to each time period. That is, since operations are expected to decline in 2025, facility requirements are considered constant, unless 5-year needs were expressed by STLAA staff. As aircraft operations start to increase again in 2030 compared to 2019 levels, facility requirements grow at the 2019-2030 compound average growth rate (CAGR) of operations. The latter assumption was adopted instead of applying an overall growth rate for the entire forecast period, to reflect the drop in total operations in the next 5 years that will result in minimal facility requirements over the next 10-year period.

STLAA occupies 15,125 sq. ft. of the 33,800 sq. ft. total floor space of the AOB. The AOB space occupied by Airport Administration on the 4th floor is available for lease. Should the space get leased, the STLAA Airport Administration staff housed in the AOB would be consolidated with other STLAA staff in Terminal 1 or be moved to other surplus space nearer the terminals. Approximately 20,000 sq. ft. of space is estimated to be required for the relocation of STLAA AOB staff.

Table 4.7-1 summarizes Airport Administration Requirements.

4.8.2 AIRPORT OPERATIONS AND MAINTENANCE

Airport Operations and Maintenance Facilities are spread throughout the Airport, within Terminal 1 and several ancillary buildings.

FIELD MAINTENANCE/MATERIALS MANAGEMENT (AIRPORT MAINTENANCE CAMPUS)

The existing Field Maintenance/Materials Management Campus is located between runway ends 12R and 6, and includes various field maintenance facilities (Auto shop, sand storage, storage, etc.). The campus is in poor to fair condition. In addition, the current layout has no undercover storage space for modern airport equipment, such as large snow removal equipment.

A 2014[9] study assessed various layouts for storing the snow removal equipment fleet, as it is currently stored in the open and subject to faster deterioration due to elements and inclement weather exposure. A 2016[10] study developed three concepts for relocating the Field Maintenance/Materials Management Campus to an approximate 19 acres of available land northwest of the existing campus. The proposed campus, the Airport Maintenance Campus (AMC), is expected to accommodate all airfield maintenance facilities, while providing a well-configured space for large equipment cover and staging, as shown in **Figure 4.7-1**.

An 18-acre footprint was calculated to be required for the AMC through the planning horizon.

Table 4.7-2 lists the airport maintenance facilities and respective building footprint incorporated within the proposed Airport Maintenance Campus alternatives.

9 Jacobsen Daniels, *Task Order No. 2: Airfield Maintenance – Concept Layout*, April 12, 2013

10 Jacobsen Daniels, *Task Order No. 6: Airfield Maintenance – Concept Layout,* June 16, 2016

Table 4.7-1: Airport Administration Facilities Requirements (in Square Feet)

	EXISTING (2019)	2025	2030	2040
Annual Aircraft Operations – Scenario 1	195,242	191,824	196,394	230,118
Compound Annual Growth Rate (CAGR)		-0.29% [1/] (2019-2025)	0.05% [2/] (2019-2030)	1.6% [3/] (2030-2040)
Building/Office Space				
Airport Office Building (4th Floor)	15,125	15,125	15,214	17,827
Terminal 1 (Upper and Lower Levels)	74,479	74,479	74,918	87,783
Total Building/Office Space	**89,604**	**89,604**	**90,133**	**105,610**
Public Space/MEP/Vertical Circulation [4/]				
Airport Office Building (4th Floor)	4,538	4,538	4,564	5,348
Terminal 1 (Upper and Lower Levels)	22,344	22,344	22,246	26,335
Total Public Space/MEP/Vert Circulation	**26,881**	**26,881**	**27,040**	**31,683**
Employee/Visitor Parking				
Airport Office Building (4th Floor)	8,280 [5/]	8,280	8,329	9,759
Terminal 1 (Upper and Lower Levels)	29,520 [6/]	29,520	29,694	34,793
Total Employee/Visitor Parking	**37,800**	**37,800**	**38,023**	**44,552**
Overall Airport Administration Facilities				
Building/Office Space	89,604	89,604	90,133	105,610
Public Space/MEP/Vertical Circulation	26,881	26,881	27,040	31,683
Employee/Visitor Parking	37,800	37,800	38,023	44,552
Total	**154,285**	**154,285**	**155,196**	**181,845**

Notes:

1/ Facility requirements for 2025 are either assumed to be the same as existing, based on the negative growth in aircraft operations between 2019 and 2025, or set to the STLAA-specified 5-year needs when provided.

2/ Facility requirements for 2030 are based on the net growth in operations between 2019 and 2030, since total aircraft operations are expected to decline in 2025 compared to 2019 operations level.

3/ Facility requirements for 2040 are based on the growth in operations between 2030 and 2040, since total aircraft operations are expected to grow during this period following recovery.

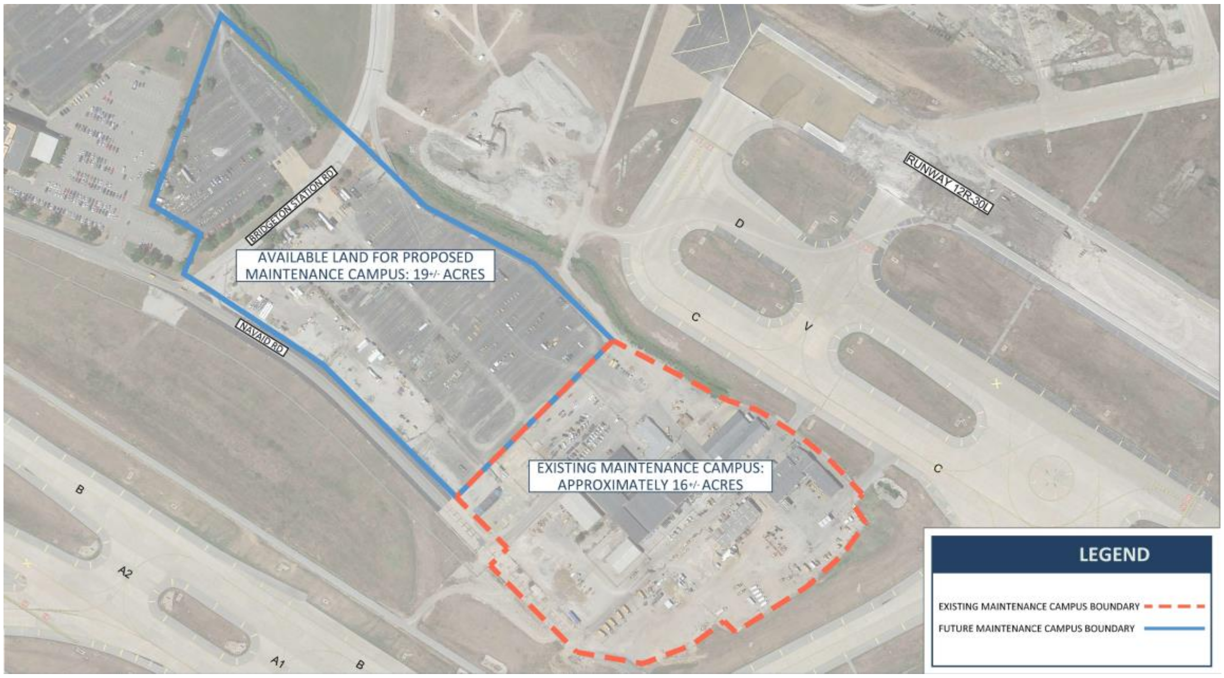
4/ Public space/ MEP/ Vertical Circulation is assumed to be 30% of the available office space.

