4

Requirements

TABLE OF CONTENTS

EXHIBITS

TABLES

4.1 OVERVIEW

To plan for near- and long-term growth at San Francisco International Airport (SFO or the Airport), forecasts were developed to address the specific types and quantities of facilities needed to serve demand at four planning activity levels: 2018, 2023, Base Constrained,[1] and High Constrained demand, as summarized in **Table 4.1-1** for passengers and in **Table 4.1-2** for passenger airline aircraft operations. These planning activity levels incorporate consideration of runway capacity constraints and all functional areas to develop balanced airside and landside facilities.

These planning activity levels were used in evaluating alternatives to identify the adequacy of existing Airport facilities to accommodate aviation demand, comply with design standards, and achieve the policy objectives established for SFO. They served as the basis for determining facility requirements, which translate into the sizing and layout of the facility planning alternatives presented in Chapter 5, Alternatives Development and Evaluation.

To accommodate forecast passenger, cargo, and aircraft operations, the requirements address the design criteria for each facility type, including the following state and federal guidelines and policy objectives established by the City:

FAA Standards and Guidance

- Advisory Circular (AC) 150/5300-13, *Airport Design*
- AC 150/5340-30, *Airport Lighting – Runway/Taxiway*
- AC 150/5340-1, *Airport Marking*
- AC 150/5340-18, *Airport Signage*
- AC 150/5360-13, *Airport Terminal Facilities*
- AC 150/5230-4, *Fuel Storage*

State of California

- California Code of Regulations, Title 21, Sections 3525 through 3560, relating to Airports and Heliports
- California Public Utilities Code, Section 21001 et seq., relating to the State Aeronautics Act

City and County of San Francisco and Airport Commission

- San Francisco Municipal Code
- *The Principles of R.E.A.C.H.,* San Francisco International Airport, 2013
- Rules and Regulations – San Francisco International Airport, Adopted: October 21, 2014

Table 4.1-1 | Planning Activity Levels – Passengers

Forecast Categories	2013	2018	2023	Base Constrained	High Constrained
Annual Passengers	44,836,000	50,482,000	57,656,000	62,225,000	71,074,000
Annual Origin and Destination Passengers	34,434,000	38,936,000	44,602,000	48,121,000	55,024,000
Annual Domestic Origin and Destination Passengers	26,790,000	29,012,000	31,444,000	33,292,000	38,234,000
Annual International Origin and Destination Passengers	7,644,000	9,924,000	13,158,000	14,829,000	16,790,000
Annual Connecting Passengers	10,401,600	11,546,400	13,054,000	14,104,000	16,050,500
Peak Hour Passengers	12,400	12,000	13,900	15,700	18,000

Note: Annual numbers are rounded to the nearest 1,000; therefore, numbers may not sum.

Source: Landrum & Brown, Inc., SFO Forecast Factors, October 31, 2014

Table 4.1-2 | Planning Activity Levels – Passenger Airline Aircraft Operations

Forecast Categories	2013	2018	2023	Base Constrained	High Constrained
Annual Passenger Aircraft Operations	386,000	408,000	452,000	455,000	463,000
Peak Month Average Day Operations	1,100	1,200	1,300	1,400	1,400

Note: Annual numbers are rounded to the nearest 1,000.

Source: Landrum & Brown, Inc., SFO Forecast Factors, October 31, 2014

1 "Constrained" refers specifically to runway capacity. While aircraft operations are forecast to increase steadily in 2018 and 2023 in an unconstrained operating environment, in the Base Constrained and High Constrained forecasts, it was assumed that the runways are at or near capacity, and additional growth in numbers of passenger would result from more efficient use of existing takeoff and landing capacity.

4.2 AIRFIELD

The existing conditions at SFO are compared with current runway and taxiway design standards in this section to identify areas that do not conform with standards for taxiway layout (alignment and dimensions), signage, and lighting. Problem areas identified by SFO Airport Traffic Control Tower (ATCT) and SFO Operations staff are also summarized in this section.

4.2.1 Runway System

The Federal Aviation Administration (FAA) prescribes minimum runway centerline to parallel taxiway centerline separations based on a critical design aircraft and runway Aircraft Approach Category, Airplane Design Group (ADG), airport elevation, and visibility minimums. SFO's critical design aircraft, defined as the most demanding aircraft with at least 500 annual operations, is the Airbus A380-800.

Runway-to-Taxiway Separation

Table 4.2-1 summarizes the percentage and number of operations at SFO by runway end for A380-800 arrivals and departures between May 2011 and December 2013. Runway 28R was used for 96.4 percent of all A380-800 arrivals and 96.0 percent of all A380-800 departures during that period. Runway 1L-19R does not serve A380-800 operations; therefore, runway-taxiway centerline-to-centerline separations should meet ADG VI standards for all runways except Runway 1L-19R and its taxiways, which should meet separation standards for ADG V aircraft. **Table 4.2-2** summarizes the runway-to-taxiway centerline-to-centerline separation standards for SFO.

Table 4.2-1 | Runway Use for Airbus A380-800

Operation	1R		19L		10L		28R		10R		28L		Total
Arrivals	0	0.0%	16	1.9%	0	0.0%	804	96.4%	0	0.0%	14	1.7%	834
Departures	2	0.2%	0	0.0%	15	1.8%	802	96.0%	1	0.1%	15	1.8%	835
Total	2	0.1%	16	1.0%	15	0.9%	1,606	96.2%	1	0.1%	29	1.7%	1,669

Note: Runway 1L-19R did not have any A380 operations.

Source: Ricondo & Associates, Inc., San Francisco International Airport, Airport Noise and Operations Monitoring System, May 2011-December 2013, October 2014

Table 4.2-2 | Runway-to-Taxiway Separation Design Standards for San Francisco International Airport

Runway	Airplane Design Group	Instrument Landing System	Minimum Runway Centerline To Parallel Taxiway Centerline Separation Distance
10L-28R	VI	CAT II/III	550 feet
10R-28L	VI	CAT II	550 feet
1L-19R	V	None	400 feet
1R-19L	VI	CAT I	500 feet

Source: Federal Aviation Administration, Advisory Circular 150/5300-13A, Airport Design, Change 1, February 26, 2014. Ricondo & Associates, Inc., October 2014; SFO Airport Layout Plan, 2014

Exhibit 4.2-1 summarizes the areas of nonconformance with runway-to-taxiway centerline separation standards and runway centerline-to-holding position separation standards at SFO.

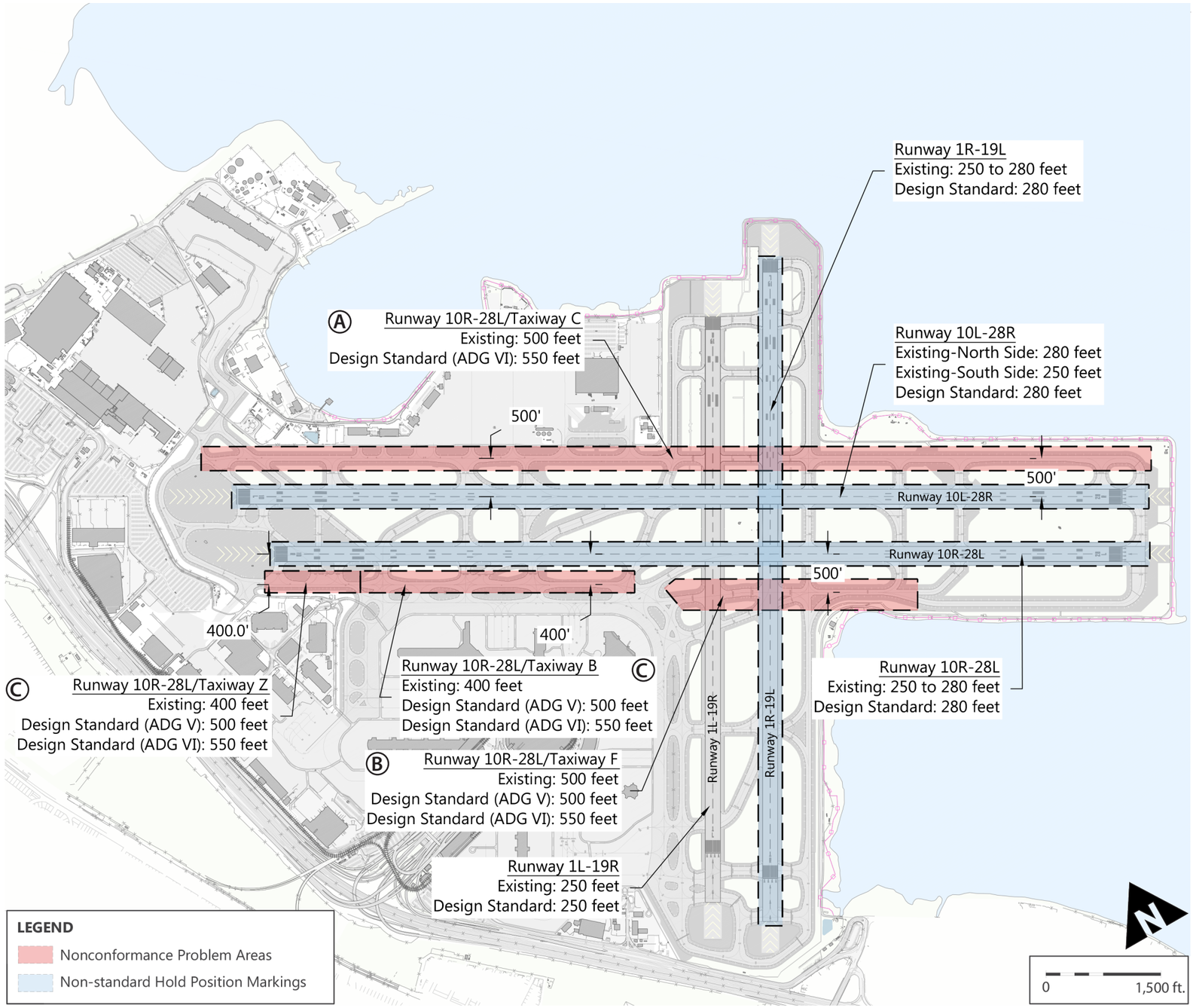
- The full length of Taxiway C does not meet the FAA separation design standard of 550 feet from Runway 10L-28R.
- Taxiway F, between Taxiway N and Runway 1R-19L, does not meet the FAA design standard of 550 feet for runway-to-taxiway separation.
- The separation between Runway 10R-28L and Taxiway B (between Taxiways J and Q) and Taxiway Z (between Taxiways Q and R) is deficient by 150 feet.

Although certain taxiways do not meet separation design standards, aircraft are able to operate at the Airport with special operational procedures and FAA-approved Modifications of Standards (MoSs).

Runway-to-Holding Position Separation

Most aircraft holding positions at the Airport are located 250 feet from runway centerlines. Runways 1R-19L, 10L-28R, and 10R-28L are required to meet separation standards for ADG VI aircraft, which require holding positions to be located 280 feet from runway centerlines. **Exhibit 4.2-1** shows that some holding positions for each of these three runways do not meet the FAA separation design standard; however, the holding positions for Runway 1L-19R do meet the ADG V separation design standard of 250 feet.

Exhibit 4.2-1 | Areas of Nonconformance, Runway-to-Taxiway Centerline Separation and Runway Centerline-to-Holding Position Separation



Source: SFO Airport Layout Plan, 2014; Ricondo & Associates, Inc., December 2015

4.2.2 Taxiway System

The FAA determines design standards for taxiways.[2] Taxiway centerline-to-centerline separations are based on ADG, as shown in **Table 4.2-3**. FAA design standards require parallel taxiways that serve ADG V aircraft to be separated by 267 feet and parallel taxiways that serve ADG VI aircraft to be separated by 324 feet. If one taxiway serves ADG V aircraft and a parallel taxiway serves ADG VI aircraft, the centerline separation requirement is reduced to 300 feet.

Taxiway-to-Taxiway Separation

Exhibit 4.2-2 identifies the areas of nonconformance for parallel taxiways at SFO. Taxiways A and B west of Taxiway Q are separated by 267 feet and accommodate independent movements of ADG V aircraft. Taxiways A and B east of Taxiway Q and along the north and east sides of the terminal area are separated by 237.5 feet. MoSs and operating rules for the Airport allow ADG V and ADG VI aircraft to operate on Taxiways A and B. For example, two Boeing 747-400 (ADG V) aircraft are able to pass one another on parallel Taxiways A and B, but are restricted to a speed not more than 5 miles per hour. All other parallel taxiways at the Airport (Taxiways S/C1 and U) have centerline separations that exceed ADG VI requirements.

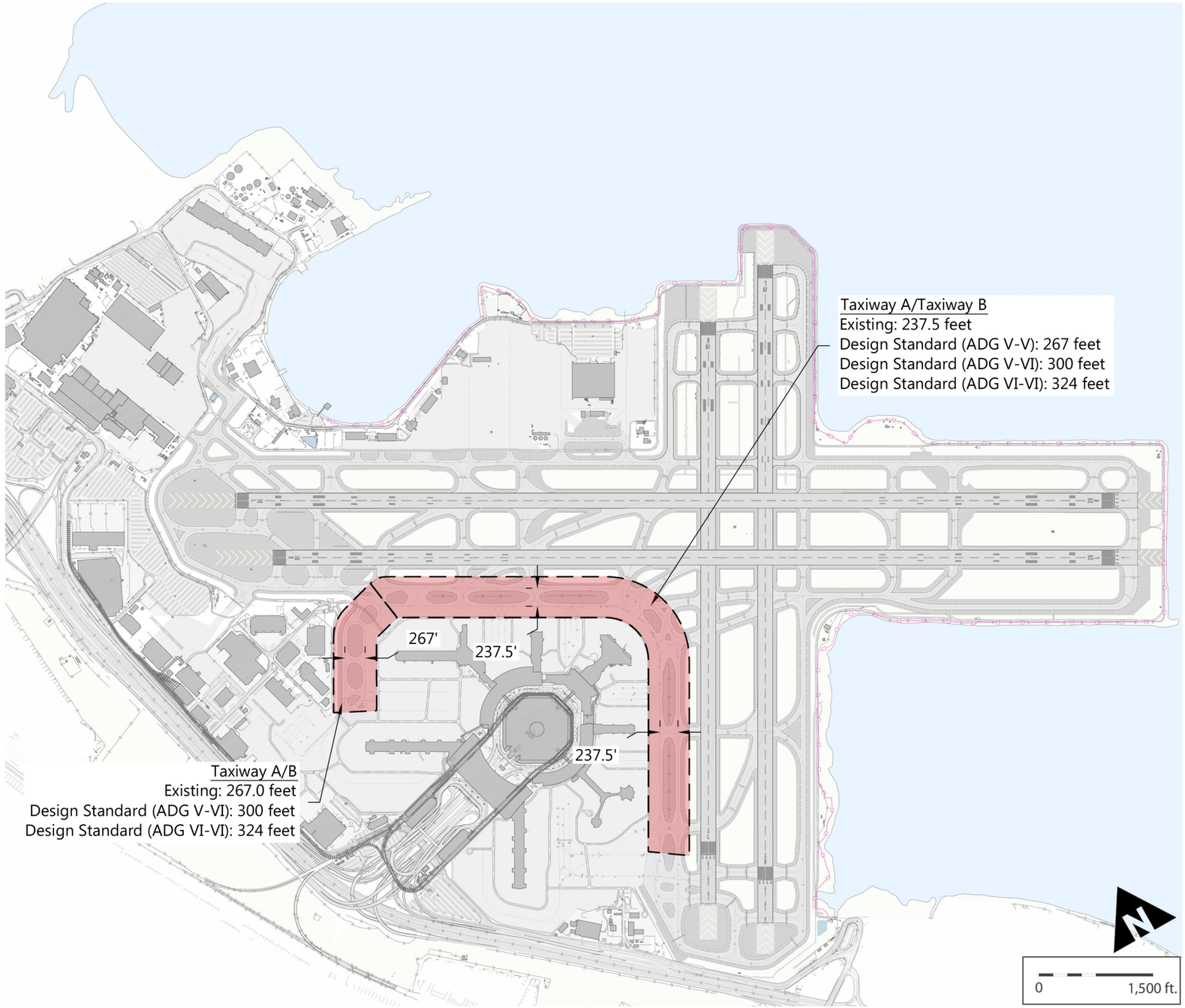
2 Aircraft are grouped into ADGs by wingspan and tail height. Aircraft are grouped into TDGs by the dimensions of their landing gear assemblies. Therefore, separation requirements are based on ADG, while pavement design requirements are based on Taxiway Design Group (TDG).

Table 4.2-3 | Taxiway-to-Taxiway Separation Design Standards for San Francisco International Airport

Airplane Design Groups	Minimum Parallel Taxiway to Parallel Taxiway Centerline Separation Distance
V - V	267 feet
V - VI	300 feet
VI - VI	324 feet

Source: Federal Aviation Administration, Advisory Circular 150/5300-13A, Airport Design, Change 1, February 26, 2014. Ricondo & Associates, Inc., October 2014; SFO Airport Layout Plan, 2014

Exhibit 4.2-2 | Areas of Nonconformance, Taxiway-to-Taxiway Centerline Separation



Source: SFO Airport Layout Plan, 2014; Ricondo & Associates, Inc., December 2015

Taxiway Width

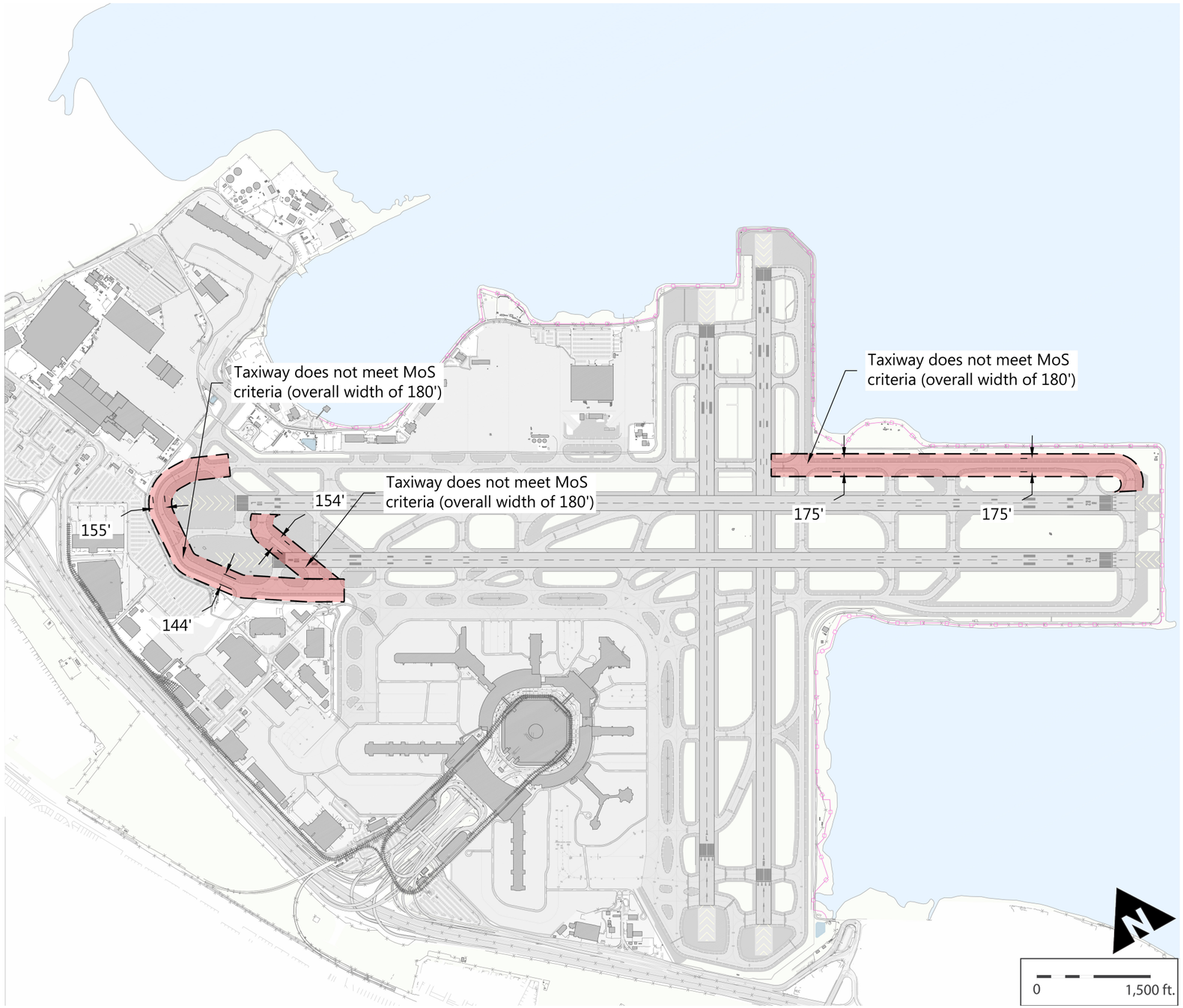
All taxiways at SFO meet the FAA-required taxiway width of 75 feet for Taxiway Design Group (TDG) 6 aircraft. Taxiway E and portions of Taxiways B, G, H, M, Q, R, and T are at least 82 feet wide, meeting TDG 7 requirements.

FAA design standards require that taxiways serving TDG 6 aircraft have shoulders at least 30 feet wide on both sides (total pavement width of at least 135 feet) and that taxiways serving TDG 7 aircraft have shoulders at least 40 feet wide on both sides (total pavement width of at least 162 feet). FAA Engineering Brief #63A, *Taxiways for Airbus A380 Taxiing Operations*, allows the operators of airports with existing 75-foot-wide taxiways to widen shoulders to provide an overall taxiway and shoulder width of at least 180 feet. New or reconstructed taxiways should comply with TDG 7 standards.

Exhibit 4.2-3 identifies the areas of nonconformance for taxiway and shoulder widths at SFO with the requirements identified in Engineering Brief #63A and FAA design standards.

The FAA establishes guidelines for taxiway design to enhance safety and allow for efficient taxiing while minimizing excess pavement. These guidelines, set forth in FAA AC 150/5300-13A, *Airport Design,* are described in **Table 4.2-4**. **Exhibit 4.2-4** through **Exhibit 4.2-6** identifies the areas of nonconformance for taxiway layouts throughout the Airport.

Exhibit 4.2-3 | Areas of Nonconformance, Taxiway and Shoulder Widths



Source: SFO Airport Layout Plan, 2014; Ricondo & Associates, Inc., December 2015

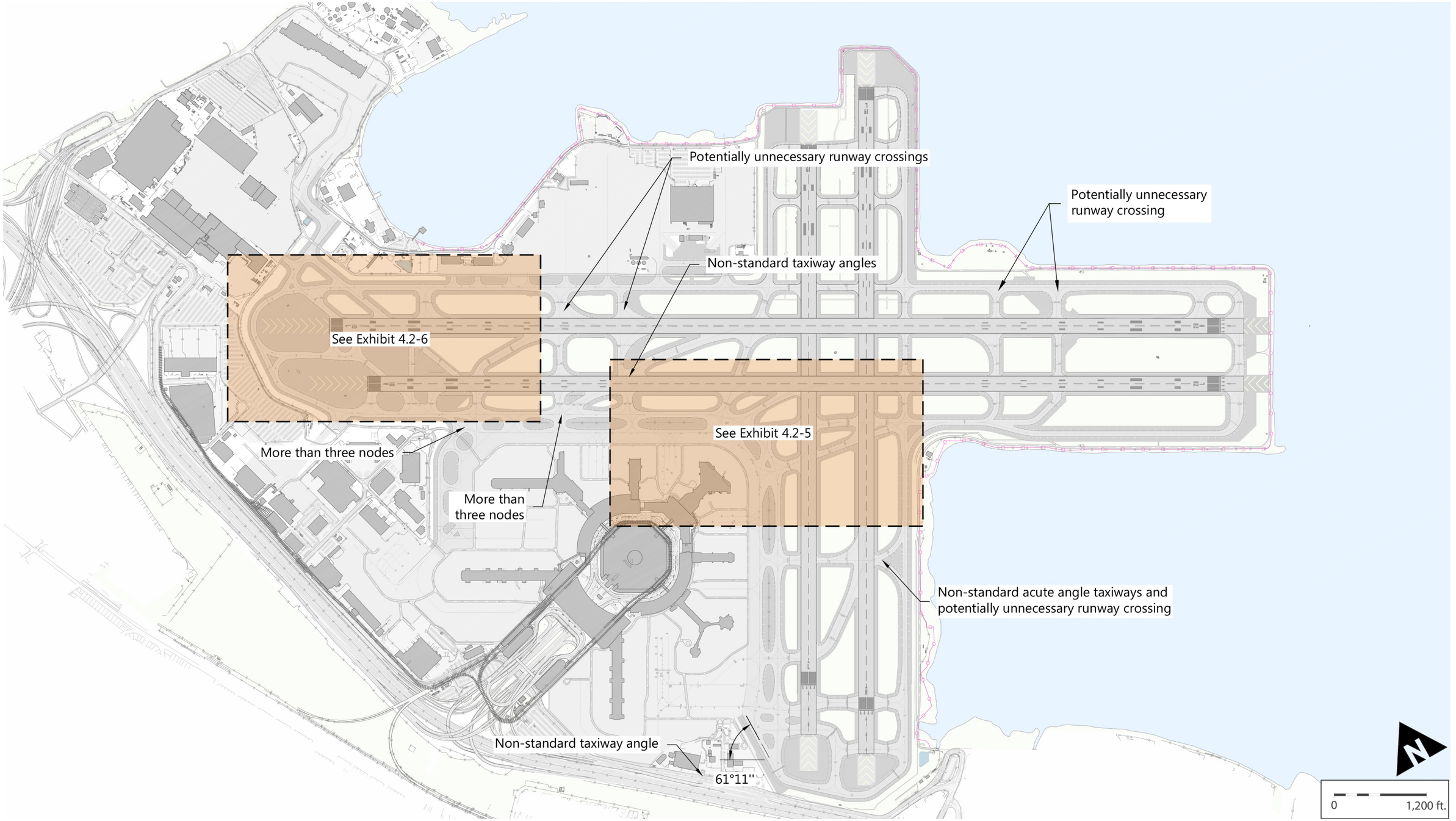
Table 4.2-4 | Guidelines for Taxiway Design and Areas of Nonconformance at SFO

