Working Paper – Element #5
Demand/Capacity and Facility Requirements

Lehigh Valley International Airport

Allentown, Pennsylvania

Airport Master Plan Update

March 5, 2018 – Final

Prepared by: C&S Engineers, Inc.

Table of Contents

Section 5 — Demand/Capacity and Facility Requirements

5.1 Introduction

In accordance with FAA AC 150/5070-6B, *Airport Master Plans*, the purpose of this section is to summarize LVIA's ability to accommodate future aviation demand throughout the planning period (2040). This summary was developed using the existing conditions inventory completed in Working Paper 3, as well as the forecasts developed in Working Paper 4, to examine the adequacy of existing facilities throughout the planning period in relation to the airport's facility requirements. Facility requirements are dimensional or FAA standard requirements that are determined based on forecasted aviation demand as well as changes to FAA development standards. These requirements will guide the alternative development process by examining projected perceived needs of the following major components: airside, terminal facilities, landside access, circulation and parking, general aviation facilities, cargo facilities, airport support facilities and equipment, utilities, and other identified infrastructure.

Facility requirements represent what should be planned under a "best case scenario." In reality, physical and financial resources often impose constraints on the development of the entirety of these requirements. For this reason in the forthcoming analysis, alternative developments will be created to meet facility requirements to achieve the LNAA's long-term development goals for the airport.

Critical Aircraft

An airport's critical aircraft referred to as a design aircraft, represents the most demanding critical dimensions and highest approach speed of all aircraft types that use the airport for at least 500 operations annually. The designation of a critical aircraft is an important component of the facilities requirements analysis because this aircraft dictates the runway and taxiway dimensions and design standards that should be in place at an airport.

As indicated in FAA AC 150/5300-13A, *Airport Design*, an airport's critical aircraft determines the Airport Reference Code (ARC), an FAA code that determines the critical family of aircrafts that each design aircraft is categorized as. An ARC is determined by combining the Aircraft Approach Category (AAC) with the Airplane Design Group (ADG). As outlined in **Table 5.1.1** and **Table 5.1.2**, AAC is determined by the design aircraft's approach speed and ADG is determined by the design aircraft's tail height and wingspan.

Table 5.1.1 Aircraft Approach Category (AAC)

AAC	Approach Speed (knots)
A	< 91 knots
B	91 ≤ and < 121
C	121 ≤ and < 141
D	141 ≤ and < 166
E	≥ 166

Source: FAA AC 150.5300-13A, Table 1-1. Aircraft Approach Category (AAC)

Table 5.1.2 Airplane Design Group (ADG)

Group #	Tail Height (ft.)	Wingspan (ft.)
I	< 20	< 49
II	20 ≤ and < 30	49 ≤ and < 79
III	30 ≤ and <45	79 ≤ and < 118
IV	45 ≤ and < 60	118 ≤ and < 171
V	60 ≤ and < 66	171 ≤ and < 214
VI	66 ≤ and < 80	214 ≤ and <262

Source: FAA AC 150.5300-13A, Table 1-2. Airplane Design Group (ADG)

An airport's ARC in combination with approach visibility minimums, as outlined in **Table 5.1.3**, determines its Runway Design Code (RDC). An airport's RDC provides guidance on required runway standards and dimensions, which if not met, must be classified as a modification of standards.

Table 5.1.3 Visibility Minimums

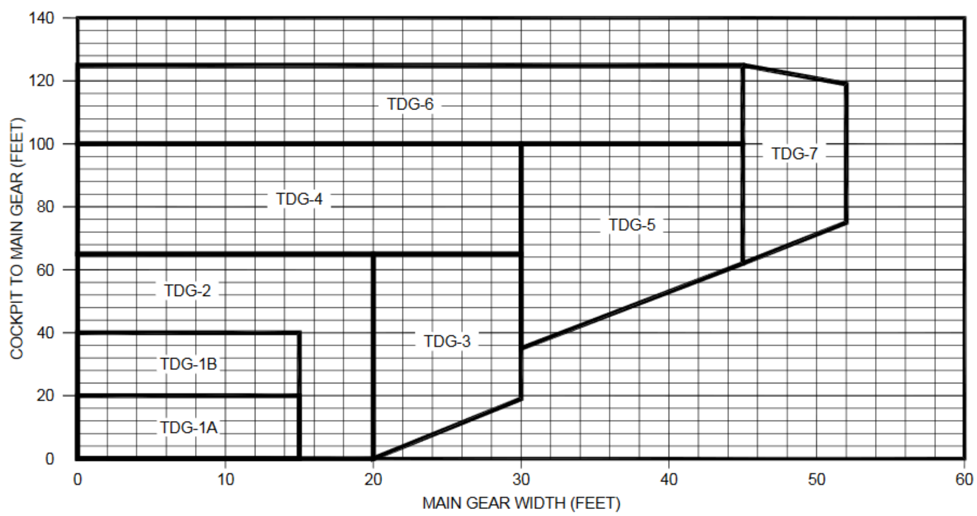
RVR[1] (ft.)	Instrument Flight Visibility Category (statute mile)
5,000	Not lower than 1 mile
4,000	Lower than 1 mile but not lower than ¾ mile
2,400	Lower than ¾ mile but not lower than ½ mile
1,600	Lower than ½ mile but not lower than ¼ mile
1,200	Lower than ¼ mile

[1]Runway Visual Range

Source: FAA AC 150/5300-13A, Table 1-3. Visibility minimums

A critical aircraft can also be used to determine the Taxiway Design Group (TDG) at an airport. The TDG dictates the taxiway/taxilane width and fillet standards, as well as taxiway/taxilane separation requirements. A TDG is determined by plotting the design aircraft's Main Gear Width (MGW) to its Cockpit to Main Gear Distance (CMG) on the following figure, **Figure 5.1.1**. Depending on the utilization of a specific area of the airport, or site limitations the TDG can vary from the critical aircraft, as described below.

Figure 5.1.1 Taxiway Design Groups



Source: FAA AC 150/5300-13A, Airport Design, Figure 1-1. Taxiway Design Groups (TDGs), Updated 12/21/12

Due to the clearly defined aprons and buildings allocated to cargo, terminal, and GA activity at LVIA, there are differences in the types of aircraft that utilize various parts of the airfield. For example, commercial carrier aircraft do not access the cargo apron and only utilize the taxiways and runways that lead to the terminal. For this reason, and to prevent the unnecessary costs of meeting facility requirements that will not be needed for portions of the airport, three future critical aircraft have been determined for purposes of this analysis. A critical aircraft has been chosen representing GA operations, terminal operations, and cargo operations, with the most demanding critical aircraft of these three serving as the overall critical aircraft for the airfield. These four critical aircraft, as portrayed in **Table 5.1.4**, will determine the design standards that must be achieved for their relevant RDCs and TDGs.

Table 5.1.4 Previous Master Plan and Future Critical Design Aircraft

Critical Design Aircraft	Previous Master Plan	Future			
		Terminal	GA	Cargo	Overall
	DC-8-63F	**Airbus 320**	**Gulfstream IV**	**Boeing 767-300ER**	**Boeing 767-300ER**
Length (ft.)	187.4	123.3	88.4	159	159
Wingspan (ft.)	148.4	111.9	77.10	156.2	156.2
Tail Height (ft.)	43.13	39.6	24.5	52.9	52.9
Maximum Take-off Weight (lbs.)	358,000	171,961	73,200	396,000	396,000
Approach Speed (knots)	143	136	149	135	135
CMG[1]	77.5	50.2	38.3	79.7	79.7
MGW[2]	20.8	29.4	13.8	35.4	35.4
RDC[3]	**D-IV**	**C-III**	**D-II**	**D-IV**	**D-IV**
TDG[4]	**4**	**3**	**2**	**5**	**5**

[1] Cockpit to Main Gear Distance
[2] Main Gear Width
[3] Runway Design Code
[4] Taxiway Design Group
Source: Airplane Design Manuals, AC 150/5300-13A Change 1, and C&S Engineers, Inc. analysis May-June 2017

5.2 Airfield

The following sections discuss airfield standards as dictated by the FAA.

Annual Service Volume (ASV)

Annual Service Volume (ASV) is an indicator of relative annual operating capacity at an airport that accounts for differences in various airfield conditions such as runway use, aircraft mix, and weather conditions. As the level of operations at an airport approaches its ASV, additional increases in air traffic movements result in disproportionate increases in aircraft delays. Although many airports commonly exceed their ASV, typical guidance indicates that when an airport reaches 60% of its ASV, planning efforts should begin to remediate aircraft delays and as an airport approaches 80% of its ASV, it should start the design process to prevent aircraft delays from becoming unmanageable. FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*, provides guidance for calculating ASV.

In the 2004 Master Plan, the ASV for the airfield was calculated to be 230,000 operations based on the airfield's weighted hourly capacity, the daily and hourly demand characteristics, as well as the assumptions outlined in the Master Plan. A demand-capacity analysis using this ASV is presented in **Table 5.2.1**.

Table 5.2.1 Airfield Demand and Capacity

	2017	2018	2019	2020	2025	2030	2035	2040
Annual Operations Demand and Capacity								
Annual Service Volume[1]	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000
Forecasted Demand	75,936	77,958	79,781	81,804	88,007	95,931	105,258	115,973
Demand Capacity-Ratio	33%	34%	35%	36%	38%	42%	46%	50%
Hourly Operations Capacity								
VFR Hourly Operations Capacity[1]	87	87	87	86	86	86	86	86
VFR Hourly Capacity Estimated by ATCT	70	70	70	70	70	70	70	70
IFR Hourly Operations Capacity[1]	46	46	46	46	46	46	46	46
IFR Hourly Capacity Estimated by ATCT	40	40	40	40	40	40	40	40

Sources: 1. From 2004 Master Plan update analysis. Updated by C&S Engineers, Inc. May-June 2017

LVIA's ASV is anticipated to reach 50% by 2040. This indicates that no action needs to be taken during the planning period for the Airport to maintain an acceptable level of relative annual operating capacity as far as the number of runways is concerned. Since previous efforts have looked into a third runway that is shown on the ALP and capacity is approaching the 60% mark, consideration to continue planning for a third runway beyond this 20-year planning period should be part of this Master Plan.

Since average daily and hourly operations approach similar demand capacity ratios as the annual numbers, hourly forecasts were not derived for this effort. It should be noted that discussions with ATCT personnel in June 2017 indicate that actual hourly capacities are slightly less than the FAA formula. These are shown in the table above; VFR 87 versus 70; and IFR 46 versus 40. They indicated that this is primarily related to the taxiway system and their ability to move aircraft from the runway after landing, or have multiple aircraft ready for departure. Airfield configurations that impact the ability to reach the higher capacity numbers include:

- Northwest winds consistent for Runway 31 and 24 use (highest in the Fall season)
- Noise abatement procedures
- Landing Runway 31 has limited taxiway exit options
- Northwest corner taxiway additions (Bravo) would help capacity
- Cargo aircraft taxiing only allows for one in, one out at a time
- General flow of taxiways for the entire airfield is limiting with larger aircraft

FAA Design Standards

As indicated by the critical aircraft, airfield design standards at LVIA should be in accordance with FAA standards for a D-IV ADG. , Every effort possible should be made to have LVIA meet current standards. If for some reason this proves unfeasible, consultation with the FAA Office of Airports and Flight Standards Service will identify any applicable FAA funding and/or will provide for adjustments necessary to accommodate operations at the maximum extent possible while maintaining acceptable safety levels.

Existing Modifications to Standards

There are currently six modifications to standards (MOS) regarding airfield geometry in place at LVIA. Existing airfield geometry MOS are outlined in **Table 5.2.2** and are presented in Figure 3.4.2 of the Existing Inventory Conditions

Table 5.2.2 Existing Airfield Geometry MOS

Standard Modified	FAA Standards	Existing Condition
Runway Object Free Area	Clear of objects	Perimeter road in ROFA of RW-24 and RW-31
Extended Object Free Area	Clear of objects	Corner of cemetery located 250' from CL with 300' width penetration
Runway Visibility Zone	Clear line of sight	Hangar 7 and Hangar 10 located in RVZ
Runway/Taxiway Separation	400' separation	Taxiway B has a 362' separation from RW 13-31
Runway Visibility Zone	Clear Line of Sight	Overnight aircraft parked on apron within RVZ
Runway Visibility Zone	Clear Line of Sight	Hangar 10 and line service building located in RVZ

Source: 2004 Master Plan Update, confirmed by C&S Engineers, Inc. May 2017

Deviations from Design Standards

To meet the design needs of LVIA's critical aircraft (Boeing 767-300ER) existing runways must be designed to meet FAA RDC D-IV and TDG 5 standards. Currently Runway 6-24 is designed to meet D-IV RDC standards while Runway 13-31 is designed to meet C-III RDC standards.

The following table, **Table 5.2.3**, illustrates deviations in design standards for the existing runways in comparison to FAA D-IV runway design standards under a visibility minimum lower than ¾ of a mile. The less than ¾ of a mile visibility minimum was chosen due to existing less than ¾ of a mile visibility statutes for Runway 24 and 31 (Runway 6 and 13 are ½ mile visibility minimums). Deviations from these standards are underlined and in **bold** type.

Table 5.2.3 FAA D-IV Runway Design Standards and Existing Deviations

	Existing RW 6-24 (D-IV)	Existing RW 13-31 (C-III)	D-IV with Lower than 3/4 mile Visibility Minimum
RUNWAY DESIGN			
Runway Length	7,599'	5,797	N/A
Runway Width	150'	150'	150'
Shoulder Width[1]	0'	0'	25'
Blast Pad Width	**0'** / 200'	200' / 200'	200'
Blast Pad Length[2]	**0'** / 200'	**325'** / **320'**	200'
Wind Crosswind Component[3]	20 knots	**16 knots**	20 knots
RUNWAY PROTECTION			
Runway Safety Area (RSA)			
Length beyond departure end	1,000' / 1,000'	EMAS (C-III)	1,000'
Length prior to threshold	600' / 600'		600'
Width	500' / 500'		500'
Runway Object Free Area (ROFA)			
Length beyond runway end	1,000' / 1,000'	EMAS (C-III)	1,000'
Length prior to threshold	600' / 600'		600'
Width	800' / 800'		800'
Runway Obstacle Free Zone (ROFZ)			
Length beyond runway end	200'	200'	200'
Width	400'	400'	400'
Precision Obstacle Free Zone (POFZ)			
Length	200' / 200'	200' / 200'	200'
Width	800' / 800'	800' / 800'	800'
Approach Runway Protection Zone (RPZ)[4]			
Length	2,500' / **1,700'**	2,500' / **1,700'**	2,500'
Inner Width	1,000' / 1,000'	1,000' / 1,000'	1,000'
Outer Width	1,750' / **1,510'**	1,750' / **1,510'**	1,750'
Acres	78.914 / **53.662**	78.914 / **53.662**	78.914
Departure Runway Protection Zone (RPZ)[4]			
Length	1,700' / 1,700'	1,700' / 1,700'	1,700'
Inner Width	500' / 500'	500' / 500'	500'
Outer Width	1,010' / 1,010'	1,010' / 1,010'	1,010'
Acres	29.465 / 29.465	29.465 / 29.465	29.465
Runway Separation			
Runway centerline to:			
Parallel runway centerline	N/A	N/A	5,000'
Holding position	250'	250'	250'
Parallel Taxiway/Taxilane centerline	400'	400'[5]	400'
Aircraft parking area	**526'**[6]	**478'**[7]	500'
Helicopter touchdown pad	N/A	N/A	N/A

[1] There are no existing paved or gravel shoulders although the ground may be graded and cleared to standards
[2] The ends of the blast pad on RW 13-31 is cut short by the Vehicle Service Road (VSR)
[3] These are the amounts required per ARP SOP No. 2.00, pg. A-10
[4] RPZ dimensions deviating from standards indicate that the Airport does not own the entirety of the land within the RPZ
[5] Portion of taxiway near the RW 31 end is only 343'
[6] Closest apron to RW 6-24 is that of Hangar 10
[7] Closest apron to RW 13-31 is that of Hangar 7
Sources: C&S Engineers, Inc. analysis May-June 2017 for existing data. FAA AC 150/5300-13A - Table A7-9. Runway Design Standards Matrix, C/D/E-IV, pg. 278 for FAA design standards.

Deviations for Runway 6-24

Deviations from FAA design standards for Runway 6-24 includes the following:

- Runway 6 Blast Pad – Is non-existent. Should be 200 feet wide by 200 feet long.
- Runway 24 Approach RPZ – Airport does not own 25.252 acres in the RPZ, needs to extend RPZ length by 800 feet and the outer width by 240 feet.
- Runway 6-24 separation from the runway centerline to the closest aircraft parking area is acceptable, but 26 feet farther than the minimum.

Deviations for Runway 13-31

Deviations from FAA design standards for Runway 13-31 includes the following:

- Runway 13 Blast Pad – Length of 325 feet is acceptable and 125 feet longer than the standard.
- Runway 31 Blast Pad – Length of 320 feet is acceptable and120 feet longer than the standard.
- Runway 13-31 EMAS designed for C-III but is deficient for D-IV.
- Runway 31 Approach RPZ – Airport does not own 25.252 acres in the RPZ, needs to extend RPZ length by 800 feet and the outer width by 240 feet.
- Runway 13-31 Crosswind – Existing crosswind component that must be met is 16 knots, not 20 knots. However, this 95% wind coverage criteria is met for 20 knots under All-weather, VFR, and IFR conditions (as indicated in Figure 3.3.3 of the Existing Conditions Inventory).
- Runway 13-31 separation from the runway centerline to the closest aircraft parking area is 478 feet, 2 feet deficient of the requirement.

Hot Spots/RIM

A "hot spot" is a location in a movement area where heightened attention by pilots is necessary due to the location having a history or the potential risk of collision or runway incursion due to causes such as airport layout, traffic flow, airport marking, signage and lighting, situational awareness, and training. The FAA Airport Design AC 150/5300-13A, Change 1 states, "to enhance safety by avoiding runway incursions, taxiway turns and intersections are designed to enable safe and efficient taxiing by airplanes while minimizing excess pavement".

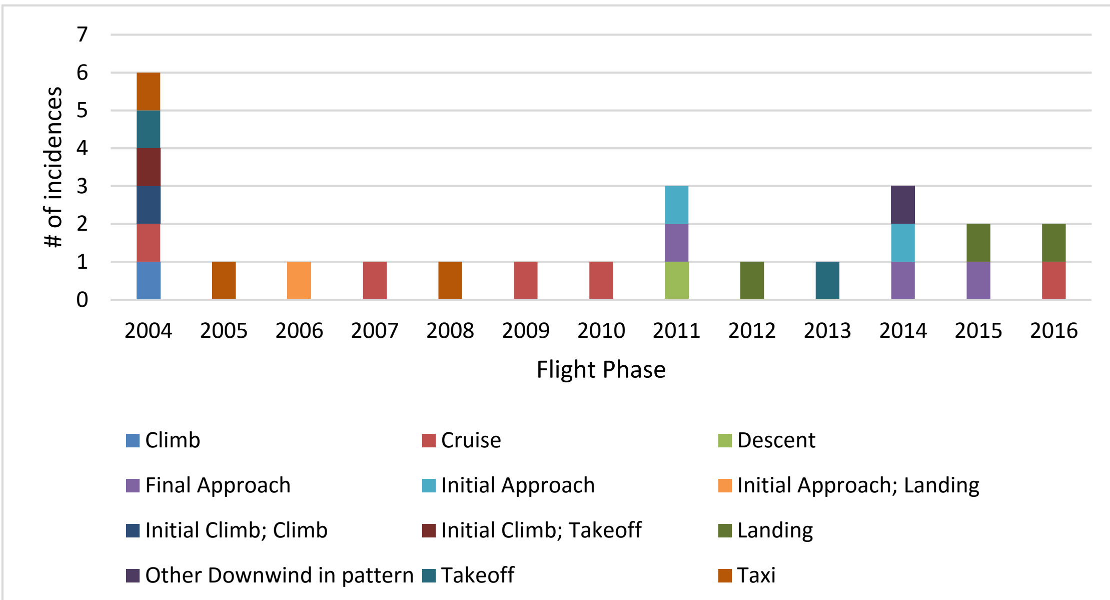
To date, there have been no major hot spots identified by the FAA at LVIA.[1] In addition, the Airport has not been identified as a location for the FAA Runway Incursion Mitigation (RIM) program, meaning that in

[1] FAA Runway Safety Hot Spots List. Accessible at: https://www.faa.gov/airports/runway_safety/hotspots/hotspots_list/ Accessed 5/22/17.

the years from 2007 to 2013, LVIA did not average at least one runway incursion per year or have three or more peak annual runway incursions occur in a given calendar year.[2]

Historical runway incursion and surface incident data was reviewed for LVIA dating back to January 2004. Sources used in the review include the Aviation Safety Reporting System (ASRS)[3] and the FAA Aviation Safety Information Analysis and Sharing (ASIAS) Accident and Incident Data System (AIDS)[4]. ASRS data shown in **Figure 5.2.1**, indicates that 24 accidents have occurred at LVIA since 2004 while FAA ASIAS AIDS data shown in **Figure 5.2.2**, indicates that 21 accidents have occurred. The majority of incidents reported have yielded minor or no damages.