5/ Existing Employee and Visitor Parking is based on the number of airport administration employees occupying the Airport Office Building, increased by 20% to account for visitors and is measured assuming 300 sq. ft. per parking space available. Note that the total surface parking lot for the AOB is approximately 245,000 sq. ft.

6/ Existing Employee and Visitor Parking is based on the number of airport administration employees occupying the upper and lower levels of Terminal 1, increased by 20% to account for visitors and is measured assuming 300 sq. ft. per parking space available.

Sources: WSP USA, July 2020 (analysis).

Figure 4.7-1: Current and Future Airport Maintenance Campus Boundaries



Source: Jacobsen Daniels, Task Order No. 6: Airfield Maintenance – Concept Layout, June 2016.

Table 4.7-2: Proposed Airport Maintenance Campus Facilities (in Square Feet)

FACILITY DESCRIPTION	BUILDING FOOTPRINT
Auto Shop	27,300
Tire Storage	1,200
Landscaping	7,000
Central Receiving Storage	42,100
Paint Vault	5,200
Covered Storage	24,100
Airfield Maintenance	15,900
Truck Bed Rack	1,800
Deicer	1,800
Security Hut/Canopy	1,500
Diesel Fuel Canopy	2,000
Gas and CNG Canopy	1,100
Sand Storage	9,500
Multi-Task Snow Vehicle Storage	35,000
Spread Truck Building	9,800
Multi-Use Building	29,600
Jet Broom Building	19,400
Warehouse	6,600

Sources: Jacobsen Daniels, June 2016; St. Louis Airport Authority, October 2020; WSP USA, July 2020.

BUILDING MAINTENANCE

MAIN FACILITY

The Building Maintenance main facility is Building #315, a 13,000-sq. ft. building located south of Concourse A. It includes offices, break rooms and workshops (signage, painting, …). The facility also includes approximately 13,000 sq. ft. of auto parking around the building. The building size is adequate, although the layout is not optimal, and the HVAC system is in poor condition. No building expansion is needed in the short term (5 years).

CLIMATE CONTROL/ELECTRICAL SHOP

Building #406 is 28,000-sq. ft. and houses the Climate Control and Electrical Shop facilities. It is located south of Concourse A. The facility also includes approximately 9,500 sq. ft. of auto parking.

The building size is adequate, although additional storage space for the Electrical Shop would improve operations. Also, the layout of the Electrical Shop is not optimal. The Climate Control facility has several window issues (window location not optimal for use, or windows not functioning properly). Auto parking is constrained.

No building expansion is needed in the short term (5 years).

WAREHOUSING/STORAGE

The following locations are used by the Building Maintenance Department for storage:

- Airfield General Building (Building #411): 1,400 sq. ft. used for storage (estimated)
- Field Maintenance/Materials Management (Building #401): area used for storage is unknown, as all airport departments use this space
- Cargo City 1: 21,000 sq. ft. used for storage (estimated)
- Concourse D: 12,000 sq. ft. used for storage (estimated)

A previous study was conducted to assess the construction of a satellite Materials Management facility closer to Building #315, for receiving/shipping and storage of materials, in order to reduce/eliminate the long transit times (up to 40 minutes per round trip) between Building #315 and Building #401.

Table 4.7-3 summarizes the Building Maintenance facility requirements.

AUTO SHOP

The Airport vehicles auto shop is located within the Airport Field Maintenance/Materials Management Campus in Buildings #403 and #404 and is in fair condition. The auto shop serves both airfield maintenance and building maintenance and is planned to occupy a total space of 27,300 sq. ft. within the proposed Airport Maintenance Campus alternatives.

Table 4.7-3: Airport Operations and Maintenance Facilities Requirements (in Square Feet)

	EXISTING (2019)	2025	2030	2040
Annual Enplanements – Scenario 1	7,915,216	8,093,867	8,842,483	10,587,325
Compound Annual Growth Rate (CAGR)	1.4% (2019-2040)			
Field Maintenance/Materials Storage		**802,700**	**802,700**	**802,700**
Auto Shop		**27,300**	**27,300**	**27,300**
Operations Control Center/Emergency Operations Center	**200**	**9,800**	**9,800**	**9,800**
Building Maintenance				
Building 315				
Office/Shop	13,000	14,131	15,148	17,408
Auto Parking/Staging	13,000	14,131	15,148	17,408
Total	**26,000**	**28,262**	**30,296**	**34,815**
Building 406 (Climate/Electrical)				
Office/Shop	28,000	30,436	32,627	37,493
Auto Parking/Staging	9,500	10,326	11,070	12,721
Total	**37,500**	**40,762**	**43,697**	**50,214**
Warehousing/Storage				
Building 411	1,400	1,522	1,631	1,875
Cargo City 1	21,000	22,827	24,470	28,120
Concourse D	12,000	13,044	13,983	16,069
Field Maintenance/Materials Storage [1/]	-	-	-	-
Total	**34,400**	**37,393**	**40,084**	**46,063**
Total Building Maintenance	**97,900**	**106,417**	**114,078**	**131,093**
Terminal Snow Removal Equipment Storage				
Snow Barn (Building #216)	5,000	5,000	5,000	5,000
Apron Storage	30,000	30,000	30,000	30,000
Total Terminal Snow Equipment Storage	**35,000**	**35,000**	**35,000**	**35,000**
Snow Dump Sites	**100,000**	**100,000**	**100,000**	**100,000**

Note:

1/ Existing storage space used for Building Maintenance in the Field Maintenance Materials Storage facility is included in the Field Maintenance facility requirements.

Sources: WSP USA, September 2020 (analysis).

OPERATIONS CONTROL CENTER AND EMERGENCY OPERATIONS CENTER

The existing Airport Operations Center (AOC) is located at the end of Concourse B, in a small space. There is no dedicated Emergency Operations Center (EOC) at STL today.

A combined 9,800 sq. ft. AOC/EOC facility is under design; it is anticipated to be located on the Terminal 1 apron level, in a space formerly occupied by HMS Host. The proposed AOC space may also house the baggage handling monitoring position and a maintenance support position for ticket generation and dispatching. The planned AOC/EOC footprint is assumed to be adequate through the planning horizon.

ADMINISTRATION OFFICES

Requirements for the Operations and Maintenance Administration offices located on the Terminal 1 Baggage Claim Level are included with the Airport Administration requirements in Section 4.7.1.

SNOW REMOVAL EQUIPMENT STORAGE

Snow removal equipment maintenance and storage for the terminal apron and airport roadways occurs on a 3-acre site located northeast of Cargo City. The site is comprised of the Snow Maintenance Barn (Building #216), which is approximately 5,000 sq. ft. and apron.

Requirements for snow equipment staging are based on overall terminal apron footprint and roadways. The overall terminal area footprint is not anticipated to increase, as there is already excess terminal apron today, and no substantial new roadways are planned. However, STLAA staff stated that a more suitable location should be explored.