Guideline Sections/Paragraphs FAA Advisory Circular 150/5300-13A, Airport Design	Description	Areas of Nonconformance
401(b)(4). Intersection Angles.	Design taxiway intersections with taxiways or runways to be 90 degrees if possible. If these intersections cannot be 90 degrees, use standard angles of 30, 45, 60, 120, 135, and 150 degrees.	Nonstandard taxiway angles occur at the intersections of Taxiway G with Runway 1R-19L and Taxiway L; high-speed exit Taxiway T and Taxiway D; and at planned Taxilanes M1 and M2 with Taxiways A and B. (Exhibit 4.2-4) FAA Hot Spot 1* and the complex intersection of Taxiways A, B, E, F, F1, J, and L have nonstandard angles. (Exhibit 4.2-5) Taxiways S and U intersect multiple taxiways and Runways 10R-28L and 10L-28R at nonstandard angles. (Exhibit 4.2-6) Taxiway N intersects Runway 10R-28L at a nonstandard angle, as well as Taxiway F. (Exhibit 4.2-4)
401(b)(3). Three-Node Concept. 401(b)(5)(a). Increase Pilot Situational Awareness. 406(c). Three-Node Concept.	Increase pilot situational awareness by reducing the complexity of taxiway intersections. Try to implement a "three-node concept" for taxiway intersections, which presents pilots with no more than three choices at an intersection – preferably left, right, and straight ahead.	The intersection of Taxiways B, K, and T has more than three nodes. (Exhibit 4.2-4) The complex intersection of Taxiways A, B, E, F, F1, J, and L has more than three pilot choices per decision point. (Exhibit 4.2-5) The intersection of Taxiways S, S1, and Z and the intersection of Taxiways R and U with Runway 10L-28R feature more than three nodes. (Exhibit 4.2-6)
401(b)(5)(b). Avoid wide expanses of pavement. 407(c). Taxiways must never coincide with the intersection of two runways. 409(d)(2). High Speed Exits.	Remove wide expanses of pavement around a taxiway. Wide pavement requires taxiway signage to be placed far from the pilot's eye and increases the chance that a sign can be missed.	Areas of wide expanses of pavement exist between Taxiways A and B and several taxiways cross runways in the middle third of the runway. (Exhibit 4.2-4) The complex intersection of Taxiways A, B, E, F, F1, J, and L has wide expanses of pavement. (Exhibit 4.2-5)
401(b)(5)(c). Limit runway crossings.	Limit runway crossings. Only allow runway/taxiway crossings where necessary to reduce the chance for human error.	Several taxiways cross runways in the middle third of the runway. (Exhibit 4.2-4) Taxiways R, S, and U cross Runways 10R-28L and 10L-28R; these crossings may be unnecessary. Aircraft taxiing south on Taxiway U use Runway 10R-28L to access Taxiway Q on the south. Conversely, pilots taxiing north on Taxiway Q must make a decision to go straight onto high-speed exit Taxiway Q or make a soft left onto Taxiway U. Pilots must make this decision while the aircraft is crossing Runway 10R-28L. (Exhibit 4.2-6)
401(b)(5)(d). Avoid "high energy" intersections.	Avoid runway/taxiway intersections in the middle third of a runway. Pilots of arriving and departing aircraft have the least maneuvering capability in this area of an active runway.	Several taxiways cross runways in the middle third of the runway. (Exhibit 4.2-4) The complex intersection of Taxiways A, B, E, F, F1, J, and L has runway crossings in the middle third of a runway. (Exhibit 4.2-5)
401(b)(5)(e). Increase visibility. 407(a). Right angle.	Increase visibility. Right angle intersections allow for the best pilot visibility to the left and right. Angled taxiways should not be used as runway entrances or for crossing a runway because the pilot would be required to look more than 90 degrees beyond the cockpit for potential oncoming aircraft.	Nonstandard taxiway angles occur at the intersections of Taxiway G with Runway 1R-19L and Taxiway L; the intersection of high-speed exit Taxiway T and Taxiway D; and at the planned intersections of Taxilanes M1 and M2 with Taxiways A and B. (Exhibit 4.2-4) The complex intersection of Taxiways A, B, E, F, F1, J, and L results in acute angle taxiway/runway intersections. (Exhibit 4.2-5) Taxiways S and U intersect multiple taxiways and Runways 10R-28L and 10L-28R at nonstandard angles. (Exhibit 4.2-6)
401(b)(5)(g). Indirect Access.	Avoid indirect access. Aprons should not be connected to a runway without requiring at least one turn. These direct access configurations create confusion when a pilot expects to encounter a parallel taxiway, but instead enters a runway.	Taxiway H provides direct access to a runway from an apron area; however, this issue will be resolved with reconstruction of Boarding Area B and construction of Taxilane AA. (Exhibit 4.2-4)

*Note: *A "hot spot" is defined as a "location on an airport movement area with a history of potential risk of collision or runway incursion, and where heightened attention by pilots and drivers is necessary." (FAA Runway Safety Hot Spots List, October 15, 2015.)*

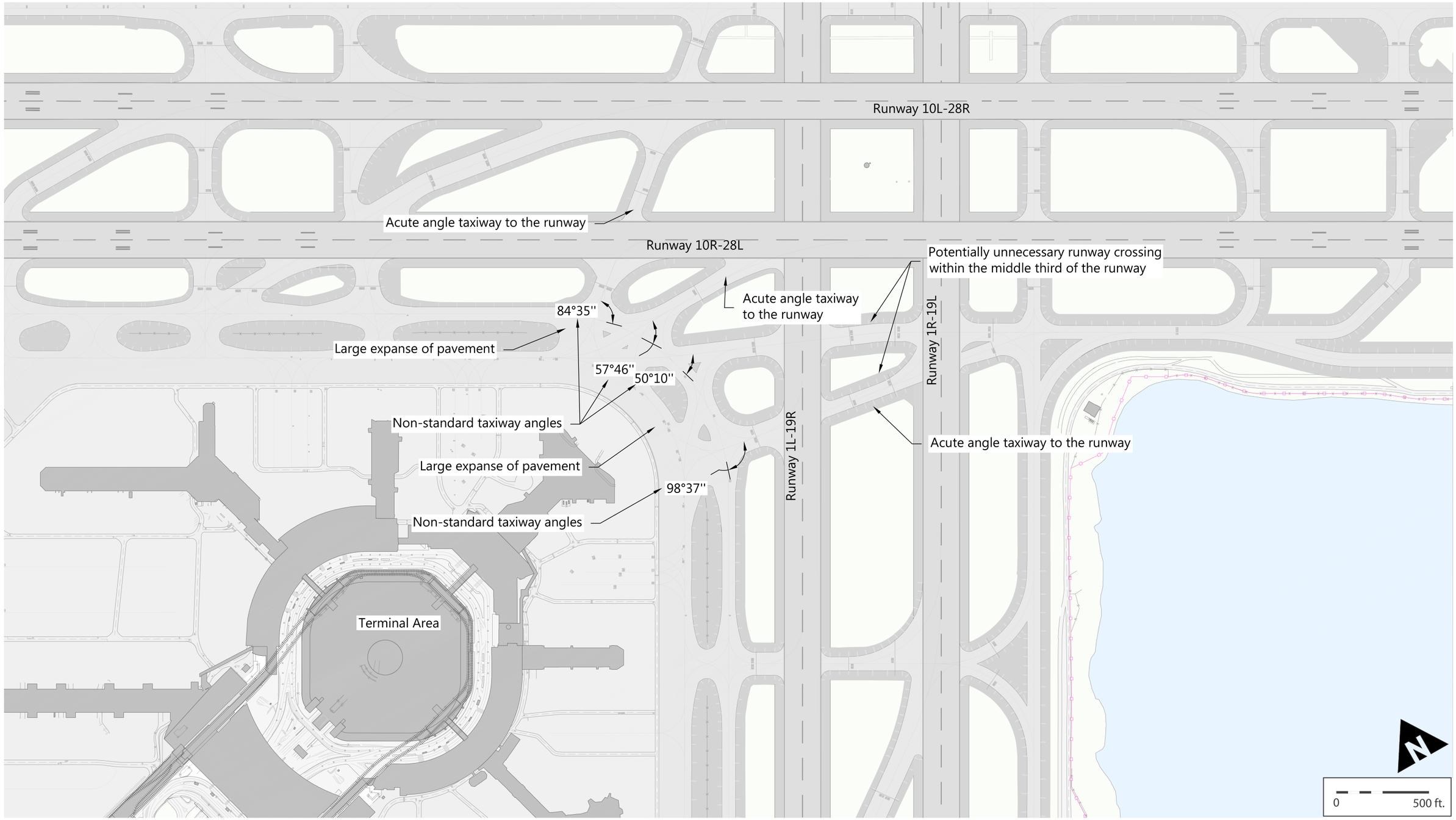
Source: Federal Aviation Administration, Advisory Circular 150/5300-13A, Airport Design, Change 1, February 26, 2014; Chapter 4. "Taxiway and Taxilane Design"

Exhibit 4.2-4 | Areas of Nonconformance, Taxiway Layout



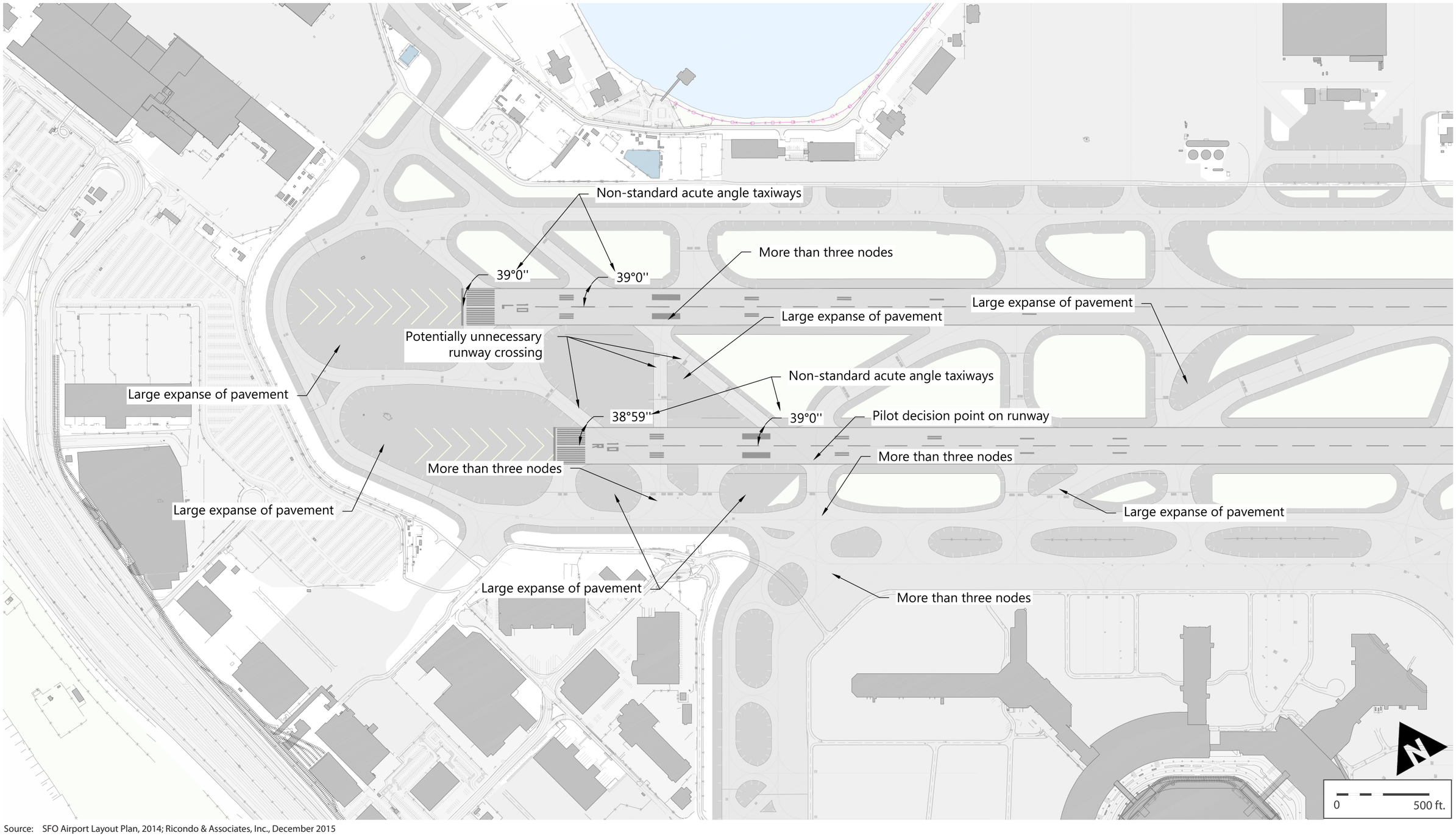
Source: SFO Airport Layout Plan, 2014; Ricondo & Associates, Inc., December 2015

Exhibit 4.2-5 | Areas of Nonconformance, Taxiway Layout – FAA Hot Spot 1



Source: SFO Airport Layout Plan, 2014; Ricondo & Associates, Inc., December 2015

Exhibit 4.2-6 | Areas of Nonconformance, Taxiway Layout – Runway 10L and 10R Thresholds



Source: SFO Airport Layout Plan, 2014; Ricondo & Associates, Inc., December 2015

Exhibit 4.2-7 shows other areas that may require taxiway improvements, as identified by SFO Operations and SFO ATCT staff.

Taxiway Width

During instrument landing system (ILS) Category (CAT) II operations on Runway 28L, aircraft are required to remain outside of the Precision Obstacle Free Zone (POFZ), which is a rectangular area centered on the runway and behind the runway threshold, 800 feet wide and 200 feet long. During CAT II operations, aircraft on Taxiway F must hold 400 feet from the runway centerline. A new runway access point northwest of Taxiway F would be outside the POFZ, enabling aircraft to queue closer to the runway. This second access point would also provide flexibility for queuing traffic on Runway 28L.

Helipad

A helicopter landing marking had been provided on Taxiway C near Taxiway R. The marking was removed in 2013, because it did not meet FAA standards that the center of the helipad final approach and takeoff areas be separated at least 700 feet from the centerline of runways serving heavy aircraft (over 300,000 pounds). During the past 3 years, Airport operations monitoring records show an average of 13 helicopter operations (takeoffs and landings) per day at SFO. As of 2015, helicopter pilots are instructed to land on the East Apron, near the Airfield Operations Building (1057), and hover taxi to their assigned parking location.

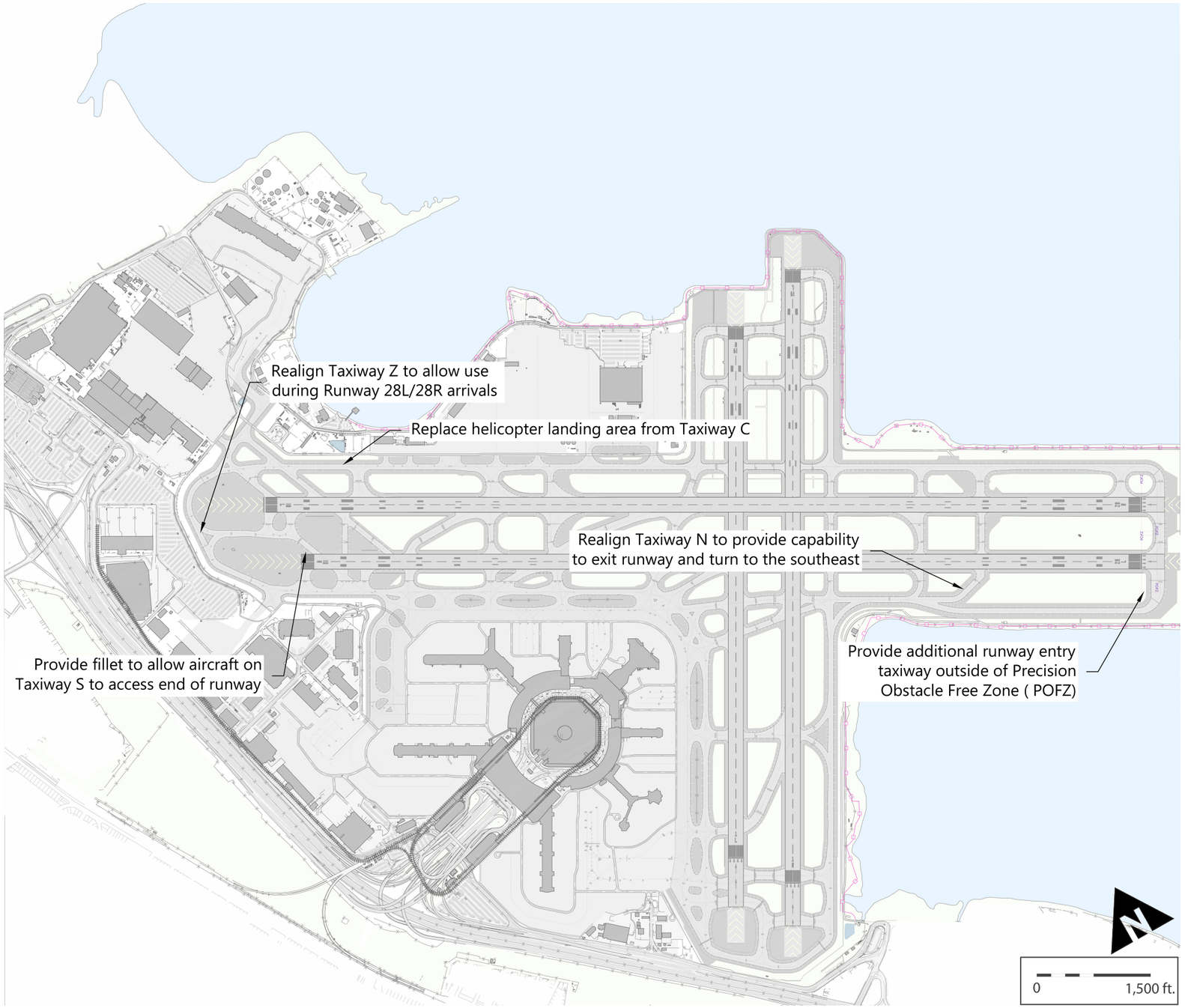
Standardize Taxiway N Geometry

Taxiway N was originally developed for use by aircraft accessing Runway 28R from the terminal area via Taxiway F (now Taxiways F1 and F). Taxiway N approaches Runway 10R-28L from an angle, requiring pilots to look back more than 90 degrees while holding on Taxiway N for potential arrivals to or departures from Runway 10R. In addition, aircraft that need to exit Runway 28L after queuing for departure cannot exit at Taxiway N and re-enter the departure queue on Taxiway F. Those aircraft would need to taxi down the runway and exit south onto Taxiway L and then turn left onto Taxiway F to rejoin the queue for Runway 28L departure. This additional taxiing time greatly increases runway occupancy time, decreasing its efficiency.

4.2.3 Airfield Signage

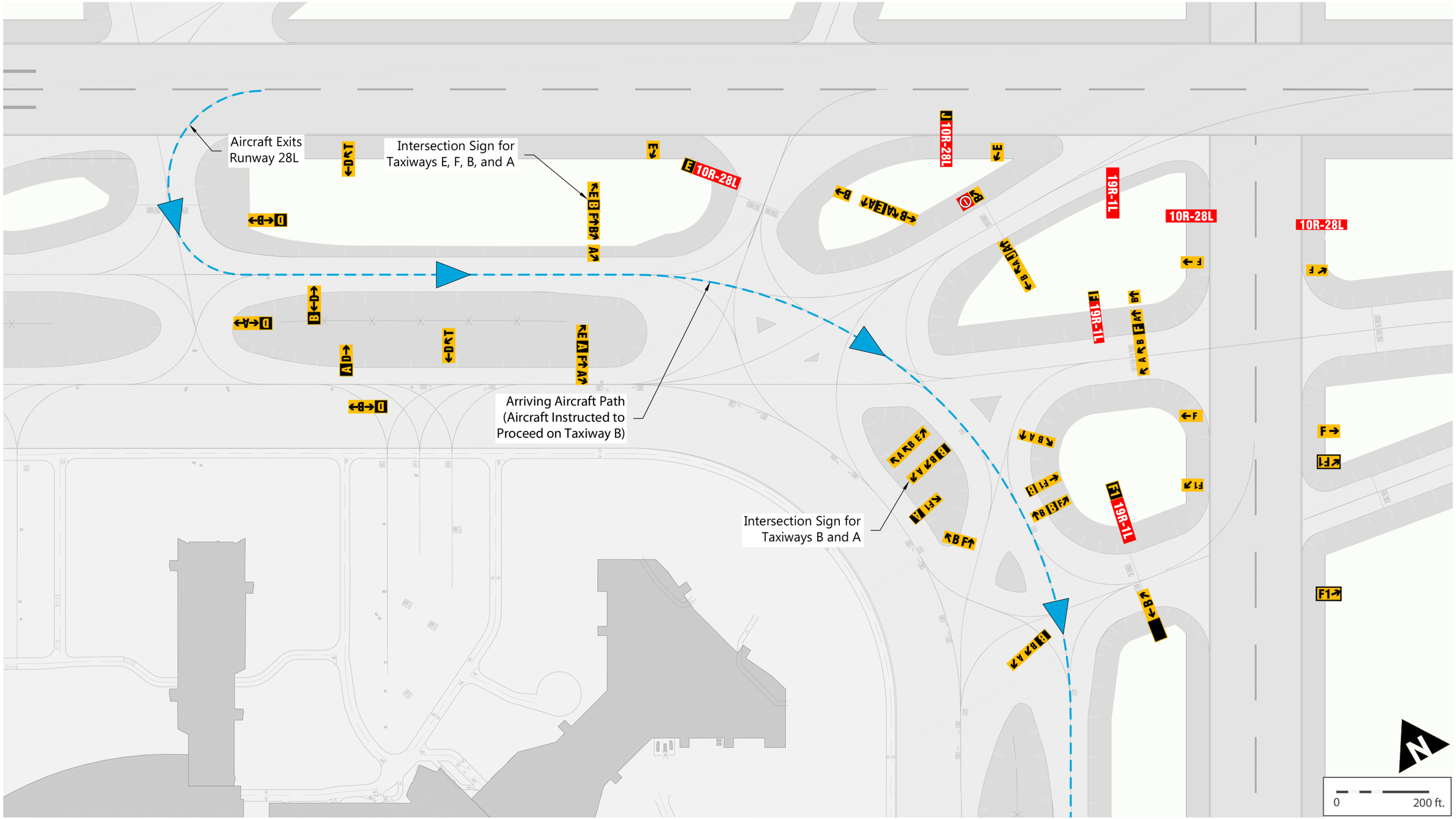
Complicated and inadequate signage exists at the complex intersection of Taxiways A, B, F, F1, and J. The FAA has designated this area as Hot Spot 1. **Exhibit 4.2-8** shows an example of the lack of signage for pilots arriving on Runway 28L and exiting the runway onto Taxiway D to proceed toward Terminal 1. Pilots are instructed to turn left on Taxiway B (from Taxiway D) and follow the taxiway through the complex intersection; only two signs on Taxiway B provide information about the taxiway name and the direction to travel.

Exhibit 4.2-7 | Other Areas for Potential Improvements



Source: SFO Airport Layout Plan, 2014; Ricondo & Associates, Inc., December 2015

Exhibit 4.2-8 | Signage Plan at FAA Hot Spot 1, Taxiway B Signage



Source: SFO Airport Layout Plan, 2014; Ricondo & Associates, Inc., December 2015

4.2.4 Runway and Airfield Lighting

Green taxiway centerline lights and blue taxiway edge lights provide guidance for pilots on the ground during nighttime operations or during inclement weather. The FAA requires different lighting systems depending on the number of operations and weather conditions at an airport. **Table 4.2-5** summarizes the airfield lighting in the FAA design standards and whether or not the lighting is currently in use at SFO.

Table 4.2-5 | Taxiway Lighting Standards and Use at San Francisco International Airport

Item	Definition	Description	Implementation of Criteria	Applicable to SFO
Taxiway Centerline Lights	Provide taxiing guidance from runways to apron areas	Unidirectional or bidirectional in-pavement lights installed parallel to the taxiway centerline	Taxiway centerline lights should be installed for movement area operations below 1,200 feet Runway Visual Range	All taxiways
Taxiway Edge Lights	Define the edges of a taxiway	Blue lights no more than 10 feet from the edge of the full-strength pavement	May be installed in addition to centerline lights if warranted by operational and weather conditions	At runway intersections and between Taxiways A and B
Runway Guard Lights	Provide visual indication to pilots of aircraft approaching the runway hold position that they are about to enter an active runway	Elevated: two alternating unidirectional yellow lights on either side of the taxiway at the runway holding position In-pavement: row of alternating illuminated, unidirectional yellow lights at the runway holding position	Elevated and in-pavement runway guard lights are not typically installed together unless taxiing aircraft approach at an acute angle between the hold position and the direction of the hold position	In-pavement runway guard lights at taxiway/runway intersections
Stop Bar Lights	Provide distinctive "stop" signal to pilots of aircraft approaching a runway	Row of unidirectional in-pavement red lights and elevated red light on each side of the taxiway	Should be installed at hold positions for operations below 600 feet Runway Visual Range	None
In-Pavement Stop Bar and Runway Guard Lights	Provide visual indication that a taxiing aircraft is approaching a runway and a distinctive "stop" signal depending on weather condition	Yellow alternating in-pavement runway guard lights (RGLs) and red in-pavement stop bar lights (wired to not operate simultaneously)	Allows for in-pavement runway guard lights above 1,200 feet Runway Visual Range and stop bar below 1,200 feet Runway Visual Range at a given location	None
Clearance Bars	Advise pilots that they are approaching a hold point (other than a runway hold position)	Row of three in-pavement yellow lights that indicate low-visibility hold point	Should be installed at low-visibility hold points other than taxiway/runway intersection	None

Sources: Federal Aviation Administration, Advisory Circular 150/5340-30H, *Design and Installation Details for Airport Visual Aids*, July 21, 2014; San Francisco International Airport management, October 2014

4.3 PASSENGER TERMINAL

4.3.1 Aircraft Gate Demand

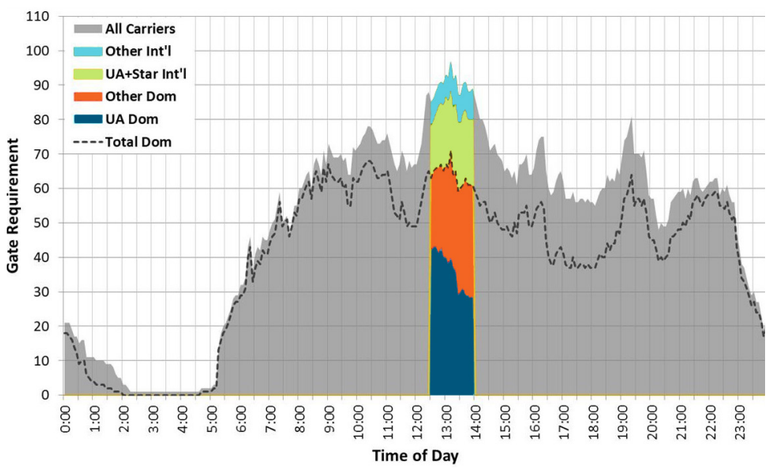
Aircraft gate capacity defines the ability of an airport to accommodate passenger aircraft demand. The analysis described in this section is conducted to determine the number of gates required at SFO based on the aviation demand forecasts for a representative peak day (known as the design day flight schedule [DDFS]).