Figure 5.2.1 ASRS Data (2004-2016)



Source: ASRS Database Online. Data from January 2004 through May 2016

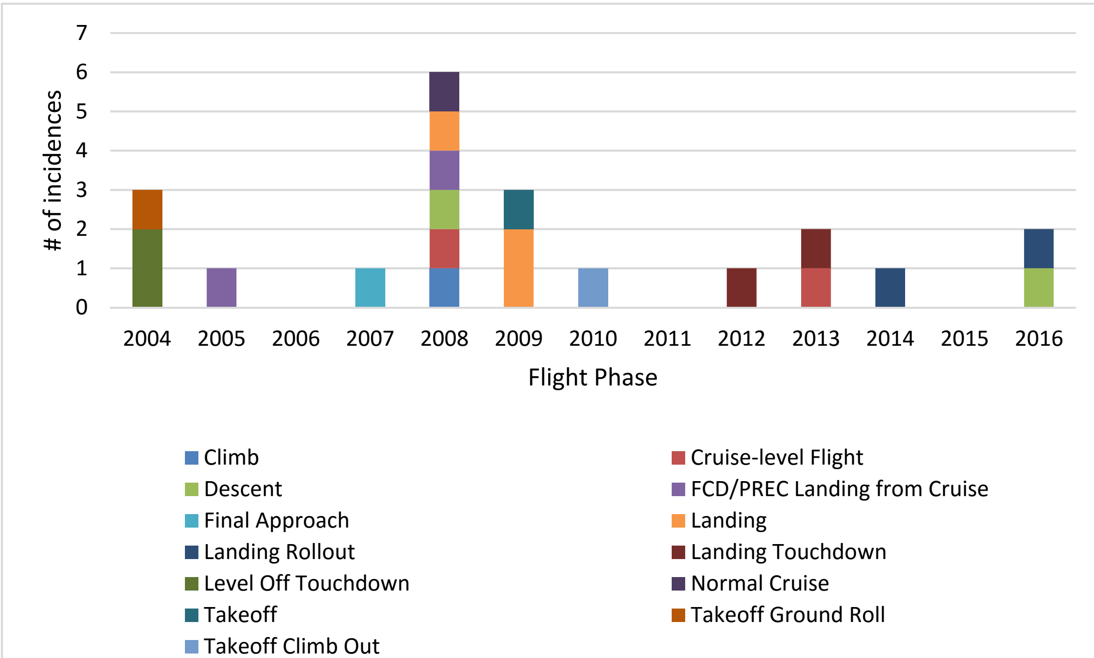
---

[2] FAA, Runway Incursion Mitigation (RIM) Program, Airports. Accessible at: https://www.faa.gov/airports/special_programs/rim/. Accessed 5/22/17.

[3] ASRS Database Online. Accessible at: https://asrs.arc.nasa.gov/search/database.html, data from January 2004 through May 2017

[4] FAA Aviation Safety Information Analysis and Sharing (ASIAS), FAA Accident and Incident Data System (AIDS), Accessible at: http://www.asias.faa.gov/pls/apex/f?p=100:12:0::NO:::, data from 01/01/04 through 05/21/17.

Figure 5.2.2 FAA ASIAS AIDS Data (2004-2016)



Source: FAA Aviation Safety Information Analysis and Sharing (ASIAS), FAA Accident and Incident Data System (AIDS), Data from 01/01/04 through 05/21/17.

Runway Safety Areas (RSA)

The purpose of a Runway Safety Area (RSA) is to enhance the safety of an aircraft that may undershoot, overrun, or veer off the runway. Current FAA standards for RSA dimensions are based on 90% overrun containment within the RSA. Currently, Runway 6-24 meets FAA standards for compliant RSAs, with the exception of the Vehicle Service Road (VSR) along the Runway 24 end. This road however is being relocated during the 2018 Runway 6/24 rehabilitation project and is therefore maintained as compliant.

Due to the close proximity of Race Street to the Runway 13 end and Postal Road on the Runway 31 end, Engineered Materials Arresting Systems (EMAS) were installed on Runway 13-31 due to the inability for the runway to otherwise meet standard RSA dimensional requirements. Since an EMAS is considered to provide a safety level equivalent to a "standard RSA," the RSAs for this runway are compliant under FAA RDC C-III standards for which they were designed, but would be deficient for D-IV standards. This is because at the time of EMAS design, the most demanding aircraft in use at the Airport and for which the EMAS was designed, was only a C-III. As a result, the EMAS cannot safely stop aircraft that have a more demanding aircraft weight, landing gear configuration, and tire pressure than that of the C-III design aircraft due to insufficient strength and depth of the arrestor bed material. However, according to FAA AC 150/5220-22B, *Engineered Materials Arresting Systems (EMAS) for Aircraft* Overruns, since EMAS are designed to meet the minimum runway width, and since the existing runway width is sufficient under D-IV standards and the same as at the time of EMAS design, it is likely that the EMAS runway width is sufficient.

Runway Protection Zones (RPZ)

The primary function of the RPZ is to enhance the protection of the people and the property on the ground. To the greatest extent possible, all efforts should be made to ensure that only compatible land-uses are located within the RPZ and to ensure that it remains clear from obstructions. Often this task requires the purchasing of property by the airport or by the airport's acquisition of avigation easements.

Currently, each RPZ at LVIA has incompatible land uses located within its boundaries. An incompatible land use is one that can pose environmental hazards or can become a serious safety hazard in the event of a runway incursion. The following summarizes land uses within LVIA's existing RPZs.

Runway 6 RPZ
The majority of property located within the Runway 6 RPZ is airport property that was acquired in fee simple as well as through multiple avigation easements. One small portion of the RPZ is not under airport control but is a known "Future Property Interest Acquisition." The property located in this area of future acquisition is an incompatible land use, a residential neighborhood.

Runway 24 RPZ
Airport owned property located within the Runway 24 RPZ was acquired through fee simple and in lesser interests. Portions of the RPZ located outside airport property are areas of "Future Property Interest Acquisition" and are currently retail land uses. Additional incompatible land uses located within this RPZ are a portion of Schoenersville Cemetery, Airport Road, and East Race Street.

Runway 13 RPZ
Although the majority of the existing Runway 13 RPZ is within airport property, the western edge of the RPZ is located in an area of "Future Property Interest Acquisition." This property is an incompatible land use in the form of Francis H. Sheckler Elementary School (the building and adjacent recreational fields) which have land uses of "residential parks and recreation" and "quasi-public." Race Street, which is located immediately off the runway end, is an additional incompatible land use in this RPZ.

Runway 31 RPZ
The Runway 31 RPZ contains airport property that was acquired through fee simples and in lesser interests as well as airport property on which right-of-way easements were condemned by the Pennsylvania Department of Transportation. Property located within this RPZ that is indicated as a 'Future Property Interest Acquisition" are mostly retail and commercial (compatible land uses), in addition to a few parcels of residential and quasi-public property (incompatible land uses). Additional incompatible land uses in this RPZ include Postal Road and Airport Road.

Runway Use and Length Analysis

Runway Use Percentages
In general, ATCT would support runway extensions to both runways as depicted in the 2004 Master Plan based on the larger cargo aircraft operating at LVIA, but deferred the actual lengths to the operators. While selecting a runway is primarily based on wind speed, direction, and length, length can be a primary decision point for some aircraft. As a result, ATCT provided high-level runway use estimates by percent and offered the following:

- Runway 6 is primary in calm wind conditions, most arrivals come from the west (this is a time based observation)
- Runway 24 receives the most operations
- Percentage of runway use based on operations:
  - Runway 6 = 30-40%;
  - Runway 24 = 45-50%;
  - Runway 13 = <5%;
  - Runway 31 = 15%
- If Runway 31 was longer and had an ILS, it would likely get used as much as Runway 24

This last bullet will be an important consideration in the runway length analysis below and help to form the alternatives analysis as part of this Master Plan.

Runway Length Analysis Update

Reviewing the 2004 Master Plan, discussions with airline and cargo users, as well as guidance from FAA AC 150/5325-4b, *Runway Length Requirements for Airport Design*, existing runway length at LVIA was analyzed for existing and future operational runway length requirements. As indicated under this guidance, runway length is dependent on several aircraft specific factors such as aircraft operating weights, and aircraft take-off and landing flap settings for significant (defined by the FAA as exceeding 500 annual operations) existing and future aircraft fleets.

Runway length requirements also include several airport site specific factors such as airport elevation above sea level, site temperature, wind velocity, runway surface conditions (wet or dry), and runway gradient(s). Airport specific factors used in this analysis include:

- An airport elevation of 393.7 feet above sea level
- An effective runway gradient of -/+ 0.189% for Runway 06-24
- An effective runway gradient of -/+ 0.057% for Runway 13-31
- A Mean Daily Maximum Temperature (MDMT) of the hottest month at the airport of 85.3°F occurring in the month of July.

The 2004 Master Plan did an extensive analysis that resulted in the recommendation to consider extensions to Runway 6-24 and Runway 13-31. This analysis was based on aircraft that were utilizing LVIA at the time and future fleet estimates. Ultimately, it was recommended to phase a Runway 6-24 extension: phase 1 to 8,600 feet, and phase 2 to 10,000 feet. For Runway 13-31, an ultimate length of 7,500 feet was recommended to be implemented using a combination of an extension and shifting of the Runway 31 threshold.

For this Master Plan, the runway length requirements focused on two areas: determining the runway length requirements of the critical aircraft; and discussion with current airline and cargo users of LVIA.

The aircraft performance guide for the Boeing 767-300 was reviewed and utilized to determine the runway length requirements. A summary utilizing these performance charts is articulated below. Since the performance has various engines, we included four variants to ultimately show a range of what might be needed for runway length to serve this aircraft type.

- Model 767-300ER, -300 Freighter (Chart 3.3.14), Standard Day +31 degrees F 11,200 feet
- Model 767-300ER, -300 Freighter (Chart 3.3.16), Standard Day +27 degrees F 9,600 feet
- Model 767-300ER, -300 Freighter (Chart 3.3.18), Standard Day +27 degrees F 8,900 feet
- Model 767-300ER, -300 Freighter (Chart 3.3.20), Standard Day +27 degrees F 8,900 feet

The interpolated lines used to determine these lengths are included in the Appendix of this working paper. As shown, dependent on the type of engines used on the aircraft, a runway length between 8,900 and 11,200 feet can be required for Maximum Takeoff Weight (MTOW). As noted in the performance charts, certain assumptions are made for wind and weather conditions that can increase or decrease the required length. The lengths under this analysis are meant to be a range for future alternative analysis.

For the crosswind runway, the FAA recommends in the Advisory Circular the length be:

> "100% of the primary runway length when built for the same individual design airplane or airplane design group that uses the primary runway, or 100% of the recommended runway length determined for the lower crosswind capable airplanes using the primary runway."

Based on this guidance, applying the critical aircraft to Runway 13-31 would yield the same runway length range noted above. If it is decided to not maintain the same design group for Runway 13-31, then runway length requirements for General Aviation aircraft would apply. The 2004 Master Plan determined a range of runway lengths from 3,900 to 7,200 feet for General Aviation aircraft. Since the General Aviation fleet mix is still similar, this range in runway lengths is still applicable.

In addition to the previous Master Plan and the performance chart for the critical aircraft, the consultant team reached out to current airline and cargo users to assess their current needs for runway length requirements. A summary of the information received from the users that responded to the consultant's request include the following:

- A cargo operator indicated that the current lengths are acceptable for the current and foreseeable future. Obstructions are currently impacting performance.
- Another cargo operator indicated the optimum length under standard conditions at 84.2 degrees F with no obstructions is 11,200 feet for the B-767-300; 10,800 feet for the B-747-800; and 10,260 feet for the B-747-400.
- A passenger airline indicated they take some load factor reductions based on destination and would support Runway 6-24 at 8,600 feet, and Runway 13-31 at 7,500 feet.
- Another airline indicated that 8,200 feet is ideal for the MD-80, and 6,200 feet is ideal for the A-320 family of aircraft. They do not use Runway 13-31 because its length is too short and the winds are not always favorable.

Overall, the input from the users continues to align with the findings of the last Master Plan, as well as the new runway length information derived from the critical aircraft analysis completed above. It is recommended that the previous runway extension preferred alternatives for Runway 6-24 and Runway 13-31 be evaluated in the alternatives development of this Master Plan.

<u>Other Operational Considerations</u>

During the ATCT discussion, the group discussed operational considerations of the airfield and LVIA's ability to maximize capacity as well as efficiency is based on ATCT's ability to have aircraft ready-to-go. ATCT reports no line-of-sight issues from the Tower. To do this, ATCT provided the following that they think would improve capacity and reduce operational conflicts:

- Taxiway E – an important airfield connector should be enhanced
- Terminal apron options to Taxiway B
- Extend Taxiway B4 to Terminal/Hangar 7 (only have B3 and A), most aircraft cannot use B3
- Parallel taxiways on both sides of runways/airfield
- Holding bays or by-pass taxiways (A1 is a good example)
- Runway 24 holding bay needed, would be very helpful
- Taxiway J extension would avoid need to cross Runway 13-31 at A or B3 (there has been two recent deviations/runway incursions at Taxiway A/Runway 13-31
- Enhancement of Taxiway C

Instrument Approaches

A Cat II ILS for Runway 6 is being discussed and appears to be moving forward in parallel with this Master Plan with construction likely in 2018. ATCT has occasionally needed to hold aircraft (in a holding pattern) for weather landing Runway 6 and 24. ATCT feels a Cat II is warranted and would improve the safety of aircraft operations. In addition, a few of the cargo users indicated that they have occasionally diverted due to inclement weather, with Cat II potentially alleviating that issue.

Airside Pavement Management Plan

An airside pavement management plan (PMP) was completed in 2017 by Airport Design Consultants, Inc. The PMP effort included a detailed inspection and evaluation of airfield pavements, confirmation of the accuracy of PennDOT provided data developed in 2016, and development of a comprehensive database in PAVER. The complete PMP will be provided as part of Element 16 – Pavement Management Plan (Airside), but a summary of its findings are presented here.

The total area of airfield pavement is approximately 6.5 million square feet or approximately 148 acres. The airside network has been divided into 21 branches that include 63 sections. Roughly 84% of the airside pavement is asphalt with 16% Portland cement concrete. Apron pavement makes up 35% of the total, with 33% dedicated to taxiways, and the remaining 32% for runways. Twelve percent of the pavement sections (7 of the 63 sections) are less than 10 years old.

In summary, 43 sections of the 63 were found to be in condition ranging from fair to good with pavement condition index (PCI) values ranging from 56 to 94 while 20 sections were found to be in poor to failed condition with PCI values from 9 to 55. Runway pavements were found to be in poor condition with an average PCI of 50 while the apron and taxiway pavements were found to be in fair condition with average PCIs being 67 and 69, respectively.

The PMP details a 5-year work plan to address priority pavement projects, but a summary identifying costs for maintenance and rehabilitation recommendations is shown in **Table 5.2.2**. The complete table in Appendix C of the PMP identifies individual projects each year by branch and section. The PMP also states that it is critical that the Airport continues to maintain the database to ensure it has the most current pavement condition data available for any decision-making processes. For each project recommended in the 5-year work plan, a more detailed analysis needs to be performed before the designing and construction of new pavement.

Table 5.2.2. – 5-Year Maintenance & Rehabilitation Work Plan

Year	Localized Preventative Maintenance	Global Maintenance	Major Rehabilitation	Total
2017[1]	$994,131	$19,374	$20,159,506	$21,173,011
2018	0	0	$344,193	$344,193
2019	0	0	$972,619	$972,619
2020	0	0	$798,663	$798,663
2021	0	0	0	$0
Totals	**$994,131**	**$19,374**	**$22,274,981**	**$23,288,486**

[1] Note – Although 91% of pavement work is required in 2017, financial resources will not be available to address needs until 2018.
Source: *Airside Pavement Management Plan*, Airport Design Consultants Inc., 2017

5.3 Terminal Area

The following section summarizes assumptions used to develop facility requirements for the key functional areas of the terminal building. Terminal facility requirements are developed based on meetings with LVIA staff, discussions with the TSA, on-site walk-through, knowledge of industry-wide trends, and published guidelines including International Air Transport Association (IATA's) *Airport Development Reference Manual,* FAA Advisory Circular (AC) 150/5360-13, *Planning and Design Guidelines for Airport Terminal Facilities,* and ACRP-25 *Airport Passenger Terminal Planning and Design.* Facility requirements were generated for aircraft parking positions/gates, check-in positions, passenger security screening, holdrooms, concessions, restrooms, baggage handling systems, baggage claim, and a Federal Inspection Service (FIS) facility. Terminal facility requirements are developed for the passenger activity levels (PALs), identified in the forecast working paper, to determine the Airport's needs to accommodate future growth. Secondary functions such as circulation and "back of house" space were also considered in the analysis.

Aircraft Parking Positions/Gates

There are currently 15 aircraft parking positions, 10 of which have passenger boarding bridges, on the concourse split between the original satellite concourse and a newer two-level building known as the Wiley Concourse. Of the fifteen total gates at the Airport, Gates 1A – 3C are currently closed and only used occasionally for charter flights. Gates 7-12, 14, and 15, on the Satellite-Wiley Concourse, are active and accommodate the current demand from Allegiant, American, Delta, and United. Gated demand, by PAL, is summarized in **Table 5.3.1**, and is based on the following planning assumptions:

- A flight schedule was created for 2022, which was used to calculate gate demand. The gate demand was used as baseline for future calculations. Beyond 2022, gate demand was developed by using the ratio of annual enplaned passengers and annual departures per gate against the gate utilization, and interpolated to the other PALs. See **Figure 5.3.1** for the 2022 flight schedule.

- In the 2022 flight schedule, standard gate occupancy times have been assumed for the duration of a given operation per gate. This includes 30-minute buffers before and after each scheduled operation to account for variability in the actual departure and arrival times.
- Gate leasing/assignment do not change from existing conditions.

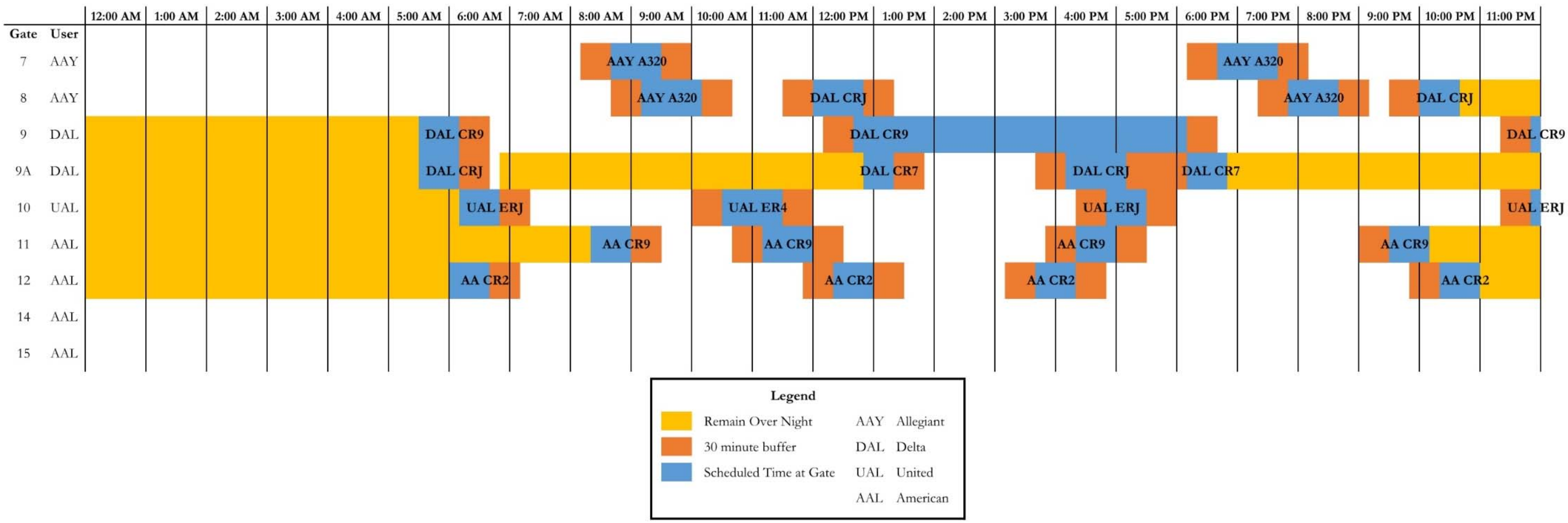
At the end of the planning period (2040), the Airport will require eight gates. Seven of these will need to accommodate large regional jets and one for a narrow-body aircraft. Based on the fleet mix and current aircraft parking positions, it is not anticipated that more gates will be needed throughout the planning horizon, based on demand, unless there is another new air-carrier entrant. However, for flexibility, it is recommended that one additional gate is considered for emergencies, maintenance of other gates, and the occasional diversions. The Airport should consider whether Gates 1A-3C are worth maintaining or be removed. Additional Remain Overnight (RON) aircraft parking positions away from the terminal area are not anticipated, to accommodate commercial airline service; any additional needs or irregular operations can be accommodated at the terminal. **Table 5.3.1** presents the anticipated commercial aviation gate demand.

Table 5.3.1 – Gate Requirements

	2017	2022	2027	2032	2037	2040
Medium Regional	2	3	2	0	0	0
Large Regional	3	3	4	6	7	7
Narrow-body	1	1	1	1	1	1
Total Gates Required	**6**	**7**	**7**	**7**	**8**	**8**
Total Gates Recommended	**7**	**8**	**8**	**8**	**9**	**9**

*Note – One additional gate for emergencies, maintenance, and diversions are recommended to be added to the total requirements
Source: CAD file provided by LNAA

Figure 5.3.1 – 2022 Flight Schedule (Thursday)



Holdrooms

Holdroom requirements can be calculated based on flight schedules or by the size of the aircraft that can be accommodated at each gate. The 2022 flight schedule along with the projected fleet mix was used as a baseline for the analysis. Requirements were also calculated separately for the Satellite-Wiley Concourse and the original satellite concourse as a whole because their attributes are significantly different and there is no realistic connection between the two where a sharing scenario would occur. Because Gates 1A-3C are not currently in use, they were not included in the analysis below.

Industry standard areas by aircraft category, including holdroom areas, including gate circulation, agent podiums, and seating areas were applied to create the overall requirement. The approximate areas used for medium regional jets, large regional jets, and narrow-bodys are 1,000 square feet, 1,400 square feet, and 2,500 square feet, respectively. In recent years, some airlines have developed their own proprietary boarding procedures that require more space, but those were omitted in the analysis because the Airport promotes a consistent experience for all passengers. A reduction of 10% was applied to the overall holdroom requirement calculation based on the assumption that passengers share holdrooms.

Review of the existing holdroom capacity and the forecast demand determined that the Airport has more than enough holdrooms to accommodate the future scenario. In 2040, the Airport will have approximately 2,400 square feet of holdroom surplus above what will be required to meet the demand. Total square footage of holdroom area required for each PAL is included in **Table 5.3.2**.