PAVEMENT DEICING FLUID STORAGE TANKS

Three 30,000-gallon tanks of airfield pavement deicing fluid are located southwest of St. Louis Air Cargo, on a site approximately 20,000 sq. ft, to allow for truck maneuvering. Four additional tanks are located on the Field Maintenance Campus: two 25,000-gallon tanks and two 20,000-gallon tanks. No additional tanks are anticipated through the planning horizon, as no additional airfield pavement is planned. The tanks located on the Field Maintenance Campus are assumed to be included in the proposed 19-acre AMC.

All tanks are mounted on gravel, but should be mounted on concrete, with a paved area for truck maneuvering.

SNOW DUMP SITES

Two areas are used as terminal apron snow dump sites: approximately 100,000 sq. ft. on the former MoANG base apron (preferred), and north of the AOB (secondary).

Requirements for additional snow dump sites are based on overall terminal apron footprint. The overall terminal area footprint is not anticipated to increase, as there is already excess terminal apron today. The MoANG site may be leased in the future, and an alternate snow dump site would be required.

SUMMARY OF AIRPORT OPERATIONS AND MAINTENANCE REQUIREMENTS

- Overall, airfield and building maintenance facilities are in poor condition, often with dated and inefficient layouts.
- Field Maintenance/Materials Management: 19 acres

- Building Maintenance:
  - Office/Shops:
    - Existing: 41,000 sq. ft.
    - 2040: 55,000 sq. ft. (additional 14,000 sq. ft.)
  - Auto Parking:
    - Existing: 23,000 sq. ft.
    - 2040: 30,000 sq. ft. (additional 7,000 sq. ft.)
  - Warehousing/Storage:
    - Existing: 34,000 sq. ft.
    - 2040: 46,000 sq. ft. (additional 12,000 sq. ft.)
  - Satellite Receiving/Shipping and Storage Facility: 20,000 sq. ft. building
- OCC/EOC:
  - Existing: 200 sq. ft.
  - 2040: 9,800 sq. ft.
- Administration offices: none (included with Airport Administration requirements)
- Terminal Apron Roadway Snow Removal Equipment Storage:
  - Existing/2040: 35,000 sq. ft. building, 3-acre site (no additional requirements)
- Pavement Deicing Fluid:
  - No additional footprint requirements
  - Upgrade surface under the tanks to concrete and pave truck maneuvering area
- Terminal Apron Snow Dump Sites:
  - Existing/2040: 100,000 sq. ft. (no additional requirements)

4.8.3 AIRPORT RESCUE AND FIRE FIGHTING

Airport emergency facilities at STL include two ARFF facilities, the West and North ARFF Stations, as well as the Medical Services Building, which was previously the South ARFF Station. Both active ARFF stations house 62 personnel in total. Typically, there are 12 personnel per shift at the North Station and 9 personnel per shift at the West Station, although this varies depending on the needs and availability.

INDEX

Per 14 CFR Part 139, for airports serving certain air carriers, the ARFF Index is based on the longest passenger aircraft that operates an average of five daily departures (equivalent to at least 1,825 annual departures). If there are fewer than five average daily departures operated by the longest air carrier aircraft serving the airport, the ARFF index will be the next lower index group than the index group prescribed for the longest aircraft. ARFF indices are based on the length of the air carrier aircraft serving that Airport, as follows:

- Index A: for aircraft less than 90 feet in length.
- Index B: for aircraft at least 90 feet in length, but less than 126 feet in length.
- Index C: for aircraft at least 126 feet in length, but less than 159 feet in length.
- Index D: for aircraft at least 159 feet in length, but less than 200 feet in length.
- Index E: for aircraft at least 200 feet in length.

Per the current STL Airport Certification Manual (ACM), the North ARFF Station is sized to meet Index E requirements, while the West ARFF Station is sized to meet Index D requirements. Both ARFF stations at STL meet Part 139 FAA regulations; however, per 14 CFR Part 139, only Index C is required at STL. Index C includes most ADG III aircraft, including the Boeing 737-800. Based on the forecasted fleet mix presented in **Table 4.7-4**, the ARFF index in 2040 would remain Index C. However, STLAA staff indicated that they wished to maintain Index E capability through the planning horizon.

Table 4.7-4: Aircraft Rescue and Firefighting Index Determination

AIRCRAFT TYPE	AIRCRAFT LENGTH (FEET)	2019 AIRCRAFT LANDINGS	2040 AIRCRAFT LANDINGS	ARFF INDEX
Airbus A321	146	1,236	2,540	C
Boeing MD-80	148	1,491	0	C
Boeing MD-88	148	1,263	0	C
Boeing MD-90	153	849	0	C
Boeing 737-800	130	13,386	25,779	C
Boeing 737-900	138	1,071	1,235	C
Boeing 757-200	155	408	0	C
Boeing 757-300	179	2	0	D
Required ARFF Index				**C**

Note:

Only passenger aircraft are considered for ARFF index determination.

Source: WSP USA, July 2020 (analysis).

RESPONSE VEHICLES

Airports with ARFF Index C are required to operate with a minimum of three vehicles, per FAA *AC 150/5220-10E, Guide Specification for Aircraft Rescue and Fire Fighting (ARFF) Vehicles*. STLAA staff indicated that they wished to maintain Index E capability through the planning horizon, which also requires a minimum of three vehicles, albeit with larger water/aqueous film forming foam agent quantities. Vehicles requirements for both Index C and E are listed in **Table 4.7-5.**

Table 4.7-5: Vehicle Class Requirements

VEHICLE	CAPACITY	INDEX C REQUIREMENTS	INDEX E REQUIREMENTS
Class 1	100-gallon Water/AFFF, and Dry Chemical (500 lbs. sodium- or 450 potassium-based), or Halogenated Agent (460 lbs.)	1	1
Class 2	300-gallon Water/AFFF, and Dry Chemical (500 lbs. sodium- or 450 potassium-based), or Halogenated Agent (460 lbs.)	1 instead of Class 1	1 instead of Class 1
Class 3	500-gallon Water/AFFF, and Dry Chemical (500 lbs. sodium- or 450 potassium-based), or Halogenated Agent (460 lbs.)	1 instead of Class 1 or 2	1 instead of Class 1 or 2
Class 4	1,500-gallon Water/AFFF	2	0
Class 5	3,000-4,500-gallon Water/AFFF	0	2

Sources: Federal Aviation Administration, Advisory Circular 150/5220-10E, *Guide Specification for Aircraft Rescue and Fire Fighting (ARFF) Vehicles*, June 1, 2011; WSP USA, 2020 (analysis).

Currently, STL's ARFF stations has twelve trucks and two utility airport rescue and fire fighting vehicles in total. The North ARFF Station typically houses two Striker 3000s, one Striker 1500, and one rapid response vehicle. The West ARFF Station typically houses one Striker 3000, one Striker 1500, and two rapid response vehicles. During maintenance cycles, the vehicle locations adjust in order to maintain the ARFF index requirements.

RESPONSE TIME

14 CFR Part 139 paragraph (h)(2)(i) specifies that "within three minutes from the time of the alarm, at least one required aircraft rescue and firefighting vehicle must reach the midpoint of the farthest runway serving air carrier aircraft from its assigned post or reach any other specified point of comparable distance on the movement area that is available to air carriers, and begin application of extinguishing agent". In addition, the following performance criteria needs to be where "within 4 minutes from the time of alarm, all other required vehicles must reach the point specified in paragraph (h)(2)(i) of this section from their assigned posts and begin application of an extinguishing agent.".