To determine gate requirements for each planning activity level, the peak demand period throughout the day was identified. As depicted in **Exhibit 4.3-1**, peak demand occurs between 12:30 p.m. and 14:00 (2:00 p.m.). This 90-minute period includes the overall Airport activity peak, overall domestic and international peak, United Airlines domestic peak, and the Star Alliance airlines' international peak.

Airlines are assigned one or more boarding areas and their flights are counted in 5-minute increments based on ground time[3] to determine gate demand for each planning activity level. The sum of the number of aircraft on the ground during any 5-minute interval determines the total number of gates required in each boarding area. The maximum value of each sum is considered as the demand for each boarding area. **Table 4.3-1** presents the number of gates required at the peak hour in each boarding area.

3 "Ground time" is the time between an aircraft's arrival and departure, plus an inter-gate time during which a given gate cannot be used while it is being prepared for the next flight. This analysis assumed an inter-gate time of 20 minutes for domestic flights and 30 minutes for international flights.

Exhibit 4.3-1 | High Constrained Activity Level – Shared Gate Demand for Passenger Traffic



Source: Landrum & Brown, Inc., September 2015

Fewer gates would be required if each airline could use any gate at the Airport (i.e., 100 percent common use). Instead, the overall gate requirement increases to account for airline boarding area assignments and preferential gate allocations. As a result, a surplus at one boarding area may not be able to mitigate a shortage at another boarding area. For example, if a gate shortage exists at Boarding Area (B/A) F and a gate surplus exists at B/A B, additional gates would still be required at B/A F, thus increasing the total gate requirement for the Airport. Within an individual boarding area, airlines are assumed to share gates.

Although Table 4.3-1 represents all gate demand equally, different types of aircraft gates provide different capabilities. Some smaller gates may only accommodate narrowbody (e.g., ADG III) aircraft, while multiple aircraft ramp system (MARS) gates may accommodate one widebody (ADG V or ADG VI) or two narrowbody (ADG III) aircraft. "Swing" gates direct arriving passengers either to U.S. Customs and Border Protection (CBP) or directly into the boarding area, so they are able to serve domestic or international arrivals.

Provision of the MARS and swing gates provides the flexibility to respond to a variety of future demand growth and airline allocation scenarios. For example, approximately 20 percent of the Star Alliance international demand is served by narrowbody aircraft that could be accommodated at the narrowbody swing gates proposed at B/A F as part of the Terminal 3 West Expansion and Renovation project.

As of summer 2015, the Airport had 88 gates; therefore, 25 additional gates would be required to accommodate the Base Constrained activity level, and 33 additional gates would be required to accommodate the High Constrained activity level.

Table 4.3-1 | Peak Hour Gate Demand

Boarding Area(s)	Existing	2018	2023	Base Constrained	High Constrained
A	12	6	8	8	9
B	9	21	21	22	25
C	10	8	8	9	9
D	14	8	8	9	10
E/F/H	31	41	41	42	43
G/H	12	15	18	18	20
Total	88	99	104	108	116
Total – Including Out-of-Service		104	109	113	121

Note: Existing gate count as of April 2015

Source: Landrum & Brown, Inc., September 2015

4.3.2 Domestic Terminals

4.3.2.1 Terminal 1

Terminal 1 was last renovated in 1985. The outdated design includes inadequate queuing areas, limited curbside depth, oversized ticket counters and airline office space, inefficient and fragmented baggage screening systems, excess baggage claim devices, and a lack of secure connections between adjacent boarding areas.

B/A B will be redeveloped into an 18-gate facility, replacing the domestic functions of existing B/A B while adding some gates with widebody and international capability. Redeveloped B/A B will provide several swing gates positioned between B/A A and B/A B and along the west side of B/A B. Some of these will be MARS gates sized to accommodate both narrowbody and widebody aircraft; ADG VI gates that can accommodate an A380 will also be capable of accommodating two ADG III aircraft. With the use of the MARS gates, B/A B would be able to accommodate up to 27 narrowbody aircraft parking positions. These facilities will provide for the overflow of international flights from B/A A into B/A B. The facility requirements identified in the Terminal 1 redevelopment program are included in the *Terminal 1 Facility Requirements Draft Report.*[4]

4.3.2.2 Terminal 2

Terminal 2, including B/A D, was renovated in 2011. The aircraft parking area at B/A D is planned to be reconfigured by down-gauging widebody aircraft parking positions and modifying the existing aircraft parking area to include an additional narrowbody aircraft parking position. The new aircraft parking position would be located adjacent to Gate 50, using existing holdroom space to minimize expansion. The terminal requirements identified for the Terminal 2 redevelopment program completed in 2011 are documented in the *Terminal Facility Requirements, Terminal 2/Boarding Area D Renovation Project Final Report.*[5] As this project was completed recently, there are no new facility requirements expected over the planning horizon.

4.3.2.3 Terminal 3

Terminal 3 is undergoing renovation projects. Renovations to Terminal 3 East, including B/A E, were completed in 2015, while the Terminal 3 West Modernization Project is in the planning stage. Issues including airside congestion, aging building utilities and infrastructure, underperforming concession revenues, undersized holdrooms, an inefficient baggage handling system, an excessive number of check-in counters, and an insufficient number of check-in kiosks will be addressed in the Terminal 3 West project.

4 *San Francisco International Airport Terminal 1 Facility Requirements Draft Report, HNTB,* September 29, 2011.

5 San Francisco International Airport Bureau of Planning and Environmental Affairs, *Terminal Facility Requirements, Terminal 2/Boarding Area D Renovation Project Final Report,* April 14, 2008.

In addition, five passenger boarding bridges on the south side of B/A F are planned to be replaced and the aircraft parking area reconfigured to provide flexibility to accommodate additional aircraft types.

The terminal requirements identified for the Terminal 3 redevelopment program are documented in the *Terminal 3 Programming and Planning Study, Final Technical Report*.[6] Since the completion of that report, the Terminal 3 East project has been completed, which improved the ticketing lobby, security checkpoints, and baggage claim facilities on the eastern portion of the terminal along with the east frontage gate holdroom and concessions areas. Upon completion of the Terminal 3 West project, the ticketing, security checkpoint areas, and baggage claim areas will be fully updated.

While the B/A F aircraft parking reconfiguration will provide some gate use flexibility, the B/A F building would need to be modernized and potentially widened to achieve the same standards as the other terminals. This could include increasing the size of the holdrooms to accommodate the larger narrowbody and widebody aircraft operating at Terminal 3, enhancing concessions spaces to improve the guest experience and increase revenue, improving restrooms, and adding other guest amenities.

4.3.3 International Terminal Building

The gate assessment determined that gate capacity at SFO is insufficient to accommodate forecast international traffic demand. In addition, increased domestic traffic Airport-wide will require additional gates; a portion of this traffic may need to be accommodated at the International Terminal Building (ITB).

The ITB was designed in the pre-9/11 era, when facility needs for passenger processing were significantly different. For example, the ITB has insufficient space for security screening, but excessive space devoted to passenger ticketing. The future facility requirements were developed using previously established planning parameters, such as those used for the ongoing Terminal 1 and Terminal 3 redevelopments and the recent Terminal 2 redevelopment, supplemented with industry standard planning factors. The aviation activity levels were used as the basis for the passenger forecasts. Planning factors were applied to the forecasts to establish the ITB requirements.

6 *Terminal 3 Programming and Planning Study Final Technical Report,* LeighFisher, April 2012.

4.3.3.1 Fleet Mix

The ITB was designed when the B747-400, B767, and B777-200ER were the most commonly used aircraft for international flights. While these aircraft continue to operate, other aircraft types have since been introduced to the global fleet mix, including the A340-600, A350, A380, B747-8, B777-300ER, and B787. To optimize ramp space and maximize aircraft parking capacity, gates should be sized to accommodate the commonly operated aircraft (e.g., ADG V aircraft such as the B777) as well as the critical design aircraft, such as the A380, which accounts for a small fraction of total operations at SFO.

B/A A was designed for a fleet mix that included more operations by ADG IV aircraft with wingspans up to 171 feet, primarily the B767. Today, the B767 is being replaced by the A350 and B787, both of which are ADG V aircraft with wingspans up to 214 feet. Therefore, the number of ADG V gates at B/A A will need to be increased to accommodate the growing number of ADG V flights.

Since the opening of the ITB, new large aircraft types have entered commercial fleets. The A380 and B747-8 are ADG VI aircraft that require wider gates, greater ramp clearance, and additional passenger service infrastructure. The first regularly scheduled A380 flight operated at SFO in 2011, and as of summer 2015, the Airport accommodates up to five ADG VI flights per day. Currently, there are four ADG VI capable gates, two each in B/As A and G. As airline traffic continues to grow and landing capacity at SFO becomes more constrained, airlines are expected to use more ADG VI aircraft. Therefore, the Airport should be developed to accommodate an increasing number of flights operated by these large aircraft.

However, ADG VI aircraft flights require the following operational restrictions that slow Airport operations and affect other flights:

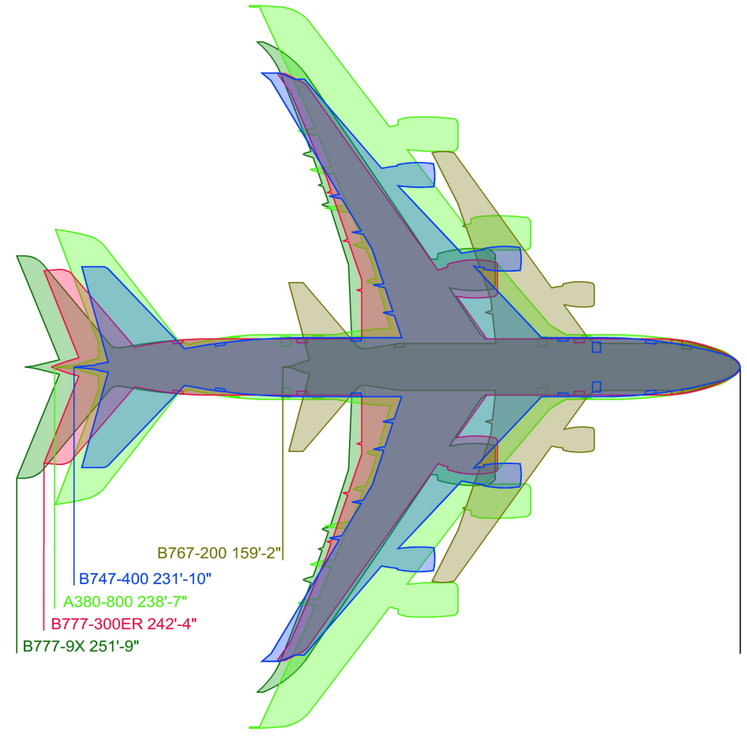
- Other aircraft cannot be paired for a simultaneous approach with an ADG VI aircraft
- Increased in-trail separation is required for other aircraft following an ADG VI aircraft on approach
- Taxiway restrictions are required for other aircraft when an ADG VI aircraft is taxiing on the airfield

Because these operational restrictions reduce airfield efficiency, to optimize airfield capacity the Airport should manage the number of ADG VI operations by limiting the development of ADG VI facilities. For example, implementing only five ADG VI capable gates will discourage additional simultaneous ADG VI operations, thereby improving the Airport's operating efficiency.

In recent years, aircraft manufacturers have introduced aircraft with longer fuselages. When the ITB opened in 2000, the B747-400 had the longest fuselage of any commercial aircraft, with a length of 231 feet 10 inches. Today, several aircraft with longer fuselages are part of the fleet mix at SFO, including the A380 (238 feet 7 inches), B777-300ER (242 feet 4 inches), A340-600 (247 feet 3 inches), and B747-8 (250 feet 2 inches).[7] The future B777X family of aircraft is expected to exceed the maximum fuselage lengths of aircraft in service today; the B777-9X has a length of 251 feet 9 inches. An overlay comparison of several of these aircraft is shown in **Exhibit 4.3-2**. To accommodate these fuselage lengths, the ramp depth should be increased to ensure that vehicle service roads remain clear of parked aircraft.

7 Airbus, www.airbus.com; Boeing, www.boeing.com, August 2015.

Exhibit 4.3-2 | Fuselage Length Comparison



Sources: PathPlanner Airside+, Landrum & Brown, Inc., 2016

4.3.3.2 Domestic and International Gate Flexibility

When the ITB opened in 2000, international traffic at the Airport did not require the full use of the gates at B/A A and B/A G and domestic flights exceeded the capacity of the domestic boarding areas; therefore, some domestic airline activity was accommodated at the ITB. For example, B/A A accommodated all Virgin America flights until the remodeled Terminal 2 opened in 2011.

Several domestic airlines continue to operate from B/A A in the ITB and, with redevelopment and construction of B/A B, domestic operations are expected to continue at the ITB until domestic gate capacity increases. Additionally, United Airlines currently uses B/A G for domestic overflow operations during international off-peak periods.

The practice of using the ITB to accommodate the overflow of domestic flights has gradually declined as international demand has increased. B/A G is used for international flights 70 percent of the time overall (90 percent during the peak), while approximately 40 percent of operations at B/A A are international. To accommodate future demand, the appropriate infrastructure will be needed to allow an overflow of international flights to be accommodated at other boarding areas. A number of gates at Terminal 3 West and B/A B are being designed to accommodate both narrowbody and widebody aircraft and domestic and international flights. To accommodate international flights, these gates must connect to CBP facilities via a sterile international arrivals corridor. Outside of the international peak period, some domestic flights will still need to be accommodated at B/As A and G.

4.3.3.3 Precleared Flights

SFO received air service from seven airports in three countries that participate in the CBP preclearance program.[8] Before these inbound international flights depart, CBP conducts the same immigration, customs, and agricultural inspections that typically occur at U.S. airports for arriving passengers on international flights. Passengers on precleared flights are considered domestic passengers upon arrival at a U.S. airport and may make connections without having to clear security again.

As the United States government intends to expand the preclearance program to additional airports worldwide, SFO should plan to accommodate increased flights from these destinations. Most of these flights will be served using widebody aircraft and will require larger baggage claim devices in domestic baggage claim areas.

8 U.S. Customs and Border Protection, www.cbp.gov/border-security/ports-entry/operations/preclearance, accessed October 2015.

4.3.3.4 Planning Parameters and Facility Requirements Overview

Planning parameters and facility requirements guide the development of alternatives for future ITB redevelopment. The planning parameters identify the key components of the ITB redevelopment and the facility requirements identify the capacity needed to accommodate the forecast growth in passenger traffic.

Planning Parameters

The ITB redevelopment analysis reflects the relevant components of *The Principles of R.E.A.C.H.* and the ideas identified during the ITB Visioning Charrette and other stakeholder meetings. To organize and prioritize the ITB redevelopment goals, components were sorted into the following categories:

Required: These components would provide adequate capacity for future growth and meet the minimum business or customer service performance objectives of SFO management.

Highly desirable: These components would enhance SFO's competitive position among North American gateway airports and significantly increase non-airline revenue generation.

Complementary: These components would enhance the passenger experience at SFO by creating unique experiences and should be incorporated where opportunities exist.

Operational improvement: These components would increase operational efficiency or provide the necessary infrastructure to increase operational flexibility.

Table 4.3-2 identifies the category for each of the ITB redevelopment components.

Facility Requirements

Facility requirements were established for each planning activity level (2018, 2023, Base Constrained, and High Constrained) using the DDFS. It was assumed that B/A H is the recommended alternative for future gate expansion (see Section 5.3.1). Planning standards from recent terminal studies at SFO were used in the facility requirements analysis, including the Terminal 1 and Terminal 3 programming efforts and industry standard planning metrics from the International Air Transport Association (IATA) and the Airport Cooperative Research Program (ACRP) Report 25, *Airport Passenger Terminal Planning and Design,* 2010[9]. For components where level of service is a factor in the facility requirements, the IATA Optimal Level of Service was used. This level of service provides sufficient space to accommodate necessary functions in a comfortable environment with "acceptable" processing and waiting times.[10] SFO policies and guidelines, including *The Principles of R.E.A.C.H.* and concession revenue performance targets, were incorporated into the facility requirements.

As discussed in Section 4.3.2, Terminals 1 and 3 will include swing gates capable of accommodating international arrivals. Because all international arriving passengers must be processed in the CBP facilities located in the ITB, international flights forecast to use these gates are included in the ITB facility requirements. Originating departing passengers on international flights at the international swing gates will use processing facilities in the ITB.[11]

The peak hour departing and arriving passenger demand were identified for each planning activity level and are shown in **Table 4.3-3**. The peak hour number of passengers serves as the basis for determining most facility requirements. Given the CBP's desire to increase the number of preclearance sites and the subsequent interest by the operators of many hub airports outside the United States, such as Tokyo Narita International Airport, London Heathrow Airport, and Amsterdam Airport Schiphol, which accommodate flights serving SFO, the peak hour international arriving passenger demand could be substantially reduced in the future (likely 2023 and beyond). International departures would largely remain unchanged, as these flights would still depart from gates at the ITB.

9 Airport Cooperative Research Program, *Report 25: Airport Passenger Terminal Planning and Design,* 2010.

10 International Air Transport Association, *Airport Development Reference Manual,* 10th Edition, March 2014.

11 With United Airlines ticketing and check-in operations being split between Terminal 3 and the ITB, it is likely that some United Airlines passengers departing on international flights will check in at Terminal 3.

Table 4.3-2 | ITB Redevelopment Components

Component	Category
Shift and expand or consolidate the security screening checkpoints (SSCPs)	Required
Increase primary processing capacity	Required
Expand international baggage claim facilities as necessary to meet requirements	Required
Accommodate A380 aircraft gate requirements	Required
Resize gates and holdrooms to accommodate the future airline aircraft fleet mix	Required
Expand domestic baggage claim as necessary to meet facility requirements	Required
Optimize self-service check-in and baggage drop capabilities	Required
Improve passenger flow to and from the SSCPs through pre- and post-security concessions	Required
Consolidate Duty Free and luxury retail brands	Required
Expand post-security concessions	Required
Create excitement for and interest in concessions	Required
Enhance the recompose area at the SSCPs	Required
Improve passenger flow to gates and post-security concessions	Required
Provide a B/A A to B/A G post-security connection to improve gate utilization flexibility and enhance the domestic-to-international connecting passenger experience	Required
Enhance the holdroom experience	Required
Provide three passenger loading bridges at A380 gates	Required
Refurbish or replace escalators	Required
Upgrade the Baggage Handling System to meet future demand and establish flexible and redundant distribution of baggage between B/A A and B/A G systems	Required
Enhance the meeters and greeters lobby	Complementary
Improve the placement and accessibility of the Baggage Service Offices	Complementary
Replace or upgrade air handling units	Operational Improvement
Improve baggage recheck operations	Highly Desirable/Operational Improvement
Enhance the international-to-domestic connecting passenger experience	Highly Desirable
Improve preclearance to domestic connections	Highly Desirable
Improve wayfinding from Terminals 1 and 3 to B/As A and G	Highly Desirable
Enhance wayfinding to and from the parking garages and ground transportation	Highly Desirable
Enhance wayfinding from curbside to check-in	Highly Desirable
Enhance passenger flow from ticketing/check-in to the SSCPs	Highly Desirable
Improve visibility from ticketing/check-in to the SSCPs	Highly Desirable
Improve the visibility of pre-security concessions	Highly Desirable
Improve visibility and the passenger experience in domestic baggage claim	Highly Desirable
Consider post-security access for airline clubs	Highly Desirable
Provide additional space for airline clubs	Highly Desirable
Optimize Smarte Carte placement	Highly Desirable
Optimize SFO Museum display placement	Highly Desirable
Optimize information booth placement	Highly Desirable
Improve staging, delivery, and return of Smarte Cartes and wheelchairs	Highly Desirable
Consolidate ground transportation services	Highly Desirable

Source: Landrum & Brown, Inc., July 2015

Table 4.3-3 | ITB Peak Hour Passenger Demand

Type	Direction	2018	2023	Base Constrained	High Constrained
International	Departures	2,447	3,383	4,079	4,351
	Arrivals	2,711	3,213	4,139	4,537
Domestic and Preclearance (for arrivals)	Departures	695	784	806	805
	Arrivals	438	508	689	720

Source: Landrum & Brown, Inc., July 2015

Facility requirements were prepared for the major functional components of the ITB, including:

- Ticketing/Check-in
- Airline Ticket Offices
- Security Screening Checkpoints
- Concessions
- Holdrooms
- U.S. Customs and Border Protection
- Baggage Claim (presented in Section 4.3.4, Baggage Handling System)
- Public Space
  - Restrooms
  - Arrivals Hall
- Non-Public Space
  - Airline Support Space
  - Terminal Support Space

The planning factors and facility requirements for each component are described in the following paragraphs.

Ticketing/Check-in: The ticketing/check-in requirements provided in **Table 4.3-4** are based on originating passenger peak hour demand and account for various methods of check-in, including: agent (full-service), self-service kiosk with baggage drop, and baggage drop only (boarding pass obtained prior to check-in). Travel document requirements and other operational procedures result in some differences between international and domestic check-in in terms of processing rates and passenger distribution among the various check-in modes.

The peak hour originating passenger forecast is provided in **Table 4.3-5**, and the resulting ticketing/check-in requirements are provided in **Table 4.3-6**. The ticketing/check-in facility requirements are based on aggregate peak hour demand, which reflects a shared-use approach in which passengers can check in at any position regardless of airline, compared to allocating positions to airlines based on a request or the size of the aircraft, which is the current practice in the ITB. These requirements represent the minimum number of check-in positions required, based on the current check-in mode used (as shown in Table 4.3-4), to accommodate peak hour demand.

Table 4.3-4 | ITB Ticketing/Check-in Planning Factors

Description	Unit	Factor
International Planning Factors		
Agent Check-in Rate[1]	minutes per passenger	2.2
Self-Service Kiosk with Bag Drop Rate[1]	minutes per passenger	3.5
Bag Drop Rate[1]	minutes per passenger	1.7
Agent Check-in Utilization[1]	percent of total passengers	88
Self-Service Kiosk Utilization[1]	percent of total passengers	12
Domestic Planning Factors		
Agent Check-in Rate[1]	minutes per passenger	1.2
Self-Service Kiosk with Bag Check Rate[1]	minutes per passenger	1.8
One-Step Bag Drop Rate[2]	minutes per passenger	0.8
Two-Step Bag Drop Rate[1]	minutes per passenger	1.7
Agent Check-in Utilization[3]	percent of total passengers	17
Self-Service Kiosk Utilization[3]	percent of total passengers	18
Web Check-in (carry-on only) Utilization	percent of total passengers	28
Bag Drop (off-site plus self-service) Utilization[3]	percent of total passengers	47

Notes: [1] *Based on SFO ITB passenger observations conducted August 26–28, 2014. Process time for self-service kiosk check-in with bag drop may involve waiting for the agent who is serving several positions.*
[2] *Based on historical observations and industry standards.*
[3] *Based on San Francisco International Airport Terminal 1 Facility Requirements Draft Report, HNTB,* September 2011.

Source: Landrum & Brown, Inc., July 2015

Table 4.3-5 | ITB Originating Peak Hour Passengers

Departures	2018	2023	Base Constrained	High Constrained
International	2,447	3,383	3,487	3,723
Domestic[1]	695	-	-	-
Combined	2,669	3,383	3,487	3,723

Notes: [1] *All Boarding Area A domestic departing passengers will check in at Terminal 1 after Terminal 1 redevelopment is complete. United Airlines domestic departing passenger check-in at Terminal 3 is not included in the totals.*

Source: Landrum & Brown, Inc., July 2015

Table 4.3-6 | ITB Ticketing/Check-in Facility Requirements

Positions	Existing	2018	2023	Base Constrained	High Constrained
Agent Check-in	142	39	51	51	60
Self-Service Kiosk Check-in	20	13	15	15	15
Baggage Drop	26	7	11	11	11
Total Ticketing/Check-in Area (square feet)	59,000	29,000	40,400	40,400	44,700

Notes: *All Boarding: Agent check-in utilization remains constant at 88 percent (existing utilization rate)*

Source: Landrum & Brown, Inc., July 2015

The ITB was designed and constructed before the advent of electronic ticketing, self-service, and off-site/mobile check-in abilities. These new check-in methods reduce the need for traditional ticket counters and queuing spaces and virtually eliminate the need for ticketing services. The demand analysis confirmed that the capacity of the ticketing/check-in hall is far greater than future demand requires.[12] As the agent check-in use rate is reduced by providing more self-service check-in options and encouraging passengers to use those options, the total check-in area required at the High Constrained demand level could be further reduced, as shown in **Table 4.3-7**.

Airline Ticket Offices: The Airline Ticket Offices (ATOs) include the office space necessary to serve the ticketing/check-in counters. The space requirement for the ATO is based on the existing ratio of 119 square feet for each fixed check-in position (including agent and baggage drop positions). This ratio reflects the total amount of ATO space available compared to the total number of fixed check-in positions to provide a general reference. Because some ATO space is vacant and not all of the fixed check-in positions are used, the required amount of ATO space must be confirmed with the airlines during the programming and design phase. As indicated in **Table 4.3-8**, the future ATO space requirements are substantially lower than existing capacity as a result of the reduction in full-service check-in positions and on-site ticketing.

Security Screening Checkpoints: The SSCP requirements are based on the peak 30-minute passenger volume during the peak hour. In the analysis, passenger traffic was increased by 3 percent to account for employees and airline crew members and it was assumed that all passengers connecting from Terminal 3 to flights at B/A G and connecting from Terminal 1 to flights at B/A A will use the secure connectors. The total area required for the SSCP includes the following facilities:

- Queueing area of 10.8 square feet per passenger[13]
- Travel Document Checker (TDC) positions and adjacent circulation
- Passenger screening equipment, including divestiture and recompose tables
- Secondary screening areas
- Holding rooms
- Recompose areas
- Egress corridors

The planning factors used to calculate the SSCP requirements include the passenger processing rates for two types of screening lanes: regular and TSA Pre✓.[14] The passenger screening rates for both types of screening lanes are provided in **Table 4.3-9**. The TSA has stated its desire to significantly increase the number of passengers using TSA Pre✓. Therefore, a 25 percent TSA Pre✓ adoption rate was used to determine SSCP requirements in the alternatives development process.