Table 5.3.2 – Holdroom Requirements Satellite-Wiley Concourse Only

	2017	2022	2027	2032	2037	2040
Required Holdroom (SF)	7,704	8,613	8,928	9,558	10,782	10,782
Existing Holdroom (SF)	13,210	13,210	13,210	13,210	13,210	13,210
Surplus/(Deficit) (SF)	**5,506**	**4,597**	**4,282**	**3,652**	**2,428**	**2,428**

Source: C&S Engineers, Inc.

Because the forecast fleet mix is an estimate, another scenario was assessed to ensure flexibility within the facility. In this scenario, holdroom requirements were calculated by using the max compatible ADG aircraft at a gate rather than the forecast fleet mix. This scenario shows an immediate deficit in holdroom area and indicates that expansion will be required should there be large changes in the aircraft fleet mix. However, given the projected flight schedules from the forecast exercise, it is recommended the first scenario be used for planning purposes.

Check-in Positions

There are two check-in areas, one for Allegiant and one for the remaining air carriers. It was observed in site observations that in both areas, not all of the existing positions were occupied. These positions are primarily in-counter kiosks built into a traditional check-in position. Each are leased to the individual airlines on an exclusive use basis. Future check-in requirements were based on the following assumptions:

- Check-in requirements were developed for individual airline's peak hour, and then summed for a total number.

- Check-in positions will continue to be leased on an exclusive-use basis to individual airlines.
- Estimated existing check-in and future percentage by types are shown in **Table 5.3.3**. With the changes in check-in modes, primarily pushed by mobile technology, the number of passengers who visit the check-in counters will be reduced, and the way passengers check-in will be modified. It is impossible to know for sure when airlines and passengers will completely integrate these changes or what new innovations will be implemented, but for the purposes of this study 2025 was assumed.
- Different types of check-in procedures process passengers at different rates. While the percentage by type will change, it is assumed that process rates will remain consistent. This is a conservative assumption since there is a lot of uncertainty as to the efficiency of new processes.
- A maximum passenger wait time is 10 minutes. While this is consistent with industry standards, it is likely more than the Airport currently experiences, except during peak periods or holidays.
- Processing time per passenger is 2.5 minutes for traditional check-in, 1 minute for a kiosk with no checked bags, and 2.5 minutes for a kiosk with checked bags/bag drops.

Table 5.3.3 – Check-in Percentages by Type

	2017	2022	2027	2032	2037	2040
Remote (no bags)	15%	15%	15%	25%	35%	35%
Remote (with bags)	25%	25%	25%	25%	35%	35%
Kiosk (with bags)	0%	0%	25%	20%	10%	10%
Kiosk (with bags)	0%	0%	25%	20%	10%	10%
Traditional Counter	60%	60%	10%	10%	10%	10%

Source: C&S Engineers, Inc.

As **Table 5.3.4** shows, there is more than a sufficient number of check-in counters through the planning period. If airlines switch check-in types, as is anticipated around 2025, some of the surplus counters can be converted into bag drop positions. Queue area is also adequate. There is generous circulation adjacent to both check-in areas. If a reconfiguration of the check-in areas were required, based on new airline processing or bag drop procedures, there is approximately 10%-15% excess area that could be utilized to accommodate the changes.

Table 5.3.4 – Check-in Requirements

	Existing	In use	2017	2022	2027	2032	2037	2040
Check-in Counters	38	19	11	11	5	5	5	5
Kiosks	-	-	0	0	5	5	4	4
Bag drops required	-	-	6	9	9	9	11	11
Total	**38**		**17**	**20**	**19**	**19**	**20**	**20**

Source: C&S Engineers, Inc.

Passenger Security Screening

The passenger security checkpoint is on the lower level, in the security screening tunnel that connects the main terminal building to the original satellite concourse. There are currently two screening lanes, including one TSA PreCheck lane. Due to the tunnel width and the adjacent vertical circulation, the area is non-standard and congested in peak periods. Future passenger security screening requirements are based on the following assumptions:

- An average throughput of 150 passengers per lane, per hour. This is a conservative assumption for TSA standards, but is a result of the non-standard and constrained layout.
- It is assumed that a minimum of one TSA PreCheck lane will be open throughout the planning period and that the percentage of passengers using PreCheck will grow from 15% to 40% over the course of the planning period.
- Airport and airline employee screening was including in the overall passenger volumes. This was an additional 5% of the peak hour enplanement.
- Passenger wait times do not exceed 10 minutes.
- Passengers will need approximately 11 square feet per person while waiting in the queue, equivalent to IATA's "Optimum" level of service

The passenger security checkpoint is currently undersized by one lane. The reduced size is largely due to the constrained location in the lower level tunnel. Another hindrance resulting from the location and layout is added congestion from the cross flow of arriving passengers headed to the curbside or baggage claim, and adjacent to the meeter and greeter area. By the end of the planning period, as many as four lanes and 3,500 square feet will be needed, double the existing layout, to accommodate passenger demand at a reasonable level of service. The requirements are presented in **Table 5.3.5**.

Table 5.3.5 – Passenger Security Screening Requirements

	2017	2022	2027	2032	2037	2040
Security area (SF)	1,875	1,875	1,875	2,500	2,500	2,500
Security queue area (SF)	750	750	750	1,000	1,000	1,000
Total (SF)	2,625	2,625	2,625	3,500	3,500	3,500
Existing (SF)	1,750	1,750	1,750	1,750	1,750	1,750
Surplus/(Deficit) (SF)	**(875)**	**(875)**	**(875)**	**(1,750)**	**(1,750)**	**(1,750)**

Source: C&S Engineers, Inc.

Concessions

Concession areas provide an improved passenger level of service, create a sense of place for the Airport, and provide an opportunity for increased revenue generations for the Airport. Ultimately, the Airport, working with a master concessionaire or a series of concessionaires, will determine what concessions areas are appropriate based on the traveling public profile. To generate an estimate of future area that would provide the Airport with a reasonable program, demand was projected using the following industry standard planning assumptions:

- Approximately 14.7 square feet of concessions space was calculated per every 1,000 annual enplanements; 10.6 square feet for food and beverage, 0.4 square feet for convenience retail, and 3.7 square feet for specialty retail.
- 75% or more of concession space should be allocated post-security, and 25% or less for pre-security.

Often at smaller airports, there is a desire to have one pre-security restaurant that Airport employees can use.

- On average, an additional 25% should be allocated for food and beverage storage, and an additional 20% should be added for retail storage, away from the immediate concessions area.

Currently, the Airport has an appropriate amount of concessions area. By the end of the planning period, the Airport will need an additional 1,500 square feet of concessions space throughout the facility. There is currently a café pre-security, which should be sufficient to meet the pre-security demand. The majority of future concession areas should be planned for the post-security concourse to maximize value. The existing concessions storage areas are forecast to be sufficient until 2027 and by the end of the planning period, the deficit will be less than 200 square feet. There is ample space at the lower level of the Satellite-Wiley Concourse to accommodate the minimal demand.

Table 5.3.6 – Concessions Area Requirements

	2017	2022	2027	2032	2037	2040
Existing Concessions Area (SF)	6,140					
Required Concessions Area (SF)	5,040	5,618	6,139	6,697	7,290	7,656
Concessions Surplus/(Deficit) (SF)	**1,100**	**522**	**1**	**(557)**	**(1,150)**	**(1,516)**
Existing Concessions Storage Area (SF)	1,450					
Concessions Storage Required Area (SF)	1,190	1,326	1,449	1,581	1,721	1,807
Concessions Storage Surplus/(Deficit) (SF)	**260**	**124**	**1**	**(130)**	**(271)**	**(357)**

Source: C&S Engineers, Inc.

Circulation

Adequate circulation is critical to move passengers from one functional area to the next in an efficient and comfortable manner. Often times, circulation is based on available space created by another functional area or constraint such as concourse width or limited area adjacent to a check-in or passenger security screening functions due to changes in processes over the years. Circulation is typically split into three areas, public circulation, FIS sterile arrivals circulations, and non-public walkways. Minimum clear circulation widths for public areas are 25 feet between major functional elements. For a concourse, 20 feet minimum for a single loaded concourse, and 30 feet minimum for a double loaded concourse without a moving walkway. For FIS sterile corridors, the width is smaller than concourses; minimum standard is 15 feet wide for a single direction. For non-public areas, such as back of house spaces, office space, etc. the width should be determined by the function (i.e. moving supplies in a corridor near a loading dock) and local building codes.

In the Satellite-Wiley Concourse, the corridor width is 45 feet, which is more than sufficient to accommodate the passenger volumes. In the lower level concourse, the circulation is 25 feet, but since it is inactive, there is no compelling reason to increase the dimensions.

At the enplaning level (2nd floor) of the main terminal, the circulation corridors near the two check-in zones range from 10 to 20 feet, below the industry standard. The central part of the enplaning level has a significant amount of open space, greater than what is needed. Non-public areas are assumed to meet building codes and no issues were reported by Airport staff.

At the deplaning level (1st floor) of the main terminal, the circulation corridors are narrow, in particular, the corridor between the bag claim area and the rental car counters. It is less than 20 feet wide and is reduced even further when people are queued up at the rental car counters.

Restrooms

Restrooms are an important, but often overlooked element at an airport. They are not one of the major functional terminal areas, but are often the area that receives the most passenger complaints when surveyed. Restroom requirements are calculated using the following assumptions:

- For main terminal building – 2.0 to 2.5 square feet per peak hour arriving and departure passengers and well-wishers/meeters and greeters.
- For satellite concourses – A restroom module of 10-12 fixtures/sex for every eight gates.

For the main terminal building, the current restrooms can accommodate the demand through the planning period. The current restroom area is approximately 1,820 square feet. By the end of the planning period, the estimated requirement for restrooms is 1,630 square feet.

For the concourses, the current restrooms can accommodate the demand through the planning period. The current restrooms have 21 fixtures for men and 25 fixtures for women. By the end of the planning period, the estimated requirement for restrooms is similar as it is today because the gate demand is not expected to exceed the existing current capacity, which is what the restrooms were designed to handle.

Baggage Screening

There are two TSA baggage screening areas, one for each of the check-in areas. According to the baseline plans provided by the Airport, there are two explosive detection screening (EDS) machines in each of the screening areas. Future requirements are based on the following assumptions:

- Within the last 5 years, TSA implemented an in-line screening system that allowed screening equipment to be removed from the check-in lobby. The new system is likely to be able to accommodate demand for some time depending on the baggage processing rate.
- Percentage of passengers checking bags is 75%
- On average, one checked bag per passenger
- EDS screening equipment throughput is 300
- Current processing rates continue throughout the planning period

Table 5.3.7 – Baggage Screening Requirements

Year	# of EDS units required	# of EDS units provided	Area Required (SF)	Existing Area (SF)	Surplus/ (Deficit) (SF)
2017	2	4	1,740	4,000	2,260
2022	2	4	1,740	4,000	2,260
2027	2	4	1,740	4,000	2,260
2032	2	4	1,740	4,000	2,260
2037	2	4	1,740	4,000	2,260
2040	2	4	1,740	4,000	2,260

Source: C&S Engineers, Inc.

The current system appears to be able to handle demand throughout the planning period. TSA is constantly improving throughput of their machines so it is likely that at the next replacement cycle for the machines, LVIA will acquire higher throughput machines that would accommodate demand beyond the planning period.

Outbound Baggage Handling

Outbound baggage is sorted and loaded onto airline carts for each departing flight. This function occurs in two areas consistent with the two check-in and baggage screening areas. Allegiant has a dedicated make-up area and all other airlines share a make-up area. Typically, baggage make-up requirements are calculated in terms of the area needed for the number of carts required and an allowance for baggage tug circulation. This is based on size of the aircraft (e.g. ADG-III aircraft is 1.0 equivalent gates, but smaller aircraft like a medium regional jet is 0.7 equivalent aircraft). For this analysis, it is assumed that airlines will remain in their current location and the operation will continue as it does today.

By the end of the planning period, outbound baggage requirements will be approximately 8,100 total square feet. The current building has approximately 10,040 total square feet split between the two check-in zones. This result is driven primarily by the fact that even in the out years most aircraft will be larger regional jets. If the fleet mix changed into a larger percentage, the baggage makeup maybe becomes closer to capacity. This analysis does not account for the age of useful life of the baggage carousel. So, while there may be adequate capacity based on the forecast assumptions, these carousels may need to be repaired or replaced during the course of the planning period.

Inbound Baggage Handling

Passenger baggage from arriving flights is unloaded in the inbound baggage handling areas adjacent to the outbound baggage makeup area #1. There are two inbound belts, which transport the baggage to the baggage claim devices at the lower level. Requirements for inbound baggage make-up are tied to the requirements for the baggage claim area. Baggage claim demand is represented by number of linear feet per carousel or flat-plate device. Whatever device is used to accommodate that demand, there is a minimum distance of inbound baggage belt that is required based on average aircraft size and number of airlines using that belt. In 2040, 205 linear feet is required for baggage claim, which is accommodated by the existing devices, therefore no further inbound baggage makeup is needed. This analysis does not account for the age of useful life of the baggage carousel. So, while there may be adequate capacity based on the forecast assumptions, these carousels may need to be repaired or replaced during the course of the planning period.

FIS Facility

The Airport does not currently have an FIS facility, but is interested in understanding what the requirements are assuming they were able to secure an international flight. The most likely scenario would be a low-cost European carrier like Condor or Norwegian, or a Caribbean or Central American flight. To this end, we have developed facility requirements for two theoretical international arrival scenarios; one for a B767-300 aircraft and one for a B737-800 aircraft.

Elements of the FIS facility include primary processing (i.e. passport check), international baggage claim, secondary processing (i.e. customs forms and baggage inspection), and office space required by Customs and Border Patrol (CBP). FIS facilities are based on the following planning assumptions:

- Primary processing is done by immigration officers working in booths. Each booth holds two agents and provides two lanes of screening capable of processing 100 passengers per hour. In the last few years, because of staffing constraints and the needs to process passengers faster, Automatic Passport Controls (APCs) have been implemented at many airports. It is possible that a combination of working booths and APCs would be implemented, given the assumption of only one international flight, this analysis assumed all booth processing.
- Requirements for baggage claim were developed using the same assumptions that are described in each process section previously noted.
- Secondary processing and general office space requirements of approximately 5,000 square feet are required based on previous CBP guidelines for small hub airports.

For a "low" scenario, an ADG-III arriving flight like a B737-800, the FIS facility would need 4 primary positions, approximately 2,000 square feet for primary processing, 160 linear feet of frontage of baggage claim, and approximately 5,000 square feet for Customs and Border Patrol (CBP) office and support space. For the "high" scenario, an ADG-IV arriving flight like a B767-300, the FIS facility would need six primary positions, approximately 3,000 square feet for primary processing, 180 linear feet of frontage of baggage claim, and approximately 5,000 square feet of CBP office and support space.

Back of House/Office Space

This includes the non-public areas that accommodate airport, airline, and TSA employees and functions. In the main terminal building, this includes airline ticket offices, TSA offices, baggage service offices, some storage space, and airport offices at the mezzanine level (3rd floor). Per our field observation and walk-through with Airport staff, most of these spaces are occupied. Also, the existing board room will be relocated and that will free up space for an additional 10 work spaces. Beyond that, more space is likely not needed as the Airport is projected to grow at a moderate, yet steady pace. Over time, there may be opportunities to reconfigure the space to achieve a more efficient and employee friendly layout, but that is outside the scope of the master plan. In addition, spaces such as airline offices may shrink as airlines continue to cut costs. For the purposes of this report, it is assumed that no further space is required.

In the concourses, there are additional airline and Airport office spaces. There is also a sizable area that is unfinished storage space that is used by both. Similar to the main terminal, it is assumed that no further space will be required. If there is a requirement, the existing holdrooms or the lower level of the unused lower level concourse could be used to meet the demand.

5.4 Access, Circulation, and Parking

The following summarizes estimated requirements for roadways, curbsides, and parking facilities through the planning period, 2040. Requirements were developed based on collected data, information from LVIA, previous studies, and industry standards for methodologies and operations of traffic and parking facilities.

Access and Circulation

The evaluation of future Airport and adjacent roadway traffic is based on projections for airport activity as well as anticipated growth of the surrounding area. The following sections describe the methodology for the projections and analysis of two intersections along Airport Road and the internal airport circulation roadways and curbside area.

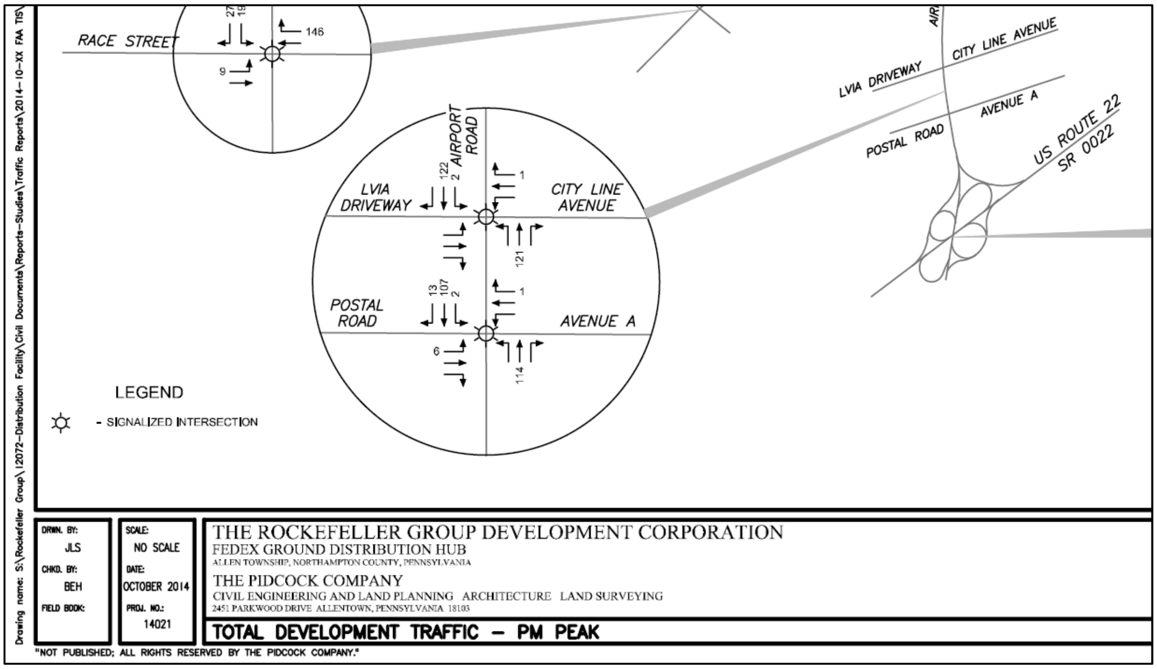
Airport Road Intersections

As with the existing condition assessment, the future 2040 operations of the intersections of Airport Road with City Line Road and Ave A/Postal Road were analyzed using Synchro, a capacity analysis software, to determine how the study intersections can be expected to operate based on the projected growth of the Airport and the surrounding area.

A previous study conducted for the LNAA, *Circulation Study and Alternatives Analysis Report March 2017*, evaluated the Airport's internal circulation roadways and a number of intersections along Airport Road adjacent to the Airport. This report assumed a 0.97% growth rate for annual background growth as suggested by the PennDOT Bureau of Planning and Research. This growth rate was used to project the December 2016 Airport Road intersection volumes to 2040. This growth rate accounts for unknown development in the areas surrounding the Airport that will travel along Airport Road. In addition to this growth, the anticipated growth at the Airport itself, along with the increase in traffic due to the new FedEx Ground Distribution Hub, was also incorporated. See the Internal Airport Roadways/Curbside section for more information on how growth at the Airport was projected.

A traffic study completed for the FedEx Ground Distribution Hub identified the anticipated increase in traffic along Airport Road due to the facility as well as recommended mitigation measures for improving traffic operations at the intersections with City Line Road and Ave A/Postal Road. **Figure 5.4.1** is an excerpt of a figure from the FedEx traffic study that shows the new traffic expected on Airport Road due to their proposed development. This volume was added to the study intersections.

Figure 5.4.1 Anticipated FedEx Traffic on Airport Road



Source: FedEx Ground Distribution Hub Transportation Assessment, October 27, 2014 – Figure 16P

Table 5.4.1, on the following page, shows the projected 2040 peak hour volumes for the Airport Road intersections included in this analysis.

Table 5.4.1: 2040 Intersection Turning Movement Counts

		Direction of Movement	2040 Peak Hour Volume (4-5 PM)
Airport Road & Ave A/Postal Road			
Airport Road	Northbound	Left	182
		Thru	1,894
		Right	185
	Southbound	Left	20
		Thru	1,704
		Right	121
Postal Rd	Eastbound	Left	265
		Thru	73
		Right	540
Ave A	Westbound	Left	400
		Thru	140
		Right	73
Airport Road & City Line Road			
Airport Road	Northbound	Left	401
		Thru	1,682
		Right	190
	Southbound	Left	47
		Thru	1,235
		Right	139
LVIA Driveway	Eastbound	Left	113
		Thru	69
		Right	349
City Line Road	Westbound	Left	324
		Thru	144
		Right	133

Source: C&S Engineers, Inc.

The improvements recommended by the FedEx traffic study of the two intersections on Airport Road were incorporated into the 2040 future condition model since the project is currently being developed:

- Airport Road & City Line Road
  - Construct an additional 250 foot westbound left turn lane along City Line Road
  - Construct a third southbound through lane along Airport Road
  - Construct a 240 foot channelized southbound right turn lane
  - Implement northbound/southbound/westbound protected/prohibited left turn phasing
  - Modify signal operations to accommodate the revised configuration

- Airport Road & Ave A/Postal Road
  - Construct a third southbound through lane along Airport Road
  - Construct a 400 foot channelized southbound right turn lane
  - Implement northbound protected/prohibited left turn phasing
  - Modify signal operations to accommodate the revised configurations

Table 5.4.2 shows the level of service (LOS), delay in seconds, volume to capacity (v/c) ratio, and 95th percentile queues for each lane group of each study intersection for the 2040 future condition.