The STL ACM states that ARFF quick-response vehicles, when assisted by ATC, are capable of reaching the midpoint of the farthest runway on Airport from their respective ARFF station and begin rescue/firefighting operations within three minutes of notification. Remaining required vehicles will respond within four minutes of notification and begin rescue/fighting operations.

However, the North ARFF Station is being engulfed by Boeing facilities, and a site with better visibility of the movement area and faster response time is desired. Additionally, FAA ATCT personnel has voiced concerns with the location of both ARFF stations, which require runway crossing in order to respond to medical calls in the terminal area. FAA inspector also recommended that the North ARFF station be relocated south of the main runways to reduce runway crossings.

FACILITIES

Based on STLAA staff comments, additional building space is not needed except for typical refurbishments in the next five years, and no additional apparatus bays are required, as the current available bays exceed the ARFF Index requirements. The existing parking facilities are also adequate, with the number of available spaces exceeding the typical personnel per shift.

STLAA staff did not report any existing ARFF facility constraints and given that both existing stations exceed Part 139 index requirements, no future expansions are planned.

Additionally, STLAA staff wishes to consolidate the North and West ARFF stations into one station, in a location that would avoid runway crossings for emergency response to the terminal.

4.8.4 LIFE SAFETY

Emergency Medical Services (EMS) are housed in the South Medical Building, west of Terminal 1 Concourse A. EMS are provided by a contract vendor and supplemented by ARFF rapid response vehicles. FAA ATCT has voiced concerns with the North and South ARFF station locations requiring runway crossings to respond to medical calls in the terminal area.

There is a potential need to reconstruct the Medical Supplies Building (Building #410), which is used for EMS and incident command vehicles. This facility could be included with a consolidated ARFF station.

4.8.5 AIRPORT POLICE AND SECURITY

Airport Police facilities are scattered throughout the Airport property, with the main police station located in the Terminal 1 lower west end level, and the police substation in the Terminal 2 lower east end level. Other facilities are in different areas of the Main Terminal Building, while the Canine Unit facility occupies Building #511.

The survey response highlighted that the main existing constraint of the current Airport Police facilities is the need for the department’s consolidation into one facility, with a designated female locker room and a training area.

Currently, there are 90 authorized personnel in total working in the Police Unit, including 78 authorized police officers. Police vehicles are stored in various locations: Main Terminal Reserved Parking, Loading Dock area, K9 facility, etc. and are maintained by the Airport auto shop through on-site services and repair contracts. Additionally, the tenants expressed a need for more covered parking space for police vehicles.

The demand for Airport Police and Security facilities is derived from passenger enplanements. The passenger forecast under Scenario 1 shows a slight increase in passenger activity by 2025 compared to 2019 traffic levels, with a more pronounced growth in passenger enplanements in 2030 and 2040. As such, an overall Compound Annual Growth Rate (CAGR) for the entire forecast period is used to derive the future requirements for Airport police facilities. **Table 4.7-6** summarizes the future requirements for Airport Police facilities.

Table 4.7-6: Airport Police Facility Requirements

	EXISTING (SF) (2019)	2025 (SF)	2030 (SF)	2040 (SF)
Commercial Passenger Enplanements – Scenario 1	7,915,216	8,093,867	8,842,483	10,587,325
Compound Annual Growth Rate (CAGR)	1.4% (2019-2040)			
Airport Police Buildings				
Terminal 1	18,704	20,325	21,782	25,018
Terminal 2	215	234	250	288
Canine Facility	5,747	6,245	6,693	7,687
Total	**24,666**	**26,803**	**28,726**	**32,993**
Landside Parking	15,000 [1/]	16,300	17,469	20,064
Total	**39,666**	**43,103**	**46,194**	**53,057**

Notes:

SF – square feet

1/ Parking requirements assume 50 parking spaces available per shift and 300 sq. ft. per parking space.

Source: WSP USA, July 2020 (analysis).

4.8.6 AIR TRAFFIC CONTROL TOWER FACILITIES

The existing Air Traffic Control Tower (ATCT) at STL was commissioned in 1999. The total height of the tower is at 752.6' MSL or 197.8' AGL. The facility is in good operating condition with regular maintenance updates conducted to maintain its current status. The only line-of-sight issues pertains to the St. Louis Air Cargo apron, approximately 100 ft east of Taxiway K and eastbound from this point; the area is hidden from ATCT personnel by buildings located on the Signature Flight Support campus. The tail of a large cargo aircraft can be seen, but a smaller aircraft such as the Cessna 402 is not visible from the ATCT.

STL ATCT personnel stated that the existing facility is adequate in size. The employee parking facility within the lower level of the main terminal parking garage is adequate as well. In addition, the ATCT currently operates four positions including one Ground Control (GC) position, one Local Control (LC) position, one Metering (ME) position and a Supervisor/Coordinator (SC) combined position. The current facility can accommodate a total of ten total positions, should additional staffing be needed in the event of a significant traffic growth. The positions that can be accommodated include the following: three GC positions and three LC positions. two ME positions, one Coordinator position and one Supervisor position, i.e., the SC position would be split into two separate positions.

No ATCT requirements are anticipated through the planning horizon.

4.8.7 AIRPORT FUEL FARM

The replacement fuel farm features three above ground storage tanks with a capacity of 3,024,000 US gallons of Jet-A fuel. The volume of fuel storage provides a nine-day reserve (at peak period consumption). If future aviation activity warrants more storage capacity, the site can be expanded to accommodate three additional storage tanks, which would double the existing capacity.

No additional fuel farm requirements are anticipated through the planning horizon.

4.8.8 AIRPORT FUELING SUPPORT

Fueling support facilities are located west of Concourse A. They include:

- Building #309: administrative and operations support for the fuel farm and the fuel vehicles maintenance facility (3,239 sq. ft.).
- Building #308: fuel service equipment and vehicle maintenance (7,092 sq. ft.)
- Staging space (75,350 sq. ft.)
- Vehicle parking (60) and truck parking (6) spaces

The overall site covers an area approximately 2 acres in size. To accommodate growth in aircraft gates/fueling needs, a site approximately 2.5 acres in size is planned for 2040.

4.8.9 CENTRALIZED RECEIVING/DISTRIBUTION FACILITY

Concessions goods and supplies are delivered to a remote commissary (Building #307) operated by HMS Host, since large trucks are not allowed on the apron, or to the Terminal 2 loading docks for concessions not operated by HMS Host.

At Building #307, deliveries are unloaded, checked by TSA, then reloaded onto small trucks and vans for delivery to the Terminals 1 and 2 loading docks. Having large trucks being able to deliver directly at Terminal 1 would be more efficient. Additionally, Building #307 is in poor condition. In Terminal 2, deliveries are moved from the loading dock to the concessions through public areas, which is undesirable.

Alternatives for a centralized receiving/distribution facility (CRDF) will be explored in the *Alternatives Development* chapter, in combination with various terminal layout alternatives that consider deliveries through non-public areas.

A CRDF is a warehouse with raised platforms and loading docks, to facilitate the movement of goods. The warehouse would have a non-secure delivery area, a security screening area, dry/cold/freezer storage, and a secure loading dock. The warehouse would also include offices and areas to accommodate future security screening facilities and requirements. Similar facilities at medium hub airports require a footprint of approximately 2 acres, including 23,000 sq. ft. of building space (warehouse and offices).