The recompose area is the zone past the SSCP exit where passengers typically collect their screened items. Recompose areas improve the throughput rate of SSCPs by encouraging passengers to move away from the x-ray machines.[15] The ITB redevelopment alternatives include additional space to meet SFO management objectives for the recompose area established in *The Principles of R.E.A.C.H.*

12 Specific airline requirements should be coordinated as proposed requirements and improvements in the SFO ADP evolve from the planning phase to the design phase.

13 Based on the International Air Transport Association, *Airport Development Reference Manual,* 10th Edition, March 2014.

14 "TSA Pre✓® is an expedited security screening program for connecting travelers departing from the United States, with smarter security and a better air travel experience. Passengers considered low-risk who qualify for the program can receive expedited screening either as a member of the program or another specific trusted traveler group." www.tsa.gov, October 15, 2015.

15 *Security Checkpoints Tiger Team 2005 – Improving Throughput,* Dallas/Fort Worth International Airport Planning Department, July 2006.

Table 4.3-7 | ITB Ticketing/Check-in Facility Requirements with Increased Use of Self-Service Check-in

Factor/Positions	Baseline (High Constrained)	Reduced Agent Check-in Use Rate (High Constrained)			
Agent Check-in Use Rate (percent)	88	80	70	60	50
Agent Check-in Positions	60	55	48	43	41
Self-service Kiosk Check-in Positions	15	29	43	56	56
Baggage Drop Positions	11	14	21	28	28
Total Ticketing/Check-in Area (square feet)	44,700	44,300	43,400	42,900	41,500

Source: Landrum & Brown, Inc., July 2015

Table 4.3-8 | ITB Airline Ticket Office Facility Requirements

Facility	Existing	2018	2023	Base Constrained	High Constrained
Total Fixed Check-in Positions	162	46	62	62	72
Square Feet of ATO per Fixed Check-in Position	119	119	119	119	119
Airline Ticket Offices (square feet)	19,280	5,470	7,380	7,380	8,570

Source: Landrum & Brown, Inc., July 2015

Table 4.3-9 | ITB Security Screening Checkpoint Planning Factors

Rate	Unit	Factor
Regular Screening[1]	passengers per lane per hour	130
TSA Pre✓[2]	passengers per lane per hour	240

Notes: [1] *Based on SFO Terminal 3 passenger screening observations in August 2012.*
[2] *Based on stated TSA industry goal and passenger screening observations in August 2012.*

Source: Landrum & Brown, Inc., July 2015

The facility requirements based on the planning factors and peak 30-minute demand are provided in **Table 4.3-10.** The combined demand applies to alternatives that include a consolidated SSCP. It was assumed in the analysis for the combined demand that all connecting passengers would access B/As A, G, and H through a secure connector from Terminal 1 or Terminal 3, as a connector between B/As A and G would be included in any alternative with a consolidated SSCP. The SSCP requirements are presented in Table 4.3-10 assuming a 25 percent TSA Pre✓ use.

Concessions: The concessions requirements include pre- and post-security concessions and are based on SFO performance targets for non-airline revenue generation, the customer experience enhancement goals established in *The Principles of R.E.A.C.H.*, and the "global marketplace" objectives from the ITB Visioning Charrette.

The planning factors used in the analysis are at the high end of the typical planning range, but are consistent with other terminals at the Airport, specifically Terminal 2. In addition, the high proportion of foreign visitors — nearly 40 percent of passengers in each boarding area — supports the more aggressive concessions planning factors because foreign visitors typically spend more on retail and duty free items than U.S. citizens.

The difference between the concessions requirements for B/As A and G is driven by the forecast numbers of departing passengers at the boarding areas. B/A G will be primarily used by United Airlines and Star Alliance members and is expected to accommodate more connecting and total passengers than B/A A. **Table 4.3-11** shows the planning factors used to develop the ITB concessions facility requirements.

The concessions facility requirements are provided in **Table 4.3-12**. The requirements are presented by boarding area and include individual requirements for pre- and post-security concessions. The pre-security requirements are substantially lower than the existing capacity, which reflects the current oversupply of pre-security concessions. The pre-security requirements for B/As G and H are combined; B/A H will not have a separate pre-security area.

Table 4.3-11 | ITB Concessions Planning Factors

Type	Unit	Factor
Food and Beverage	square feet per 1,000 enplaned passengers	7.0
Retail	square feet per 1,000 enplaned passengers	7.1
Services	square feet per 1,000 enplaned passengers	0.1
Duty Free	square feet per 1,000 enplaned passengers	6.7

Notes: Factors were based on LeighFisher analysis provided in ITB Concessions Planning, April 2014. Factors reflect leasable space only and do not include concessions storage, non-public circulation, or common seating areas.

Source: Landrum & Brown, Inc., July 2015, except as noted

Table 4.3-10 | ITB Security Screening Checkpoint Peak Facility Requirements – 25 Percent TSA Pre✓

Boarding Area(s)	Lane Type	Existing	2018	2023	Base Constrained	High Constrained
A	Regular Lanes	6	5	5	9	9
	TSA Pre✓ Lanes	1	2	2	2	2
	Total Area (square feet)	11,100	13,820	13,900	20,680	18,800
G and H	Regular Lanes	6	5	6	6	7
	TSA Pre✓ Lanes	1	2	2	1	2
	Total Area (square feet)	11,100	13,840	16,340	14,550	18,160
Combined	Regular Lanes	-	8	10	11	11
	TSA Pre✓ Lanes	-	2	2	2	3
	Total Area (square feet)	-	20,100	23,582	25,860	27,510

Source: Landrum & Brown, Inc., July 2015

Table 4.3-12 | ITB Concessions Facility Requirements (square feet)

Zone	Type	Existing	2018	2023	Base Constrained	High Constrained
Boarding Area A Pre-Security	Food and Beverage	9,400	6,900	7,200	7,700	9,000
	Retail and Service	8,800	3,500	3,700	3,900	4,500
	Subtotal	18,200	10,400	10,900	11,600	13,500
Boarding Area A Post-Security	Food and Beverage	8,000	12,100	12,900	13,600	15,700
	Retail and Service	13,500	15,500	16,200	17,400	21,100
	Duty Free	10,500	19,300	20,500	21,600	25,100
	Subtotal	32,000	46,900	49,600	52,600	60,900
Boarding Areas G and H Pre-Security	Food and Beverage	4,500	6,500	10,900	11,300	12,900
	Retail and Service	13,000	3,500	4,800	5,100	5,700
	Subtotal	17,500	9,500	15,700	16,400	18,600
Boarding Area G Post-Security	Food and Beverage	4,800	13,300	16,500	19,800	21,400
	Retail and Service	14,700	16,800	21,200	25,100	27,100
	Duty Free	14,100	20,100	25,300	30,000	32,400
	Subtotal	33,600	50,200	63,000	74,900	80,900
Boarding Area H[1] Post-Security	Food and Beverage	[1]	[1]	2,100	3,300	4,800
	Retail and Service	[1]	[1]	2,500	4,200	6,200
	Duty Free	[1]	[1]	3,300	5,000	7,400
	Subtotal	[1]	[1]	7,900	12,500	18,400

Note: [1] Boarding Area H is expected to be operational in 2023/2024.

Source: Landrum & Brown, July 2015

Holdrooms: Table 4.3-13 shows the planning factors used to develop the ITB boarding area holdroom facility requirements. The holdroom requirements reflect the highest-capacity aircraft served by each gate. These factors reflect Airport management's desire to provide additional amenities in the holdrooms, such as computer workstations and pod seating.

To improve profitability and utilize slots more efficiently at capacity-constrained airports, airlines globally are trending toward reduced frequencies, which results in higher load factors. This change substantially affects the total area required for each holdroom; the 10–15 percentage point increase in load factors over the years represents 40–70 passengers and 500–1,000 square feet of additional holdroom space for widebody aircraft.

Holdroom requirements by aircraft type served are provided in **Table 4.3-14**.

The holdroom facility requirements are based on the total numbers of each type of gate, as provided in **Table 4.3-15**. Most of the existing ADG IV gates at B/A A will be converted to ADG V and ADG VI gates, resulting in a reduction of one gate. One of the ADG V gates at B/A G will be decommissioned when B/A H becomes operational, which is expected to occur in 2024. The total area requirements for the boarding area holdrooms are provided in **Table 4.3-16**.

Table 4.3-13 | ITB Boarding Area Holdroom Planning Factors

Description	Unit	Factor
Load factor[1]	percent of total seats	95
Seated passengers[1]	percent of total passengers	80
Standing passengers[1]	percent of total passengers	20
Seating area per passenger[1]	square feet	17
Standing area per passenger[1]	square feet	12
ADG V total seats[2]	quantity	425
ADG VI total seats[3]	quantity	526
Podium and queue area[1]	square feet per gate	800
Contiguous holdroom factor[1,4]	percent	10
Computer workstations (ADG V)[1]	square feet per gate	450
Computer workstations (ADG VI)[1]	square feet per gate	600
Pod seating (ADG V)[1]	square feet per gate	675
Pod seating (ADG VI)[1]	square feet per gate	900

Notes: *ADG = Airplane Design Group*
[1] Based on Terminal 3 Programming and Planning Study, HNTB, October 2011.
[2] ADG V total seats based on the highest seating configuration for a B777-300ER in accordance with the Landrum & Brown SFO Forecast Update, April 2014.
[3] ADG VI total seats based on the highest seating configuration for an A380-800 in accordance with the Landrum & Brown SFO Forecast Update, April 2014.
[4] The contiguous holdroom factor only applies to ADG V gates.

Source: Landrum & Brown, July 2015

Table 4.3-14 | ITB Boarding Area Holdroom Requirements

Holdroom Type	Target
ADG V (square feet)	7,300
ADG VI (square feet)	8,800

Note: *ADG = Airplane Design Group*

Source: Landrum & Brown, Inc., July 2015

Table 4.3-15 | ITB Gate Requirements

Boarding Area	Gate Type	Existing	2018	2023	Base Constrained	High Constrained
A	ADG IV	3	1	1	1	1
	ADG V	7	9	9	9	9
	ADG VI	2	2	2	2	2
	Total Gates	12	12	12	12	12
G	ADG V	10	10	9	9	9
	ADG VI	2	2	2	2	2
	Total Gates	12	12	11	11	11
H	ADG V	-	-	6	6	6

Note: *ADG = Airplane Design Group*
Totals do not include the future Terminal 1 or Terminal 3 swing gates

Source: Landrum & Brown, Inc., July 2015

Table 4.3-16 | ITB Boarding Area Holdrooms – Total Area Requirements (square feet)

Boarding Area	Holdroom Type	Existing	2018	2023	Base Constrained	High Constrained
A	ADG IV	12,600	3,200	3,200	3,200	3,200
	ADG V	37,400	65,700	65,700	65,700	65,700
	ADG VI	12,800	17,600	17,600	17,600	17,600
	Total Holdroom Area	62,800	86,500	86,500	86,500	86,500
G	ADG V	60,790	73,000	65,700	65,700	65,700
	ADG VI	6,210	17,600	17,600	17,600	17,600
	Total Holdroom Area	67,000	90,600	83,300	83,300	83,300
Boarding Area H	ADG V	-	-	43,800	43,800	43,800

Note: *ADG = Airplane Design Group*

Source: Landrum & Brown, Inc., July 2015

U.S. Customs and Border Protection: The CBP facility requirements are based on the CBP Airport Technical Design Standards (ATDS) issued in June 2012. This document identifies all CBP spatial requirements based on the projected numbers of peak hour arriving passengers. The ATDS do not account for processing efficiencies associated with recent initiatives, such as Automated Passport Control (APC) and Mobile Passport Control (MPC), which were implemented at many U.S. gateway airports, including SFO. The ATDS do not account for actual CBP officer staffing limitations. As APC and MPC use increases and become available to passengers with visitor visas, throughput will increase and the overall spatial requirements will be reduced.

The peak hour arriving passenger count for each of the planning activity levels is provided in **Table 4.3-17**. Peak hour arriving passengers are divided by boarding area because the CBP primary and secondary processing areas are separate. The corresponding CBP facility requirements are provided in **Table 4.3-18**.

Public Space – Restrooms: Pre-security public restroom requirements are based on a square footage factor applied to the peak number of originating and terminating passengers plus meeters and greeters and well-wishers. The total area for pre-security restrooms have been converted into the number of modules required.

The facility requirements for post-security public restrooms are based on a typical restroom module for each equivalent aircraft (EQA), which is a narrowbody aircraft with 150 seats. The widebody aircraft gates at each boarding area have been converted to EQA using the number of seats on the largest aircraft accommodated at each gate. The typical restroom module is approximately 2,500 square feet and includes men's and women's restrooms with 15–20 fixtures each, a nursing room, a gender-neutral or family restroom, and a janitor's closet. This matches the average size of post-security public restrooms in Terminal 2.

Table 4.3-19 shows the planning factors for the pre-security restroom requirements. **Table 4.3-20** shows the planning factors for the post-security restroom requirements.

Table 4.3-17 | ITB Peak Hour International Arriving Passengers

Boarding Area	2018	2023	Base Constrained	High Constrained
A	1,588	1,914	2,431	2,503
G	1,690	1,960	2,714	2,969

Notes: Boarding Area A includes passengers on international flights arriving at the future Terminal 1 swing gates.
Boarding Area G includes passengers on international flights arriving at the future Terminal 3 swing gates and Boarding Area H.

Source: Landrum & Brown, Inc., July 2015

Table 4.3-18 | ITB U.S. CBP Facility Requirements

Facility	Unit	Existing	2018	2023	Base Constrained	High Constrained
Boarding Area A Primary Processing	booths	19	16	19	24	25
	square feet	25,610	21,120	25,080	31,680	33,000
Boarding Area G Primary Processing	booths	23	17	20	27	30
	square feet	28,750	22,400	26,400	35,640	39,600
Boarding Area A Secondary Processing	square feet	6,280	6,300	7,190	9,560	9,560
Boarding Area G Secondary Processing	square feet	6,280	6,300	7,190	9,560	9,560
Boarding Area A Secondary Operations	square feet	[1]	1,660	1,660	2,210	2,210
Boarding Area G Secondary Operations	square feet	[1]	1,660	1,660	2,210	2,210
CBP Administration	square feet	10,600	5,280	5,280	6,720	6,720
Subtotal Area	net square feet	-	64,720	74,460	97,580	102,860
Total Gross Area[2]	square Feet	77,520	71,100	81,400	106,700	112,000

Notes: [1] Secondary Operations space is included in Secondary Processing under existing conditions.
[2] A net-to-gross area factor of 30 percent was applied to Secondary Processing and Administration areas.

Source: Landrum & Brown, Inc., July 2015

Table 4.3-19 | Pre-Security Restroom Planning Factors

Description	Unit	Factor
Restroom area per peak hour passenger	square feet	2
Well-wisher ratio	well-wishers per passenger	0.5
Meeter and greeter ratio	meeters and greeters per passenger	0.3

Source: Landrum & Brown, Inc., July 2015

Table 4.3-20 | Post-Security Restroom Planning Factors

Description	Unit	Factor
Equivalent aircraft	passengers per equivalent aircraft	150
Restroom ratio	equivalent aircraft per restroom	8
Restroom module size	square feet	2,500

Source: Landrum & Brown, Inc., July 2015

Table 4.3-21 shows the facility requirements for the post-security restrooms. As indicated, the number of restroom modules does not increase because the number of EQA at each boarding area remains the same. However, the restroom module used to determine the requirements is larger than most of the existing restrooms in the ITB, and will ultimately increase the total area of restrooms at each boarding area. **Table 4.3-22** shows the facility requirements for pre-security restrooms.

Public Space – Arrivals Hall: Table 4.3-23 shows the planning factors used to develop the Arrivals Hall requirements. **Table 4.3-24** shows the resulting facility requirements.

Table 4.3-21 | ITB Post-Security Restroom Facility Requirements

Boarding Area	Unit	Existing[1]	2018	2023	Base Constrained	High Constrained
A	EQA	44	44	44	44	44
	restroom modules	6	6	6	6	6
G	EQA	47	47	44	44	44
	restroom modules	6	6	6	6	6
H	EQA	-	-	10	10	10
	restroom modules	-	-	2	2	2

Notes: EQA = Equivalent Aircraft
Existing boarding area restrooms include those in the international arrivals corridor.
[1] Existing restroom modules are smaller than planned modules.

Source: Landrum & Brown, Inc., July 2015

Table 4.3-22 | ITB Pre-Security Restroom Facility Requirements

Description	Existing	2018	2023	Base Constrained	High Constrained
Occupants (passengers, well-wishers, and meeters and greeters)	5,350	6,060	7,090	8,270	9,490
Restroom Area (square feet)	13,900	17,500	20,000	20,000	25,000
Restroom Modules	8	7	8	8	10

Note: Total restroom modules requirements include all pre-security restrooms on the Departures and Arrivals levels of the ITB.

Source: Landrum & Brown, Inc., July 2015

Table 4.3-23 | Arrivals Hall Planning Factors

Description	Unit	Factor
Meeter and Greeter Ratio[1]	meeters/greeters per passenger	0.3
Area per Occupant[2]	square feet	20.5
Seating Area[2]	percent of total area	20
Circulation Width	feet	25
Dwell Time – Passengers[2]	minutes	5
Dwell Time – Meeters and Greeters[2]	minutes	30

Note: [1] Based on Landrum & Brown analysis and industry comparisons.
[2] International Air Transport Association and Airport Cooperative Research Program Report 25, Airport Development Reference Manual, 10th Edition, March 2014.

Source: Landrum & Brown, Inc., July 2015, except as noted

Table 4.3-24 | Arrivals Hall Facility Requirements

Description	Existing	2018	2023	Base Constrained	High Constrained
Total Occupants (Passengers, Meeters, and Greeters)[1]	-	610	720	950	1,025
Total Occupant Area[2] (square feet)	-	15,140	17,870	23,360	25,200
Circulation Area (square feet)	-	6,500	6,500	6,500	6,500
Total Arrivals Hall Area (square feet)	30,000	21,640	24,370	29,860	31,700

Notes: [1] Based on peak hour arriving passengers and meeters and greeters ratio.
[2] Based on Optimal Level of Service as described in International Air Transport Association, Airport Design Reference Manual, 10th Edition, March 2014.

Source: Landrum & Brown, Inc., July 2015

Non-Public Space – Airline Support Space: Airline support space includes the space required for GSE operations, crew services, aircraft and ground vehicle maintenance, and airline administration. These functions are primarily accommodated on Level 1 of the ITB. The facility requirements for airline support space are based on the ratio of existing square footage of airline support space per EQA. This approach provides a general reference for airline support space requirements that should be confirmed with the airlines during the programming and design phase.

Non-Public Space – Terminal Support Space: Terminal support space includes the areas for building maintenance offices, workshops and storage, and janitorial closets and storage. The facility requirements for terminal support space are based on the ratio of existing terminal support space to functional area.[16] This approach provides a general reference for terminal support space requirements, but the requirements should be confirmed during the programming and design phase.

Table 4.3-25 shows the planning factor used to develop the airline and terminal support space requirements. **Table 4.3-26** shows the resulting requirements.

16 Functional area includes all areas used to process, or support the processing of, passengers and aircraft, including concessions.

Table 4.3-25 | Support Space Planning Factor

Description	Unit	Factor
Airline		
Support Space per Equivalent Aircraft	square feet	584
ITB		
Terminal Support Space to Total Functional Terminal Area	percent	2.80

Source: Landrum & Brown, Inc., July 2015

Table 4.3-26 | Support Space Planning Factor

Description	Existing	2018	2023	Base Constrained	High Constrained
Airline					
Support Space (square feet)	53,170	53,170	57,230	57,230	57,230
ITB					
Support Space (square feet)	42,560	42,160	55,660	56,070	57,660

Source: Landrum & Brown, Inc., July 2015

4.3.4 Baggage Handling System

The facility requirements for the baggage handling system (BHS) were developed based on an analysis of future flight schedules and the applicable passenger and baggage processing metrics. The requirements were determined for the 2018, Base Constrained, and High Constrained planning activity levels. The requirements to consider in designing a BHS are:

Outbound Baggage

- Originating Bag Rate – the peak baggage processing demand for departing passengers whose journeys begin at SFO. The originating bag rate is measured in bags per minute (BPM).
- Transfer Bag Rate – the peak baggage processing demand for passengers that use SFO as a transfer point within their journeys. The transfer bag rate is measured in BPM.
- Screening Bag Rate – the peak baggage processing demand for checked baggage that must be screened at SFO. The screening bag rate includes the combined peak baggage processing demand for originating, international-to-domestic, and international-to-international transfer passengers. This screening bag rate is measured in BPM.
- Early Bag Storage (EBS) – if a bag arrives into the BHS before the flight's baggage make-up position is open in the bagroom, the bag is considered early and must be stored within the system until the baggage make-up area for its flight is open. EBS requirements are measured in numbers of bags that must be stored in the system.
- Baggage Make-up Requirements – the peak number of baggage carts that must be available at the baggage make-up area at any one time to load baggage from the BHS to the carts for transport to the appropriate departing aircraft. Depending on aircraft size, between one and eight carts per aircraft may be required during the baggage make-up period. Baggage makeup demand varies based on whether or not a bulk EBS area is available, so the requirements are calculated with and without EBS. These requirements are measured in numbers of baggage cart staging positions.

Inbound Baggage

- Arriving Bag Rate – the peak baggage processing demand for passengers who end their journeys at SFO. The arriving bag rate is measured in BPM.
- Claim Presentation – the perimeter length of the baggage claim devices required to provide adequate space for passengers in the baggage claim area. Claim presentation is measured in linear feet of claim device accessible to passengers retrieving bags.

Details concerning the development of BHS facility requirements can be found in **Appendix G, Baggage Handling System Alternatives Analysis**. A summary of BHS baggage requirements for each boarding area based on the three future peak month average day flight schedules are provided in **Table 4.3-27** through **Table 4.3-33**.

Table 4.3-27 | Boarding Area A Facility Requirements

Facility Requirements	Planning Activity Levels		
	2018	Base Constrained	High Constrained
Originating Bag Rate (bags per minute)	15	26	28
Transfer Bag Rate (bags per minute)	0	0	0
Screening Bag Rate (bags per minute)	17	30	32
Early Bag Storage (number of bags)	281	491	532
Make-Up Requirements with EBS (positions)	54	80	80
Make-Up Requirements without EBS (positions)	70	94	94
Arriving Bag Rate (bags per minute)	52	87	90
Claim Presentation (linear feet)	1,122	2,427	2,970

Note: EBS = Early Bag Storage

Sources: Landrum & Brown, Inc., Peak Month Average Day Flight Schedules, October 2014; BNP Associates, October 2014

Table 4.3-28 | Boarding Area B and C Facility Requirements

Facility Requirements	Planning Activity Levels		
	2018	Base Constrained	High Constrained
Originating Bag Rate (bags per minute)	26	29	31
Transfer Bag Rate (bags per minute)	7	8	8
Screening Bag Rate (bags per minute)	28	30	33
Early Bag Storage (number of bags)	527	602	635
Make-Up Requirements with EBS (positions)	108	108	112
Make-Up Requirements without EBS (positions)	152	153	158
Arrival Bag Rate (bags per minute)	75	83	89
Claim Presentation (linear feet)	1,067	1,291	1,601

Note: *EBS = Early Bag Storage*

Sources: Landrum & Brown, Inc., Peak Month Average Day Flight Schedules, October 2014; BNP Associates, October 2014

Table 4.3-29 | Boarding Area D Facility Requirements

Facility Requirements	Planning Activity Levels		
	2018	Base Constrained	High Constrained
Originating Bag Rate (bags per minute)	10	14	17
Transfer Bag Rate (bags per minute)	9	11	13
Screening Bag Rate (bags per minute)	15	17	21
Early Bag Storage (number of bags)	254	335	411
Make-Up Requirements with EBS (positions)	46	62	70
Make-Up Requirements without EBS (positions)	63	86	97
Arrival Bag Rate (bags per minute)	42	52	56
Claim Presentation (linear feet)	460	720	924

Note: *EBS = Early Bag Storage*

Sources: Landrum & Brown, Inc., *Peak Month Average Day Flight Schedules*, October 2014; BNP Associates, October 2014

Table 4.3-30 | Boarding Area D (United Airlines Only) Facility Requirements

Facility Requirements	Planning Activity Levels		
	2018	Base Constrained	High Constrained
Originating Bag Rate (bags per minute)	2	2	3
Transfer Bag Rate (bags per minute)	22	15	19
Screening Bag Rate (bags per minute)	4	6	8
Early Bag Storage (number of bags)	118	119	150
Make-Up Requirements with EBS (positions)	16	17	20
Make-Up Requirements without EBS (positions)	21	23	29
Arrival Bag Rate (bags per minute)	32	21	34
Claim Presentation (linear feet)	265	210	275

Note: *EBS = Early Bag Storage*

Sources: Landrum & Brown, Inc., Peak Month Average Day Flight Schedules, October 2014; BNP Associates, October 2014

Table 4.3-31 | Boarding Area E and F Facility Requirements

Facility Requirements	Planning Activity Levels		
	2018	Base Constrained	High Constrained
Originating Bag Rate (bags per minute)	17	20	21
Transfer Bag Rate (bags per minute)	36	33	42
Screening Bag Rate (bags per minute)	21	23	25
Early Bag Storage (number of bags)	727	845	900
Make-Up Requirements with EBS (positions)	116	122	127
Make-Up Requirements without EBS (positions)	184	192	200
Arrival Bag Rate (bags per minute)	52	47	61
Claim Presentation (linear feet)	710	702	718

Note: *EBS = Early Bag Storage*

Sources: Landrum & Brown, Inc., Peak Month Average Day Flight Schedules, October 2014; BNP Associates, October 2014

Table 4.3-32 | Boarding Area G Facility Requirements

Facility Requirements	Planning Activity Levels		
	2018	Base Constrained	High Constrained
Originating Bag Rate (bags per minute)	15	22	24
Transfer Bag Rate (bags per minute)	14	26	20
Screening Bag Rate (bags per minute)	20	27	30
Early Bag Storage (number of bags)	434	591	680
Make-Up Requirements with EBS (positions)	88	97	97
Make-Up Requirements without EBS (positions)	107	127	126
Arrival Bag Rate (bags per minute)	66	106	95
Claim Presentation (linear feet)	1,508	2,016	2,212

Note: *EBS = Early Bag Storage*

Sources: Landrum & Brown, Inc., Peak Month Average Day Flight Schedules, October 2014; BNP Associates, October 2014

Table 4.3-33 | Boarding Area H Facility Requirements

Facility Requirements	Planning Activity Levels		
	2018	Base Constrained	High Constrained
Originating Bag Rate (bags per minute)	0	1	2
Transfer Bag Rate (bags per minute)	0	4	11
Screening Bag Rate (bags per minute)	0	2	2
Early Bag Storage (number of bags)	0	41	74
Make-Up Requirements with EBS (positions)	0	5	8
Make-Up Requirements without EBS (positions)	0	8	10
Arrival Bag Rate (bags per minute)	0	5	16
Claim Presentation (linear feet)	0	66	127

Note: *EBS = Early Bag Storage*

Sources: Landrum & Brown, Inc., Peak Month Average Day Flight Schedules, October 2014; BNP Associates, October 2014

4.4 GROUND ACCESS AND PARKING

The landside ground access and parking facilities requirements are summarized in this section. Requirements are based on data and observations collected between 2012 and 2014, escalated to reflect facility needs corresponding to the four planning activity levels.