Table 5.4.2: 2040 Future Condition Intersection Capacity Analysis – PM Peak Hour

			LOS	Delay (sec)	v/c Ratio	95th % Queue (ft)
Airport Road & Ave A/Postal Road						
Airport Road	Northbound	Left	E	66.4	0.83	#265
		Thru	F	106.9	1.14	#1304
		Right	B	10.2	0.24	93
	Southbound	Left	E	71.8	0.48	m23
		Thru	E	71.9	1.01	#774
		Right	B	13.6	0.22	m41
Postal Road	Eastbound	Left/Thru	F	178.3	1.25	#623
		Right	E	58.1	0.93	#655
Ave A	Westbound	Left	F	250.0	1.46	#703
		Thru/Right	C	29.0	0.32	215
		Average Intersection	*F*	*96.7*		
Airport Road & City Line Road						
	Northbound	Left	E	67.2	0.97	m264
		Thru/Right	C	23.5	1.00	m168
	Southbound	Left	D	36.0	0.48	48
		Thru	D	43.2	0.73	475
		Right	A	8.8	0.24	68
LVIA Driveway	Eastbound	Left/Thru	F	178.4	1.20	#333
		Right	D	49.9	0.90	248
City Line Road	Westbound	Left	E	67.1	0.72	223
		Thru/Right	F	145.5	1.14	#477
		Average Intersection	*D*	*52.5*		

- 95th % volume exceeds capacity, queue may be longer

m - volume for 95th % queue is metered by upstream signal

Source: C&S Engineers, Inc.

While the Airport is not responsible for the operations of Airport Road, it should be noted that operations on Airport Road are expected to include significant delays by 2040 with only the improvements recommended in the FedEx traffic study. The average intersection LOS for Ave A/Postal Road is expected to change from a LOS E with 78.2 seconds of delay to a LOS F with 96.7 seconds of delay and the City Line Road intersection would change from a LOS B with 19.2 seconds of delay to a LOS D with 52.5 seconds of delay. Specifically, those exiting the Airport during the PM peak period may experience over 2 minutes of delay compared to the minute they may currently be experiencing. The Airport may want to consider access changes to these two intersections to improve operations and their experience as passengers, visitors, and employees travel to and from the Airport.

Internal Airport Roadways/Curbside

The analysis of the internal roadways at the Airport are based on projections of the existing condition (December 2016) volumes to the peak hour of an average day in the peak month of the year 2040. Based on the analysis of the Airport's existing operations and forecasts highlighted in the Working Paper 4 – Forecasts of Aviation Demand, the peak month for the Airport is July.

Two methodologies were considered to estimate future projected traffic:

1. Calculate the existing ratio of peak hour vehicles entering/exiting the Airport to peak hour passengers from December 2016 which is then applied to July 2040 average day/peak hour passengers to calculate 2040 peak hour entering/exiting vehicles:

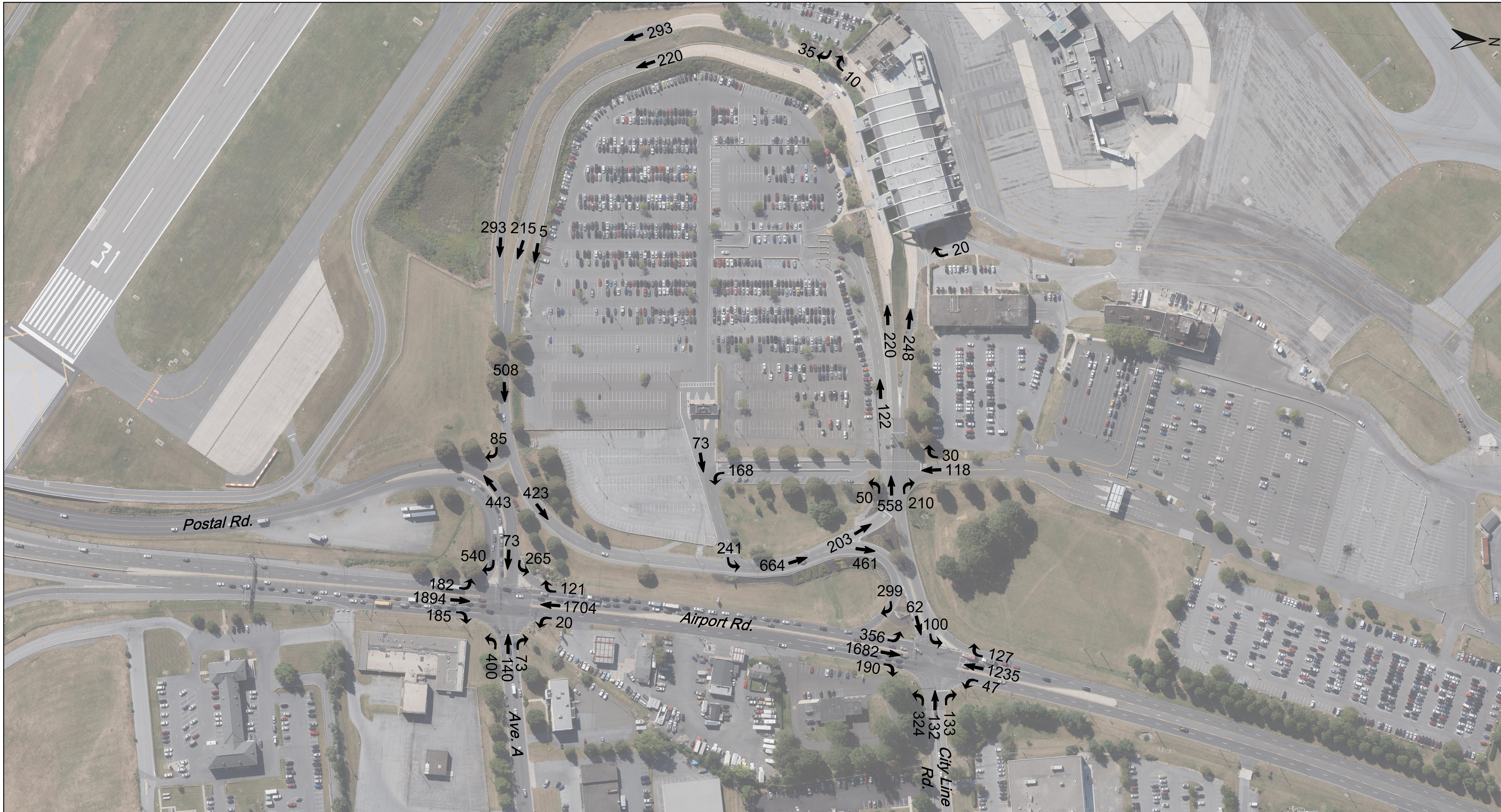
December 2016 peak hour vehicles entering/exiting Airport:	432
Estimated December 2016 peak hour passengers:	328
Ratio:	1.32
Peak hour passengers for average day in July 2040:	816
Calculated peak hour traffic for average day in July 2040:	1,075

2. Project December 2016 volumes to peak hour/average day/peak month volumes, then apply the anticipated growth rate of enplanements (1.73%) to peak hour/average day/peak month volumes to estimate 2040 volumes

Estimated July 2016 peak hour vehicles entering/exiting Airport:	600
Enplanement Growth Rate:	1.73%
Calculated peak hour traffic for average day in July 2040:	907

Since methodology 1 results in a higher volume, therefore a more conservative analysis, this is the preferred approach to estimating 2040 peak month/average day/peak hour volumes. The projected 2040 entering and exiting volumes are approximately 2.5 times higher than the existing entering and exiting volumes. Therefore, the existing condition volumes throughout the Airport circulation roadways were grown by a factor of 2.5.

Figure 5.4.2 shows the 2040 peak hour volumes throughout the Airport. Adjustments were made based on the recent construction of the multi-modal center. When counts were conducted in December 2016, rental car ready activity was based in the long-term parking area. The estimated number of vehicles associated with rental car activity was redistributed to the new multi-modal center. It is also anticipated that the LANta bus stop would move to the multi-modal center as well. These vehicles were redistributed then grown at the same rate as the rest of the 2016 volumes.



2040 Peak Hour Traffic Volume

Lehigh Valley International Airport
Master Plan Update

Figure 5.4.2

The bus terminal portion of the multi-modal center will also serve as a hub for Trans-Bridge Lines, Inc. A representative for the bus line indicated that they are expecting up to 12 buses in and out of the facility during a peak hour, which equates to approximately 115 passengers during that hour. They also indicated that their passengers often use a private vehicle to arrive or depart the terminal. To be conservative for this analysis, it was assumed all 115 passengers would drive alone and would be equally split between arriving and departing the terminal. The buses were assumed to be traveling to/from RT 22 while the passenger traffic was distributed through the intersections on Airport Road based on existing travel patterns.

A microsimulation model developed for the Airport's circulation roadway provided insight on the operations of the main intersection as vehicles approach the decision point between the multi-modal center, both curbside areas, short- and long-term parking, and the cell phone lot. While the weaving will continue to be a point of conflict and potential confusion for drivers, all approaches to that intersection will continue to operate at an acceptable level of service through the 2040 projections.

The 2040 volume projection estimates that 248 vehicles will travel through the arrivals area and 220 will travel through the departures area. In 2016, 52% of those on the arrivals roadway stopped curbside while 63% stopped along the departure roadway. Using that same breakdown, 129 vehicles will stop on the arrivals curbside and 139 on the departures curbside. A desktop analysis using the Quick Analysis Tool for Airport Roadways (QATAR) (v0.6) was used to determine the anticipated level of service (LOS) for each curbside area. As defined in ACRP 40: *Airport Curbside and Terminal Area Roadway Operations*, the LOS of a curbside roadway is based on curbside utilization ratio, which is a comparison of the length of the vehicles stopped along the curbside and the effective length of the curbside. A curbside area is considered insufficient if it operates at a LOS C or worse.

The QATAR analysis indicates that with 2040 traffic using the same dwell time information observed in 2016, the departures curbside is expected to operate at a LOS C while the arrivals curbside would operate at a LOS E. The microsimulation model confirms that activity for both curbside areas will result in the curb being more utilized and the incidence of double parking will increase, but traffic still flows with minimal delays and/or blockages. The microsimulation model shows that the main cause of delay for vehicles traveling through the curbside areas is stopping for pedestrian activity.

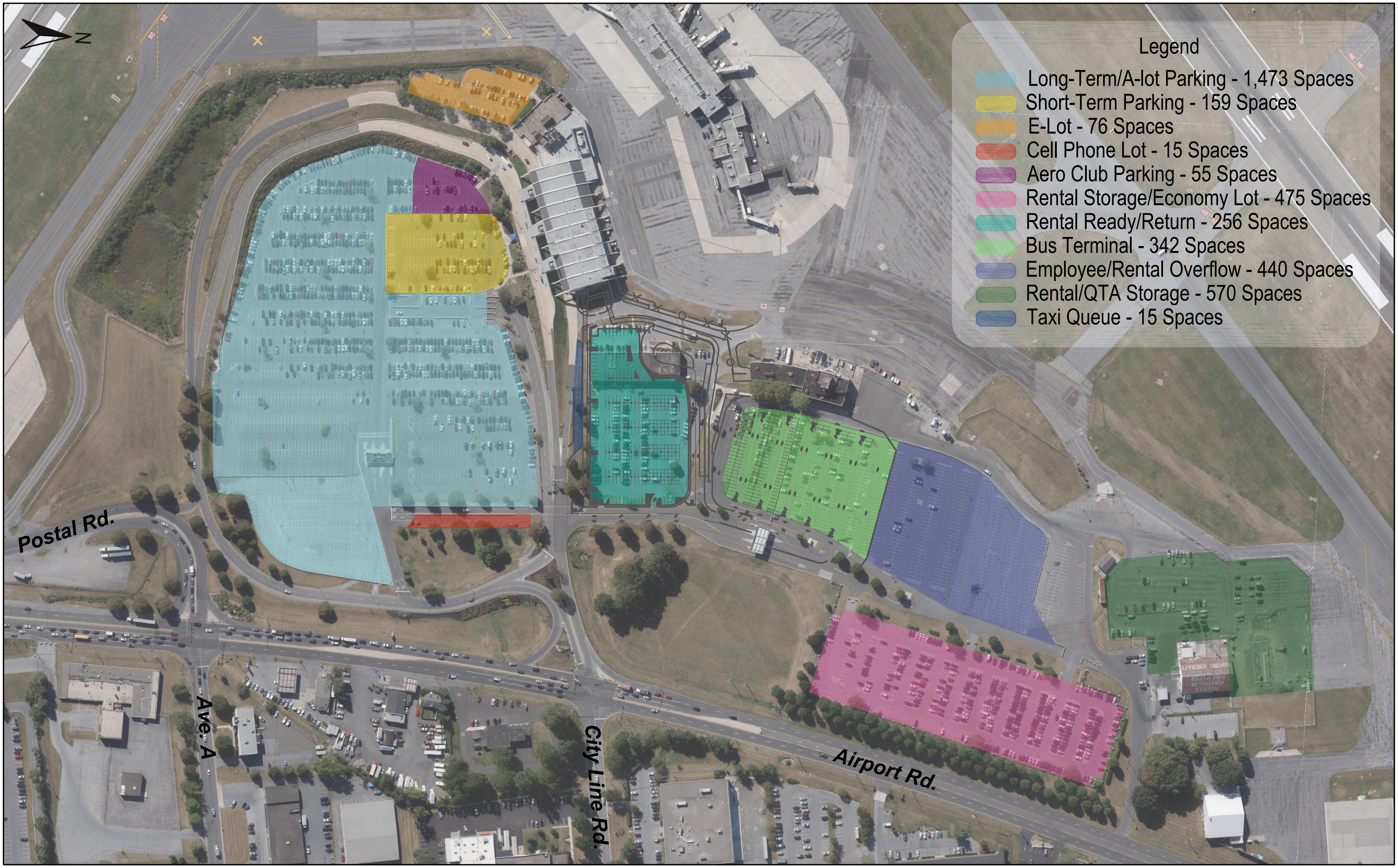
The appendix contains detailed volume projection information and QATAR analysis reports.

The Airport should consider alternatives to reduce confusion and conflict points as drivers decide between the multi-modal center, both curbside areas, short- and long-term parking, and the cell phone lot. The Airport should also monitor curbside activity, including taxi/limo/transportation network carriers (TNC) activity, to capitalize on potential revenue and to be informed in case they need to consider improving future curbside operations.

Parking

Future parking demand estimations are conducted for short- and long-term parking, employee parking, and rental car parking based on demand ratios provided in ACRP 25: *Airport Passenger Terminal Planning and Design* compared to existing activity at the Airport. **Figure 5.4.3** shows parking areas at the Airport with the new multi-modal center.

Jun 08, 2017 – 8:27am
F:\Project\N93 – Lehigh-Northampton Airport Auth\N93012001 ABE Airport Master Plan Update\Planning-Study\CADD\Exhibits\Chapter 5\5.4.3.dwg



Future Parking Facilities

Lehigh Valley International Airport
Master Plan Update

Figure 5.4.3

There are currently 1,687 public parking spaces available in the form of short-term and long-term/A-lot parking in front of the terminal, plus additional lots to the north, currently used for rental storage, that could be converted to public parking in the future. For planning purposes, a 10% buffer is incorporated into the supply and demand comparison to assume a maximum 90% utilization of public facilities. Therefore, future demand estimates are compared to 90% of the total supply in front of the terminal, or 1,518 spaces. This reduced supply is called the effective supply.

Table 5.4.3: Existing Public Parking Supply by Type

Type	Existing Supply	Effective Supply
Aero Club	55	50
Short-term	159	143
Long-term/A-lot	1,473	1,326

Source: LNAA

On December 2, 2016, there were 1,651 passengers and the peak public parking occupancy was noted as 464 vehicles. This is a ratio of 0.28 occupied spaces/daily passengers. Applying this ratio to the 2040 forecasted peak day passengers, the estimated 2040 peak parking occupancy would be 1,155 vehicles, 75% utilization. Since the current peak parking occupancy data is not broken down into short- versus long-term parking, using this ratio does not provide enough information to know whether the current breakdown will accommodate future demand by parking type.

ACRP 25 provides rules-of-thumb regarding required parking supply by type based on the number of annual enplanements at an airport. The ACRP indicates 1,400 spaces per million enplanements with 70% dedicated to long-term parking. The future requirements for the Airport based on this ratio compared to the existing effective supply is shown in **Table 5.4.4.**

Table 5.4.4: Future Public Parking Supply by Type

Year	Enplanements	Total Public Parking Supply Req.	Total Surplus/ (Deficit)	Long-term Supply Req.	Long-term Surplus/ (Deficit)	Short-term Supply Req.	Short-term Surplus/ (Deficit)
2016	344,895	966	552	676	700	290	(147)
2020	367,108	1,028	490	720	656	308	(165)
2030	440,259	1,233	285	863	513	370	(227)
2040	520,800	1,458	60	1021	355	437	(294)

Source: C&S Engineers, Inc.

Based on this calculation, there is enough public parking supply in front of the terminal to accommodate 2040 activity, but more supply should be dedicated to short-term parking. An analysis of the number of existing and required ADA accessible spaces determined that the short-term parking lot has 4 surplus ADA spaces, the combination long-term/A-lot is deficient 12 ADA spaces, and the E-lot is deficient 2 ADA spaces. If additional public parking areas are needed, the economy lot has just under 500 spaces that could be made available. It is recommended that public parking in front of the terminal be reallocated to provide at least 440 short-term spaces and no less than 1,100 long-term spaces.

Based on discussions with LVIA staff, there is currently a demand for 170 employee spaces, which is accommodated in E-lot dedicated to employees and other overflow parking areas on the Airport. Compared to 2016 annual enplanements, the current ratio of employee parking demand to enplanements is 0.000493. **Table 5.4.5** shows that approximately 90 additional spaces should be dedicated to employee parking through 2040 but the additional employee spaces north of the multi-modal center will accommodate this demand.

Table 5.4.5: Future Employee Parking Needs

Year	Enplanements	Employee Supply Req.	Additional Employee Needs
2016	344,895	170	
2020	367,108	181	11
2030	440,259	217	47
2040	520,800	257	87

Source: C&S Engineers, Inc.

The multi-modal center will include 256 rental car ready/return parking spaces. The existing rental quick turn-around (QTA) area is estimated to have 125,000 square feet of space. This is the equivalent of 570 parking spaces. This area is expected to remain and be used by the car rental companies. Therefore, a total of 826 spaces will be dedicated to rental car activity. FAA AC 150/5360-13, *Planning and Design Guidelines for Airport Terminal Facilities* estimates that a ratio of 1 rental car space for each 750 annual enplanements should be considered for planning purposes. Using this ratio, the Airport should have approximately 700 spaces dedicated to rental car activity. As shown in **Table 5.4.6**, the Airport has sufficient capacity to accommodate 2040 rental car activity demand.

Table 5.4.6: Future Rental Car Activity Parking Needs

Year	Enplanements	Rental Car Supply Req.	Rental Car Surplus/ (Deficit)
2016	344,895	460	366
2020	367,108	489	337
2030	440,259	587	239
2040	520,800	694	132

Source: C&S Engineers, Inc.

After the completion of the multi-modal center, the Airport will have enough parking spaces on-site to accommodate their public, employee, and rental car needs through 2040.

Landside Pavement Condition Assessment

A Landside Pavement Management Plan was conducted in October 2016 to evaluate and analyze the landside pavement networks at the Airport. The report summarizes pavement inspection efforts, pavement condition findings, and order of magnitude costs to repair pavement projects that are prioritized for the next 5 years. The pavement network evaluated includes:

- Terminal area roadways and access-ways
- Parking lots
- Maintenance pavement surrounding the Maintenance Building
- Taxilane pavements surrounding T-hangar buildings
- Pavements surrounding Hangar 9

Table 5.4.7 highlights the recommended 5-year capital improvement program. These projects should be considered as part of the Airport requirements in the short-term. See the plan itself for more detailed information for each project.

Table 5.4.7: Landside Pavement Priority Projects

Year	Priority	Description	Cost (2016 Dollars)
1	1	4" Mill & overlay of long-term Parking Lot A (northeast corner)	$1.6 million
2	2-3	4" Mill & overlay of roadways, 2" mill & overlay of long-term Parking Lot D (southeast corner)	$1.5 million
3	4	4" Mill & overlay of Maintenance Lot (does not include expansion)	$1.2 million
4	5-6	2" Mill & overlay of t-hangar & Hangar 9 areas	$1.4 million
5	7-8	Crack sealing of remainder of long-term, short-term, and cell phone lots, 2" mill & overlay of other parking lots	$3.2 million
		Total Cost =	**$ 8.9 million**

Source: Landside Pavement Management Plan, ADCI/Arora, October 2016

5.5 General Aviation

As documented in Working Paper 4 – Forecasts of Aviation Demand, GA operations are expected to account for approximately 80% of all operations in 2017 and national FAA forecasts anticipate a 1.8% increase in average annual growth for GA operations. For this reason, it is important to ensure that GA facilities such as t-hangars, conventional hangars, and apron tie-down areas are adequate throughout the planning period.

Hangars and Aprons

There are currently eight existing conventional hangars as well as one conventional hangar under construction that can support GA activities. Combined, these facilities will provide 58,036 square feet of hangar facility storage space for exclusive GA activities in addition to 271,706 square feet of hangar storage space for non-exclusive GA activities, totaling 329,742 square feet of GA hangar space. T-hangars at the

Airport also provide an additional 62,436 square feet of non-exclusive aircraft parking. These facilities and their square footages are outlined in **Table 5.5.1**.

Table 5.5.1 Existing Hangar Space

Building Name	Building Area Hangar (SF)	Building Area Office (SF)	Total (SF)
Hangar No. 2	8,000	2,034	10,034
Hangar No. 3	25,428	15,314	40,742
Hangar No. 5	5,760	1,500	7,260
Exclusive Conventional Hangar Total	*39,188*	*18,848*	*58,036*
Hangar No. 4	3,100		3,100
Hangar No. 7 (FBO)	23,550	25,770	49,320
Hangar No. 8	26,250		26,250
Hangar No. 9	71,938	16,880	88,818
Hangar No. 10	40,654	6,564	47,218
Hangar under construction	54,000	3,000	57,000
Non-exclusive Conventional Hangar Total	*219,492*	*52,214*	*271,706*
Conventional Hangar Total	258,680	71,062	329,742
T-Hangars	62,436		62,436
Exclusive Total	39,188	18,848	58,036
Non-exclusive Total	281,928	52,214	334,142
TOTAL	**321,116**	**71,062**	**392,178**

Note: Exclusive means the hangar is owned/leased and controlled by a corporate tenant and the space is not readily available to the public for aircraft storage. T-hangars are considered non-exclusive.
Source: C&S Engineers, Inc. May-June 2017; Hangar/Office square footages from LNAA, updated July 2017

In addition to the above facilities, additional GA aircraft storage includes 560,709 square feet of aircraft parking apron. Existing aircraft parking aprons that were excluded from this analysis include the terminal apron, the Air Cargo Apron, and the Hangar 7 apron due to their support in transient rather than based aircraft operations. Parking aprons included in this analysis are summarized in **Table 5.5.2**.