4.8.10 CENTRAL UTILITY PLANT

Consideration should be given to consolidating the two existing utility plants into a Central Utility Plant (CUP). A site approximately 1 acre in size is planned for 2040.

4.8.11 SUMMARY OF AIRPORT SUPPORT FACILITIES REQUIREMENTS

- Airport administration:
  - Relocate AOB staff closer to Terminal 1
  - Existing: 154,285 sq. ft.
  - 2040: additional 27,000 sq. ft. (for a total of 181,845 sq. ft.)
- Airport operations and maintenance:
  - Overall, airfield and building maintenance facilities are in poor condition, often with dated and inefficient layouts.
  - Field maintenance/materials management: 19 acres
  - Building maintenance:

    Office/Shops:
    - Existing: 41,000 sq. ft.
    - 2040: 55,000 sq. ft. (additional 14,000 sq. ft.)

    Auto Parking:
    - Existing: 23,000 sq. ft.
    - 2040: 30,000 sq. ft. (additional 7,000 sq. ft.)

    Warehousing/Storage:
    - Existing: 34,000 sq. ft.
    - 2040: 46,000 sq. ft. (additional 12,000 sq. ft.)

    Satellite Receiving/Shipping and Storage Facility: 20,000 sq. ft. building
  - OCC/EOC:
    - Existing: 200 sq. ft.
    - 2040: 9,800 sq. ft.
  - Administration offices: none (included with Airport Administration requirements)
  - Terminal apron and roads (landside) snow removal equipment storage:
    - Existing: 3-acre site
    - 2040: 2.5-acre site (no additional requirements)

  - Pavement deicing fluid:
    - No additional footprint requirements
    - Upgrade surface under the tanks to concrete and pave truck maneuvering area
  - Snow dump sites:
    - Existing: 100,000 sq. ft.
    - 2040: 100,000 sq. ft. (no additional requirements)
- Airport rescue and firefighting: Consider relocating the North ARFF station to a site with better visibility of the movement area, faster response time and south of the main runways to reduce runway crossings.
- Airport police and security:
  - Consolidate all functions into one facility
  - Existing: 39,666 sq. ft.
  - 2040: additional 13,000 sq. ft. (for a total of 53,000 sq. ft.)
- Air traffic control tower: none
- Airport fuel farm: none, Replacement Fuel Farm under construction
- Airport Fueling Support:
  - Existing: 2 acres
  - 2040: total of 2.5 acres
- Centralized Receiving/Delivery Facility: 2 acres, including 23,000 sq. ft. of building space
- Consolidate two existing utility plants into a Central Utility Plant, on a 1-acre site

4.9 AIRLINE SUPPORT FACILITIES

Airline support facilities include buildings and other structures used to support the operations of the airlines at the Airport. The purpose of airline support facilities ranges from aircraft and ground support equipment maintenance, to ground handling, to flight kitchens. The following sections describe the existing and future facility requirements for the various STL airline support facilities, based on the information provided through maps, tenant surveys, STLAA staff and passenger and operations forecasts.

4.9.1 AIRCRAFT MAINTENANCE, REPAIR AND OVERHAUL

STL's MRO service providers include Trans State Holdings, Cape Air, American Airlines and Air Choice One, and perform a range of services pertaining to the airframe, powerplant, avionics, interiors, A Checks, landing gear, etc. These activities require various facility needs that were documented through surveys and questionnaires addressed to the tenants and are summarized in **Table 4.8-1**.

Table 4.8-1: Maintenance, Repair and Overhaul Facilities Requirements

	EXISTING (SF) (2019)	2025 (SF)	2030 (SF)	2040 (SF)
Commercial Passenger Aircraft Operations – Scenario 1	171,909	168,069	172,349	203,934
Compound Annual Growth Rate (CAGR)		-0.38% [1/] (2019-2025)	0.02% [2/] (2019-2030)	1.7% [3/] (2030-2040)
Air Choice One				
Hangar and Terminal Facility	9,764	40,000 [4/]	40,000	47,330
Apron	61,500	61,500	61,657	72,957
Auto Parking (Landside) [5/]	2,100	2,100	2,105	2,491
Total	**73,364**	**103,600**	**103,763**	**122,779**
American Airlines [6/]				
Hangar and Terminal Facility	155,276	245,276 [7/]	245,276	290,226
Apron	166,700	391,700 [8/]	391,700	463,484
Auto Parking (Landside) [5/]	50,400	50,400	50,529	59,789
Total	**372,376**	**687,376**	**687,505**	**813,498**
Cape Air				
Hangar and Terminal Facility	22,000	22,000	22,056	26,098
Apron	52,000	52,000	52,133	61,687
Auto Parking (Landside) [5/]	6,000	6,000	6,015	7,118
Total	**80,000**	**80,000**	**80,205**	**94,903**
Trans State Holdings				
Hangar and Terminal Facility	99,380	99,380	99,634	117,894
Apron	220,000	220,000	220,563	260,984
Auto Parking (Landside)	82,000	82,000	82,210	97,276
Total	**401,380**	**401,380**	**402,407**	**476,153**
Overall Existing MRO Facilities Needs				
Hangar and Terminal Facility	286,420	406,656	406,967	481,548
Apron	500,200	725,200	726,054	859,112
Auto Parking (Landside)	140,500	140,500	140,860	166,674
Total (in SF)	**927,120**	**1,272,356**	**1,273,880**	**1,507,333**
Total (in Acres)	**21.3**	**29.2**	**29.2**	**34.6**
New Entrant Needs				
Total (in Acres)		**14**	**14**	**14**
Overall Existing and New Operator Needs (in Acres)	**21.3**	**43**	**43**	**49**

Notes:

Projected totals are rounded.

Terminal facilities include office, warehouse, and shops.

SF – square feet

1/ Facility requirements for 2025 are either assumed to be the same as existing, based on the negative growth in operations between 2019 and 2025, or set to the tenant-specified 5-year needs, when provided.

2/ Facility requirements for 2030 are based on the net positive growth in operations between 2019 and 2030, since commercial operations are expected to decline in 2025 compared to 2019 operations' level.

3/ Facility requirements for 2040 are based on the growth in operations between 2030 and 2040, since commercial operations are expected to grow during this period following recovery.

4/ Hangar, shops and office space requirement for 2025 is based on a 40,000 sq. ft. maintenance base needed by Air Choice One per STLAA input.

5/ Total parking space is measured assuming 300 sq. ft. per parking space available for Air Choice One, American Airlines and Cape Air.

6/ American Airlines' hangar and apron area exclude area leased to Cape Air.

7/ Hangar and office space requirement for 2025 is based on 90,000 sq. ft. in additional building needed by American per their survey response.

8/ Apron space requirement for 2025 is based on 225,000 sq. ft. in additional apron needed by American per their survey response.

Sources: Tenant Surveys, 2020; WSP USA, July 2020 (analysis).

Although MRO facility requirements are based on individual air carrier decisions and strategies, for planning purposes, MRO facility requirements were derived using commercial passenger aircraft operations growth rate. Note that total operations were considered, instead of differentiating between domestic and international operations, as domestic traffic consistently accounted for over 98 percent of STL's total enplanements between 2000 and 2019, and 98% of the average daily departures at STL during CY 2019 were domestic.