4.4.1 Terminal Circulation Network

Airport staff collected data on peak hour terminal area roadway traffic during the peak month for activity at SFO. These hourly counts were assumed to increase proportionately with peak hour origin and destination (O&D) passengers. The hourly counts are based on the continuation of current roadway operational patterns and existing land uses, with the exception of the proposed hotel on South McDonnell Road. Roadway capacities were identified using the flow rates for airport terminal area access and circulation at Level of Service (LOS) C as defined in ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations,* 2010. The peak hour counts were compared with existing roadway capacities to determine the need for future improvements.

Terminal area roadways are shown on **Exhibit 4.4-1**. **Table 4.4-1** defines the roadway segments shown on the exhibit and shows the projected traffic volumes and existing roadway capacities. Volumes shown in **red** on the table indicate where roadway segment demand exceeds the capacity at LOS C.

Table 4.4-1 | Peak Hour Traffic Volumes on Terminal Roadways

Segment	Roadway and Location	Peak Hour	Existing Lanes	Capacity (LOS C)	2013	2018	2023	Base Constrained	High Constrained
Q	Southbound 101 Ramp to Lower ITB	Th – 5 pm	1	1,250	499	600	620	910	980
R	Southbound 101 Ramp to Upper ITB	Sa – 11 am	1	1,250	601	730	740	1,090	1,190
S	Northbound 101 Ramp to Upper ITB	Su – 11 am	1	1,250	531	640	650	970	1,050
T	Northbound 101 Ramp to Lower ITB	M – 12 pm	1	1,250	255	310	310	460	500
U	Northbound 101 Ramp to Lower Domestic Terminals	Th – 9 pm	1	1,250	478	577	650	710	800
V	Northbound 101 Ramp to Upper Domestic Terminals	W – 6 am	1	1,250	524	630	710	780	880
W	Southbound 101 Ramp to Lower Domestic Terminals	Su – 2 pm	2	2,500	1,606	1,940	2,180	2,400	2,700
X	Upper Level ITB Roadway	Su – 11 am	2	1,600	1,119	1,350	1,380	2,040	2,210
Y	Lower Level ITB Roadway	W – 1 pm	2	1,600	868	1,050	1,070	1,580	1,710
AD	Eastbound S. Link Road East of S. McDonnell Road	F – 1 pm	1	800	110	130	140	200	220
AE	Westbound S. Link Road East of S McDonnell Road	Th – 5 pm	1	800	619	750	760	1,130	1,220
AF	Lower Level Domestic Terminals Roadway	Th – 9 pm	2	1,600	1,328	1,600	1,810	1,980	2,230

Notes: Locations Z through AC were analyzed as part of the curbside roadway requirements. Parking entrances and exits (locations P1 through P7) were not included in this analysis.

Source: LeighFisher, October 2014, except as noted

M = Monday
T = Tuesday
W = Wednesday
Th = Thursday
F = Friday
Sa = Saturday
Su = Sunday

ITB = International Terminal
LOS = Level of Service
N = North
S = South

Table 4.4-1 | Peak Hour Traffic Volumes on Terminal Roadways (continued)

Segment	Roadway and Location	Peak Hour	Existing Lanes	Capacity (LOS C)	2013	2018	2023	Base Constrained	High Constrained
AG	Upper Level Domestic Terminals Roadway	M – 6 am	2	1,600	1,790	2,160	2,430	2,670	3,010
AH	Domestic Terminals Return-to-Terminal	Tu – 10 pm	1	800	90	110	120	130	150
AI	Eastbound N. Link Road east of N. McDonnell Road	Tu – 3 pm	2	800	482	580	590	880	950
AJ	Westbound N. Link Road east of N. McDonnell Road	W – 2 pm	1	800	70	80	90	130	140
AK	ITB Return-to-Terminal	M – 10 pm	2	1,600	659	800	810	1,200	1,300
AL	ITB Arrivals Exit to Southbound 101	Tu – 3 pm	1	1,250	327	390	400	600	650
AM	ITB Arrivals Exit to Northbound 101 and 380	Tu – 3 pm	1	1,250	264	320	330	480	520
AN	ITB Departures Exit to Northbound 101 and 380	M – 11 am	1	1,250	539	650	660	980	1,060
AO	ITB Departures Exit to Southbound 101	M – 11 am	1	1,250	438	530	540	800	860
AP	Domestic Terminal Exit to Southbound 101	Su – 8 pm	2	2,500	834	1,010	1,130	1,240	1,400
AQ	Domestic Terminal Exit to Northbound 101 and 380	W – 2 pm	2	2,500	1,502	1,810	2,040	2,240	2,520
AR	Domestic Terminal entrance ramp to Northbound 101	Th – 9 pm	1	1,250	1,203	1,450	1,480	2,190	2,370
AS	Ramp to 380	Th – 6 pm	2	2,500	543	660	670	990	1,070
AT	Terminal 1 Turnaround	M – 11 am	1	800	340	410	460	510	570

Notes: Locations Z through AC were analyzed as part of the curbside roadway requirements. Parking entrances and exits (locations P1 through P7) were not included in this analysis.

Source: LeighFisher, October 2014, except as noted

M = Monday
T = Tuesday
W = Wednesday
Th = Thursday
F = Friday
Sa = Saturday
Su = Sunday

ITB = International Terminal
LOS = Level of Service
N = North
S = South

As shown on **Exhibit 4.4-2**, currently one roadway segment is over capacity:

- Upper Level Domestic Terminals Roadway [AG]

Also shown on Exhibit 4.4-2, one additional roadway will be over capacity at the 2018 activity level:

- Domestic Terminal entrance ramp to northbound U.S. 101 [AR]

As shown on **Exhibit 4.4-3**, another roadway will be over capacity at the 2023 activity level:

- Lower Level Domestic Terminals Roadway [AF]

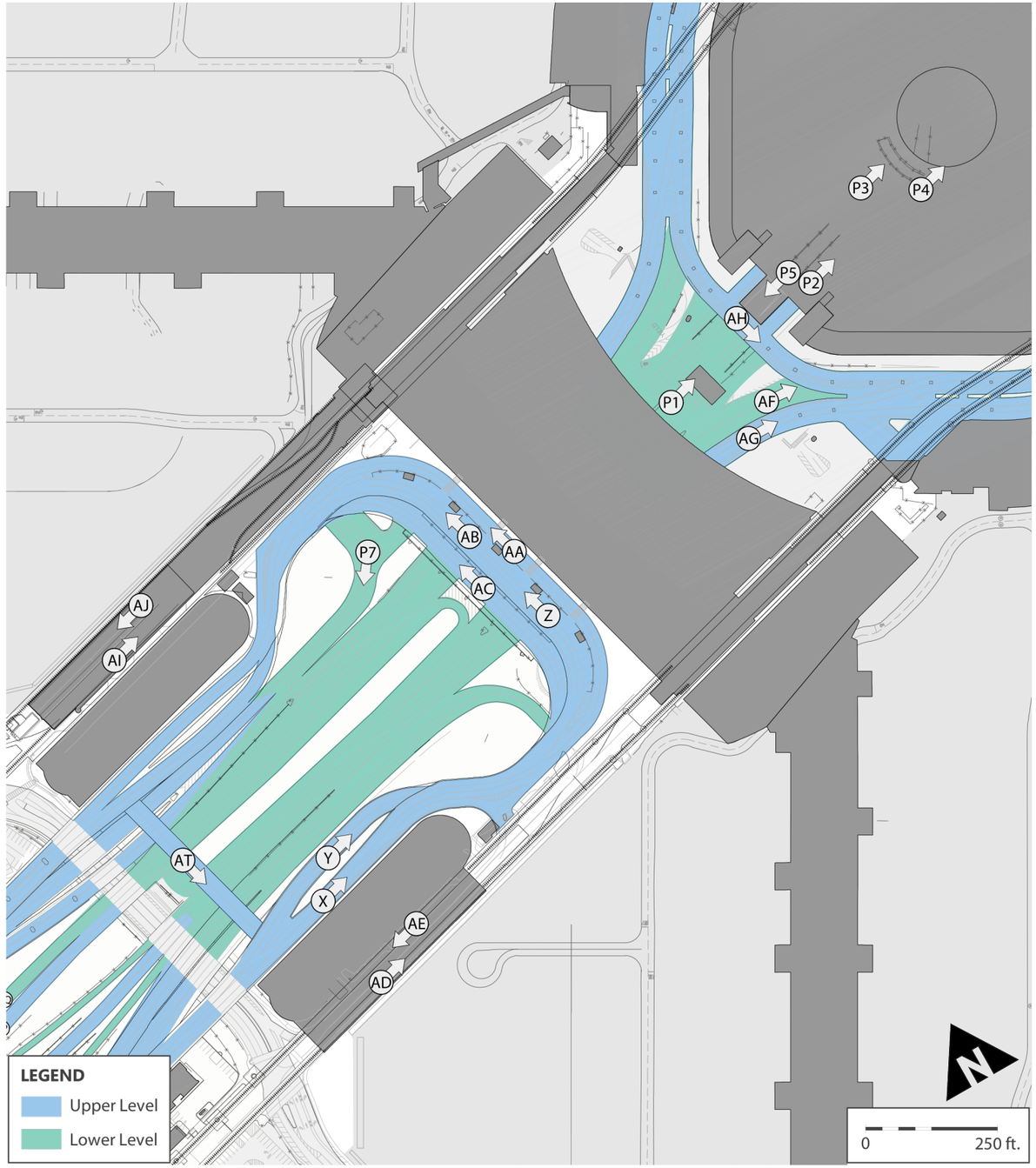
As shown on **Exhibit 4.4-4**, three additional roadways will be over capacity at the Base Constrained activity level:

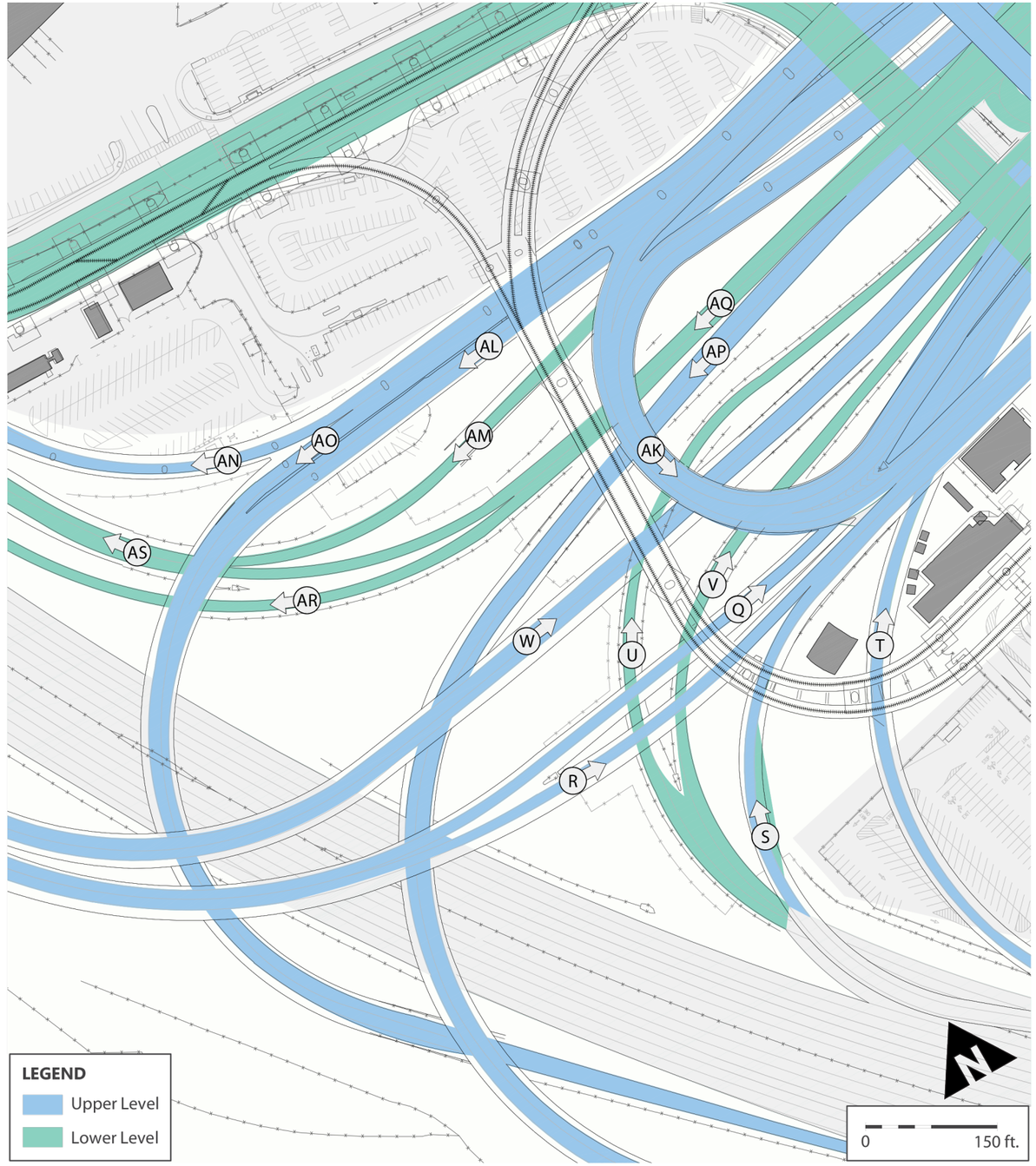
- Upper Level ITB Roadway [X]
- Westbound S. Link Road east of S. McDonnell Road [AE]
- Eastbound N. Link Road east of N. McDonnell Road [AI]

As shown on **Exhibit 4.4-5**, two additional roadway segments will be over capacity at the High Constrained activity level:

- Southbound US-101 ramp to the Lower Domestic Terminals Roadway [W]
- Lower Level ITB Roadway [Y]

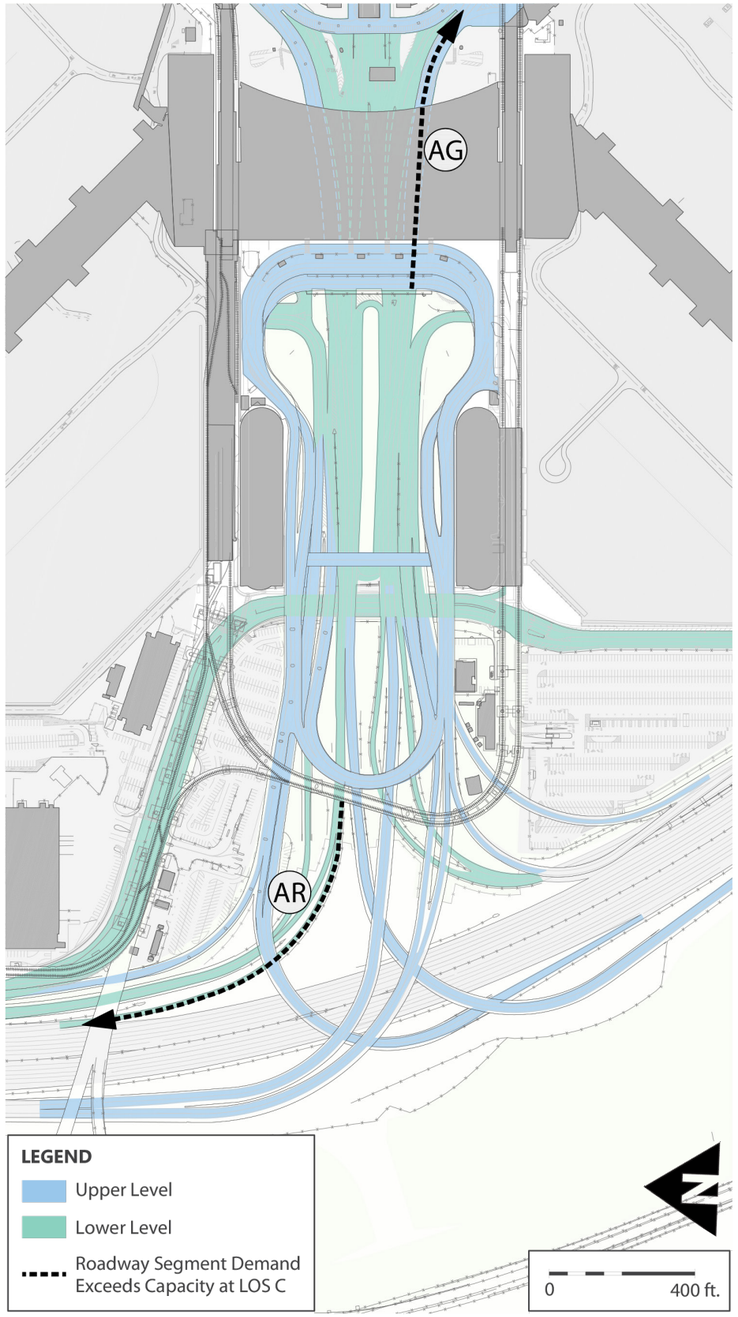
Exhibit 4.4-1 | Terminal Area Roadways





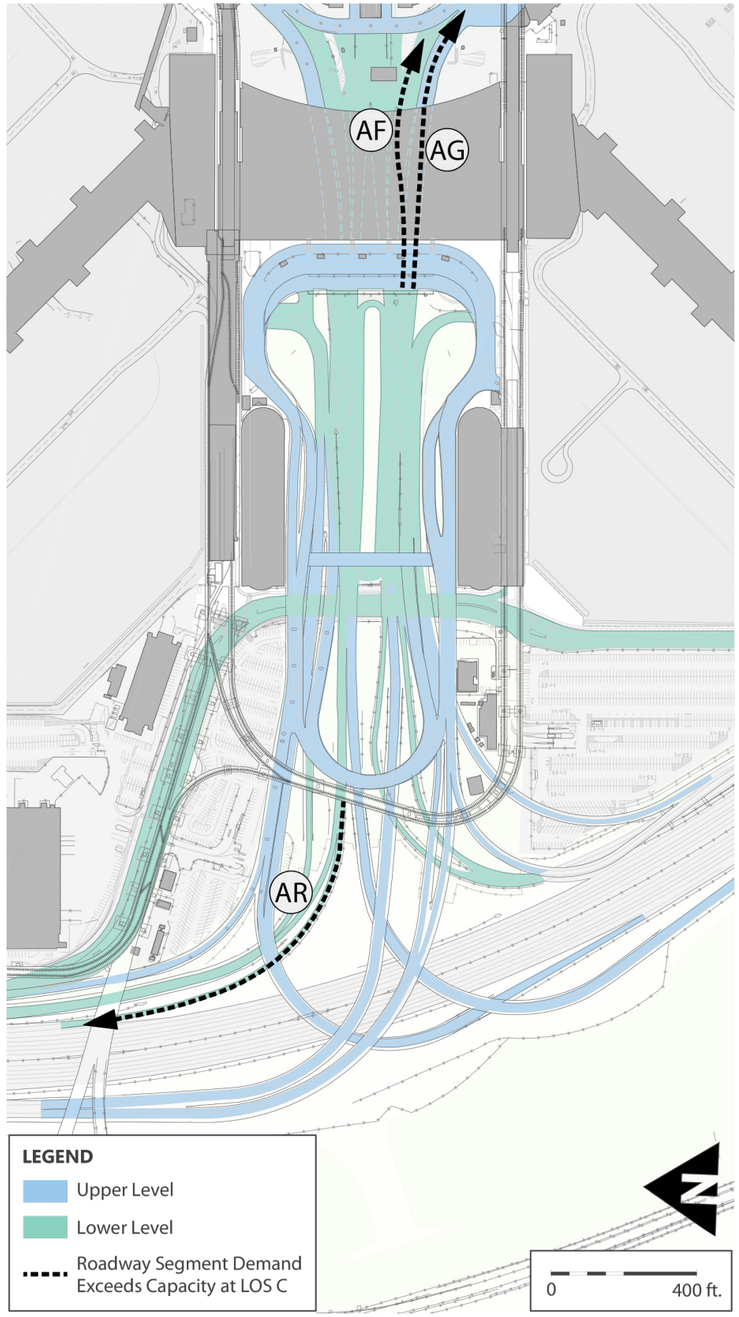
Sources: LeighFisher, October 2014; traffic count locations provided by San Francisco International Airport, Landside Operations: Ricondo and Associates Inc., 2016

Exhibit 4.4-2 | Terminal Area Roadway Requirements – Existing and 2018 Activity Levels



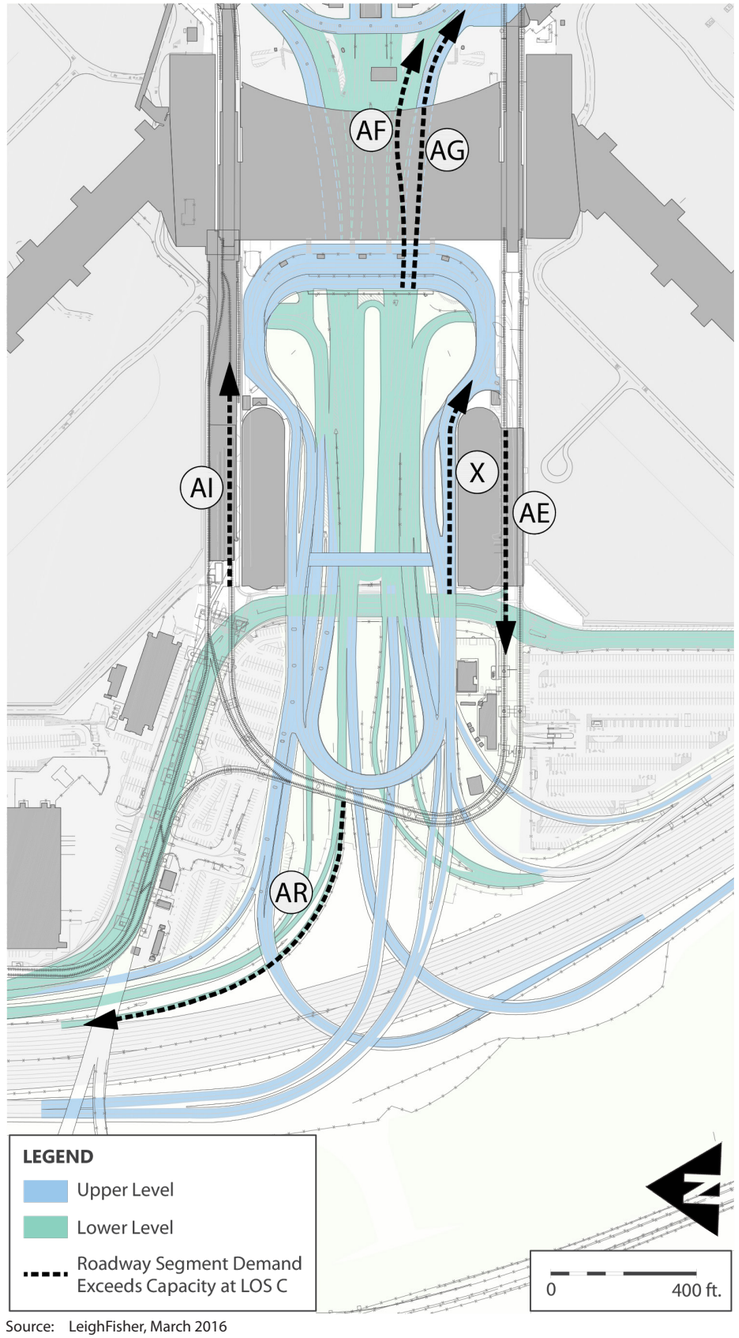
Source: LeighFisher, March 2016

Exhibit 4.4-3 | Terminal Area Roadway Requirements – 2023 Activity Level



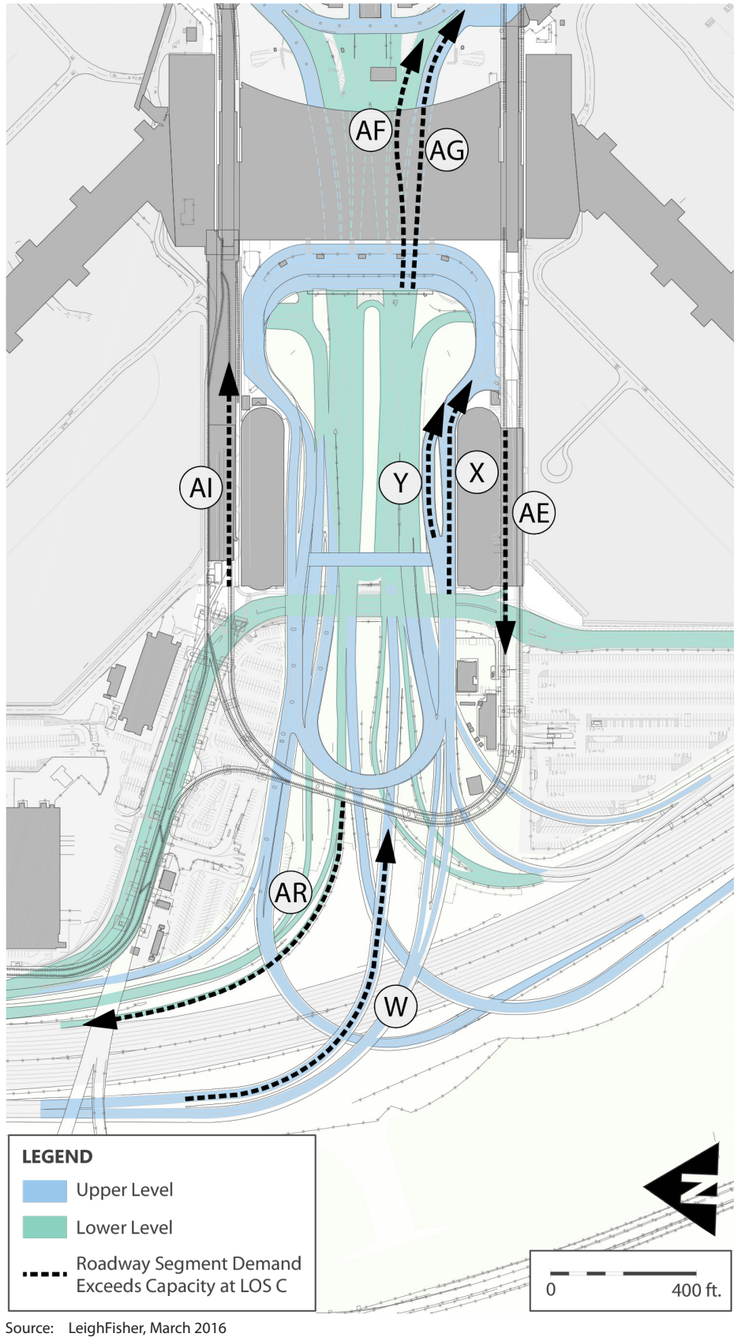
Source: LeighFisher, March 2016

Exhibit 4.4-4 | Terminal Area Roadway Requirements – Base Constrained Activity Level



Source: LeighFisher, March 2016

Exhibit 4.4-5 | Terminal Area Roadway Requirements – High Constrained Activity Level



Source: LeighFisher, March 2016

4.4.2 Curbside

Curbside length requirements were estimated using 2013 and forecast peak hour traffic volumes by terminal for the planning activity levels. The peak hour traffic volumes were calculated using the *San Francisco International Airport Forecast Update* report, Landrum & Brown Inc., April 2014. Mode splits (i.e., type of ground transportation service) provided in the *Curbside Alternatives Analysis Simulation Report,* HNTB, February 2013, were used in the analysis conducted to determine curbside requirements. Flow rates for airport terminal area access and circulation roadways at LOS C define curbside capacities. Levels of service are defined in ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations,* 2010, as shown in **Exhibit 4.4-6**.