Table 5.5.2 GA Based Aircraft Parking Aprons

Location	Area (Sq. Yd.)	Area (SF)
Hangar 2	6,015	54,135
Hangar 3	3,036	27,324
GA Based Exclusive Total	**9,051**	**81,459**
North GA Apron	14,949	134,541
Hangar 8	7,056	63,504
Hangar 9	10,970	98,730
Hangar 10	10,830	97,470
Hangar under construction	9,445	85,000
GA Based Non-exclusive Total	**53,250**	**479,250**
TOTAL GA BASED	**62,301**	**560,709**

Source: C&S Engineers, Inc. May-June 2017

The adequacy of existing GA facilities to support forecasted GA needs was analyzed using information regarding current based aircraft storage and forecasted based aircraft. Existing based aircraft were separated by engine type (single-engine, multi-engine, jet, and rotorcraft) and their storage location (conventional hangar, t-hangar, or apron) to create the existing based aircraft location ratios presented in **Table 5.5.3**.

Table 5.5.3 – Existing Based Aircraft Location Ratios

	Aircraft Engine Type			
Storage Location	**Single-engine**	**Multi-engine**	**Jet**	**Rotorcraft**
Conventional Hangar	0.2985	0.6364	1.0000	0.0000
T-Hangar	0.6418	0.3636	0.0000	0.0000
Tie-downs/Apron	0.0597	0.0000	0.0000	0.0000

Source: C&S Engineers, Inc. May-June 2017

These ratios were applied to the number of forecasted single-engine, multi-engine, jet, and rotorcraft based aircraft.

Industry standards regarding facility space for GA based aircraft were developed using guidance from ACRP Report 113, *Guidebook on General Aviation Facility Planning* and modified to represent existing space requirements for aircraft typical to LVIA and are unique to the type of aircraft engine for based aircraft at LVIA. The adjusted ratios are as follows:

- 1,200 square feet per one single-engine aircraft
- 1,800 square feet per one multi-engine aircraft
- 6,500 square feet per one jet engine aircraft
- 1,800 square feet per one rotorcraft engine aircraft

The above methodology was applied to determine conventional hangar, t-hangar, and GA apron requirements. The application of the existing based aircraft location ratios to the forecasted based aircraft throughout the planning period determined the future split of aircraft storage locations. **Table 5.5.4** shows the future split of based aircraft stored in conventional hangars, t-hangars, and on GA aprons. **Table 5.5.5** applies the engine type based area ratios to the types of based aircraft to determine the total square feet required to house future based aircraft.

According to this analysis, t-hangars and GA aprons are sufficient to meet facility requirements through 2040. Existing conventional hangar storage is insufficient, requiring an additional 120 square feet of conventional hangar capacity as of 2017. This need for conventional hangar capacity square footage is expected to increase to 162,620 square feet by 2040.

Table 5.5.4 Future Based Aircraft Storage Split (2016-2040)

	Conventional Hangar Based Aircraft					T-Hangar Based Aircraft					Apron/Tie-downs Based Aircraft				
Year	Piston	Turboprop	Jet	Rotorcraft	Total	Piston	Turboprop	Jet	Rotorcraft	Total	Piston	Turboprop	Jet	Rotorcraft	Total
2016	21	7	33	0	61	45	4	0	0	49	4	0	0	0	4
2017	21	7	34	0	62	45	4	0	0	49	4	0	0	0	4
2022	20	7	38	0	65	43	4	0	0	47	4	0	0	0	4
2027	20	8	43	0	71	42	5	0	0	47	4	0	0	0	4
2032	19	8	49	0	76	40	5	0	0	45	4	0	0	0	4
2037	18	9	55	0	82	38	5	0	0	43	4	0	0	0	4
2040	18	9	59	0	86	38	6	0	0	44	4	0	0	0	4

Note: Total values may vary from LVIA Based Aircraft Forecast presented in Working Paper 4 due to rounding
Source: C&S Engineers, Inc. May-June 2017

Table 5.5.5 Future Capacity Requirements (2016-2040)

	Conventional Hangar Storage Requirements (SF)					Conventional Hangar Capacity/(Deficit) (SF)	T-Hangar Storage Requirements (SF)					T-Hangar Available Capacity (SF)	Apron/Tie-downs Storage Requirements (SF)					Apron Available Capacity (SF)
Year	Piston	Turboprop	Jet	Rotorcraft	Total		Piston	Turboprop	Jet	Rotorcraft	Total		Piston	Turboprop	Jet	Rotorcraft	Total	
2016	25,200	12,600	214,500	0	252,300	6,380	54,000	7,200	0	0	61,200	8,636	4,944	0	0	0	4,944	555,765
2017	25,200	12,600	221,000	0	258,800	(120)	54,000	7,200	0	0	61,200	8,636	4,944	0	0	0	4,944	555,765
2022	24,000	12,600	247,000	0	283,600	(24,920)	51,600	7,200	0	0	58,800	11,036	4,740	0	0	0	4,740	555,969
2027	24,000	14,400	279,500	0	317,900	(59,220)	50,400	9,000	0	0	59,400	10,436	4,596	0	0	0	4,596	556,113
2032	22,800	14,400	318,500	0	355,700	(97,020)	48,000	9,000	0	0	57,000	12,836	4,452	0	0	0	4,452	556,257
2037	21,600	16,200	357,500	0	395,300	(136,620)	45,600	9,000	0	0	54,600	15,236	4,236	0	0	0	4,236	556,473
2040	21,600	16,200	383,800	0	421,300	(162,620)	45,600	10,800	0	0	56,400	13,436	4,164	0	0	0	4,164	556,545

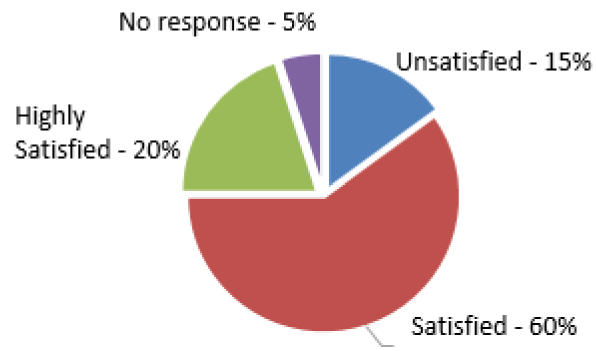
Note: Total values may vary from LVIA Based Aircraft Forecast presented in Working Paper 4 due to rounding. Future capacity requirements compared to existing building hangar storage capacity (excludes office space).
Source: C&S Engineers, Inc. May-June 2017

General Aviation Tenant Survey

A survey was sent on March 8, 2017 to all General Aviation tenants at the Airport soliciting input regarding issues, concerns, and potential future plans in order to determine the adequacy of GA facilities and desired potential facility improvements. This survey, closed on April 10, 2017, captured 20 responses for a 25% response rate.

As displayed in **Figure 5.5.1**, the majority of survey respondents indicated that they were "Satisfied" with existing GA facilities. Suggestions for improvements focused on improvements and expansion of Hangar 7 (the FBO) and the re-surfacing of taxiways and GA aprons. Additional suggestions included: improved lavatory facilities, external hose hookups, and cosmetic improvements for the t-hangars, improved customer services, self-service fueling, and a desire for the ability to pull vehicles planeside with easier airfield access.

Figure 5.5.1 GA Tenant Facility Satisfaction



Source: C&S Engineers, Inc.; GA Tenant Survey 03/08/17 – 4/10/17

Eight respondents indicated an anticipation in their needs and/or services at the Airport changing over time. Perceived needs to accommodate these changes include additional aprons, t-hangars, and corporate hangars, additional office space/classrooms in Hangar 7, as well as additional specialized maintenance and full-service avionics shops.

5.6 Cargo

As indicated by Working Paper 4 – Forecasts of Aviation Demand analysis, air cargo is expected to grow to 157,141 metric tons (173,218 tons) by 2040. This is an approximate 89% growth from existing (2017) air cargo tonnages. The purpose of this section is to analyze estimated requirements for the Airport's air cargo facilities under this anticipated growth in air-cargo operations. This section will examine requirements for forecasted cargo quantities using standard tonnages.

Air cargo can be separated into two main categories: all-cargo and belly cargo. All-cargo refers to air cargo that is transported by carriers that exclusively transport cargo. Belly cargo refers to cargo that is transported by commercial air carriers under the main deck of the airplane. Since belly-cargo carriers are not utilized at LVIA to support air-cargo operations, air cargo anticipated capacities and requirements were only analyzed using all-cargo operations and variables.

The adequacy of existing air cargo hangar and air cargo ramp space was analyzed using two methods. The first method assessed requirements based on existing 2017 space-tonnage utilizations, creating a ratio of 1.49 tons of cargo per square foot of cargo building space and 7.71 square feet of ramp space per square foot of cargo building space. The second method utilized industry standard ratios[5] of one ton of cargo per 1.5 square feet of cargo building space and five square feet of cargo apron per one square foot of cargo building space. An average of both methodologies was used to develop a final comparison.

Existing cargo facilities and apron square footages were used to apply the above ratios. Cargo facilities used in this analysis are presented in **Table 5.6.1**.

Table 5.6.1 Air Cargo Facilities

Facility		Gross SF
Cargo Buildings		
FedEx Freight		35,570
ABX/ATI/Atlas Cargo Apron Facility		1,008
2202 Hangar Place		60,000
	Total	**96,578**
Cargo Aprons		
Air cargo apron		400,000
Air cargo apron addition		74,530[1]
	Total	**474,530**

[1] Represents an estimated SF for one D-IV aircraft parking position currently under construction

Source: C&S Engineers, Inc. May-June 2017

The following tables, **Table 5.6.2** and **Table 5.6.3**, display the anticipated cargo building and apron requirements anticipated through 2040 using the above methodology.

Table 5.6.2 All-Cargo Building Requirements (SF)

Year	Existing LVIA Ratio	Industry Standard Ratio	Average of Existing LVIA Ratio and Industry Standard Ratio
2022	122,087	85,675	103,881
2027	133,390	93,607	113,498
2032	145,170	101,874	123,522
2037	157,222	110,331	133,776
2040	164,557	115,479	140,018

Source: C&S Engineers, Inc. May-June 2017

[5] Industry Standard Ratios from ACRP Report 143, Guidebook for Air Cargo Facility Planning and Development (Sections 4.3.4 & 4.3.5)

Table 5.6.3 All-Cargo Apron Requirements (SF)

Year	Existing LVIA Ratio	Industry Standard Ratio	Average of Existing LVIA Ratio and Industry Standard Ratio
2022	1,476,342	428,375	952,359
2027	1,613,017	468,035	1,040,526
2032	1,755,478	509,370	1,132,424
2037	1,901,206	551,655	1,226,431
2040	1,989,912	577,395	1,283,654

Source: C&S Engineers, Inc. May 2017

According to both methodologies and their average, existing cargo building square footages are not sufficient for operations expected throughout the entirety of the planning period through 2040. Cargo building area is estimated to be deficient by a range of approximately 19,000 – 68,000 square feet by 2040. Cargo apron square footage is also insufficient under all methodologies except the industry standard ratio, in which case apron square footage is sufficient to 2032. Cargo apron area is estimated to be deficient by a range of approximately 100,000 – 1.5 million square feet by 2040.

5.7 Airport Support Facilities and Equipment

Ground Service Equipment (GSE)

All GSE captured in the inventory has reached or is expected to reach its useful life throughout the planning period. It is recommended wherever possible, to purchase hybrid or electric vehicles as replacements. Currently the LVIA Maintenance Department facility is inadequate in size for the entirety of GSE storage, with a large portion of existing GSE stored exposed to the elements on the Maintenance Department ramp, as well as in Hangar 7 and Hangar 9.

Discussions with the Superintendent of Maintenance have indicated the need to construct a building to house all snow removal equipment separately, which would clear space for GSE and other equipment in the Maintenance Department facility. Another suggestion was to construct a canopy or roof off the existing maintenance facility, over an existing gravel area, to provide more covered storage space. See the section below on Airport Maintenance for more information.

Aircraft Rescue and Firefighting (ARFF)

14 CFR Part 139 requires the FAA to issue operating certificates to airports that serve scheduled and unscheduled air carrier aircraft with more than 30 seats and airports that serve scheduled air carrier operations in aircraft with more than 9 seats but less than 31 seats. To obtain certification, an airport must abide by certain operational and safety standards for ARFF facilities and equipment.[6]

As a registered Index C Airport, LVIA must comply with 14 CFR Part 139 guidelines. 14 CFR Part 139

[6] "What is Part 139?", Part 139 Airport Certification, FAA, Accessible at: https://www.faa.gov/airports/airport_safety/part139_cert/what-is-part-139/. Accessed 5/26/17

guidelines for Index C ARFF require equipment meeting one of the following:

- Three vehicles – one vehicle carrying the extinguishing agents and two vehicles carrying an amount of water and the commensurate quantity of AFFF so that the total quantity of water for foam production carried by all three vehicles is at least 3,000 gallons.
- Two vehicles – one vehicle carrying the extinguishing agents and one vehicle carrying water and the commensurate quantity of AFFF so the total quantity of water for foam production carried by both vehicles is at least 3,000 gallons.[7]

As indicated in **Table 3.9.6** of Working Paper 3 – Existing Conditions/Inventory, LVIA currently has five fire trucks, one utility truck, and one support vehicle. All of these vehicles are expected to reach their useful life throughout the planning period. Replacement of these vehicles throughout the planning period must be phased correctly to ensure 14 CFR Part 139 guidance.

An ARFF index is determined by a combination of the length of air carrier aircraft and the average daily departures of air carrier aircraft. If there are five or more average daily departures of air carrier aircraft in a single Index Group, the longest aircraft with an average of five or more daily departures determines the index required for the airport. When there are fewer than five daily departures of the longest air carrier aircraft at the airport, the index will be the next lower Index Group than the Index Group prescribed for the longest aircraft.[8]

Projected flight growth indicates the possibility of a cargo carrier adding 9-10 wide-body flights at LVIA by 2022. The length of this aircraft (B767-300ER) is 180 feet and 3 inches, which will prescribe a new Index Group, Index D, for LVIA. Equipment requirements for Index D airports to comply with 14 CFR Part 139 guidelines include:

- One vehicle carrying the necessary extinguishing agents
- Two vehicles carrying an amount of water and the commensurate quantity of AFFF so that the total quantity of water for foam production carried by all three vehicles is at least 4,000 gallons.[9]

The existing ARFF facility was constructed in 2003, complete with four vehicle bays, and has adequate storage for ARFF vehicles under Index Group D requirements. The facility was strategically located in its present location so that there is adequate room for expansion and for its ability to meet response times in the event of the construction of a future parallel Runway 6-24.[10] Currently, the facility has adequate space in the form of dormitories to house the two personnel that must be on active duty at all times as an Index C

[7] Part 139.315-319 Certification of Airports Guidelines, Accessed at: https://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=8313bccee050ec81d7e8fb3377331177&rgn=div5&view=text&node=14:3.0.1.1.14&idno=14#se14.3.139_1315

[8] Part 139.315-319 Certification of Airports Guidelines, Accessed at: https://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=8313bccee050ec81d7e8fb3377331177&rgn=div5&view=text&node=14:3.0.1.1.14&idno=14#se14.3.139_1315

[9] Part 139.315-319 Certification of Airports Guidelines, Accessed at: https://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=8313bccee050ec81d7e8fb3377331177&rgn=div5&view=text&node=14:3.0.1.1.14&idno=14#se14.3.139_1315

[10] 2004 Master Plan Update

ARFF. For airport growth towards an Index D, the dormitories should be expanded so that the number of rooms is equal to the number of firefighters required per shift (with 20% of the total set aside for female firefighters).[11]

As indicated in FAA AC 150/510-15a, *Aircraft Rescue and Firefighting Station Building* Design, there is stringent materials storage space requirements that must be followed at ARFF stations. Foam agent recharge must be provided and foam storage tanks should have the capacity sufficient to fill all vehicles with at least twice their assigned capacity.

Discussions with the Fire Chief indicated the need to provide additional bay/equipment storage space. The suggestion was to extend the two existing drive through bays 40-45 feet to provide covered space off the back of the building. The ARFF facility also needs four new high-speed roll up doors.

Airport Maintenance

A significant portion of existing SRE is expected to need replacement throughout the planning period. This includes several pieces of equipment that are already past their expected useful life. In addition, the Airport may consider purchasing additional equipment that is currently being rented seasonally. Equipment replacement must be phased correctly to ensure that the entirety of the Priority 1 Airfield (approximately 2,426,020 square feet) can be cleared within a half hour response time. Any additions to the Priority 1 Airfield during the alternatives development process may require the addition of SRE equipment and their appropriate storage capacity.

There is also a need for additional SRE equipment storage since there is not enough inside storage located on-site at the Maintenance Department facility where SRE is currently stored. Additional SRE storage should be planned with consideration for the minimum equipment space allocations for the clearances of equipment safety zones as indicated in Table 3-1 of FAA AC 150/5220-18A, *Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials*. The Superintendent of Maintenance indicated that a new storage building for SRE should be constructed in the newly acquired property just north of the existing maintenance facility. Once the SRE are in their own, dedicated building, the existing facility could house additional GSE or other equipment. (Size of this building is unknown at this time, but should be large enough to house all SRE)

The Superintendent also indicated that sand is currently stored in the maintenance facility and is expected to remain. Approximately 250-300 tons of salt is also currently stored in one-third of the existing rental car quick turnaround building. He indicated that the building is in good condition and could be used for equipment storage, if the salt could be stored elsewhere.

[11] Federal Aviation Authority AC 150/5210-15A, *Aircraft Rescue and Firefighting Station Building Design,* Section 3-17. Accessed 11/13/17. Accessible at: https://www.faa.gov/documentLibrary/media/advisory_circular/150-5210-15A/150_5210_15a.pdf

Fuel Storage/Supply

The fuel farm for aircraft currently contains three 50,000 Jet A fuel tanks and one 12,000 gallon 100LL (Avgas) fuel tank. The facility has capacity for an additional above-ground 50,000 fuel tank within its fencing, although there have been no documented needs for its construction.

The projected fuel storage requirements at LVIA's fuel farm were calculated by determining the average number of projected daily turbine and piston operations throughout the planning period. Using ratios of approximately 10 gallons of Jet A fuel per turbine operation and 4.2 gallons of Avgas fuel per piston operation; two-week fuel storage requirements were developed, including a 10% increase adjustment for peak periods. **Table 5.7.2** illustrates projected fuel storage requirements throughout the planning period.

Table 5.7.2 Fuel Storage Requirements (Two-Week Period)

Year	Average Daily Piston Operations	Average Daily Turbine Operations	Average Demand (gal.)		Peak Demand (+10%) (gal.)	
			Avgas	Jet A	Avgas	Jet A
2017	56	153	3,293	21,420	3,622	23,562
2022	54	174	3,175	24,360	3,493	26,796
2027	53	196	3,116	27,440	3,428	30,184
2032	51	212	2,999	29,680	3,299	32,648
2037	50	249	2,940	34,860	3,234	38,346
2040	49	267	2,881	37,380	3,169	41,118

Note: Utilizes ratios of 10 gal of Jet A per turbine operation and 4.2 gallons of Avgas per piston operation
Source: C&S Engineers, Inc. May 2017

The aircraft fuel farm fuel capacity storage is expected to remain adequate throughout the planning period including under periods of peak demand. In the event of a supply disruption, the fuel farm has the capacity to meet fuel demand in 2040 for approximately seven weeks under peak demand conditions. However, existing FBO fuel truck vehicles are anticipated to reach life expectancy towards the middle of the planning period. This vehicle replacement must be phased to prevent delays in the ability for fuel distribution.

The Superintendent of Maintenance indicated that the existing vehicle fuel farm, located just north of the maintenance facility, is over 20 years old and is susceptible to spills/leaks. He recommended a new facility relocated to an area between the maintenance facility and ATCT that could be easily accessible.

5.8 Utilities and Infrastructure

As projected demand for services at the Airport is primarily incremental in nature, including for facilities such as the air carrier terminal, FBO and other general aviation hangars, and cargo buildings, utility requirements are anticipated be limited to maintenance and the minor upgrade of existing equipment and lines, rather than major expansion.

Future development will be concentrated in areas of existing airport facilities, particularly the terminal complex, and the cargo, FBO, and corporate hangar buildings on the south side. Limited development of the general aviation complex on the far north side is anticipated. As such, major trunk line expansions for water, sewer, and electricity are not anticipated. Communication utility requirements are expected to remain to be served by existing corridors for telephony and fiber optic lines. Stormwater requirements will be developed as part of Element 15 – Drainage Evaluation and Master Plan.

As noted during the utility inventory, CAD, GIS, and other recent data regarding as-built utility conditions is limited, particularly across the entire Airport. More data is available for recent projects, such as the Runway 13-31 Safety Area improvements and Economy Parking Lot. However, with supplemental utility drawings being made available by LNAA, additional review and analysis of recent utility data will assist in evaluating needs on a project-by-project basis.

Utilities are generally served by the following providers:

- Water & Sewer
  - Hanover Township (from Lehigh County)
  - Adjoining service providers include the Borough of Catasauqua and City of Bethlehem
- Electricity: PPL Corporation
- Natural Gas: UGI Utilities, Inc.
- Telecommunications: Various, including AT&T and Verizon

The following is a utility overview of the areas around the airport, as per quadrants defined by the two runways:

- **East Side – Air Carrier Terminal Area**: As landside circulation, passenger processing, and gate capacity needs will not necessitate significant changes in the current facility footprint, no major expansion of utility capacity will be needed. There are also a few hangar buildings that are not planned to be expanded, or may be relocated, so no additional utilities will be needed. Since any redevelopment is likely to incorporate more recent energy-efficient technologies and equipment, this should mitigate any significant utility expansion needs.