The commercial aircraft forecast under Scenario 1, based on a 3-year recovery, shows a decline in commercial operations for the short-term forecast in 2025, followed by a recovery for the medium- and long-term forecasts in 2030 and 2040, respectively. As a result, facility requirements are based on the growth rate in commercial operations that is relevant to each time period. That is, since operations are expected to decline in 2025, facility requirements are maintained at the same existing levels unless needs were expressed by the tenants for the next 5 years. As operations start to increase again in 2030 compared to 2019 levels, facility requirements grow at the 2019-2030 CAGR of operations. The latter assumption was adopted instead of applying an overall growth rate for the entire forecast period, to reflect the drop in commercial operations in the next 5 years that will result in minimal facility requirements over the next 10-year period.

Survey responses from Trans States Holdings and Cape Air did not indicate any future needs to accommodate their operations. However, Cape Air reported the age of their building as an existing constraint to their operations. The main problems associated with the age of building and raised by Cape Air include hangars' doors breaking often, small leaks on the roof and heaters on the roof breaking.

STLAA indicated that Air Choice One's constraint is the need for a maintenance base with 40,000 sq. ft. of hangar with attached shops and offices. Air Choice One and Cape Air both share facilities with other tenants, and indicated to STLAA that they would like their own facilities.

Survey responses from American Airlines indicated that up to 225,000 sq. ft. of additional apron area was needed in 5 years, as well as an additional 10,000 sq. ft. of office space, 20,000 sq. ft. in additional hangar parts storage, 45,000 sq. ft. in aircraft maintenance hangar and 15,000 sq. ft. in additional support shop space. In addition, the tenant highlighted that the major existing constraint is the inability to fully enclose any fleet type airplane operated in the STL market inside the maintenance hangar.

Additionally, a site of approximately 14 acres is included for a potential new MRO entrant. The acreage was determined through a benchmark analysis of other MRO sites in the nation.

4.9.2 GROUND SUPPORT EQUIPMENT MAINTENANCE AND GROUND HANDLING

GROUND SUPPORT EQUIPMENT MAINTENANCE

Future facility requirements for GSE storage and maintenance are based on needs expressed by the tenants and the commercial passenger aircraft operations' growth rate. The commercial passenger traffic forecast under Scenario 1 is used as the basis for determining future facility requirements for GSE Maintenance facilities.

GSE maintenance facilities are located in the Cargo City complex and Building #310, south of Concourse A. Future needs for GSE maintenance facilities, summarized in **Table 4.8-2**, are based on forecasted commercial operations, survey responses when available, and professional judgment when no survey responses were provided.

Survey responses from Airport Terminal Services (ATS), one of the GSE Maintenance facilities tenants occupying the south end of Building #310, indicated that their current space does not meet their needs. ATS looked into relocating to the former space occupied by Allied Aviation in Cargo City 4, providing an additional 1,465 sq. ft. compared to their current available space, to help meet their needs for the next ten years.

This space would also allow to accommodate two fuel trucks inside for maintenance and provide additional outside space for GSE work and employee parking. It should be noted though that some tenants in Building #310 do not have restrooms and use adjacent tenants' restrooms.

In Cargo City, the shared auto parking is insufficient. Textron Technologies stated the need for an additional 1-foot clearance for the upper door in Cargo City 5. Textron Technologies also expressed a need for additional building space of 1,429 sq. ft. in the next 5 years.

GROUND HANDLING

Air General and World Flight Services provide ground handling services for belly cargo, out of Cargo City, while Majestic Terminal Services operates in the St. Louis Air Cargo area and provides ground handling service for Amazon Air; requirements for these cargo ground handlers are assessed in Section 4.6.

ELECTRIC GSE TRENDS/REQUIREMENTS

With electric aircraft emerging as a significant component of electric mobility, planning considerations for the future integration of electric aircraft at airports will identify additional opportunities for airports to integrate electric technology with electrified ground support equipment. GSE vehicles such as baggage tractors, forklifts, aircraft tugs, pushback vehicles and belt loaders are well positioned to benefit from electrification as they operate on a short range, make frequent stops and depend on low-end torque.

Table 4.8-2: Ground Support Equipment Maintenance Facilities Requirements

	EXISTING (SF) (2019)	2025 (SF)	2030 (SF)	2040 (SF)
Commercial Passenger Traffic Operations – Scenario 1	171,909	168,069	172,349	203,934
Compound Annual Growth Rate (CAGR)		-0.38% [1/] (2019-2025)	0.02% [2/] (2019-2030)	1.7% [3/] (2030-2040)
Building #310 (Delta Air Lines, Jett Pro, ATS)				
Building	16,930	18,395 [5/]	18,395	21,766
GSE Outdoor Staging/Storage	2,240	2,240	2,246	2,657
Employee/Visitor Parking	3,600 [4/]	3,600	3,609	4,271
Total	**22,770**	**24,235**	**24,250**	**28,694**
Cargo City 5 (Southwest Airlines, Textron Technologies)				
Building	10,521	11,950 [6/]	11,950	14,140
GSE Outdoor Staging/Storage	9,878	9,878	9,903	11,718
Employee/Visitor Parking	Shared Cargo Parking [7/]			
Total	**20,399**	**21,828**	**21,853**	**25,858**
Overall Ground Support Equipment Maintenance Facilities				
Building	27,451	30,345	30,345	35,906
GSE Outdoor Staging/Storage	12,118	12,118	12,149	14,375
Employee/Visitor Parking	3,600	3,600	3,609	4,271
Total	**43,169**	**46,063**	**46,103**	**54,552**

Notes:

SF – square feet

1/ Facility requirements for 2025 are either assumed to be the same as existing, based on the negative growth in operations between 2019 and 2025, or set to the tenant-specified 5-year needs, when provided.

2/ Facility requirements for 2030 are based on the net positive growth in operations between 2019 and 2030, since commercial operations are expected to decline in 2025 compared to 2019 operations level.

3/ Facility requirements for 2040 are based on the growth in operations between 2030 and 2040, since commercial operations are expected to grow during this period following recovery.

4/ Parking space is measured assuming 300 sq. ft. per parking space and 4 parking spaces per tenant.

5/ Building space requirement for 2025 is based on the additional space needed by ATS, in their tenant interview.

6/ Building space requirement for 2025 is based on the additional building needed by Textron Technologies per their survey response.

7/ Southwest airlines indicated that the available parking is limited.

Sources: Tenant Surveys, 2020; WSP USA, July 2020 (analysis).

Electric charging stations needed to support eGSE can be located throughout the Airport to eliminate "deadhead" refueling travel; deadhead travel also applies to electric aircraft requiring charging power under 80 kW, which can help achieve cost synergies. Current fast charging technologies make charging times less, while powering GSE vehicles for longer hours. Electric GSE have been in use since 2001, and ground service charging equipment can be funded through the FAA Voluntary Low Emissions (VALE) grants, as well as the Volkswagen Clean Air Settlement's mitigation trust fund.

4.9.3 PASSENGER LOADING BRIDGE MAINTENANCE

Passenger loading bridge maintenance is provided at STL by Airport Bridge Company (ABC), located in the Cargo City 2 building and Professional Business Providers (PBP), located northeast of the Cargo City 1 building.