The non-uniform arrival rate and distribution of vehicles at the terminal curbside were accounted for by using a Poisson distribution-based adjustment factor, assuming a 90 percent probability that a space would be available.

The analysis reflects standard vehicle lengths and an allowance for maneuvering space, as shown in **Table 4.4-2**.

Table 4.4-2 | Curbside Allowance to Accommodate Vehicle Types

Vehicle Type	Curbside Allowance (Feet)
Private Vehicle	25
Taxicab	25
Limousine	30
Shared-Ride Van	30
SFO Parking Shuttle	30
Off-Airport Parking Shuttle	30
Hotel/Motel Shuttle	30
Airporter	50
Airline Crew Bus	50
Public Bus (SamTrans)	50
Charter Bus	50
SFO Employee Shuttle	30
Service Vehicle	30

Note: Curbside allowance Includes vehicle length plus maneuvering space.
Source: LeighFisher, November 2014

Exhibit 4.4-6 | Airport Curbside Levels of Service

Source: LeighFisher. ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations*, 2010

Table 4.4-3 presents curbside dwell times by vehicle type for the domestic terminals; **Table 4.4-4** presents dwell times for the ITB. Reported dwell times on the Departures Level (drop-off) are as much as 17 percent longer than the reported dwell times on the Arrivals Level (pick-up), which is inconsistent with observations at other airports and may represent aggressive enforcement of no-waiting rules on the Arrivals Level.

Table 4.4-5 summarizes the available and required curbside lengths for drop-off and pick-up operations. Curbside requirements that exceed existing curbside capacities are indicated in **red** in the table. None of the existing curbside facilities provides sufficient length to accommodate the High Constrained LOS C curbside requirements.

These requirements address only curbside length and not the number and geometry of adjacent through lanes. The number of required adjacent through lanes at a curbside may vary based on the volume of traffic, the amount of double and triple parking allowed by curbside enforcement personnel, the number of lanes designated for curbside parking and maneuvering, and the number of crosswalks. A minimum of two through lanes is recommended at any locale, and as many as four through lanes may be required in some locations.

Terminal 1 Curbside
Source: San Francisco International Airport

Table 4.4-3 | Domestic Terminals Average Dwell Times at Curbside (seconds)

Vehicle Type	Drop-Off	Pick-Up	Combined Drop-Off/Pick-Up
Private Vehicle	82	68	--
Taxicab	74	41	--
Limousine	81	78	--
Shared-Ride Van	94	564	--
SFO Parking Shuttle	--	--	28
Off-Airport Parking Shuttle	--	--	36
Hotel/Motel Shuttle	--	--	88
Airporter	71	84	--
Airline Crew Bus	164	No data	--
Public Bus (SamTrans)	--	--	No data
Charter Bus	69	No data	--

Note: Dwell times listed as "–" indicate that the vehicle mode does not stop for this purpose (e.g., a private vehicle does not have a combined pick-up/drop-off dwell time, as this vehicle mode drops off and picks up in separate locations).

Source: Curbside Alternatives Analysis Simulation Report, February 2013

Table 4.4-4 | International Terminal Building Average Dwell Times at Curbside (seconds)

Vehicle Type	Drop-Off	Pick-Up	Combined Drop-Off/Pick-Up
Private Vehicle	128	97	–
Taxicab	112	87	–
Limousine	No data	65	–
Shared-Ride Van	64	325	–
SFO Parking Shuttle	–	–	158
Off-Airport Parking Shuttle	–	–	29
Hotel/Motel Shuttle	–	–	126

Note: Dwell times listed as "–" indicate that the vehicle mode does not stop for this purpose (e.g., a private vehicle does not have a combined pick-up/drop-off dwell time, as this vehicle mode drops off and picks up in separate locations).

Source: Curbside Alternatives Analysis Simulation Report, February 2013

Table 4.4-5 | Available and Required Curbside Length at Level of Service C (feet)

Terminal[1]	Available	Planning Activity Levels				
		2013	2018	2023	Base Constrained	High Constrained
Departure (Drop-Off) Curb						
1	1,770	1,950	1,980	2,060	2,240	2,410
2	1,221	1,390	1,410	1,560	1,710	1,850
3	1,541	1,710	1,740	1,990	2,190	2,390
International	1,038	1,860	2,000	2,350	2,570	2,820
Arrival (Pick-Up) Curb						
1	1,143	880	910	1,060	1,160	1,270
2	661	670	720	770	820	880
3	1,242	1,010	1,060	1,220	1,320	1,430
International	859	890	970	1,040	1,170	1,360

Note: [1] *Curb lengths exclude crosswalks, no parking zones, and other zones that are not available for pick-up/drop-off. Available curb lengths exclude space currently allocated for taxicab pick-up and future departure curb requirements exclude space required by taxicabs.*

Source: LeighFisher, October 2014

4.4.3 Public Parking

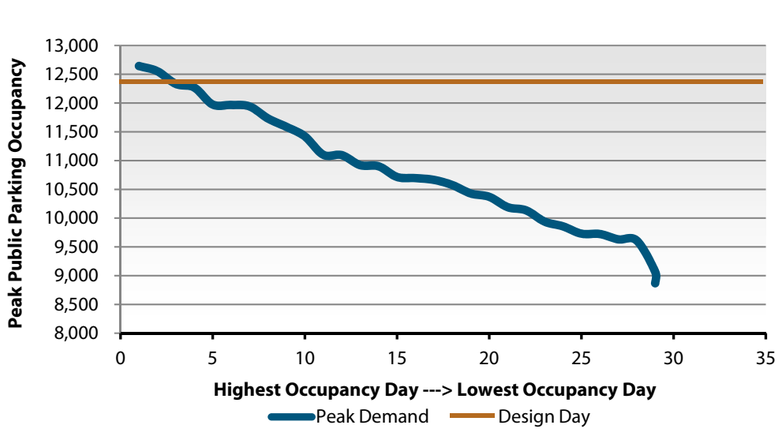
Public parking requirements are based on a design day, which represents a typical busy day during the busiest month. The design day does not represent the few days during the year, such as days during the winter holiday season, when the Airport experiences exceedingly high demand. Given the competing priorities for land at the Airport, it is not economically prudent to provide spaces that are needed only a few days of the year.

Public Parking and Latent Demand

The design day parking requirements were determined by sorting the historical peak period occupancies of all facilities and ranking them from highest to lowest occupancy. **Exhibit 4.4-7** shows the resulting distribution for the peak month for parking at the Airport (June).

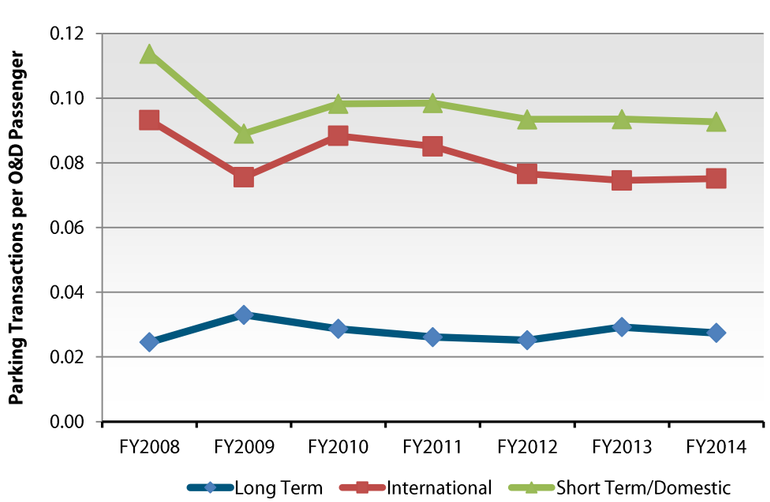
If existing parking facility occupancy were well below capacity, future requirements could be extrapolated based on the ratio of occupied spaces to the number of O&D enplaned passengers. However, an insufficient number of spaces are provided at SFO to accommodate all of the customers who wish to park at the Airport, resulting in a latent demand. Evidence of latent parking demand for short-duration Airport parking can be seen by the variations in the proportion of passengers parking at the Airport. As shown on **Exhibit 4.4-8**, between Fiscal Years (FYs) 2008 and 2009, when there were sufficient parking spaces available in all parking products as a result of the downturn in airline passenger traffic, the proportion of passengers parking at the Airport was higher than today's constrained environment.

Exhibit 4.4-7 | Daily Peak Public Parking Occupancy, All Facilities, June 2014



Source: LeighFisher, October 2014; based on data from San Francisco International Airport, Aviation & Parking Management, September 2014

Exhibit 4.4-8 | Parking Transactions per Origin & Destination Passenger



Note: O&D = Origin and Destination

Source: LeighFisher, October 2014; based on data from San Francisco International Airport, Aviation & Parking Management, September 2014

To account for latent demand, three alternative estimates of future parking demand are presented (low-, mid-, and high-growth scenarios) that reflect different historical rates of design day occupied spaces per O&D enplaned passenger:

- In the low-growth scenario, the long-term parking rate observed in FY 2008 and terminal area parking rate observed in FY 2009 were assumed.
- In the mid-growth scenario, the average parking rate for all facilities between FY 2008 through FY 2014 was assumed.
- In the high-growth scenario, the long-term parking rate observed in FY 2009 and the terminal area parking rate observed in FY 2008 were assumed.

In determining future parking requirements, the following conditions were assumed:

- Parking duration patterns (customer length of stay) and seasonal variations will remain unchanged.
- There will be no significant change in the use of transit or non-private vehicles by parking customers. This assumption provides for the most conservative estimate of parking requirements.
- The growth rate of customers parking in privately operated, off-Airport parking facilities will increase at the same rate as the number of O&D passengers.
- There is a circulation factor of 10 percent of the design day requirement. The factor reflects the difficulty motorists have in locating the last available parking spaces in a large facility, accounts for vehicles circulating in a parking structure, and allows for improperly parked vehicles and other inefficiencies. Technologies such as single-space parking detection systems[17] could reduce the circulation factor.

Table 4.4-6 shows total forecast parking space requirements by product type.

17 Single-space parking detection systems consist of sensors that determine the occupancy status of individual parking spaces and display equipment that directs passing motorists to empty spaces.

Electric Vehicle Parking

SFO management policy supports the expanded use of zero-emission vehicles (ZEVs), including electric vehicles (EVs), by employees and passengers. Data provided by SFO Aviation and Parking Management show a 46 percent increase in ChargePoint energy use between January and August 2014 compared with the same period in 2013. Some of this increase is likely to be the result of previously unmet demand because additional charging stations were installed at the Airport in 2014. According to a University of Central Florida Electric Vehicle Transportation Center report,[18] five different sources forecast that electric vehicle sales will increase 20 percent annually in the United States; therefore, a 20 percent growth rate was used throughout the planning period.

Table 4.4-7 summarizes the future requirements for EV parking spaces. At the Base Constrained demand level, EV spaces account for 3 percent to 4 percent of total public parking spaces. At the High Constrained demand level, EV spaces account for 6 percent to 8 percent of total public parking spaces. However, this space allocation does not account for improvements in EV battery life, vehicle range, charging station capabilities, or required charge times.

18 *Electric Vehicle Sales for 2014 and Future Projections*, Electric Vehicle Transportation Center, March 2015. The Electric Vehicle Transportation Center is a University of Central Florida Transportation Center funded by the U.S. Department of Transportation and is a research and education effort to help create the nation's electric-vehicle transportation network.

Table 4.4-6 | Total Public Parking Requirements

Product Type	Existing	2018	2023	Base Constrained	High Constrained
Low-Growth Scenario	15,224	16,900	19,400	20,900	23,900
Close-In Domestic	5,773	6,800	7,700	8,300	9,500
International	2,129	2,600	3,000	3,200	3,700
Long Term	7,322	7,600	8,700	9,300	10,700
Mid-Growth Scenario	15,224	18,700	21,500	23,200	26,500
Close-In Domestic	5,773	7,400	8,400	9,100	10,400
International	2,129	2,900	3,300	3,500	4,000
Long Term	7,322	8,500	9,800	10,600	12,100
High-Growth Scenario	15,224	22,100	25,300	27,300	31,200
Close-In Domestic	5,773	8,600	9,900	10,700	12,200
International	2,129	3,300	3,700	4,000	4,600
Long Term	7,322	10,200	11,600	12,600	14,400
Off-Airport	8,050	8,700	9,900	10,700	12,200

Note: *Number of spaces*

Source: LeighFisher, October 2014; based on data from San Francisco International Airport, Aviation & Parking Management, September 2014

Table 4.4-7 | Electric Vehicle Parking Stall Requirements

User	Existing	2018	2023	Base Constrained	High Constrained
Public	73	151	377	781	1,944
Employee	33	68	170	353	879
Total	106	219	547	1,134	2,823

Source: LeighFisher, November 2014

4.4.4 Rental Car Center

The *Rental Counter Operations Study*, LeighFisher, August 2014, and the *Analysis of Near- and Long-Term Rental Car and Parking Facility Expansion Options Study*, LeighFisher, April 2013, provide an inventory of Rental Car Center (RCC) activity levels in 2013.

The propensity to rent a car, as measured by rental car transactions per O&D passenger, increased by an average of 4.3 percent between 2010 and 2014. The rental car fleet and corresponding facility requirements have increased by approximately 2.2 percent above the proportional growth in O&D passenger traffic.

To account for variability in passenger demand for rental cars, two alternative estimates of future parking demand are presented, low- and high-growth scenarios, which reflect different historical rates of rental car transactions per O&D enplaned passenger:

- **Low-growth scenario:** Requirements increase in direct proportion to growth in O&D passenger traffic, with the exception of the customer service lobby requirement, which increases at half the rate of the other rental car facilities.
- **High-growth scenario:** Requirements increase in proportion to growth in O&D passenger traffic plus the 2.2 percent observed growth in passenger propensity to rent a car.

Table 4.4-8 presents rental car facility requirements. Ready/return car requirements were converted to "equivalent spaces." An equivalent space is a standard 90 degree, 9.5-foot-wide parking space. The total number of equivalent spaces is approximately 87.5 percent of the combined number of ready and return spaces because of the use of nose-to-tail parking for car return spaces.

Table 4.4-8 | Rental Car Facility Requirements

Forecast	2013		2018		2023		Base Constrained		High Constrained	
Growth Scenario	Existing	Required	Low	High	Low	High	Low	High	Low	High
Customer Service Area										
Customer Service Area (square feet)	26,200[1]	19,500	21,400	23,200	23,800	27,700	25,200	30,800	27,900	37,400
Counter Positions	134	69	78	86	89	109	96	125	110	162
Vertical Circulation/ Cores (square feet)	N.A	4,900	5,400	5,800	5,900	6,900	6,300	7,700	7,000	9,400
Ready/Return Facilities										
Ready Spaces		1,700	1,900	2,100	2,200	2,700	2,400	3,100	2,700	4,000
Return Spaces		1,000	1,100	1,200	1,300	1,600	1,400	1,800	1,600	2,300
Total Spaces (efficiency for flexibility)	2,510	2,700	3,000	3,300	3,500	4,300	3,800	4,900	4,300	6,300
Equivalent Spaces	2,861	2,400	2,700	2,900	3,000	3,700	3,300	4,300	3,700	5,500
Quick Turn Around Facilities										
Fuel Nozzles/Vacuums	120	95	110	120	120	150	130	170	150	220
Car Wash Bays	14	12	14	15	16	19	17	22	19	28
Vehicle Stacking/Staging Spaces (nose to tail)	1,714	1,600	1,900	2,100	2,100	2,600	2,300	3,000	2,600	3,900
Vehicle Storage Spaces (nose to tail)	1,820	3,900	6,300	7,000	7,200	8,900	7,800	10,100	8,900	13,100

Note: [1] *Existing lobby space includes both Level 1 and Level 4 lobbies.*

Source: LeighFisher, October 2014, except as noted

4.4.5 Vehicle Staging Areas

Airport policies dictate the size of vehicle staging areas. For master planning purposes, spaces available in commercial vehicle hold lots and private vehicle cell phone lots increase at a rate consistent with numbers of O&D passengers.

Table 4.4-9 shows the requirements for the commercial vehicle hold lot, cell phone lot, and taxicab hold lot.

4.4.6 AirTrain

SFO Operations and Security staff provided data identifying the boarding and alighting counts for five AirTrain stations during a peak month (August 2014). Supplemental AirTrain ridership surveys were conducted in February 2015.

The design hour was identified by analyzing the peak hours across each day. The system-wide design peak hour occurred between 11:00 a.m. and 12:00 p.m. Within the peak hour, observed ridership was ranked from highest to lowest for the 31 days in August 2014, and the peak day (90th percentile busiest day of the month) and average day riderships were identified. **Exhibit 4.4-9** shows a sample analysis for the Blue Line station at Terminal 1. Similar analyses were conducted for each station and line (or direction).

The AirTrain ridership forecast is based on the SFO flight forecasts and Airport survey data:

- *San Francisco International Airport Forecast Update,* Landrum & Brown Inc., April 2014
  - Design-day peak hour passengers for each boarding area
  - Percent of design day O&D and connecting peak hour passengers for each boarding area
  - Percent of overall O&D passengers by boarding area
- *SFO Customer Survey Report*, Corey, Canapary & Galanis, 2013
  - Customer use – Determines the proportion of airline passengers using public transit, rental cars, or Airport parking.
- SFO Aviation & Parking Management, September 2014
  - Parking transaction data at the Airport determine the proportion of customers from each terminal that parked in each on-Airport parking facility. Counts per hour are taken from the Ticket Type Report, while monthly revenue and transactions are taken from the SFO Parking Revenue and Transaction Report.

Trip origin and destination matrices were calibrated against current AirTrain boarding and alighting counts. In determining the future AirTrain ridership requirements, the following were assumed:

- New stations will serve the Airport hotel (Blue and Red Lines) and planned long-term parking facilities at Lot DD (Blue Line), as shown in **Exhibit 4.4-10**.
- Twenty percent of hotel guests will use the AirTrain during the peak hour.
- Ten percent of the number of employee vehicles in the West Field Employee Parking Garage will enter or exit in the peak hour based on prior experience with employee shift change behavior.
- Headways are 3.1 minutes on the Blue Line and 3.5 minutes on the Red Line.
- Vehicle capacity is 40 passengers with luggage and carts, as provided by SFO Operations and Security.

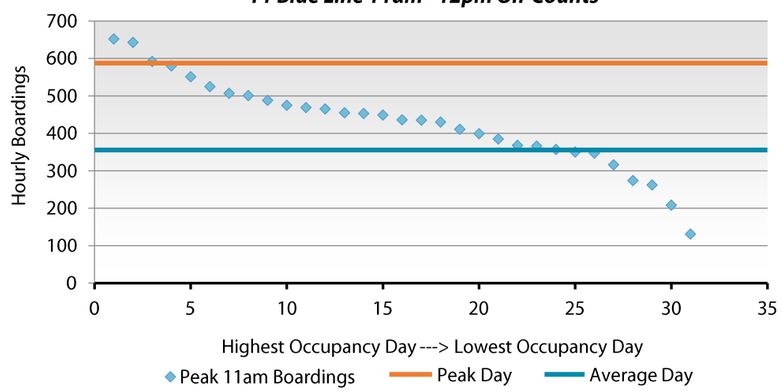
Table 4.4-9 | Hold Lot and Cell Phone Lot Space Requirements

Parking Spaces	Existing	2018	2023	Base Constrained	High Constrained
Commercial Vehicle Hold Lot	94	110	130	140	160
Cell Phone Lot	71	80	90	100	110
Taxicab Hold Lot	359	410	470	510	580

Note: TNCs are included in commercial vehicles.

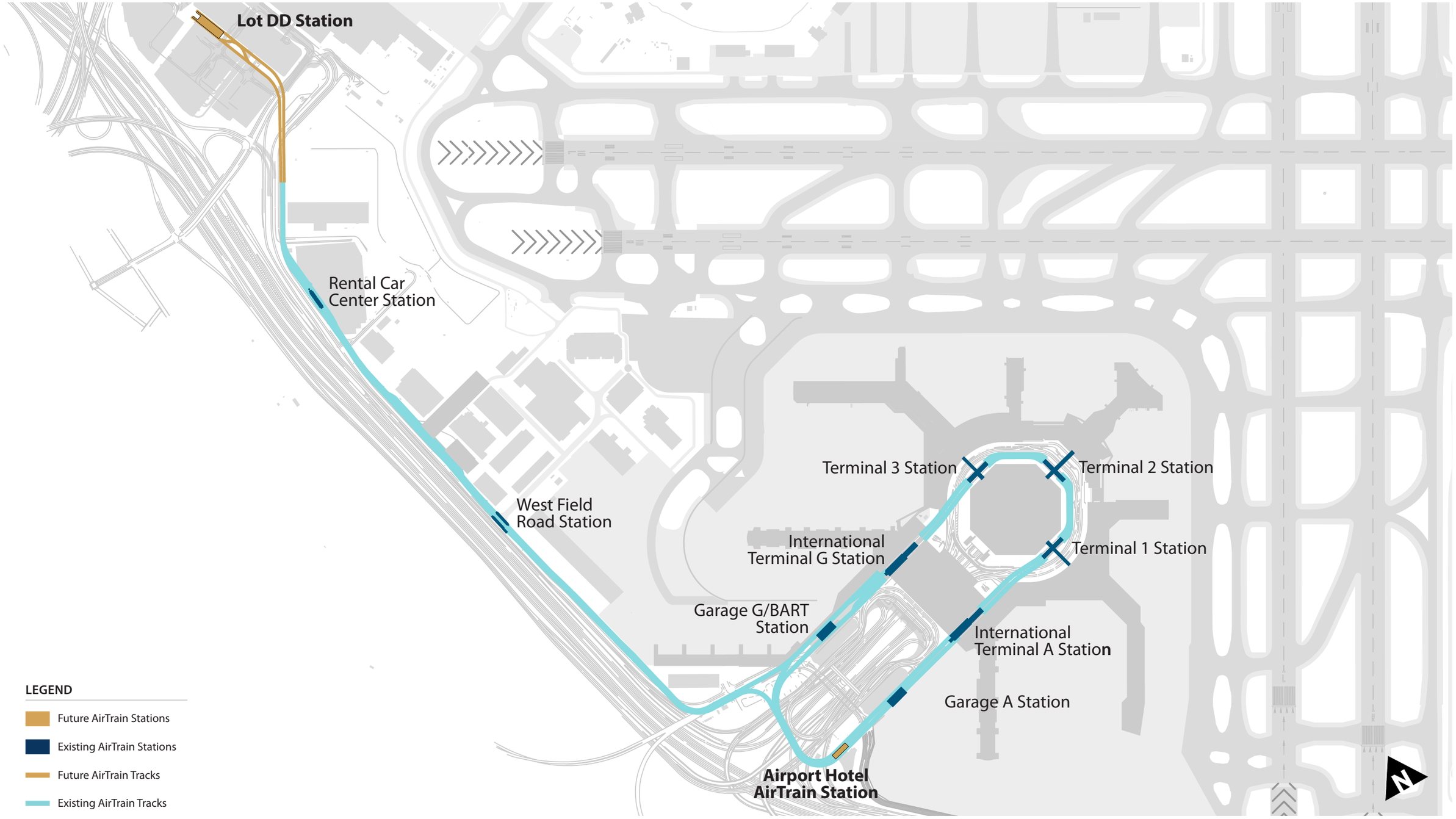
Source: LeighFisher, October 2014, based on forecast factors by Landrum & Brown, Inc., October 2014

Exhibit 4.4-9 | Peak AirTrain Boarding, Terminal 1 Blue Line, August 2014



Source: LeighFisher, October 2014; based on data from San Francisco International Airport, Operations and Security, September 2014

Exhibit 4.4-10 | Proposed Future AirTrain Stations



Source: SFO Airport Layout Plan, 2014; Leigh Fisher 2015; Landrum & Brown, Inc., March 2016

Exhibit 4.4-11 and **Exhibit 4.4-12** summarize the peak hour ridership by line and segment for the Base Constrained and High Constrained flight schedules. A surge factor based on the peak 15-minute ridership rate was applied to the link loads to account for variability in demand over the peak hour.[19] For the Blue Line, the surge factor is 1.24, and for the Red Line, the surge factor is 1.40.

The busiest link on the Blue Line is between Terminal 2 and Terminal 3 and the busiest link on the Red Line is between International Terminal G and Terminal 3. The surged link load on the busiest link for the Blue Line is estimated to be 4,070 passengers in the Base Constrained planning activity level and 4,660 passengers in the High Constrained planning activity level, while the surged link load on the busiest link for the Red Line is 1,060 passengers in the Base Constrained planning activity level and 1,220 passengers in the High Constrained planning activity level. The surged peak link loads for each line are expected to exceed the current capacity of each line.