- **South Side – Cargo/FBO/Corporate Aviation Area**: This sector of the Airport is largely developed and built-out with corporate general aviation- and air cargo-related facilities, along a developed corridor in Hanover Township. Additional properties proposed to be acquired in this area are also developed with pre-existing buildings. Proposed expansion of apron areas, particularly for the air cargo area, will necessitate stormwater mitigation, but should not require significant upgrading of other utility items such as electricity for lighting, however the fiber optic infrastructure and tying it back to the airport's main terminal will need to be evaluated.

- **North Side – Light General Aviation (previous master plan).** This sector of the Airport is limited to general aviation that is recreational in nature, with a series of T-hangar buildings and a parking apron. As general aviation demand of this type is forecasted to be limited in growth, and facilities such as T-hangars typically create relatively less additional demand than other airport facilities, utility capacity should be adequate in this area. Additionally, any development to the north of Race Street, after any proposed land acquisitions, will entail refurbishment or replacement of existing buildings, and should not create a need for increased utility capacities. So long as LVIA's airfield consists of just the two current runways, growth for this area will be limited in nature, with limited need for utility expansion. Any potential development alternatives that differ from GA will need to consider utilities in this area.

- **West Side – Undeveloped Greenfield.** This is one of the only areas of the airport that is not developed. Since appropriate incremental development in the other three areas around the airfield will largely accommodate future facility requirements, it is not anticipated that any development, including utility needs, will occur in this area. Should demand and conditions change that necessitate development in this area, it will require additional analysis as to the utilities available and capacities they can serve, and potentially coordinate upgrades to them. Requirements will depend on the nature and scale of facilities and their respective proposed uses. Particularly, water and sewer would need to be coordinated with the Borough of Catasauqua, which controls these utilities in the area. As an example, corporate hangars would largely mean increased stormwater management, but with some water, sewer, and potentially power and telecommunications extensions.

5.9 Requirements Summary

This section summarizes the facility requirements that should be considered as alternatives to Airport development are analyzed.

Airfield

- No action needs to be taken during the planning period in order for the Airport to maintain an acceptable level of relative annual operating capacity as far as the number of runways is concerned. Since previous efforts have included a third runway that is shown on the previous ALP and capacity is approaching the 60% mark, consideration to continue planning for a third runway beyond this planning period should be included.
- Airfield configurations that impact the ability to reach higher capacity numbers that should be considered include:
    - Limited taxiway exit options landing RW 31
    - Additions to Taxiway B
    - Increased cargo aircraft taxiing area
    - Improve taxiing flow for larger aircraft
- Remove existing modifications to standards as noted in **Table 5.2.2** and summarized below:
    - Perimeter road in ROFA of RW 24 and RW 31
    - Corner of cemetery within object free areas
    - Hangars, aircraft parking, and line service building within RVZ
    - Taxiway B separation from RW 13-31
- Need RW 6 blast pad
- RW 13-31 EMAS should be evaluated for upgrade to D-IV standards
- All runway RPZs need to be controlled and cleared of incompatible land uses for existing and lower than ¾ mile visibility minimums for RW 24 and RW 31

- Input from users aligning with the findings of the previous master plan and the runway length information derived from the critical aircraft analysis indicate that the previous runway extension alternatives for both runways be considered (RW 13-31 extend to 7,500 feet; RW 6-24 extend to 8,600 feet then ultimately 10,000 feet)
- Input from ATCT indicates the following improvements:
  - Enhance Taxiways C and E
  - Add air carrier apron options to Taxiway B
  - Extend Taxiway B4 to Terminal/Hangar 7
  - Provide parallel taxiways on both sides of runways
  - Add holding bays or by-pass taxiways, especially at RW-24
  - Extend Taxiway J
- Cat II ILS for RW 6 is being discussed and progressing in parallel with this master plan effort
- An airside PMP has recommended a 5-year maintenance and rehabilitation work plan. Detailed projects are identified by pavement branch and section with a priority and cost estimated.

Terminal Area Facility Requirements

- **Aircraft Parking Positions/Gates** – The Airport will require 9 gates: 7 for large regional jets, 1 for a narrow-body aircraft, and 1 spare. The Airport should consider whether Gates 1A-3C are worth maintaining or should be removed.
- **Holdrooms** – Based on the forecasted demand and fleet mix, holdroom capacity will continue to meet 2040 demand. If the fleet mix changes such that the gates are occupied by the maximum compatible ADG aircraft, there would be an immediate deficit in holdroom area.
- **Check-in Positions** – There is a sufficient number of check-in counters, queue area, and generous circulation in the check-in areas.
- **Passenger Security Screening** – The passenger security area is currently undersized by 1 lane due to its constrained location in the lower tunnel. As many as 4 lanes and 3,500 square feet will be needed, double the existing layout, to accommodate passenger demand at a reasonable level of service.
- **Concessions** – The Airport will need an additional 1,500 square feet of concessions space, post-security, by the end of the planning period. The storage areas will be sufficient until 2032 and will ultimately need an additional 360 square feet.
- **Circulation** – The circulation corridors within the main terminal are below industry standard near the check-in zones, baggage claim area, and near the rental car counters.
- **Restrooms** – No additional restrooms will be required.
- **Baggage Screening** – The current system appears to be able to handle demand through the planning period. Since newer machines are improving their throughput, any upgrades would also continue to accommodate future demand.

- **Outbound/Inbound Baggage Handling** – By the end of the planning period, the outbound baggage handling area will be 300 square feet less than what is required, but the inbound baggage area will be sufficient.

- **FIS Facility** – The Airport does not have a FIS facility but 2 different potential buildings were sized depending on the aircraft expected to be used: B767-300 or B737-800. The B737-800 would require 4 primary positions, 2,000 square feet for processing, 160 linear feet of frontage for baggage claim, and 5,000 square feet for Customs and Border Patrol (CBP). The B767-300 would require 6 primary positions, 3,000 square feet for processing, 180 linear feet for baggage claim, and 5,000 square feet for CBP.

- **Back of House/Office Space** – The existing LNAA board room will be relocated, freeing up space for 10 more work stations. This will accommodate growth in the near-term. Overtime, there may be opportunities to reconfigure the space to achieve a more efficient and employee friendly layout, but that is outside the scope of the master plan. In addition, spaces such as airline offices may shrink as airlines continue to cut costs. For the purposes of this report, it is assumed that no further space is required.

Access, Circulation, and Parking Facility Requirements

- **Airport Road -** While the Airport is not responsible for the operations of Airport Road, it should be noted that operations on Airport Road are expected to include significant delays by 2040 with only the improvements recommended in the FedEx traffic study. The Airport may want to consider access changes to these two intersections to improve operations and their experience as passengers, visitors, and employees travel to and from the Airport.

- **Circulation & Curbside -** The Airport should consider alternatives to reduce confusion and conflict points as drivers decide between the rental car area, arrivals, departures, short- and long-term parking, and the cell phone lot. The Airport may wish to consider implementing technology to monitor taxi/limo/TNC activity curbside to capture potential revenue. The Airport should also consider improving future curbside operations on the arrivals roadway, which are expected to operate at a LOS E.

- **Parking – Table 5.9.1** summarizes the estimated parking requirements:

Table 5.9.1: Parking Requirements Summary

Year	Long-term Parking Requirement	Surplus/ (Deficit)	Short-term Parking Requirement	Surplus/ (Deficit)	Employee Parking Requirement	Surplus/ (Deficit)	Rental Car Parking Requirement	Surplus/ (Deficit)
2016	676	700	290	(147)	170		460	366
2020	720	656	308	(165)	181	(11)	489	337
2030	863	513	370	(227)	217	(47)	587	239
2040	1,021	355	437	(294)	257	(87)	694	132

Parking in the public lots in front of the terminal should be reallocated to provide at least 440 short-term spaces and no less than 1,100 long-term spaces. Employee parking and rental car activity will be accommodated through 2040 in the areas northeast of the terminal.

- **Landside Pavement** – See **Table 5.4.7** for the priority pavement projects identified in the recent Landside Pavement Management Plan.

General Aviation Facility Requirements

- T-hangars and apron areas are sufficient to meet facility requirements through 2040. An additional 120 square feet of conventional hangar space is needed starting in 2017 with a total need for approximately 163,000 square feet by 2040.
- A GA tenant survey indicated the desire for FBO improvements and expansion, self-service fueling, the ability to pull vehicles planeside with easier airfield access, specialized maintenance, and full-service avionics shops.

Cargo Facility Requirements

- Cargo building area is estimated to be deficient by a range of approximately 19,000 – 68,000 square feet.
- Cargo apron area is estimated to be deficient by a range of approximately 100,000 – 1.5 million square feet.

Airport Support Facility Requirements

- Construct new SRE storage facility north of the existing maintenance facility
- Install canopy/roof for covered storage adjacent to existing maintenance facility
- Relocate and update vehicle fuel farm facility
- Relocate salt storage
- Expand drive through bays on ARFF building for additional covered storage
- Install new high-speed roll up doors on ARFF building

Element 5 Appendix

Runway Length Analysis

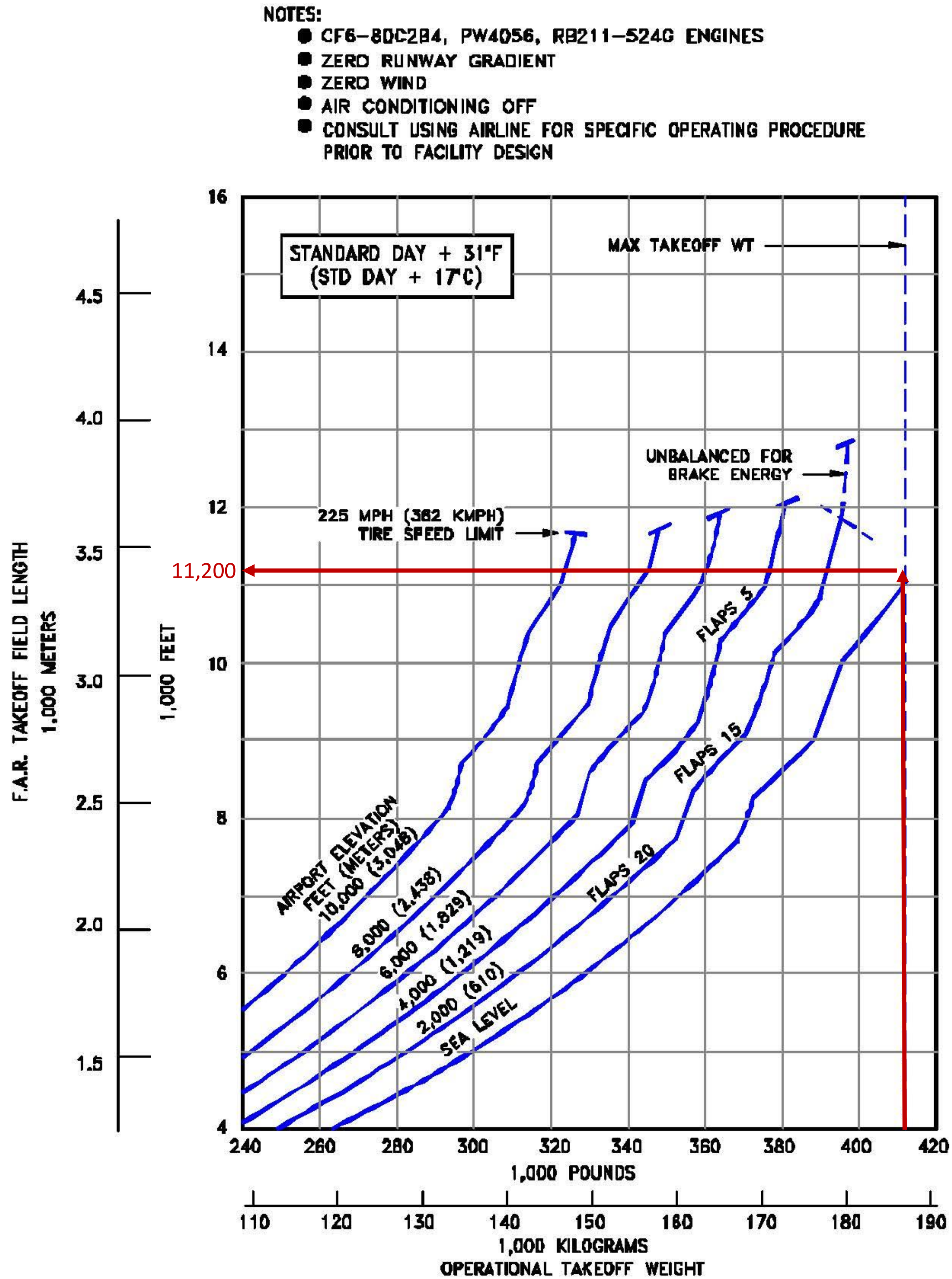
Runway Length Requirement Summary

AIRPORT CONDITIONS

Elevation above sea level	393.7 feet
Runway gradient	
Runway 06-24	-/+ 0.189%
Runway 13-31	-/+ 0.057%
Mean Daily Maximum Temperature of the hottest month	85.3°F

F.A.R. TAKEOFF RUNWAY LENGTH REQUIREMENTS

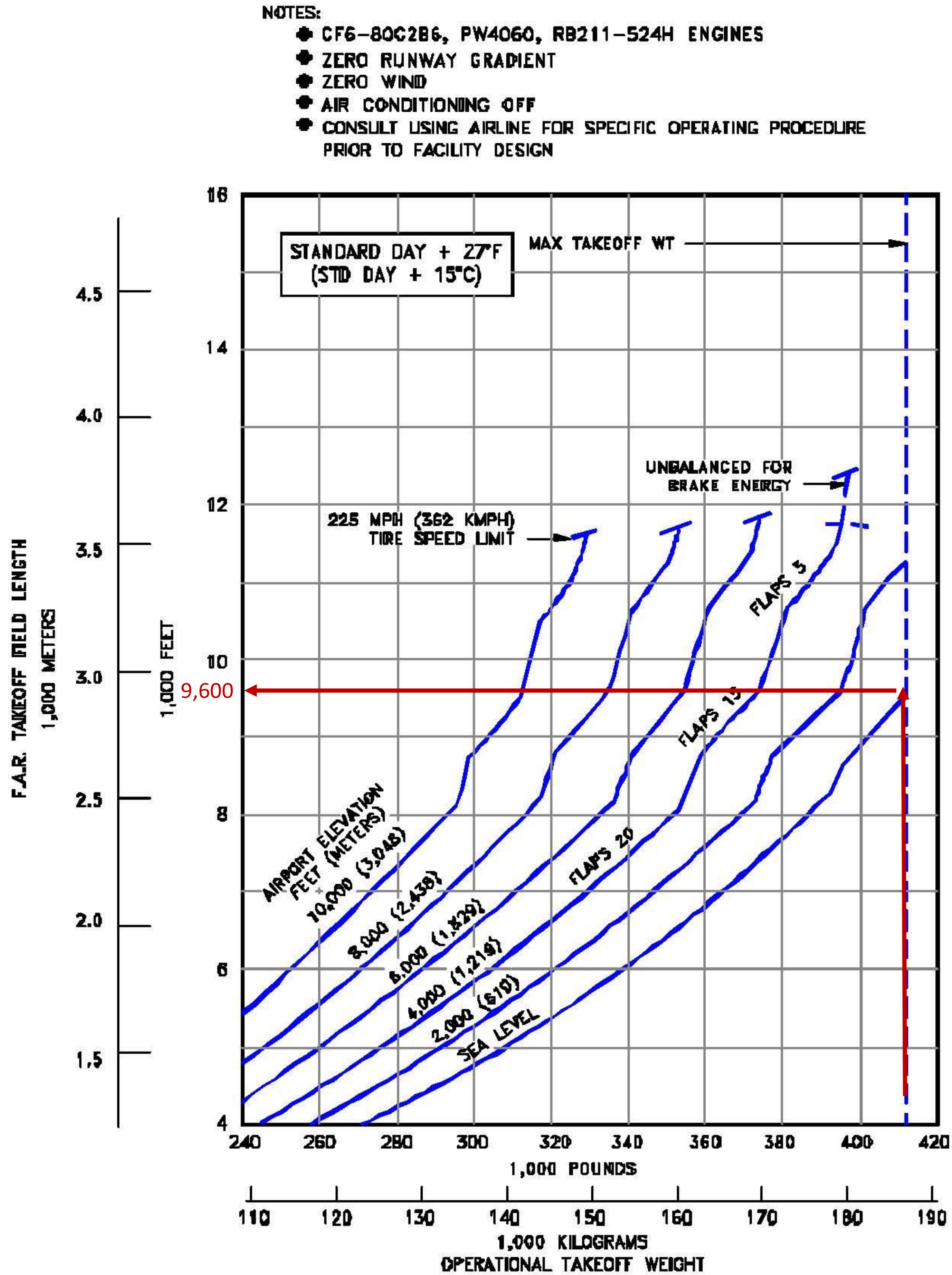
Boeing 767-300 ER, -300 Freighter Performance Chart	Temperature	Length Requirement
3.3.14	Standard Day +31 degrees F	11,200 feet
3.3.16	Standard Day +27 degrees F	9,600 feet
3.3.18	Standard Day +27 degrees F	8,900 feet
3.3.20	Standard Day +27 degrees F	8,900 feet



3.3.14 F.A.R. TAKEOFF RUNWAY LENGTH REQUIREMENTS

STANDARD DAY + 31°F (STD + 17°C)

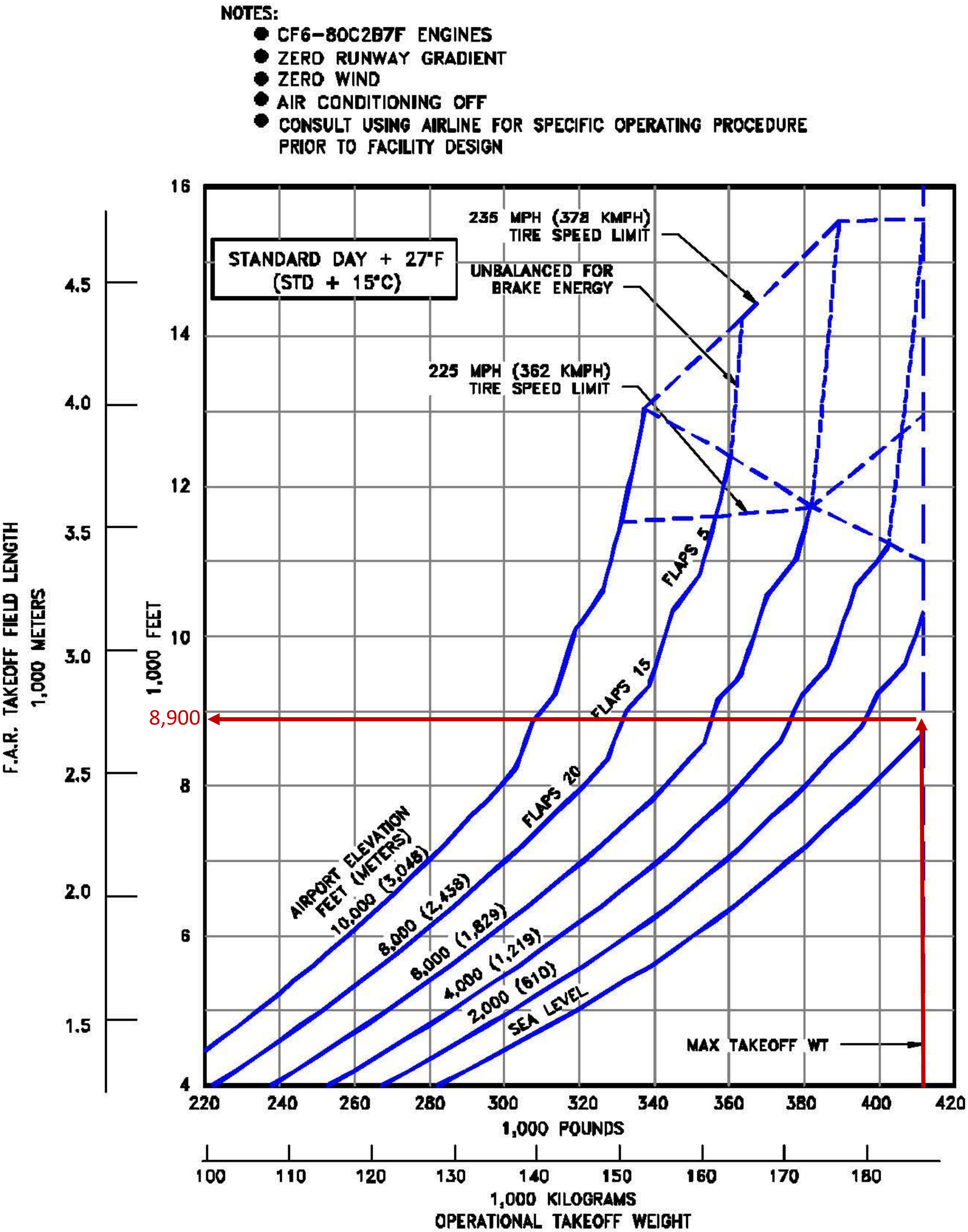
MODEL 767-300ER, -300 FREIGHTER (CF6-80C2B4, PW4052, RB211-524G ENGINES)



3.3.16 F.A.R. TAKEOFF RUNWAY LENGTH REQUIREMENTS

STANDARD DAY + 27°F (STD + 15°C)

MODEL 767-300ER, -300 FREIGHTER (CF6-80C2B6, PW4060, RB211-524H ENGINES)