In Cargo City, the shared auto parking is insufficient and twice the available space is needed for 2025. The reported overall condition of their building facilities and the overall condition of the shared parking space in Cargo City is good. No additional facility requirements were expressed by the tenants for the next 5 years, and therefore the commercial passenger traffic forecast under Scenario 1 is used as the basis for determining future facility requirements, as shown in **Table 4.8-3**.

Table 4.8-3: Passenger Loading Bridge Maintenance Facilities Requirements

	EXISTING (SF) (2019)	2025 (SF)	2030 (SF)	2040 (SF)
Commercial Passenger Traffic Operations – Scenario 1	171,909	168,069	172,349	203,934
Compound Annual Growth Rate (CAGR)		-0.38% [1/]	0.02% [2/]	1.7% [3/]
Airport Bridge Company				
Building	5,238	5,238	5,251	6,214
Outdoor Equipment Storage	5,230	5,230	5,243	6,204
Auto Parking	Shared Cargo City Parking			
Total	**10,468**	**10,468**	**10,495**	**12,418**
Professional Business Providers				
Building	4,000	4,000	4,010	4,745
Outdoor Equipment Storage	6,000	6,000	6,015	7,118
Auto Parking	Shared Cargo City Parking [4/]			
Total	**10,000**	**10,000**	**10,026**	**11,863**

Notes:

SF – square feet

1/ Facility requirements for 2025 are assumed to be the same as existing, based on the negative growth in operations between 2019 and 2025, or set to the tenant-specified 5-year needs, when provided.

2/ Facility requirements for 2030 are based on the net positive growth in operations between 2019 and 2030, since commercial operations are expected to decline in 2025 compared to 2019 operations level.

3/ Facility requirements for 2040 are based on the growth in operations between 2030 and 2040, since commercial operations are expected to grow during this period following recovery.

4/ Per STLAA, PBP needs double the available space with parking in the shared Cargo City area.

Sources: Tenant Surveys, 2020; WSP USA, July 2020 (analysis).

4.9.4 FLIGHT KITCHEN

Gate Gourmet is the only flight kitchen provider at STL. Flight kitchen operations consist of preparing in-flight meals and storing any food, beverage and snacks for in-flight service. The Gate Gourmet facility was constructed in 2003 to support the TWA hub and is oversized for today's needs. No expansion needs are anticipated through the planning horizon.

The Southwest Airlines Commissary is housed in Cargo City 3 and handles the airline's aircraft provisioning needs. The demand for flight kitchen services is derived from passenger enplanements. The passenger forecast under Scenario 1 shows a slight increase in passenger activity by 2025 compared to 2019 traffic levels, with a more pronounced growth in passenger enplanements in 2030 and 2040. As such, an overall Compound Annual Growth Rate (CAGR) for the entire forecast period is used to derive the future requirements for Southwest Airlines provisioning facility.

Table 4.8-4 summarizes the future requirements for flight kitchen facilities. In determining future facility requirements for flight kitchens, it is important to note that the demand for flight kitchen space has decreased over the past decade due to cutbacks in in-flight meal service, specifically on domestic flights. However, the demand for onboard meal services on international flights is not affected.

Table 4.8-4: Flight Kitchen Facility Requirements

	EXISTING (SF) (2019)	2025 (SF)	2030 (SF)	2040 (SF)
Commercial Passenger Enplanements – Scenario 1	7,915,216	8,093,867	8,842,483	10,587,325
Compound Annual Growth Rate (CAGR)	1.4% (2019-2040)			
Gate Gourmet				
Building	85,640	85,640	85,640	85,640
Truck Loading/Staging Docks	55,760	55,760	55,760	55,760
Landside Parking	65,102	65,102	65,102	65,102
Total	**206,502**	**206,502**	**206,502**	**206,502**
Southwest Airlines Provisioning				
Building	18,324	19,912	21,340	24,510
Landside Parking	Shared Cargo City Parking City Parking[1/]			
Total	**18,324**	**19,912**	**21,340**	**24,510**
Overall Total Flight Kitchen	**224,826**	**226,414**	**227,842**	**231,012**

Notes:

SF – square feet

1/ Southwest airlines indicated that the available parking is limited.

Sources: Tenant Surveys, 2020; WSP USA, July 2020 (analysis).

4.9.5 SUMMARY OF AIRLINE SUPPORT FACILITIES REQUIREMENTS

- Aircraft MRO:
  - Existing: 927,120 sq. ft.
  - 2040: additional 1,183,220 sq. ft. (for a total 2,110,343 sq. ft.)
- GSE maintenance:
  - Existing: 43,169 sq. ft.
  - 2040: additional 11,000 sq. ft. (for a total 54,552 sq. ft.)
- Ground handling: included in Cargo requirements
- Passenger loading bridge maintenance:
  - Existing: 20,468 sq. ft.
  - 2040: additional 4,000 sq. ft. (for a total 24,281 sq. ft.)
- Flight Kitchen:
  - Existing: 224,826 sq. ft.
  - 2040: additional 6,200 sq. ft. (for a total 231,012 sq. ft.)

4.10 GENERAL AVIATION FACILITIES

Facility requirements for General Aviation facilities are based on space needed to accommodate based and itinerant aircraft. Specifically, GA demand will drive the assessment for the existing and future needs for the FBO facilities and corporate aviation at STL including terminal, office and auto parking space, as well as aircraft storage (hangars and apron).

Future facility requirements are based on needs expressed by FBOs and corporate aviation tenants and the GA forecasted activity. The short (2025), medium- (2030) and long-term forecasts (2040) for GA activity at STL shows a 0% growth in number of operations and based aircraft, as GA operations are expected to stay constant over the forecast period.

An analysis of 2019 Harris Data shows that most aircraft that used GA facilities fall under ADG **II** (68%), followed by 23% of ADG **I** aircraft and 9% of ADG **III** aircraft, as summarized in **Table 4.9-1**:

Table 4.9-1: General Aviation Fleet Mix (2019)

AIRPLANE DESIGN GROUP (ADG)	TOTAL ANNUAL OPERATIONS	PERCENTAGE OF ALL GENERAL AVIATION OPERATIONS
I	3,277	23%
II	9,830	68%
III	1,362	9%
IV	15	0%

Total	**14,484**	

Source: St. Louis Airport Authority, *L3 Harris Operations Data,* January-December 2019 (aircraft activity); WSP USA, July 2020 (analysis.

4.10.1 FIXED BASE OPERATORS

A Fixed Base Operator (FBO) is a service provider that offers a multitude of aeronautical activities at an airport, such as fueling, tie-down and parking, aircraft storage, maintenance, aircraft rental, and flight training.

Future needs, summarized in **Table 4.9-2**, are based on forecast GA aircraft activity, survey responses when available, STLAA staff input and professional judgment when no survey responses were provided.

Survey responses from Signature Flight Support indicated that up to 100,000 sq. ft. of additional apron area was needed in 5 years, which will be able to accommodate a Boeing 767, as well as an additional 50 auto parking spaces. Signature Flight Support is also in the early planning stages for a hangar up to 40,000 sq. ft. in size. In addition, the tenant highlighted that the major existing constraint is ramp congestion during traffic peaks, especially with a trend for increasing aircraft size.

Given a 0 percent projected growth in GA activity and no needs expressed by the ATS Jet Center, facility requirements for ATS Jet Center are expected to remain the same as existing through the planning horizon.