19 The surge factor can be interpreted as the ratio of peak hour passengers served in the peak 15 minutes to one-quarter of total peak hour passengers. A surge factor of 1.0 means that one-quarter of peak hour passengers are served in the peak 15 minutes, while a surge factor of 4.0 means that 100 percent of peak hour passengers are served in the peak 15 minutes.

4.4.7 Public Transit

Table 4.4-10 shows the existing and forecast BART ridership at the SFO station. According to San Francisco Area Rapid Transit District, ridership is expected to increase from 4,410,000 in 2015 to 6,160,000 in 2023. The existing SFO Airport station has three platforms, each capable of accommodating 10-car trains, the longest that BART can operate. The station was designed to accommodate more than 17,800 daily passengers, so there are no additional requirements to accommodate the forecast ridership.[20]

Caltrain and SamTrans forecasts were not provided or are not available. Because all Caltrain passengers must use BART to reach the Airport, growth in Caltrain ridership is already factored into the BART ridership forecast. Similarly, because SamTrans buses must use the airport roadway system, growth in ridership is already factored into the requirements for terminal area roadways and curbside.

Pending the construction of the High Speed Rail (HSR) and the connection to the Airport, HSR could be used as an alternative from downtown San Francisco and San Jose, similar to express rail services in Europe and Asia (e.g., Heathrow Express, Hong Kong Airport Express).

20 *Final Environmental Impact Report/Final Environmental Impact Statement for the BART San Francisco Airport Extension, Northern San Mateo County, California, 1996.*

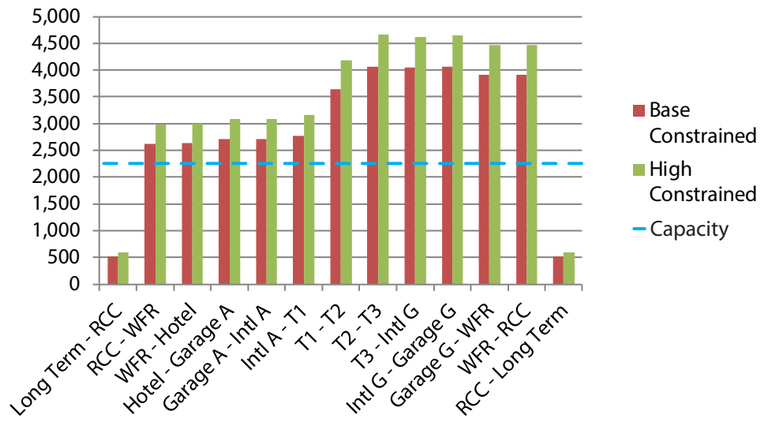
4.4.8 Future Technologies That Could Affect Ground Transportation Requirements

There are several technological advances expected to occur, either in the near- or long-term, that could affect demand for ground transportation. These include:

- ***Ticketless parking*** – reduces the area needed for entry/exit plazas
- ***Transportation network companies (TNCs)*** – fewer taxicabs but greater curbside requirements, though with less dwell times than taxicabs
- ***Car-sharing*** – new services offering customers one-way rentals, which would be less expensive than parking for the duration of the trip, reducing the need for parking spaces
- ***Single-space parking detection*** – reducing the parking circulation factor leads to the need for fewer parking spaces
- ***Electronic tolling of airport roadways*** – potential to have "managed" curbsides
- ***Virtual hold lots/virtual taxicab queue*** – smaller commercial vehicle staging area
- ***High Speed Rail*** – potential to affect aviation activity and ground transportation mode choice
- ***Autonomous vehicles*** – greater curbside requirements
  - Self-parking – less space required per parking stall
  - Self-driving – less parking space is required

For the purposes of the ADP, a conservative approach was taken for the facility requirements to ensure that sufficient facility capability is provided to meet the High Constrained forecast demand. At the time of design of specific facilities, updated facility requirements analyses would be undertaken which would take into account these and other future technologies or trends.

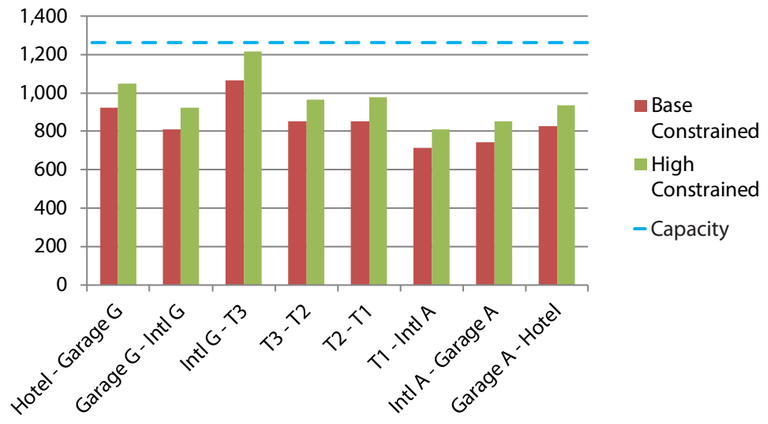
Exhibit 4.4-11| Blue Line Forecast Ridership by Segment, Peak 15-Minute



Notes: *RCC = Rental Car Center*
WFR = West Field Road
Blue Line has a capacity of 2,290 passengers (6 three-car trains at a 3.1 minute headway)

Source: LeighFisher, May 2015; based on Landrum & Brown, Inc., "February 2015 AirTrain survey and forecast factors," October 2014

Exhibit 4.4-12 | Red Line Forecast Ridership by Segment, Peak 15-Minute



Notes: *Red Line has a capacity of 1,333 passengers (3 two-car trains at a 3.5 minute headway)*

Source: LeighFisher, May 2015; based on Landrum & Brown, Inc., "February 2015 AirTrain survey and forecast factors," October 2014

Table 4.4-10 | BART Ridership at SFO Station

Annual Passengers	Existing	Planning Activity Forecast	
	2013	2018	2023
BART Ridership	4,022,101	5,040,000	6,010,000

Note: *Forecast data available until 2023.*

Source: San Francisco Bay Area Rapid Transit District, Financial Planning, November 18, 2014

4.5 SUPPORT FACILITIES

This section presents the facility requirements for Airport support facilities, organized by type:

- Air Cargo
- General Aviation
- Remain Overnight Parking
- Airport Maintenance
- Aircraft and Vehicle Fueling
- Airport Administration
- Emergency Response Facilities
- Museum Storage and Education
- Flight Kitchen
- Ground Support Equipment Maintenance
- Employee Parking
- Airline Maintenance
- FAA Facilities

Facility requirements are based on the planning activity levels established by the SFO activity forecasts. The difference between the Base Constrained and High Constrained demand levels is an increase in passenger airline operations and load factors. Therefore, the facility requirement for a number of the support facilities that are not dependent on passenger activity are the same for these two planning activity levels.

4.5.1 Air Cargo

Cargo building area, overall lot area, cargo aircraft parking positions, and apron area requirements are based on:

- Cargo forecasts from the *San Francisco International Airport Forecast Update,* Landrum & Brown, April 2014
- 2013 SFO Monthly Traffic Reports
- SFO ADP Facilities Inventory, October 2014
- 2014 SFO Airport Cargo Development and Business Plan
- Industry trends in space usage and facility layouts provided in the Airports Council International-North America (ACI-NA) *Air Cargo Guide*, December 2013
- On-site observations and aerial mapping assessments of SFO
- Facility use at SFO and other airports

Table 4.5-1 summarizes the cargo forecast. Facility requirements were determined for four planning activity levels: 2018, 2023, Base Constrained, and High Constrained. The two Constrained forecasts prioritize passenger traffic over cargo and therefore no increase in cargo growth is projected beyond the Base Constrained demand level. As a result, the cargo requirements analysis combines these planning levels.

Building Area

Cargo building utilization rates vary based on the type of cargo operation. Integrated carriers often use automated warehouses to process cargo more quickly than cargo airlines or belly cargo handlers. The utilization rate may vary between international and domestic cargo, reflecting the additional space required to process customs clearance for imports.

The ACI-NA *Air Cargo Guide* indicates that the industry standard for cargo building utilization rates for large airports is one square foot of warehouse space per metric ton of cargo processed annually. Therefore, the warehouse area requirements are directly proportional to the forecast cargo volumes. Requirements for office space and other areas use the existing building space divisions of warehouse (71 percent), office (24 percent), and other (5 percent) areas.[21]

Table 4.5-2 shows the supply[22] and future requirements for cargo building areas. A total of 754,700 square feet of cargo building is required at the Base/High Constrained demand level, indicating that the existing cargo building area of 950,800 square feet will exceed long-term demand.

Land Area

Cargo land area includes employee vehicle parking, truck docks and maneuvering space, building footprints, and container staging and GSE storage areas. Areas occupied by aircraft parking positions are discussed in Section 4.5.3 and are excluded from this section.

Cargo land area requirements are based on recommended ratios from the ACI-NA *Air Cargo Guide* and adjusted to account for the higher ratio of belly cargo to freighter cargo at SFO. The container staging area/GSE storage area was increased to reflect the larger area required to organize cargo that is bound for a greater number of flights, compared to all-cargo or integrated cargo operations.

The existing vehicle parking ratio of 1.7 vehicle stalls per 1,000 square feet of building area is lower than industry standards. ACI-NA recommends a planning

21 *2014 Airport Cargo Development and Business Plan,* San Francisco International Airport Bureau of Planning and Environmental Affairs, January 2014.

22 The existing total cargo building area includes the recently built Building 632, which was vacant at the time of survey, and Building 900, a dedicated cargo building that is partially vacant.

Table 4.5-1 | ADP Cargo Forecast

Cargo Demand	2013	2018	2023	Base Constrained/ High Constrained
Annual Tonnage (metric tons)	363,794	417,100	516,800	536,700
Belly	284,670	328,241	410,127	426,533
All-Cargo (includes integrated cargo)	79,124	88,859	106,673	110,167
Annual Operations	5,920	6,200	7,000	7,000
Widebody	4,375	4,716	5,411	5,505
Narrowbody	6	124	140	142
Turboprop	1,539	1,360	1,449	1,453

Source: SFO Forecast Factors, Landrum & Brown Inc., 2014, October 31, 2014

Table 4.5-2 | Cargo Building Area – Supply and Requirements

Facility	Supply	2018	2023	Base Constrained/ High Constrained
Warehouse	676,100	417,100	516,800	536,700
Office	229,400	141,500	175,400	182,100
Other	45,200	27,900	34,600	35,900
Total	950,800	586,500	726,800	754,700

Note: Measured in square feet

Source: RS&H, December 2014; 2014 Airport Cargo Development Business Plan

factor of two to eight employee vehicle stalls per 1,000 square feet of warehouse or office space and 0.1 customer vehicle stalls per 1,000 square feet of the total building area. For SFO, a slightly increased planning factor of 2.3 vehicle parking stalls per 1,000 square feet of cargo building area, offering a slight improvement in parking facilities, was applied to determine employee and customer vehicle parking requirements. At the Base/High Constrained demand level, this results in a requirement for approximately 1,700 employee vehicle parking stalls.

Exhibit 4.5-1 shows a schematic land area layout for typical SFO cargo facilities and **Table 4.5-3** shows the current supply and future area requirements.

Aircraft Parking Positions and Apron Area

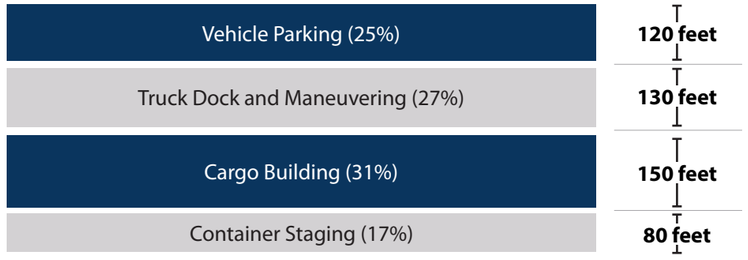
Cargo aircraft parking position and apron area requirements are based on peak activity. The 2013 SFO Monthly Traffic Reports indicate May as the peak month of cargo operations, comprising 9.22 percent of annual cargo operations. Daily cargo operations are consistent throughout the peak month. The forecast uses the average day of the peak month, determined by dividing the peak month operations by 26 to account for a 6-day operating week. Hourly cargo activity is consistent throughout the day with an estimated three cargo operations during the peak hour (12.9 percent of the average day). The monthly, daily, and hourly operations ratios remain constant throughout the planning horizon.

The total apron area was determined by multiplying the area for each aircraft type in the forecast fleet mix by the number of required parking positions and summing the results. The ADP forecast projects an increase in widebody cargo aircraft and decrease in turboprops.

The requirements include three spare Boeing 747-8F capable parking positions where, if an aircraft were delayed and could not leave the assigned parking position, it would not prevent another arriving aircraft from parking. The requirement for spare positions is allocated as follows:

- One spare position in the North Field – Plot 50
- One spare position in the West Field – Plots 6, 8, and 9
- One spare position in the West Field – Plots 10, 11, and 12

Exhibit 4.5-1 | Schematic Land Area Layout for Cargo Facilities



Notes: *Excludes the aircraft parking apron.*
Source: RS&H, December 2014; ACI-NA Air Cargo Guide, Airlines for America

Table 4.5-4 and **Table 4.5-5** present the current supply and future area requirements for the number of aircraft parking positions and apron area, respectively.

U.S. Postal Service Facility

The U.S. Postal Service facility, located in Building 660, is expected to remain in its current location for the foreseeable future. The existing facility is assumed adequate to meet the U.S. Postal Service requirements through the planning horizon.

Table 4.5-3 | Cargo Land Area – Supply and Requirements

Facility	Supply	2018	2023	Base Constrained/ High Constrained
Vehicle parking	760,600	469,200	581,400	603,800
Truck dock/maneuvering	824,000	508,300	629,900	654,100
Building	950,800	586,500	726,800	754,700
Container staging/GSE storage	677,900	312,800	387,600	402,500
Total	3,213,300	1,876,800	2,325,800	2,415,000

Note: *Measured in square feet*
Source: RS&H, December 2014

Table 4.5-4 | Cargo Aircraft Parking Positions – Supply and Requirements

Aircraft Size	Supply	2018	2023	Base Constrained/ High Constrained
Widebody	9	5	5	6
Narrowbody	0	0	0	0
Turboprop	0	1	1	1
Total	9	6	6	7

Source: RS&H, December 2014

Table 4.5-5 | Cargo Aircraft Apron Area – Supply and Requirements

Aircraft Size	Supply	2018	2023	Base Constrained/ High Constrained
Widebody	490,800	347,400	352,800	430,200
Narrowbody	0	0	0	0
Turboprop	0	5,400	5,400	5,400
Total	490,800	347,400	352,800	430,200

Note: *Measured in square feet*
Source: RS&H, December 2014

4.5.2 General Aviation

General aviation (GA) hangar, building, apron, and landside area requirements were determined using the following sources:

- GA forecasts from *San Francisco International Airport Forecast Update*, Landrum & Brown Inc., April 2014
- SFO ADP Facilities Inventory, October 2014
- On-site observations and aerial mapping assessments of SFO
- Facility use at SFO and other airports

General Aviation Forecast Summary

GA operations remain nearly constant over the forecast period with less than one percent annual growth, while the air taxi component grows at approximately 3.5 percent per year. The two constrained forecasts prioritize passenger traffic over cargo and no GA growth is projected. As a result, the GA requirements analysis combines these planning levels.

Hangar and Building Area

There are 10 aircraft based at SFO, which is down from 29 aircraft in 1990.[23] The number of based aircraft is forecast to remain at 10 aircraft throughout the planning horizon.[24] The requirements analysis assumes hangar storage of all based aircraft.

As of late 2014, the Fixed Base Operator (FBO), Signature Flight Support, operated three airplane hangars. Each hangar is approximately 25,000 square feet. While typical private aircraft at SFO vary in size from small turboprops to large jets, it is assumed the average SFO based aircraft requires 5,350 square feet of hangar space (based on the Cessna Citation X, a medium-size business jet). Therefore, ten based aircraft would require 53,500 square feet of hangar space, plus ten percent for storage (5,530 square feet). The three FBO hangars total 75,000 square feet, leaving about 16,000 square feet of hangar space available for transient or in-maintenance aircraft. Therefore, no additional hangar space is required to accommodate the ADP forecasts of aviation demand.

The existing FBO terminal building (Building 1052) totals 12,000 square feet and the existing fuel/maintenance buildings (Building 1053 and Building 1055) total 8,630 square feet. Based on the hangar and building area requirements summarized in **Table 4.5-6**, the terminal and fuel/maintenance buildings are adequate to accommodate demand through the planning horizon.

23 *Airport Master Record, San Francisco International Airport,* FAA Form 5010-1, July 2016.
24 *2014 FAA Terminal Area Forecast.*

Apron Area

Transient aircraft parking and aircraft staging for arrival, departure, parking, and maneuvering occurs on the FBO apron. The existing FBO apron area totals approximately 266,000 square feet of circulation and hangar frontage apron. When the FBO apron is full, the FBO uses the public apron area in Plot 41 for overflow parking. Plot 41 is located southeast of the FBO. A survey of aerial photos indicates that more than half of the FBO parking demand is accommodated in Plot 41.

GA apron requirements are based on the GA peak month average day forecast. The forecast projects 91 operations in the Base Constrained/High Constrained demand level, with air taxis accounting for about two-thirds of the total. This is an increase of 20 operations from 2015, or about 28 percent. Based on existing usage of the apron as observed through aerial photography, the analysis assumes one-third of the daily operations require apron area for parking at any given time. This usage rate is held constant through the planning horizon.

GA activity at SFO includes larger business jet aircraft and high-performance turboprop business aircraft. The average GA/air taxi aircraft requires 5,350 square feet of apron area for parking.[25]

25 Based on the Cessna Citation X aircraft.

An area of approximately 160,500 square feet will be required to accommodate 30 GA parking positions at the Base Constrained/High Constrained demand levels. The required apron area, plus pavement for circulation and access, totals 321,000 square feet. **Table 4.5-6** summarizes the apron area requirements.

The facility requirements analysis does not consider the atypical GA activity that occurs at SFO, which includes very large business aircraft that require substantially more apron space or special events that may substantially increase demand for apron area parking for brief periods. To accommodate those surges in demand, the Airport should maintain the existing GA area and general aviation access to Plot 41. Detailed GA apron requirements may be determined through additional analysis, data collection, and tenant interviews.

Landside Area

The GA landside area includes vehicle access, vehicle parking, and all undefined portions of the GA area except for unused green space. The existing general aviation landside area is approximately 28 percent of the total GA area. This proportion remains constant through the planning period. Up to 12 percent of the existing FBO consists of undeveloped space, which is included to account for landscaping needs. Table 4.5-6 summarizes the landside area requirements.

Table 4.5-6 | General Aviation Facilities – Supply and Requirements

Facility	Supply	2018	2023	Base Constrained/ High Constrained
Aircraft hangar	75,000	58,850	58,850	58,850
Fuel/maintenance building	8,600	8,600	8,600	8,600
Terminal building	12,000	12,000	12,000	12,000
Apron (including circulation)	266,400	289,000	321,000	321,000
Landside (undefined areas)	166,100	168,500	180,700	180,700
Undeveloped green space	72,900	72,900	72,900	72,900
Total	601,000	609,900	654,100	654,100
Aircraft parking positions (1/3 of daily operations)	*~23*	*27*	*30*	*30*

Note: Measured in square feet except for Aircraft parking positions
Source: RS&H, December 2014

4.5.3 Remain Overnight (RON) Aircraft Parking

SFO currently has 91 remote passenger aircraft parking positions located away from the main passenger terminal and not used for GA or cargo activity. Passenger aircraft with long ground times park at these remote positions during the daytime to alleviate gate congestion. However, the majority of activity at these positions occurs overnight to alleviate gate congestion during the early morning departure peak that occurs between approximately 6:00 a.m. and 9:00 a.m. Some aircraft also park for multiple days to undergo maintenance or for storage. Maintenance and storage activities typically occur on a tenant leasehold such as the United Airlines San Francisco Maintenance Center.

The total number of remote aircraft parking positions SFO requires was determined based on the demand for passenger remain overnight (RON) parking. The total requirement does not consider future cargo and general aviation demand and excludes use of the Plot 50 freight cargo positions and FBO GA positions in Plot 41.[26] The analysis assumes that Big H is the recommended boarding area expansion alternative. This would replace two widebody remote RON positions with six widebody or ten narrowbody contact gates, increasing contact RON capacity and thereby reducing remote RON demand.

Passenger RON demand was determined based on discussions with SFO staff regarding RON usage and the following datasets:

- ADP Design Day Flight Schedule (DDFS)
  - This was the primary data source used to determine the RON demand in the original analysis.
- SFO Aircraft Parking System (APS) Data
  - The APS records reservation data for all SFO-managed aircraft parking positions. The dataset includes airline, aircraft type, and reservation block time for the aircraft parking positions managed by SFO in August 2015. The data excludes reservations for airline-leased positions (e.g., parking positions at the United Airlines Maintenance Operations Center (MOC), parking positions leased to United Airlines and American Airlines in the East Field).
- PASSUR Data
  - The PASSUR data is a record of SFO aircraft movement data. The dataset includes arrival and departure times for all flights captured by air traffic monitoring radar technology in August 2015.
- Nighttime RON Occupancy Survey
  - SFO Operations surveyed actual remote RON position usage at SFO-managed and airline-leased parking positions during nighttime hours between December 3, 2015, and December 10, 2015.

26 The future GA parking demand includes approximately 10 Cessna Citation X aircraft on the existing general aviation leasehold and 20 Cessna Citation X aircraft on a portion of Plot 41.

The following is a summary of the methodology used for the analysis.

1. Determine SFO-managed RON position demand for 2015
2. Determine airline-leased RON position demand for 2015
3. Determine other RON position demand
4. Determine forecast demand levels
5. Determine the fleet mix of required positions by narrowbody and widebody aircraft

SFO-Managed RON Positions

The SFO-managed RON position demand was determined based on the following considerations:

- APS data indicates August 8, 2015 (Saturday), had the highest demand for SFO-managed RON positions. The RON position demand includes the total number of reservations made on August 8, 2015, as well as any aircraft still on the ground that reserved the position on a previous day (as far back as July 31, 2015).
- Most aircraft on the ground (~85–93 percent) reserved a position starting between 8:00 p.m. and 10:00 a.m.
- SFO-managed RON reservations in the APS between July 31, 2015 ,and August 8, 2015, averaged a duration of eight hours, with no reservation exceeding two days.

The APS data revealed 33 reservations in 22 positions on August 8, 2015. The SFO-managed RON position requirement for reservations with a duration of less than two days is 33 positions to ensure availability of positions and maintain flexibility in reserving positions for the Airport and aircraft operators.

The analysis excludes reservations with start dates prior to July 31, 2015, which may indicate longer-term reservations. It was therefore supplemented with an analysis of PASSUR data on August 8, 2015, which provided an estimate of six long-term reservations exceeding two days in an SFO-managed RON position.

The total 2015 SFO-managed RON position demand or requirement is 39 positions.[27]

27 The sum of 33 required positions with a duration of less than two days and six required positions with a duration of more than two days.

Airline-Leased RON Positions

The airline-leased RON position demand was determined based on the following considerations.

- SFO Operations midnight occupancy counts in December 2015 reflects airline-leased RON position demand for United Airlines and American Airlines in 2015.
- Virgin America leases four positions in the West Field and Southwest Airlines leases two positions in the South Field. The analysis assumes demand for Virgin America and Southwest Airlines leased RON positions equals supply in 2015.

December 2015 nighttime occupancy counts for United Airlines and American Airlines at the United Airlines MOC, the Superbay Hangar in the East Field, and the airline-leased positions in the East Field indicated a demand of 28 positions. The total airline-leased RON position demand and requirement in 2015 is 34 positions.

Other RON Positions

SFO maintains two Very Important Person (VIP) widebody parking positions in Plot 40 for aircraft such as Air Force One. These may be reserved by airlines but must be vacated if needed for a VIP movement. This requirement is expected to continue through the planning horizon. In the future, SFO will also need to provide one additional position for ADG VI parking. The overall RON requirements reflect these additional RON positions.

Analysis Results

Future remote RON position requirements are based on the compound annual growth rate of 0.7 percent for forecast unpaired operations.[28] Use of the same data determined the widebody shares as summarized in **Table 4.5-7.**

Table 4.5-8 presents the total remote RON position requirements. The existing 91 positions available today are adequate to accommodate demand through the planning horizon, although the size of the positions must be adjusted to match the changing fleet mix.

28 Unpaired operations are the last bank of arrival flights for the night and the first bank of departure flights in the morning from the DDFS.

Table 4.5-7 | Widebody Aircraft Departure Percentages

Planning Factors	2015	2018	2023	Base Constrained	High Constrained
Estimated RON Operations[1]	88	92	100	94	97
Widebody Operations	7	7	8	15	15
Widebody Percentage	7.60%	7.60%	8.00%	16.00%	15.50%

Note: [1] *The number of operations or aircraft estimated to require overnight parking is the sum of the unpaired operations in the DDFS from the last bank of arrival flights in the night or from the first bank of flights in the morning. RON operations for 2015 are an estimate based on the compound annual growth rate of 1.7 percent between 2018 and 2023.*

Source: 2014 ADP Design Day Flight Schedule, Landrum & Brown Inc., October 2014; SFO staff, January 2016, RS&H, March 2016

Table 4.5-8 | RON Aircraft Parking – Supply and Requirements

Aircraft Type	Supply	2018	2023	Base Constrained	High Constrained
SFO-Managed Positions (<2 days)	45[1]	34	35	36	37
Widebody	20	3	3	6	6
Narrowbody	25	31	32	30	31
SFO-Managed Positions (=>2 days)	See above	6	6	6	7
Widebody		0	0	1	1
Narrowbody		6	6	5	6
American Airlines Leased Positions	10	7	7	8	8
Widebody	3	1	1	1	1
Narrowbody	7	6	6	7	7
United Airlines Leased Positions	30	21	22	23	23
Widebody	8	2	2	4	4
Narrowbody	22	19	20	19	19
Virgin America Leased Positions[2]	4	4	4	4	4
Widebody	0	0	0	0	0
Narrowbody	4	4	4	4	4
Southwest Airlines Leased Positions[3]	2	2	2	2	2
Widebody	0	0	0	0	0
Narrowbody	2	2	2	2	2
Total Positions	91	77	79	82	84
Widebody	32	8	8	14	14
Narrowbody	61	69	71	68	70

Notes: [1] *The capacity shown reflects inventory efforts from FY 2015/2016. In FY 2016/2017, SFO has plans to remove one SFO-managed position in Plot 3, reducing the total capacity from 45 to 44 positions.*
[2] *SFO has plans in FY 2024/2025 to eliminate the Virgin America leased positions in the West Field. Future alternatives assume Virgin America will use in SFO-managed positions.*
[3] *SFO has plans in FY 2016/2017 to eliminate the Southwest Airlines leased positions in the South Field. Future alternatives assume Southwest Airlines will use SFO-managed positions.*

Source: SFO Staff, January 2016; RS&H, March 2016

4.5.4 Airport Support

This section documents the support area facility requirements for the following areas:

- Airport Maintenance
- Construction Staging Areas
- Aircraft and Vehicle Fueling
- Airport Administration
- Emergency Response Facilities
- Museum Storage and Education

Facility conditions, usage, and future space considerations were conveyed to the study team by SFO staff or gathered by the study team during site visits. This information along with the ADP forecast and industry standard planning factors (adjusted for specific conditions at SFO) determines support area facility requirements.