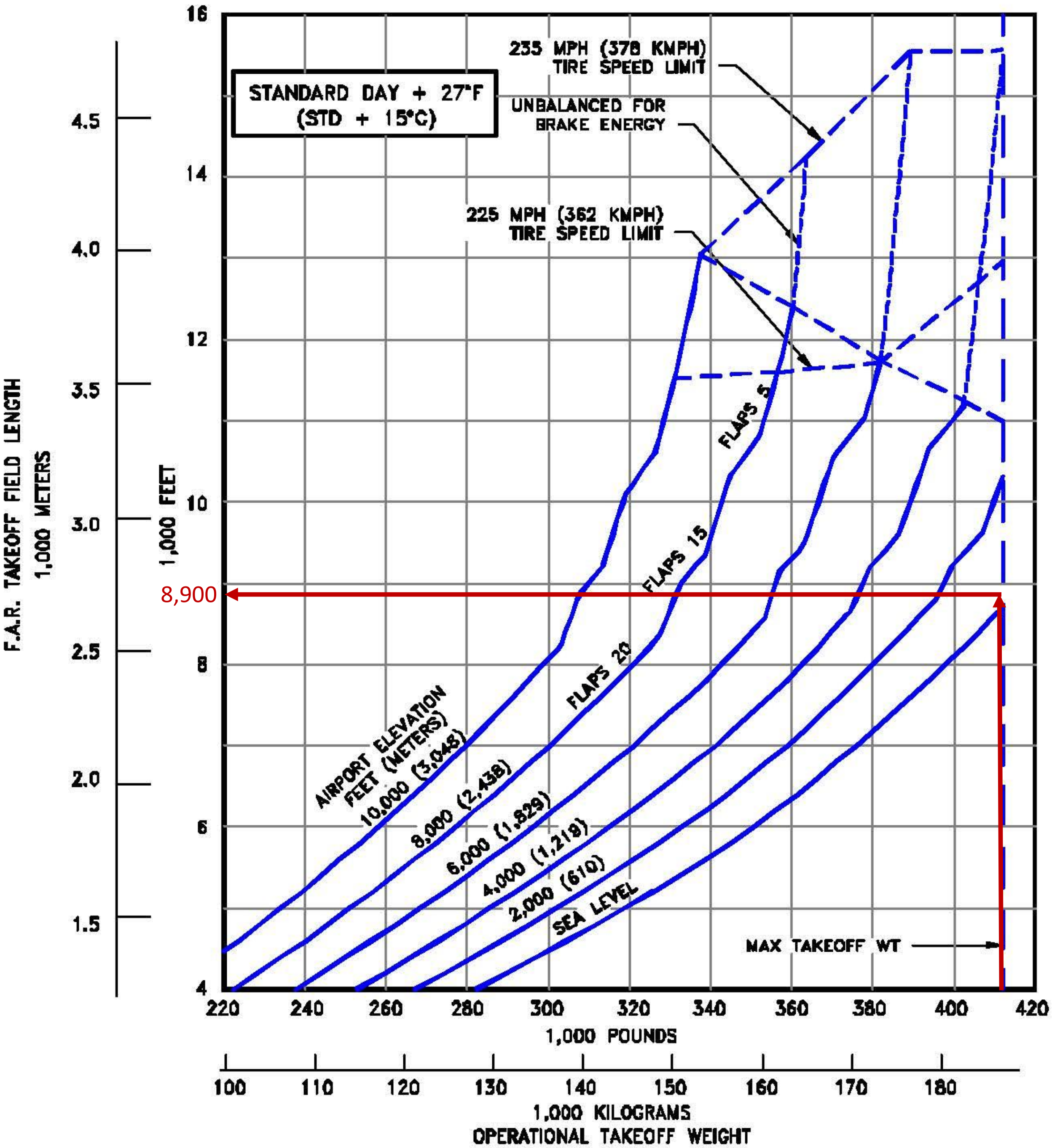


3.3.18 F.A.R. TAKEOFF RUNWAY LENGTH REQUIREMENTS

STANDARD DAY + 27°F (STD + 15°C)

MODEL 767-300ER (CF6-80C2B7F ENGINES)

NOTES:
- PW4062 ENGINES
- ZERO RUNWAY GRADIENT
- ZERO WIND
- AIR CONDITIONING OFF
- CONSULT USING AIRLINE FOR SPECIFIC OPERATING PROCEDURE PRIOR TO FACILITY DESIGN



3.3.20 F.A.R. TAKEOFF RUNWAY LENGTH REQUIREMENTS

STANDARD DAY + 27°F (STD + 15°C)

MODEL 767-300ER (PW4062 ENGINES)

Element 5 Appendix
Landside Analysis

Forecasting Calculations

Peak Month - July   Peak Day - Thursday

Forecast	Annual Passengers	Peak Day Passengers	Average Day Passengers	Peak Hour Passengers	Average Hour Passengers	Enplanements	Growth Rate		Operations	Growth Rate	
2016		2,700	2,300	535		344,895			10,100		
2020						367,108	1.57%		11,202	2.62%	
2030						440,259	1.83%		12,243	0.89%	
2040	1,041,599	4,109	3,500	816	225	520,800	1.69%	1.73%	13,795	1.20%	1.31%
		0.39%		20%	6%	50%					

Future peak day passengers will be less than 0.4% of annual passengers
Future peak hour passengers will be 20% of peak day passengers

Growth rate for peak day passengers from 2016 to 2040 =
1.8%

2040 enplanements is 50% of annual passengers

Friday, December 2nd, 2016		
Enplanements	897	
Deplanements	754	
Total	1651	
Peak hour passengers = 20% of daily passengers	328	close to actual (approximately 23%) - see en-deplane summary tab
% of 2016 peak hour passengers	61%	
4-5 pm		
Inbound volume	247	57%
Outbound volume	185	43%
Total (main airport access)	432	
Estimated peak hour volume	600	since 12/2 passengers = 61% of peak hour passengers, increase volumes by 39%

existing ratio of vehicles/passenger for peak hour	1.32	
2040 peak hour passengers	816	
2040 peak hour vehicles	1075	
inbound	615	
outbound	460	

projected to 2040 peak hour/average day/peak month volumes using existing veh/pax ratio for 12/2

2.5
2040 volumes are approximately 2.5 times more than 12/2/16 volumes

growth rate	1.73%
Estimate peak hour 2016 volume	600
2040 volume	907
inbound	518
outbound	388

projected using enplanement growth rate from 2016 - 2040 on estimated peak hour data

Future Airport Rd Information

Recommended improvements from 10/2014 FedEx traffic impact study

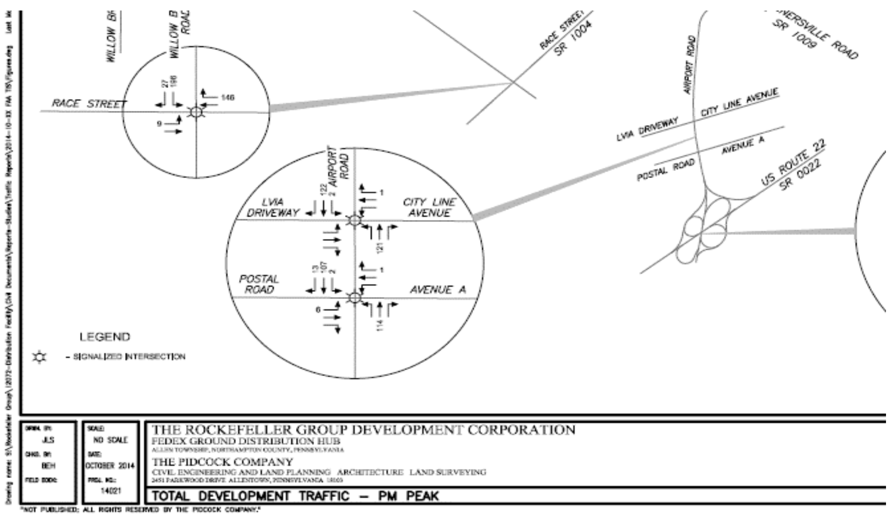
3. Airport Road (SR 0987) & City Line Road / LVIA Driveway
   - Construct an additional 250-foot westbound left turn lane along City Line Road.
   - Construct the third southbound through lane along Airport Road.
   - Construct a 240-foot channelized southbound right turn lane.
   - Implement northbound protected/prohibited left turn phasing.
   - Implement southbound protected/permitted left turn phasing.
   - Implement westbound left turn protected/prohibited phasing.
   - Traffic signal operations will be modified to accommodate the intersection configuration.

4. Airport Road (SR 0987) & Postal Road / Avenue A
   - Construct the third southbound through lane along Airport Road.
   - Construct a 400-foot channelized southbound right turn lane.
   - Implement northbound protected/prohibited left turn phasing.
   - Modify the traffic signal to accommodate the revised configuration.

Background growth rate (page 9)

1.35% growth rate for background growth through 2025

FedEx traffic on Airport Rd during PM peak (Figure 16P)



Background growth rate from 3/2017 Circulation Study & Alternatives Analysis Report

0.97% growth rate for background growth through 2019

Future Parking Calculations

Existing Number of Spaces

Type	Existing Supply	Effective Supply
Aero Club	55	50
Short-term	159	143
Long-term	1,473	1,326
Employee	74	
Cell phone	15	
Overflow employee	?	

Total public parking	1,687	total number of spaces that is documented through parking booth (Aero Club, short- and long-term)
Total effective supply	1,518	assumes max 90% utilization (keeps 10% spaces as buffer)
Total public parking - current rental allocation	1,357	total number of spaces that is documented through parking booth (Aero Club, short- and long-term) minus rental car allocation
Total effective supply (rental allocation)	1,221	assumes max 90% utilization (keeps 10% spaces as buffer)
Peak occupancy on 12/2/2016	464	9:00 AM
	31%	Existing utilization
	38%	Existing utilization (rental allocation)

12/2/2016 passengers:	1651
12/2/2016 peak parking occupancy:	464
ratio of occupied spaces/daily passenger:	0.28

2016 peak day passengers:	2,700	
estimated 2016 peak parking occupancy:	759	using existing ratio
	50%	Peak day utilization rate
	62%	Peak day utilization rate (altered for rental allocation)
2040 peak day passengers:	4,109	
estimated 2040 peak parking occupancy:	1,155	using existing ratio
	76%	2040 peak day utilzation rate

ACRP 25

The number of passenger and public parking spaces at an airport varies greatly depending on the policies of each airport operator (See Table VII-4). Local conditions for each airport should determine the ultimate number of spaces to meet anticipated demand. While there is a great deal of variation based on local conditions, passenger parking demand has been demonstrated to be related to the number of originating passengers (*50*). As a general rule of thumb, parking supply should range from 900 to 1,400 spaces per million enplaned passengers, with 25% to 30% of spaces designated for short-term parking (*49*).

To avoid long walking distances for passengers, a maximum distance should be established between parking spaces and the terminal building (close-in facilities) or transit pick-up/drop-off

Table VII-4. Examples of rule-of-thumb passenger parking*.

Originating Enplanements	Parking Supply	Approximate Number of Short-Term Parking Spaces	Approximate Number of Long-Term Parking Spaces
500,000	450 - 700	100 - 200	350 - 500
1,000,000	900 - 1,400	225 - 425	675 - 975
1,500,000	1,350 - 2,100	325 - 625	1,025 - 1,475

*Exact parking space numbers depend on the type of flights the airport services

Source: Kimley-Horn and Associates, Inc., All rights reserved.

	Enplanements	Public Parking Supply Low	Public Parking Supply High	Existing Supply	Existing Effective Supply	Overall High Surplus
2016	344,895	621	966	1,687	1,518	552
2020	367,108	661	1028	1,687	1,518	490
2030	440,259	792	1233	1,687	1,518	285
2040	520,800	937	1458	1,687	1,518	60

	Enplanements	Public Parking Supply Low	Public Parking Supply High	Long-term Low	Long-term High	Short-term Low	Short-term High	Short-term Deficit Low	Short-term Deficit High
2016	344,895	621	966	435	676	186	290	-43	-147
2020	367,108	661	1028	463	720	198	308	-55	-165
2030	440,259	792	1233	554	863	238	370	-95	-227
2040	520,800	937	1458	656	1021	281	437	-138	-294

If we use assumption that 25-30% of parking should be allocated to short-term, ABE is currently short approximately 130 spaces and will need an additional 275 by 2040 for a total of 437 short-term spaces

emplanements	Low Spaces	High Spaces	
500,000	900	1400	
	0.0018	0.0028	spaces/enplanement
	Low	High	

	Low	High	
Employee parking:	250	400	per million enplanements
	0.00025	0.0004	employee parking space/enplanement

or use 1 space per 3 employees

According to LNAA, currently employee demand = 170 spaces

ratio of employee spaces per enplanement = 0.000493

ACRP ratios

	Enplanements	Employee Parking Supply Low	Employee Parking Supply High	Existing Ratio	
2016	344,895	86	138	170	
2020	367,108	92	147	181	11
2030	440,259	110	176	217	47
2040	520,800	130	208	257	87

need approx 90 more employee spaces

Rental car spaces:

FAA AC 150/5360 page 123	1 rental stall per 750 enplanements	0.001333

Year	Enplanements	Rental Car Spaces Needed	Rental Car Surplus/(Deficit)
2016	344,895	460	366
2020	367,108	489	337
2030	440,259	587	239
2040	520,800	694	132

new multi-modal center:	256	spaces
existing QTA:	570	spaces
Total rental spaces	826	

Future Curbside Calculations

	Arrivals		Departures		
	Vehicle Count	Average Dwell Time (min:sec)	Vehicle Count	Average Dwell Time (min:sec)	
All curb vehicles	52	6:40	58	4:24	
Passenger vehicles	50	6:25	54	4:22	
Taxis	1	25:22	1	2:48	
Buses	1	0:19	3	5:41	
Thru	48		33		
Total	100		91		

There will be no buses curbside with the new multi-modal center
remove bus volume

	Arrivals		Departures		
	Vehicle Count	Average Dwell Time (min:sec)	Vehicle Count	Average Dwell Time (min:sec)	
All curb vehicles	51	6:40	55	4:24	
Passenger vehicles	50	6:25	54	4:22	96%
Taxis	1	25:22	1	2:48	1%
Buses		0:19		5:41	3%
Thru	48		33		
Total	99		88		

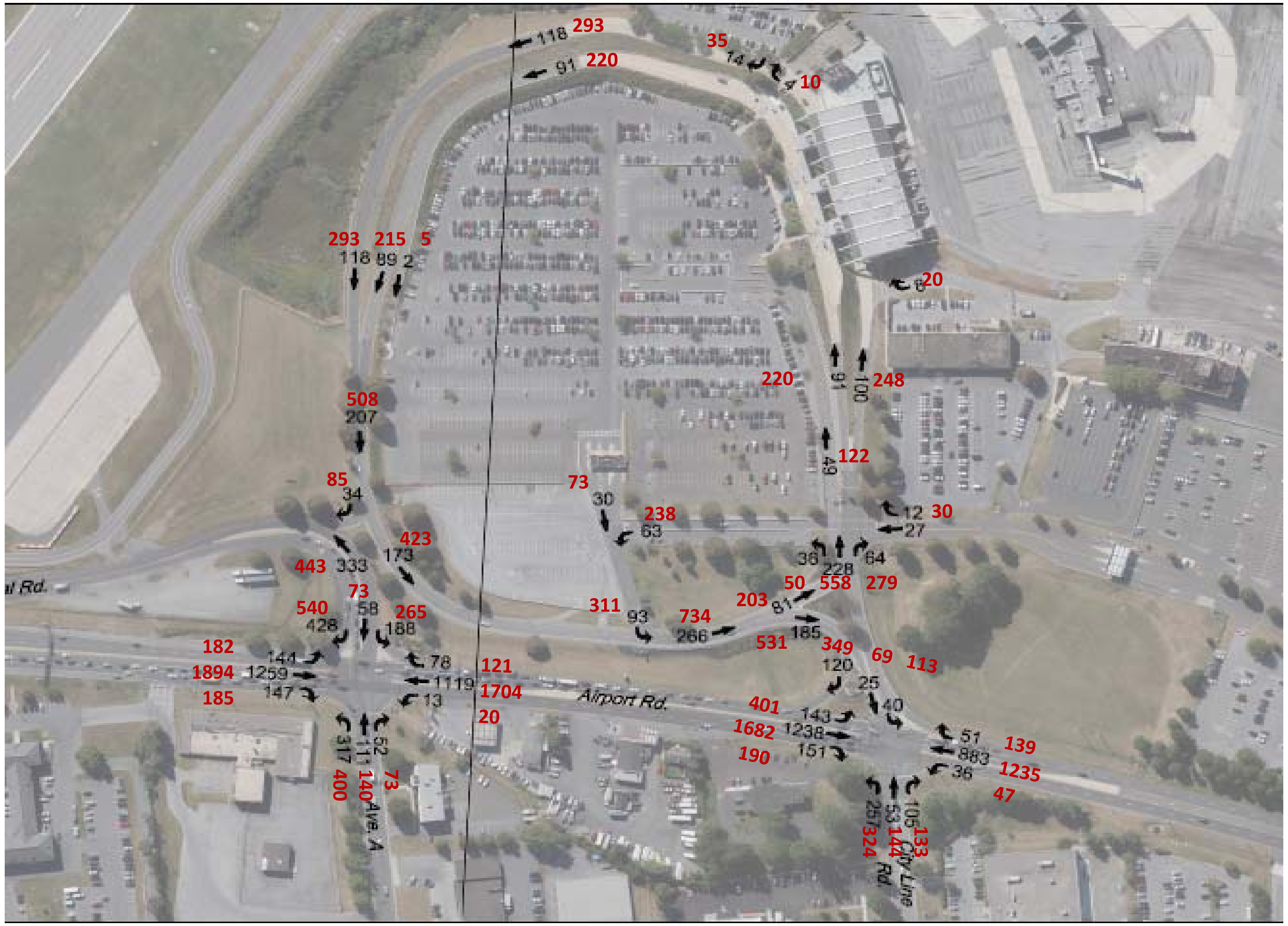
	Arrivals	Departures
	Vehicle Count	Vehicle Count
All curb vehicles	52%	63%
Passenger vehicles	51%	61%
Taxis	1%	2%
Thru	48%	37%
Total	99	88

Future Arrivals Volume	248	
Future Departures Volume	220	2040 volumes are 2.5 times existing

	Arrivals		Departures		
	Vehicle Count	Average Dwell Time (min:sec)	Vehicle Count	Average Dwell Time (min:sec)	
All curb vehicles	128	6:40	139	4:24	
Passenger vehicles	126	6:25	135	4:22	
Taxis	2	3:00	4	2:48	
Thru	120		81		
Total	248		220		changed arrival taxi dwell time to a typical time as per ACRP 25
	passenger veh	99%		98%	
	taxis	1%		2%	

Future curbside breakdown - with projected volumes, same dwell time except arrival taxi,

existing peak hour passengers		535		
assume 50/50 split en/deplanements		267.5		
currently LOS A	arrival curb	300	1.12	ft/deplanement
	departure curb	320	1.20	ft/enplanement
2040 peak hour passengers		816		
assume 50/50 split en/deplanements		408		
2040 LOS E	arrival curb	300	0.74	ft/deplanement
2040 LOS C	departure curb	320	0.78	ft/enplanement



since 2040 volumes are approximately 2.5 times 12/2/16 volumes, Airport Rd volumes were estimated first, then airport circulation volumes were calculated from there using the 2.5 factor with rounding/adjusting as needed for balancing purposes

red values are 2040 volumes

moved 4 buses (1 from arrivals, 3 from departures) to multi-modal center

to account for rental car activity:

during 12/2/16 counts, rental return/pick up was located in longterm parking - they took a left by cell phone parking

counts taken in Sept 2016 for 3/2017 Circulation Study shows only 22 vehicles typically making a left turn by cell phone parking

Therefore, to account for rental activity in the future, 16 vehicles currently taking a left by cell phont parking will be redistributed to the right to the new rental car facility then grown like other volumes

to account for bus terminal:

from Transbridge - 12 buses in/out and 115 passengers during peak hour

assume 12 buses go to/from RT22

assume 115 passengers equally split in/out and distributed on Airport Rd via existing traffic patterns

make 16 vehicles to/from new multi-modal center buses

no heavy vehicles to terminal

Table of Delay

File: c:\gts consulting\active projects\460 - c&s - lehigh valley airport\vissim\pmnobuild.inp
Comment:
Date: Monday, July 10, 2017 6:51:54 AM
VISSIM: 5.10-12 [24505]

No. 1: Travel time section(s) 1 Westbound Entering Traffic
No. 2: Travel time section(s) 2 Southbound
No. 3: Travel time section(s) 3 Northbound Circulating Traffic

Time	Delay	Stopd	Stops	#Veh	Pers.	#Pers
VehC	All					
No.:	1	1	1	1	1	1
900						
4500	0.2	0	0	670	0.2	670
Total	0.2	0	0	670	0.2	670

Delay	Stopd	Stops	#Veh	Pers.	#Pers
	All				
2	2	2	2	2	2
14.5	1.9	1.33	227	14.5	227
14.5	1.9	1.33	227	14.5	227

Delay	Stopd	Stops	#Veh	Pers.	#Pers
	All				
3	3	3	3	3	3
18.9	8.1	1.78	192	18.9	192
18.9	8.1	1.78	192	18.9	192