Per STLAA staff, a 25 percent allowance for expansion/potential new entrant was added to FBO requirements.

4.10.2 CORPORATE AVIATION

Corporate aviation facilities at STL consist of business aviation hangars and aircraft management facility buildings operated by MHS Travel and Jet Linx.

Future needs, summarized in **Table 4.9-3**, are based on forecast GA aircraft activity, survey responses when available, STLAA staff and professional judgment when no survey responses were provided.

STLAA receives inquiries for corporate hangar sites on a regular basis; however, there is currently no site that is ready to be developed to accommodate corporate hangars without significant investment. To meet demand for corporate hangars, new entrant needs are assumed to be one new 20,000 sq. ft. corporate hangar per year (assumed to correspond to an overall 50,000-sq. ft site per hangar).

Jet Linx has five based jet aircraft, including an Embraer Phenom. Jet Linx has expressed the need to hangar all five aircraft, requiring a minimum 25,000 sq. ft. of added hangar space.

Table 4.9-2: Fixed Base Operator Facility Requirements

	EXISTING (SF)	2025 (SF)	2030 (SF)	2040 (SF)
Signature				
Hangar	64,475	104,475	104,475	104,475
Apron	290,000	390,000	390,000	390,000
Terminal	9,250 (5,640 footprint)	9,250 (5,640 footprint)	9,250 (5,640 footprint)	9,250 (5,640 footprint)
Landside	191,819	206,819 [1/]	206,819	206,819
Landscaping	205,730	205,730	205,730	205,730
Fuel Storage	17,700	17,700	17,700	17,700
Total Signature	**775,364**	**930,364**	**930,364**	**930,364**
ATS Jet Center				
Hangar	0	0	0	0
Apron	75,000	75,000	75,000	75,000
Terminal	1,929	1,929	1,929	1,929
Landside	16,388	16,388	16,388	16,388
Landscaping	0	0	0	0
Fuel Storage	15,202 [2/]	15,202	15,202	15,202
Total ATS Jet Center	**108,519**	**108,519**	**108,519**	**108,519**
Total Existing FBOs (Sq. Ft)	**883,883**	**1,038,8831**	**1,038,8831**	**1,038,8831**
(Acres)	**20**	**24**	**24**	**24**
Expansion/New Entrant Allowance (+25%) (Acres)		**6**	**6**	**6**
Total FBO Requirements (Acres)	**25**	**30**	**30**	**30**

Notes:

The general aviation forecast shows a 0% growth in activity through the planning horizon. Facility requirements for Signature Flight Support are based on survey responses. Facility requirements for ATS Jet Center are assumed to remain the same as existing.

Per STLAA staff, a 25 percent allowance for FBO expansion/new entrant was added.

SF – square feet

1/ Assuming 300 sq. ft. per additional vehicle parking space needed.

2/ Includes 5,000 sq. ft. leasehold area for ATS fuel tank.

Sources: Tenant Surveys, 2020; WSP USA, July 2020 (analysis).

Table 4.9-3: Corporate Operator Facility Requirements

	EXISTING (SF)	2025 (SF)	2030 (SF)	2040 (SF)
MHS Travel				
Hangar	68,077	68,077	68,077	68,077
Apron	0	0	0	0
Terminal	0	0	0	0
Landside	41,890	41,890	41,890	41,890
Landscaping	113,800	113,800	113,800	113,800
Fuel Storage	0	0	0	0
Total	**223,767**	**223,767**	**223,767**	**223,767**
Jet Linx				
Hangar	59,800	59,800	59,800	59,800
Apron	126,360	126,360	126,360	126,360
Terminal	3,500	3,500	3,500	3,500
Landside	64,010	64,010	64,010	64,010
Landscaping	30,200	30,200	30,200	30,200
Fuel Storage	0	0	0	0
Total	**283,870** [1/]	**283,870**	**283,870**	**283,870**
New Entrant Needs				
Number of Hangars		5	10	20
New Entrants Hangar Site Requirements [2/]		**250,000**	**500,000**	**1,000,000**
Total Corporate Aviation Requirements (Sq. Ft.)	**507,637**	**757,637**	**1,007,637**	**1,507,637**
(Acres)	**12**	**17**	**23**	**35**

Notes:

SF – square feet

MHS Travel terminal and shop space are included in the hangar space.

1/ Total Area excludes hangar/apron area leased to Air Choice One

2/ Additional corporate hangar space assumes one additional 20,000-sq. ft. hangar per year (50,000 sq. ft. for the overall site).

Source: WSP USA, November 2020 (analysis).

4.10.3 TECHNOLOGICAL INNOVATIONS IN GENERAL AVIATION

This section discusses facility requirements for emerging aviation users, such as small Unmanned Aerial System (UAS) and Urban Air Mobility (UAM).

SMALL UNMANNED AERIAL SYSTEMS FOR AIRPORT OPERATIONS

The use of sUAS by airport operators is growing. sUAS can provide a wide variety of services, from perimeter surveillance to jet bridge inspection. Based on current investigations of sUAS uses, specific facility requirements are not necessary for sUAS. Services are typically provided by external providers on demand. In the future, airport operators might acquire UAS for their own needs. However, neither should require specific accommodation from an airport long-term planning standpoint, giving the size and concept of operations of these aircraft.

ELECTRIC AIRCRAFT

There is an increased interest in electric aircraft by industry and stakeholders. While the electrification of larger commercial service aircraft seems today beyond the planning horizons of the STL ALPU, e-aircraft (new models or variant and retrofit of existing types) might be available in the short-term in the general aviation and commuter market segments. Prototypes are already flying and ongoing research projects are paving the way for this technology and its integration in the airport environment. They will most likely require high-power charging stations to recharge their batteries, similar to a 400Hz Ground Power Unit (GPU), which could be made available at the gate or on RON/hardstand parking positions.

URBAN AIR MOBILITY

UAM encompasses the operation of sUAS for delivery services and new electrical 'air taxis' in dense, urban environments. In the United States, both are still in a research and development stage.

In June 2020, the FAA published a Concept of Operations (ConOps 1.0)[11] for incorporating UAM operations in the National Airspace System and supports the projected growth of UAM operations in urban environments. UAM operations will occur between specific aerodromes and within defined UAM Corridors, identified as performance-based airspace in which aircraft will need to adhere to the UAM specific rules, procedures and participation requirements (navigation, flight intent sharing for tactical separation, strategic deconfliction, etc.). The UAM Corridor structure will help increase operations without the need for additional ATC involvement and resources, i.e., tactical separation services will not be provided by the ATC within the UAM Corridors, but will be assigned to the UAM operators, i.e., the onboard Pilot in Command (PIC) and the Providers of Services for UAM (PSUs). In addition, the stakeholder UAM community will develop Community Business Rules (CBRs) to define standards for operations, which will need to be approved by the FAA.

[11] Federal Aviation Administration, NextGEN Urban Air Mobility, Concept of Operations v1.0, June 2020.

4.10.4 SUMMARY OF GENERAL AVIATION REQUIREMENTS

- FBO:
  - Existing/Needed: 20 acres/25 acres
  - 2040: additional 5 acres (total of 30 acres)
- Corporate Aviation:
  - Existing: 12 acres
  - 2040: additional 23 acres (total of 35 acres)