4.5.4.1 Airport Maintenance

The SFO Facilities department manages Airport maintenance activities from several facilities throughout the Airport.

Landside comprises employee vehicle parking and general storage areas outside of the buildings. The existing Airport maintenance area encompasses approximately 833,900 square feet. The dispersed nature of the existing maintenance facilities makes it challenging to ascertain precisely how maintenance space is allocated among office, workshop, and storage areas.

Building and Landside Areas

Based on observations and interviews with SFO staff, Airport maintenance facilities are at or near capacity. The planning activity forecasts assume that the existing maintenance facilities are 100 percent utilized.

For the purposes of this study, Airport maintenance and construction activities are proportional to the total area of buildings, landscaping, and infrastructure SFO Facilities maintains. According to information provided by SFO staff, SFO Facilities maintains approximately 50 to 60 percent of the buildings on-Airport, or approximately 8,572,500 square feet of building area. This building area includes all SFO maintained support facilities, passenger terminals, ground access facilities, and parking facilities.

The total area of landscaping (e.g., pavement areas and general green space) and infrastructure (e.g., runway/taxiway/apron pavement areas, lighting, roadways, and utilities) maintained by SFO Facilities was not considered within the calculation of Airport maintenance facility requirements because the total area of landscaping and infrastructure will not increase substantially.

The SFO Facilities maintenance areas include workshops, storage areas, and offices, including employee vehicle parking and storage areas outside of the building such as the Corporation Yard and Bone Yard. The existing ratio of building area maintained by SFO Facilities to the total building area SFO Facilities occupies is 10.3 to 1. This ratio is the planning factor for determining Airport maintenance area requirements. **Table 4.5-9** presents the Airport maintenance facility requirements.

4.5.4.2 Construction Staging Areas

Construction staging areas, including materials laydown and office areas, will be necessary to support the capital development program. Construction staging areas vary in size depending on the volume of construction and the area available to support construction staging. Based on the size of construction staging areas at airports with similar levels of construction activity, construction staging areas totaling between 100,000 and 300,000 square feet may be required. This estimate will need to be refined prior to the design and construction of future projects.

4.5.4.3 Aircraft and Vehicle Fueling

Over 600 buses, vans, taxicabs, and passenger automobiles operating at SFO run on compressed natural gas (CNG) or gasoline.[29] SFO vehicles obtain fuel from two CNG fueling stations and one gasoline station located on Airport property. The CNG facilities are open to the public, while the gasoline station is open only to City and County of San Francisco (CCSF) vehicles.

Because the CNG facilities are open to the public, additional capacity requirements are driven by local/regional demand for CNG, which is not exclusively related to Airport activity.

Plans currently exist to relocate the CCSF Vehicle Fuel Station (gasoline station) that is currently located in the South Field to a 3,810-square-foot space in Plot 700 in the North Field.

29 SFO Clean Vehicle Fact Sheet, http://www.flysfo.com/community-environment/air-quality, January 2016.

Table 4.5-9 | Airport Maintenance – Supply and Requirements

Component	Supply	2018	2023	Base Constrained	High Constrained
Building	147,900	166,500	190,200	205,300	234,500
Landside	686,000	772,400	882,100	952,000	1,087,400
Total	833,900	938,900	1,072,300	1,157,300	1,321,900

Notes: *Measured in square feet*
The SFO Facilities maintenance area includes the total building area used by SFO Facilities for workshops, storage, and offices. It also includes land areas outside of the building, such as employee vehicle parking areas, equipment storage areas, and materials storage areas, including the Corporation Yard and Bone Yard.

Source: RS&H, October 2014; *Proposed Space Program*, Consolidated Airport Campus, HKS, July 2014

4.5.4.4 Airport Administration

SFO plans to develop a Consolidated Administration Campus (CAC)[30] in the West Field that would accommodate all Airport administrative functions except SFO Operations (located in the East Field) and SFO Facilites (located in various areas throughout the Airport). The first phase of the CAC will be constructed by 2018 and will include the following Airport Commission divisions and shared facilities:

- Airport Commission Divisions
  - Planning and Environmental Affairs
  - Business & Finance
  - Communications & Marketing
  - Information Management & Telecommunications
  - Design & Construction
  - Museum Support
- Shared Facilities
  - Public support spaces
  - Campus-wide amenities
  - Campus utilities

Employee parking structures will also be provided in the CAC facility. The CAC facility, approximately 256,100 square feet, was designed to accommodate long-term Airport Administration requirement.

4.5.4.5 Emergency Response Facilities

The Airport's Emergency Response Facility (ERF) #2 (Building 1064) in the East Field meets the FAA's Part 139 certification requirement for Aircraft Rescue and Firefighting (ARFF) response times across the airfield. Two other ERFs and one maritime ERF serve the Airport but are not Part 139 certified. Because the size of the airfield will not change within the planning horizon, there is no regulatory need to expand or modify the Airport's ERFs. However, optimization of limited real estate may require that these buildings be relocated on-Airport within the planning horizon.

There are no operational requirements influencing the location of the police facility in the East Field. However, Building 1059 is in poor condition and SFO staff indicated a need to expand and improve the existing building and shooting range facilities to serve the San Francisco Police Department – Airport Bureau personnel and other facility users.

30 *Consolidated Administration Campus Master Plan*, HKS, December 2014.

4.5.4.6 Museum Storage and Education

Educational facilities are not required to be located on Airport property. Based on discussions with SFO staff, education facilities can potentially be downsized or remain as is. For planning purposes, the City College of San Francisco, Department of Aeronautics campus is assumed to remain in place through the planning horizon until a time when it is needed for Airport Maintenance. However, in concept development, the Airport will explore options for keeping or downsizing education facilities based on highest and best land use.

4.5.5 Airline Support

This section documents the support area facility requirements for the following areas:

- Flight Kitchen
- Ground Support Equipment (GSE) Maintenance
- Employee Parking
- Airline Maintenance
- Federal Aviation Administration (FAA)

Future development for many support facilities, such as GSE maintenance, flight kitchens, and airline maintenance, is driven by tenant demand and market forces outside of the Airport's direct control. Additional tenant consultation is necessary for advanced planning and preliminary design efforts prior to project implementation.

4.5.5.1 Flight Kitchen

On-Airport flight kitchen tenants operate out of Building 649. The building floor area totals 135,000 square feet with a building footprint of 84,926 square feet. The landside area totals approximately 129,400 square feet for employee parking and truck dock areas. The main building footprint was not included. The building area of four off-Airport flight kitchens located in Burlingame totals approximately 152,900 square feet.[31] In summary, approximately 287,900 square feet of flight kitchen building space serves SFO, with about 50 percent located off-Airport.

Flight kitchen sizes varies from airport to airport due to industry volatility. Therefore, no reliable industry metrics are available to establish flight kitchen requirements. This analysis is based on professional judgment and comparable experience at large hub and international gateway airports.

Based on tenant interviews conducted with a flight kitchen operator at LAX[32] a 35,000-square-foot facility supplies 10,000 to 11,500 meals per day to international airlines. The LAX operator indicated that the existing facility was undersized and that an 80,000-square-foot facility would address the space constraints. This produces a planning factor of approximately 7.0 square feet per daily international meal, which was applied to the flight forecast to establish requirements. It was assumed that each enplaning international passenger requires 2.5 meals. This reflects that nearly 90 percent of SFO international enplanements are long-haul flights to Asia and Europe.

Domestic meals are generally simpler than international meals and require less space to prepare. Domestic meals are commonly pre-packaged, processed foods served in sealed boxes. This analysis assumes domestic meals require approximately 10 percent of the preparation space of international meals or 0.7 square feet per daily domestic meal. It was assumed that each enplaning domestic passenger requires 0.2 meals (two meals per ten passengers). This calculation is based on the rarity with which meals are served on domestic flights.

The landside area is based on the existing ratio between building footprint and landside area. This ratio was maintained at 0.78 to 1. **Table 4.5-10** presents the current supply and existing and future flight kitchen requirements. To meet the total building area requirement of 609,300 square feet at the High Constrained demand level, an additional 321,400 square feet of flight kitchen building is needed. An additional 343,600 square feet of flight kitchen landside area is needed to meet the total landside area requirement of 651,500 square feet.

31 The space inventory for the off-Airport flight kitchens were estimated from Google Earth imagery.
32 The interviews took place in September 2014.

Table 4.5-10 | Flight Kitchen Facilities – Supply and Requirements

Component	Supply	2018	2023	Base Constrained	High Constrained
Building Floor[1]	287,900	333,000	410,700	533,400	609,300
Landside[2]	307,900	356,100	439,100	570,300	651,500
Land[3]	513,700	594,100	732,600	951,500	1,087,000

Notes: Measured in square feet. Flight kitchen requirements consider both on- and off-Airport flight kitchens.
[1] The building floor area considers multi-level facilities.
[2] The landside area excludes the building footprint, but includes employee parking and truck dock areas.
[3] The total land area includes the building footprint area and the landside area.

Source: RS&H, December 2014

The requirement for additional on-Airport flight kitchen infrastructure is highly variable, based in part on the local real estate market because half of these facilities are located off-Airport. Tenant interviews and surveys are recommended to validate the flight kitchen requirements.

Flight kitchens must be located near the Airport, but do not require frontage to the terminals or aprons. Therefore, the requirements for on-Airport flight kitchens can be substituted with off-Airport facilities as dictated by competing space constraints. However, this will increase demand on the vehicle security checkpoints at the Airport.

4.5.5.2 Ground Support Equipment Maintenance

Ground handlers at SFO provide ground handling services to airlines and GSE maintenance. The requirements for ground handling services provided to cargo carriers were included in the overall cargo requirements as presented in Section 4.5.1. Ground handlers and some airlines also provide GSE maintenance, typically at a separate, designated on-Airport facility.

SFO currently has five dedicated GSE maintenance facilities. The overall GSE maintenance lot area includes employee parking and GSE storage areas, but excludes the building footprint. The GSE maintenance buildings total approximately 100,200 square feet and the lot areas total approximately 377,200 square feet.

GSE maintenance area requirements are determined by cargo and passenger aircraft operations. According to Airport staff, GSE maintenance facilities currently operate above capacity, resulting in some tenants moving off airport property. For planning purposes, these facilities are assumed to be operating at 120 percent of capacity.

There is no reliable industry metric to identify future GSE maintenance area requirements. This is because the GSE function occupies any available space regardless of whether it can efficiently accommodate GSE maintenance activities. Therefore, these requirements are based on maintaining the existing ratio of GSE maintenance area per aircraft operation. The existing GSE maintenance building square footage per aircraft operation is 0.34. The existing GSE maintenance landside area square footage per aircraft operation is 1.27. **Table 4.5-11** presents the supply and the future requirements for GSE maintenance facilities. To meet the total building area requirement of 143,700 square feet at the High Constrained demand level, an additional 43,500 square feet of GSE maintenance building is needed. To meet the total landside area requirement of 541,100 square feet at the High Constrained demand level, an additional 164,000 square feet of GSE maintenance landside area is needed.

4.5.5.3 Employee Parking

The employee vehicle parking area is the area where employees park their personal vehicles. Landside area includes employee vehicle parking, circulation, and general public areas outside the building. Because employee parking facilities can be shared between tenants, their requirements are presented together in this section.

Table 4.5-12 presents the employee parking requirements for GSE maintenance, Airport administration, Airport maintenance, flight kitchens, and airline maintenance for all demand levels.

Interim Parking for Construction Workers and Contract Employees

The Airport has identified an immediate need to provide additional parking for construction workers and contract employees. Existing parking facilities are not sufficient to accommodate the influx of construction workers and contract employees as major capital projects begin construction in 2016. An SFO Task Force has estimated that 2,000 parking spaces will be needed for temporary employee parking until the new Long Term Parking Garage #2 in Lot DD is completed in 2019.

Table 4.5-11 | GSE Maintenance Facilities – Supply and Requirements

Component	Supply[1]	2018	2023	Base Constrained	High Constrained
Total Building	100,178	126,500	140,200	141,100	143,700
Total Landside[2]	377,170	476,400	527,900	531,300	541,100
Total	477,348	602,900	668,100	672,400	684,800

Note: Measured in square feet
[1] Current GSE Maintenance Facilities supply detailed in Section 3.6 in Chapter 3.
[2] The landside area includes employee parking areas, GSE storage areas, and other areas that are not inside a building. The surface lot area excludes the building footprint area.
Source: RS&H, December 2014

Table 4.5-12 | Employee Parking – Supply and Requirements

User	Supply	2018	2023	Base Constrained	High Constrained
GSE Maintenance	377,100	476,400	527,900	531,300	541,100
Airport Administration	389,300[1]	341,000	341,000	341,000	341,000
Airport Maintenance	685,980	772,400	882,100	952,000	1,087,400
Flight Kitchen	307,900	356,100	439,100	570,300	651,500
Airline Maintenance	431,058	453,800	502,800	506,100	515,400

Notes: Measured in square feet
A stall requirement rather than an area was defined in the Ground Access and Parking analysis prepared by LeighFisher, Inc.
[1] The existing employee vehicle parking area for Airport administration is based on surface lot area takeoffs taken from aerial imagery and includes employee parking, landscaping, and circulation for Buildings 60, 575, 612, 670, 676, and 710.
Source: RS&H, December 2014

4.5.5.4 Airline Maintenance

Basic aircraft maintenance facilities are necessary at large airports to accommodate airline maintenance activities and typical aircraft repairs. These types of facilities are proportional to Airport operations levels and fleet mix.

Airlines and their maintenance partners managing large, full-service aircraft maintenance bases establish facility requirements based on the specific needs of the airline's maintenance activities. As such, full-service aircraft maintenance facility requirements address specific operational needs. Therefore, metrics dictating specific aircraft maintenance facility requirements vary greatly from airport to airport. United Airlines operates a hub at SFO and a large maintenance base. The maintenance base, the United Airlines San Francisco Maintenance Center (Building 800), is on a long-term lease and there are no plans to expand it at this time.

Building Area

Lufthansa Technik and Singapore Airlines Engineering (SIA Engineering USA) conduct aircraft maintenance services in Building 16. Certified Aviation Services, an aircraft maintenance tenant, has office and storage areas in this building. Building 16 will be demolished in 2016. The airline maintenance facilities located in Building 16 require replacement on a one-to-one basis.

American Airlines and United Airlines conduct aircraft maintenance services in the Superbay Hangar (Building 1060). The Superbay Hangar and Building 16 provide 267,890 square feet for aircraft maintenance, including office, maintenance/ workshop, and storage space. The Superbay Hangar is in constant use, but is in poor condition. An alternate hangar is therefore necessary to facilitate renovation of the Superbay Hangar. This facility should accommodate one Airbus A380 and one Boeing 787, requiring an area approximately half as large as the existing Superbay Hangar and forming the basis for future building area requirements.

Table 4.5-13 presents the supply and requirements for airline maintenance facilities. To meet the total building area requirement of 401,800 square feet at the High Constrained demand level, an additional 133,900 square feet of airline maintenance building is needed.

Employee Parking Area

The current employee parking area totals approximately 431,100 square feet. The existing vehicle parking lot to airline maintenance building area ratio of 1.61:1 is maintained throughout the planning horizon. Future expansions of the employee vehicle parking lot are projected only with increases in passenger operations. Additional information about parking lot usage will be obtained from tenants for advanced planning work prior to project implementation.

Apron Area

Apron area requirements are included in the RON parking requirements in Section 4.5.3.

4.5.5.5 Federal Aviation Administration

A new FAA ATCT was recently constructed in the courtyard between Terminals 1 and 2, providing sufficient FAA office space and space for air traffic control functions. The FAA is anticipated to move into the new tower in 2016. No additional FAA facilities are expected to be required through the planning horizon.

Table 4.5-13 | Airline Maintenance Facilities – Supply and Requirements

Facility	Supply	2018	2023	Base Constrained	High Constrained
Building	267,890	401,800	401,800	401,800	401,800

Notes: *Measured in square feet*
Source: RS&H, December 2014

4.6 UTILITIES

Utility requirements at SFO are grouped into three categories:

- Requirements to support increased demand and growth of the facilities, such as an increase in electrical demand resulting from building expansion
- Requirements to support SFO strategic initiatives, including the SFO Sustainability and Net Zero initiatives
- Requirements incidental to solutions proposed by other ADP focus areas, including modifications to underground utilities to eliminate conflicts with proposed airfield modifications or building expansions

A requirement for a particular alteration or modification to a utility sector may, on occasion, fall into multiple categories. For example, Information Technology and Telecommunications (ITT) utilities would be required to support a strategic initiative (Perimeter Security Enhancements) and to meet growing demand (existing infrastructure appears to be at or near capacity).

4.6.1 Demand-Based Requirements

Certain utility systems require modifications or expansions to support increased capacity and future growth or to mitigate existing shortcomings.

4.6.1.1 Fueling Systems Infrastructure

Requirements were developed for the pipeline transmission, fuel storage, and local distribution subsystems of the SFO aviation fuel system.

Pipeline Transmission

Observed peak daily volumes in 2016 and 2018 forecast demand levels materially exceed the Kinder-Morgan supply pipeline's current daily capacity (see **Table 4.6-1**). There is not a redundant line under lease by SFO Fuel; however, other lines from the Richmond refinery to the vicinity of the Airport exist and offer an opportunity to supplement the Kinder-Morgan supply pipeline to support the demand forecast.

Fuel Storage

Local bulk storage capacity of the on- and off-Airport facilities consists of 12 tanks ranging in size from 18,000 barrels to 71,600 barrels (see **Table 4.6-2**). An Ongoing Project undertaken by SFO Fuel will expand storage capacity by adding two tanks totaling 137,535 barrels. This project would provide additional on-Airport storage capacity to maintain sufficient supply during tank closures for regular maintenance, extended outages, and contingency for fuel supply interruptions (see **Table 4.6-3**).[33]

Local Distribution

The existing on-Airport distribution systems consists of two 24-inch-diameter supply lines that have sufficient capacity to meet the High Constrained activity level. The existing load-rack tanker refueling station also has sufficient capacity to meet the High Constrained demand level.

The apron hydrant systems will require local modifications to support the evolving terminal designs.

33 *IATA Guidance on Airport Fuel Storage Capacity – Edition 1*, International Air Transport Association (IATA), May 2008, pg. iv suggests that a three-day supply capacity is the minimum operational requirement. This three-day supply capacity allows a fuel farm operator to dispense a day's supply of fuel from one tank, while filling the second tank over the 24-hour period, and allowing fuel to settle for 24 hours in the third tank. Greater than a three-day supply allows for periodic maintenance of tanks, accumulation of surplus supply to accommodate unusual situations, and other operational benefits.

Table 4.6-1 | Fueling Systems – Supply Capacity

Year	2015	Estimated 2016	2023	Base Constrained	High Constrained
12" Kinder-Morgan Daily Capacity (barrels)	75,000				
Peak Month Average Day (barrels)[1]	69,908	77,300	83,300	84,000	85,400
Peak Month Peak Day (barrels)[2]	72,400	80,400	86,600	87,400	88,800

Notes: [1] *Peak Month Average Day is peak month divided by 31 days per month.*
[2] *Peak Month Peak Day is the 90th percentile highest day of the peak month.*

Source: RS&H, July 2016

4.6.1.2 Recycled Water Infrastructure and Distribution

As terminal buildings are converted to use recycled water for flushing fixtures and new construction is designed to use recycled water to achieve SFO management's goal of 100 percent recycled water use in non-potable applications, extension of the distribution network from the recycled water plant will be required.

Table 4.6-2 | Fueling Systems – Existing Storage Tanks

Tank	Usable Storage (barrels)
On-Airport Storage (269,300)	
Existing	
T6	8,000
T12	8,000
T17	18,000
T18	46,500
T19	70,800
JFT 1	59,000
JFT 2	59,000
Planned	
2 tanks[1]	137,545
Off-Airport Storage[2] (186,000)	
42	14,900
43	19,800
44	34,900
45	44,800
46	71,600

Notes: [1] *Planned capacity is two 75,000-barrel tanks with an estimated 91.7% usable storage capacity.*
[2] *Off-Airport storage is leased by Shell.*

Source: RS&H and SFO Fuel, July 2016

Table 4.6-3 | Fueling Systems – Storage Capacity

Location	2014	High Constrained[1]
On-Airport	4.1	4.4
On-Airport and Near-Airport	7.0	6.3

Notes: [1] *Includes two planned tanks*

Source: RS&H, April 2016

4.6.1.3 Fire Water and Potable Water Supplies

The SFO water supply system provides both fire water and potable water. Because fire supply lines must be much larger than potable water lines, they are oversized relative to the daily domestic water demand, causing low flow velocities and poor water quality. SFO management is currently implementing a recycled water supply system, with all new facilities being designed to accommodate both potable and recycled water in an effort to support SFO management's sustainability goals. As the demand for potable water decreases because of an increase in recycled water availability, the oversizing issue will become more severe and further affect domestic water quality. Therefore, the supply infrastructure and demand impacts will need to be evaluated to determine the most efficient pipe network solution to address the quality issues and modifications to the existing distribution network are likely to be required to supply water to the terminals.

Currently, no storage tanks or pump stations are located within the SFO water system. Therefore, the SFO system is wholly dependent on the San Francisco Water Department to maintain capacity and pressure. No emergency water supply is maintained at SFO at this time. SFO management is currently working with the City of Millbrae on a proposal to tie into the City of Millbrae water supply at two locations to provide an emergency non-potable water supply. The need to provide an emergency potable water supply for SFO may be considered.

4.6.1.4 Electrical Power

The current peak electrical power demand at SFO is 47 megavolt amperes (MVA). Substation BA has two 55 MVA transformers and Substation M has one 55 MVA transformer. The current electrical system at SFO provides a redundant electrical power distribution system. If Substation BA's power is interrupted, then Substation M has the capacity to provide electrical service to the entire Airport because current demand is less than 55 MVA.

The use of energy-efficient and sustainable design will likely reduce the growth rate in capacity requirements; however, building expansions, the BHS, AirTrain, and electric vehicle charging stations will likely increase the peak demand at SFO above 55 MVA during the planning period. To maintain same level of redundancy in the future, upgrades to Substation M are planned to address energy needs above 55 MVA. After the upgrade of Substation M is complete, no additional electrical supply improvements will be required.

4.6.1.6 Information Technology and Telecommunications

According to previous studies, the existing ITT infrastructure at SFO is currently at or near maximum capacity or is not in conformance with current standards. This is due in large part to abandoned or unidentified legacy copper systems located in the existing ductbanks and throughout SFO properties. As data and IT capacity needs increase, a strategy to address the conversion of existing copper technology to more efficient systems will be necessary.

Additionally, ITT infrastructure is not present in certain areas of Airport property and will need to be extended into those areas to support future growth needs and initiatives.

4.6.2 Strategic Initiative Requirements

Current SFO strategic initiatives, including environmental sustainability, airport security enhancements and shoreline protection will, affect certain utility systems.

These initiatives will directly affect the Central Utility Plant (CUP), electrical power, IT/communications, and stormwater infrastructure, and the Airport seawall system.

4.6.2.1 Climate Action Plan and Carbon Neutrality Initiatives

The SFO Climate Action Plan calls for a reduction in greenhouse gas (GHG) emissions at the Airport to the following levels:

- 25 percent below 1990 emission levels by 2017
- 40 percent below 1990 emission levels by 2025
- 80 percent below 1990 emission levels by 2050

Several measures have already been implemented at SFO that have resulted in achievement of the 25 percent reduction goal several years ahead of the 2017 deadline.

SFO purchases 100% GHG-free electricity, but the consumption of natural gas at the Airport is a significant contributor to GHG emissions at the Airport. The CUP is one of the largest consumers of natural gas at the Airport. As a result, the CUP is a primary focus of efforts to improve energy efficiency and reduce natural gas consumption to enable SFO to achieve management's goals. SFO Engineering has investigated multiple preliminary options to improving CUP performance. These options require a new CUP design and installation. SFO Engineering has determined a preliminary requirement of approximately two acres to house a new CUP.

Additional Climate Action Plan initiatives involving electric vehicles will require significant improvements within the parking garages to support increased electric vehicle charging demands, but this impact on the overall electrical capacity of SFO can be absorbed by Substation BA and expanded Substation M.

4.6.2.2 Security Enhancements

SFO management has undertaken an initiative to reduce perimeter security incidents at the Airport. This initiative includes providing technology improvements to monitor the perimeter, such as ground-based radar, thermal imaging, and digital video closed caption television (CCTV) cameras. Currently, the existing IT/communications infrastructure does not extend around the entire perimeter of the Airport property, especially along the San Francisco Bay. Proper support of the technology for the enhanced security systems will require extension of both IT ductbank and cabling infrastructure.

4.6.2.3 Shoreline Protection

A previous shoreline protection study[34] identified deficiencies in the existing system. The requirements from that report were integrated into the ADP.

4.6.3 Incidental Facility Requirements

The majority of the determined utility requirements are related to modifications proposed by other ADP focus areas and, therefore, are deemed incidental facility requirements. These incidental requirements include modifications to particular areas of and items in the utility systems. These incidental requirements could be considered as enabling projects to construction of the proposed projects. The enabling projects could be constructed independently from the "parent" project, although it is more logical to construct them as an enabling phase of the parent project to minimize conflicts and potential rework. These incidental requirements include:

- Modifications to existing stormwater infrastructure to support the realignment of Taxiway C
- Potential modifications to underground utilities to support the realignment of Taxiways A and B
- Modifications to existing pump stations for sanitary sewer and industrial waste to support the San Bruno Avenue intersection modifications
- Modifications to underground utilities to support boarding area expansions

The utility incidental facility requirements are incorporated into the alternatives analyses and grouped with parent projects as part of the recommended plan.

34 *SFO Shoreline Protection Feasibility Study Evaluations and Recommendations Report*, Moffatt & Nichol + AGS Joint Venture, June 2015.