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	113	69	349	324	144	133	401	1682	190	47	1235	139
Future Volume (vph)	113	69	349	324	144	133	401	1682	190	47	1235	139
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	200		0	340		0	190		240
Storage Lanes	0		1	2		0	1		0	1		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00	1.00	1.00	0.95	0.95	1.00	0.91	1.00
Frt			0.850		0.928			0.985				0.850
Flt Protected		0.970		0.950			0.950			0.950		
Satd. Flow (prot)	0	1720	1599	3400	1686	0	1805	3439	0	1671	4988	1524
Flt Permitted		0.970		0.950			0.078			0.071		
Satd. Flow (perm)	0	1720	1599	3400	1686	0	148	3439	0	125	4988	1524
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			51		27			12				125
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		380			575			945			531	
Travel Time (s)		8.6			13.1			21.5			12.1	
Peak Hour Factor	0.70	0.70	0.70	0.80	0.80	0.80	0.98	0.98	0.98	0.91	0.91	0.91
Heavy Vehicles (%)	6%	9%	1%	3%	7%	2%	0%	3%	7%	8%	4%	6%
Adj. Flow (vph)	161	99	499	405	180	166	409	1716	194	52	1357	153
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	260	499	405	346	0	409	1910	0	52	1357	153
Turn Type	Split	NA	pm+ov	Split	NA		pm+pt	NA		pm+pt	NA	Perm
Protected Phases	4	4	1	8	8		1	6		5	2	
Permitted Phases			4				6			2		2
Detector Phase	4	4	1	8	8		1	6		5	2	2
Switch Phase												
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0		7.0	7.0		5.0	7.0	7.0
Minimum Split (s)	12.0	12.0	12.0	12.0	12.0		12.0	12.0		9.5	12.0	12.0
Total Split (s)	24.0	24.0	35.0	30.0	30.0		35.0	86.0		10.0	61.0	61.0
Total Split (%)	16.0%	16.0%	23.3%	20.0%	20.0%		23.3%	57.3%		6.7%	40.7%	40.7%
Maximum Green (s)	19.0	19.0	30.0	25.0	25.0		30.0	81.0		5.5	56.0	56.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		3.5	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)		0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0
Total Lost Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		4.5	5.0	5.0
Lead/Lag			Lead				Lead	Lag		Lead	Lag	Lag
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None	None	None	None		None	Max		None	C-Max	C-Max
Act Effct Green (s)		19.0	49.0	25.0	25.0		91.0	83.0		62.0	56.0	56.0
Actuated g/C Ratio		0.13	0.33	0.17	0.17		0.61	0.55		0.41	0.37	0.37
v/c Ratio		1.20	0.90	0.72	1.14		0.97	1.00		0.48	0.73	0.24
Control Delay		178.4	49.9	67.1	145.5		67.2	17.2		36.0	43.2	8.8
Queue Delay		0.0	0.0	0.0	0.0		0.0	6.3		0.0	0.0	0.0
Total Delay		178.4	49.9	67.1	145.5		67.2	23.5		36.0	43.2	8.8
LOS		F	D	E	F		E	C		D	D	A
Approach Delay		93.9			103.2			31.2			39.6	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		F			F			C			D	
Queue Length 50th (ft)		~306	268	195	~372		309	~1024		20	417	17
Queue Length 95th (ft)		#333	248	223	#477		m264	m168		48	475	68
Internal Link Dist (ft)		300			495			865			451	
Turn Bay Length (ft)				200			340			190		240
Base Capacity (vph)		217	556	566	303		421	1908		108	1863	647
Starvation Cap Reductn		0	0	0	0		0	41		0	0	0
Spillback Cap Reductn		0	0	0	0		0	0		0	0	0
Storage Cap Reductn		0	0	0	0		0	0		0	0	0
Reduced v/c Ratio		1.20	0.90	0.72	1.14		0.97	1.02		0.48	0.73	0.24

Intersection Summary

Area Type: Other

Cycle Length: 150

Actuated Cycle Length: 150

Offset: 20 (13%), Referenced to phase 2:SBTL, Start of Yellow

Natural Cycle: 150

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 1.20

Intersection Signal Delay: 52.5 Intersection LOS: D

Intersection Capacity Utilization 98.6% ICU Level of Service F

Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 3: Airport Rd & City Line Rd

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	265	73	540	400	140	73	182	1894	185	20	1704	121
Future Volume (vph)	265	73	540	400	140	73	182	1894	185	20	1704	121
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		300	200		0	600		275	220		400
Storage Lanes	0		1	1		0	1		1	1		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.91	1.00
Frt			0.850		0.949				0.850			0.850
Flt Protected		0.962		0.950			0.950			0.950		
Satd. Flow (prot)	0	1767	1583	1752	1670	0	1671	3471	1495	1671	5085	1429
Flt Permitted		0.627		0.176			0.069			0.074		
Satd. Flow (perm)	0	1152	1583	325	1670	0	121	3471	1495	130	5085	1429
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			58		4				106			124
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		686			621			947			945	
Travel Time (s)		15.6			14.1			21.5			21.5	
Peak Hour Factor	0.82	0.82	0.82	0.91	0.91	0.91	0.97	0.97	0.97	0.92	0.92	0.92
Heavy Vehicles (%)	3%	5%	2%	3%	10%	4%	8%	4%	8%	8%	2%	13%
Adj. Flow (vph)	323	89	659	440	154	80	188	1953	191	22	1852	132
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	412	659	440	234	0	188	1953	191	22	1852	132
Turn Type	Perm	NA	pm+ov	pm+pt	NA		pm+pt	NA	Perm	Perm	NA	Perm
Protected Phases		4	1	3	8		1	6			2	
Permitted Phases	4		4	8			6		6	2		2
Detector Phase	4	4	1	3	8		1	6	6	2	2	2
Switch Phase												
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0
Minimum Split (s)	12.0	12.0	14.0	12.0	12.0		14.0	14.0	14.0	14.0	14.0	14.0
Total Split (s)	48.0	48.0	20.0	22.0	70.0		20.0	80.0	80.0	60.0	60.0	60.0
Total Split (%)	32.0%	32.0%	13.3%	14.7%	46.7%		13.3%	53.3%	53.3%	40.0%	40.0%	40.0%
Maximum Green (s)	43.0	43.0	16.0	17.0	65.0		16.0	74.0	74.0	54.0	54.0	54.0
Yellow Time (s)	4.0	4.0	3.0	4.0	4.0		3.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0		1.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)		0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)		5.0	4.0	5.0	5.0		4.0	6.0	6.0	6.0	6.0	6.0
Lead/Lag	Lag	Lag	Lead	Lead			Lead			Lag	Lag	Lag
Lead-Lag Optimize?				Yes								
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	Max	None	None		Max	Max	Max	C-Max	C-Max	C-Max
Act Effct Green (s)		43.0	64.0	65.0	65.0		76.0	74.0	74.0	54.0	54.0	54.0
Actuated g/C Ratio		0.29	0.43	0.43	0.43		0.51	0.49	0.49	0.36	0.36	0.36
v/c Ratio		1.25	0.93	1.46	0.32		0.83	1.14	0.24	0.48	1.01	0.22
Control Delay		178.3	58.1	250.0	29.0		66.4	106.6	10.2	71.8	71.9	13.6
Queue Delay		0.0	0.0	0.0	0.0		0.0	0.3	0.0	0.0	0.0	0.0
Total Delay		178.3	58.1	250.0	29.0		66.4	106.9	10.2	71.8	71.9	13.6
LOS		F	E	F	C		E	F	B	E	E	B
Approach Delay		104.3			173.3			95.7			68.1	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		F			F			F			E	
Queue Length 50th (ft)		~501	568	~481	147		132	~1171	44	16	~563	20
Queue Length 95th (ft)		#623	#655	#703	215		#265	#1304	93	m23	#774	m41
Internal Link Dist (ft)		606			541			867			865	
Turn Bay Length (ft)			300	200			600		275	220		400
Base Capacity (vph)		330	708	302	725		226	1712	791	46	1830	593
Starvation Cap Reductn		0	0	0	0		0	0	0	0	0	0
Spillback Cap Reductn		0	0	0	0		0	142	0	0	0	0
Storage Cap Reductn		0	0	0	0		0	0	0	0	0	0
Reduced v/c Ratio		1.25	0.93	1.46	0.32		0.83	1.24	0.24	0.48	1.01	0.22

Intersection Summary

Area Type: Other
Cycle Length: 150
Actuated Cycle Length: 150
Offset: 0 (0%), Referenced to phase 2:SBTL, Start of Yellow, Master Intersection
Natural Cycle: 150
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.46
Intersection Signal Delay: 96.7 Intersection LOS: F
Intersection Capacity Utilization 117.2% ICU Level of Service H
Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 6: Ave A & Airport Rd

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	113	69	349	324	144	133	401	1682	190	47	1235	139
Future Volume (vph)	113	69	349	324	144	133	401	1682	190	47	1235	139
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	200		0	340		0	190		240
Storage Lanes	0		1	2		0	1		0	1		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00	1.00	1.00	0.95	0.95	1.00	0.91	1.00
Frt			0.850		0.928			0.985				0.850
Flt Protected		0.970		0.950			0.950			0.950		
Satd. Flow (prot)	0	1720	1599	3400	1686	0	1805	3439	0	1671	4988	1524
Flt Permitted		0.397		0.462			0.075			0.083		
Satd. Flow (perm)	0	704	1599	1653	1686	0	142	3439	0	146	4988	1524
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			16		36			12				125
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		380			575			945			531	
Travel Time (s)		8.6			13.1			21.5			12.1	
Peak Hour Factor	0.70	0.70	0.70	0.80	0.80	0.80	0.98	0.98	0.98	0.91	0.91	0.91
Heavy Vehicles (%)	6%	9%	1%	3%	7%	2%	0%	3%	7%	8%	4%	6%
Adj. Flow (vph)	161	99	499	405	180	166	409	1716	194	52	1357	153
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	260	499	405	346	0	409	1910	0	52	1357	153
Turn Type	Perm	NA	pm+ov	Perm	NA		pm+pt	NA		pm+pt	NA	Prot
Protected Phases		4	1		8		1	6		5	2	2
Permitted Phases	4		4	8			6			2		
Detector Phase	4	4	1	8	8		1	6		5	2	2
Switch Phase												
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0		7.0	7.0		5.0	7.0	7.0
Minimum Split (s)	12.0	12.0	12.0	12.0	12.0		12.0	12.0		9.5	12.0	12.0
Total Split (s)	52.0	52.0	37.0	52.0	52.0		37.0	76.0		12.0	51.0	51.0
Total Split (%)	37.1%	37.1%	26.4%	37.1%	37.1%		26.4%	54.3%		8.6%	36.4%	36.4%
Maximum Green (s)	47.0	47.0	32.0	47.0	47.0		32.0	71.0		7.5	46.0	46.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		3.5	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)		0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0
Total Lost Time (s)		5.0	5.0	5.0	5.0		5.0	5.0		4.5	5.0	5.0
Lead/Lag			Lead				Lead	Lag		Lead	Lag	Lag
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None	None	None	None		None	Max		None	C-Max	C-Max
Act Effct Green (s)		47.0	82.0	47.0	47.0		83.0	73.6		55.4	48.0	48.0
Actuated g/C Ratio		0.34	0.59	0.34	0.34		0.59	0.53		0.40	0.34	0.34
v/c Ratio		1.10	0.53	0.73	0.59		0.93	1.05		0.39	0.79	0.25
Control Delay		131.7	18.9	50.0	39.0		63.2	39.2		28.3	46.2	9.6
Queue Delay		0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0
Total Delay		131.7	18.9	50.0	39.0		63.2	39.2		28.3	46.2	9.6
LOS		F	B	D	D		E	D		C	D	A
Approach Delay		57.5			45.0			43.4			42.0	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		E			D			D			D	
Queue Length 50th (ft)		~268	243	167	234		288	~1005		19	417	17
Queue Length 95th (ft)		#300	229	197	288		m245	m156		44	479	70
Internal Link Dist (ft)		300			495			865			451	
Turn Bay Length (ft)				200			340			190		240
Base Capacity (vph)		236	965	554	589		464	1813		140	1709	604
Starvation Cap Reductn		0	0	0	0		0	0		0	0	0
Spillback Cap Reductn		0	0	0	0		0	0		0	0	0
Storage Cap Reductn		0	0	0	0		0	0		0	0	0
Reduced v/c Ratio		1.10	0.52	0.73	0.59		0.88	1.05		0.37	0.79	0.25

Intersection Summary

Area Type: Other
Cycle Length: 140
Actuated Cycle Length: 140
Offset: 20 (14%), Referenced to phase 2:SBTL, Start of Yellow
Natural Cycle: 130
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.10
Intersection Signal Delay: 45.2 Intersection LOS: D
Intersection Capacity Utilization 98.6% ICU Level of Service F
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 3: Airport Rd & City Line Rd

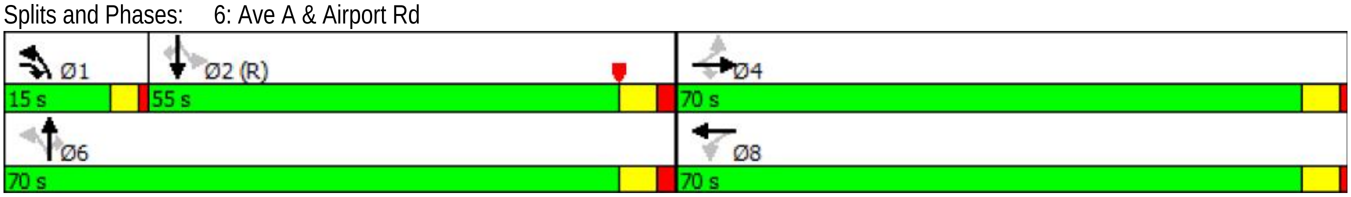
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	265	73	540	400	140	73	182	1894	185	20	1704	121
Future Volume (vph)	265	73	540	400	140	73	182	1894	185	20	1704	121
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		300	200		0	600		275	220		400
Storage Lanes	0		1	1		0	1		1	1		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.91	1.00
Frt			0.850		0.949				0.850			0.850
Flt Protected		0.962		0.950			0.950			0.950		
Satd. Flow (prot)	0	1767	1583	1752	1670	0	1671	3471	1495	1671	5085	1429
Flt Permitted		0.567		0.382			0.075			0.082		
Satd. Flow (perm)	0	1042	1583	705	1670	0	132	3471	1495	144	5085	1429
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			23		3				106			131
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		686			621			947			945	
Travel Time (s)		15.6			14.1			21.5			21.5	
Peak Hour Factor	0.82	0.82	0.82	0.91	0.91	0.91	0.97	0.97	0.97	0.92	0.92	0.92
Heavy Vehicles (%)	3%	5%	2%	3%	10%	4%	8%	4%	8%	8%	2%	13%
Adj. Flow (vph)	323	89	659	440	154	80	188	1953	191	22	1852	132
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	412	659	440	234	0	188	1953	191	22	1852	132
Turn Type	Perm	NA	pm+ov	Perm	NA		pm+pt	NA	Perm	Perm	NA	Perm
Protected Phases		4	1		8		1	6			2	
Permitted Phases	4		4	8			6		6	2		2
Detector Phase	4	4	1	8	8		1	6	6	2	2	2
Switch Phase												
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0
Minimum Split (s)	12.0	12.0	14.0	12.0	12.0		14.0	14.0	14.0	14.0	14.0	14.0
Total Split (s)	70.0	70.0	15.0	70.0	70.0		15.0	70.0	70.0	55.0	55.0	55.0
Total Split (%)	50.0%	50.0%	10.7%	50.0%	50.0%		10.7%	50.0%	50.0%	39.3%	39.3%	39.3%
Maximum Green (s)	65.0	65.0	11.0	65.0	65.0		11.0	64.0	64.0	49.0	49.0	49.0
Yellow Time (s)	4.0	4.0	3.0	4.0	4.0		3.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0		1.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)		0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)		5.0	4.0	5.0	5.0		4.0	6.0	6.0	6.0	6.0	6.0
Lead/Lag			Lead				Lead			Lag	Lag	Lag
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	Max	None	None		Max	Max	Max	C-Max	C-Max	C-Max
Act Effct Green (s)		65.0	81.0	65.0	65.0		66.0	64.0	64.0	49.0	49.0	49.0
Actuated g/C Ratio		0.46	0.58	0.46	0.46		0.47	0.46	0.46	0.35	0.35	0.35
v/c Ratio		0.85	0.71	1.35	0.30		1.03	1.23	0.26	0.44	1.04	0.23
Control Delay		51.6	25.7	206.7	24.4		108.4	144.1	11.1	80.0	90.4	21.4
Queue Delay		0.0	0.0	0.0	0.0		0.0	0.6	0.0	0.0	0.0	0.0
Total Delay		51.6	25.7	206.7	24.4		108.4	144.6	11.1	80.0	90.4	21.4
LOS		D	C	F	C		F	F	B	F	F	C
Approach Delay		35.7			143.4			130.8			85.8	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		D			F			F			F	
Queue Length 50th (ft)		327	400	~522	129		~132	~1153	44	19	~644	32
Queue Length 95th (ft)		420	464	#738	192		#293	#1289	95	m27	#746	m68
Internal Link Dist (ft)		606			541			867			865	
Turn Bay Length (ft)			300	200			600		275	220		400
Base Capacity (vph)		483	925	327	776		183	1586	740	50	1779	585
Starvation Cap Reductn		0	0	0	0		0	0	0	0	0	0
Spillback Cap Reductn		0	0	0	0		0	244	0	0	0	0
Storage Cap Reductn		0	0	0	0		0	0	0	0	0	0
Reduced v/c Ratio		0.85	0.71	1.35	0.30		1.03	1.46	0.26	0.44	1.04	0.23

Intersection Summary

Area Type: Other
Cycle Length: 140
Actuated Cycle Length: 140
Offset: 0 (0%), Referenced to phase 2:SBTL, Start of Yellow, Master Intersection
Natural Cycle: 140
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.35
Intersection Signal Delay: 100.6 Intersection LOS: F
Intersection Capacity Utilization 117.2% ICU Level of Service H
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 6: Ave A & Airport Rd



Quick Analysis Tool for Airport Roadways

QATAR v0.6 developed by LeighFisher in association with Dowling Associates, Inc.

Summary of Inputs and Assumptions

Model run by: KMF on 5/15/2017

Airport	ABE
Roadway location	Arrivals
Scenario	Future
Level / type of roadway	Arrivals
Total lanes / approach lanes	3 / 2
Number of curbside zones	2
% of 1st lane full when next vehicle double parks	80%
% of 2nd lane full when next vehicle triple parks	0%
Crosswalk adjustment factor	100%
Regional adjustment factor	95%

Frontage and dwell time per curbside operation

Vehicle class	Vehicle parking length (feet)	Average dwell time (minutes)
Private vehicles	25.0	6.7
Taxis	20.0	3.0
Limousines	30.0	5.5
Shuttle vans	30.0	2.7
Buses	50.0	0.3
Courtesy vehicles	30.0	2.8

Assumptions by zone

Zone ID	Zone 1	Zone 2
Name		
Type	active	active
Curbside frontage (feet)	150	150
Number of lanes	3	3
Number of approach lanes	2	2

Volume of vehicles using roadway (vph)

Private vehicles	246	246
Taxis	2	2
Limousines	-	-
Shuttle vans	-	-
Buses	-	-
Courtesy vehicles	-	-

Volume of vehicles using curbside (vph)

Private vehicles	63	63
Taxis	1	1
Limousines	-	-
Shuttle vans	-	-
Buses	-	-
Courtesy vehicles	-	-

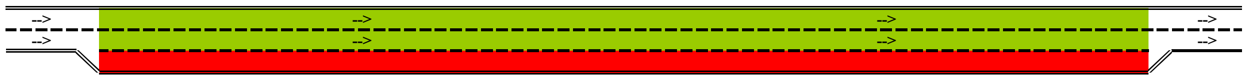
Quick Analysis Tool for Airport Roadways

QATAR v0.6 developed by LeighFisher in association with Dowling Associates, Inc.

Results: Level-of-Service by Zone

Model run by: KMF on 5/15/2017

Airport	ABE
Roadway location	Arrivals
Scenario	Future
Level / type of roadway	Arrivals
Total lanes / approach lanes	3 / 2
Number of curbside zones	2



Zone ID	**Zone 1**	**Zone 2**
Name/description		
Curb length (feet)	150	150
Zone type	active	active
Roadway volume (vph)	248	248
Roadway capacity (vph)	722	722
Roadway V/C ratio	0.344	0.344
Roadway LOS	B	B
Curb demand (# in sys 95% of time)	12.0	12.0
Curb capacity per lane (vehicles)	6.0	6.0
Curb utilization ratio	2.000	2.000
Curb LOS	E	E

Level-of-service (LOS) key:

A

B

C

D

E

F

Quick Analysis Tool for Airport Roadways

QATAR v0.6 developed by LeighFisher in association with Dowling Associates, Inc.

Summary of Inputs and Assumptions

Model run by: KMF on 5/15/2017

Airport	ABE
Roadway location	Departures
Scenario	Future
Level / type of roadway	Departures
Total lanes / approach lanes	3 / 2
Number of curbside zones	1
% of 1st lane full when next vehicle double parks	80%
% of 2nd lane full when next vehicle triple parks	0%
Crosswalk adjustment factor	100%
Regional adjustment factor	95%

Frontage and dwell time per curbside operation

Vehicle class	Vehicle parking length (feet)	Average dwell time (minutes)
Private vehicles	25.0	4.4
Taxis	25.0	2.8
Limousines	30.0	1.9
Shuttle vans	30.0	3.5
Buses	50.0	5.7
Courtesy vehicles	30.0	1.2

Assumptions by zone

Zone ID	Zone 1
Name	
Type	active
Curbside frontage (feet)	320
Number of lanes	3
Number of approach lanes	2

Volume of vehicles using roadway (vph)

Private vehicles	216
Taxis	4
Limousines	-
Shuttle vans	-
Buses	-
Courtesy vehicles	-

Volume of vehicles using curbside (vph)

Private vehicles	135
Taxis	4
Limousines	-
Shuttle vans	-
Buses	-
Courtesy vehicles	-

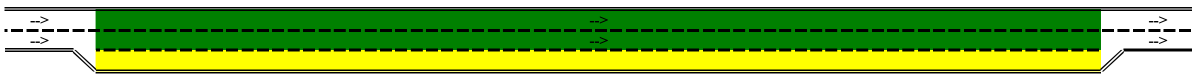
Quick Analysis Tool for Airport Roadways

QATAR v0.6 developed by LeighFisher in association with Dowling Associates, Inc.

Results: Level-of-Service by Zone

Model run by: KMF on 5/15/2017

Airport	ABE
Roadway location	Departures
Scenario	Future
Level / type of roadway	Departures
Total lanes / approach lanes	3 / 2
Number of curbside zones	1



Zone ID	**Zone 1**
Name/description	
Curb length (feet)	320
Zone type	active
Roadway volume (vph)	220
Roadway capacity (vph)	1,624
Roadway V/C ratio	0.135
Roadway LOS	A
Curb demand (# in sys 95% of time)	16.0
Curb capacity per lane (vehicles)	13.0
Curb utilization ratio	1.231
Curb LOS	C

Level-of-service (LOS) key:

A
B
C
D
E
F