From: scottkeat@gmail.com [mailto:scottkeat@gmail.com] **On Behalf Of** Scott Keatley
Sent: Monday, November 26, 2012 3:04 PM
To: Duffy, Daniel
Subject: Freedom of Information Request

Dear Mr. Duffy:

I am seeking the following runway length analysis:

Benefit/Cost Analysis of Runway 4L/22R RSA Compliance Rehabilitation, John F. Kennedy International Airport, July 2011.

This document was cited in the draft environmental assessment for runway 4L/22R improvements at JFK Airport as prepared by Landrum and Brown. Thank you in advance for your assistance.

--
Scott Keatley
Environmental Law Advocate
Eastern Queens Alliance

w: 347.824.2301
f: 212.500.3393

skeatley@easternqueensalliance.org

****
This email (and any attachments) is intended solely for the individual(s) to whom it is addressed. It is confidential and may contain legally privileged information.
****

THE PORT AUTHORITY OF NY & NJ

FOI Administrator

March 21, 2013

Mr. Scott Keatley
Eastern Queens Alliance

Re: Freedom of Information Reference No. 13591

Dear Mr. Keatley:

This is a response to your November 26, 2012 request, which has been processed under the Port Authority's Freedom of Information Code (the "Code") for a copy of the Benefit/Cost Analysis of Runway 4L/22R RSA Compliance Rehabilitation at John F. Kennedy International Airport on July 2011.

Material responsive to your request and available under the Code can be found on the Port Authority's website at http://www.panynj.gov/corporate-information/foi/13591-O.pdf. Paper copies of the available records are available upon request.

Please refer to the above FOI reference number in any future correspondence relating to your request.

Very truly yours,

Daniel D. Duffy
FOI Administrator

225 Park Avenue South
New York, , NY 10003
T: 212 435 3642 F: 212 435 7555

BENEFIT COST ANALYSIS OF RUNWAY 4L/22R RSA COMPLIANCE

JOHN F. KENNEDY INTERNATIONAL AIRPORT

THE PORT AUTHORITY OF NY & NJ

Prepared by:
DY Consultants in association with Landrum & Brown
July 2011
Reviewed August 2012

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1. PROJECT DESCRIPTION

1.1 INTRODUCTION

With over 4,930 acres, 9 miles of runways, 35 miles of taxiways, and 7 independent terminals with 188 contact or hardstand gates servicing over 80 airlines, JFK is the largest facility in the Port Authority of New York and New Jersey (PANYNJ) Airport system. In 2010, JFK carried 1.4 million tons of cargo and handled over 46.5 million passengers. Over 397,600 aircraft operations JFK remains the premiere international gateway with over 61 carriers serving 100 international nonstop destinations.

Over the past few years, JFK has undergone significant airfield improvements in order to enhance its overall capacity. The most recent one was the complete rehabilitation of Runway 13R/31L which was widened to be able to accommodate Group VI aircraft such as the Airbus A380. Taxiway improvements and new high-speed exits were also built in order to enhance capacity.

JFK's Runway 4L/22R is primarily used for departures and is a key element of the airfield in various runway flow configurations. Indeed, Runway 4L/22R is the primary departure runway in both Southwest and Northeast flows. This runway is also occasionally used as a second departure runway in Northwest flow.

This analysis focuses on current runway safety area requirements for Runway 4L/22R. The PANYNJ requested a Benefit-Cost Analysis (BCA) to support the Letter of Intent (LOI) to the FAA, with the overall goal to acquire AIP funding for the Runway 4L/22R improvements.

1.2 PROBLEM STATEMENT

Currently, Runway 4L/22R does not comply with the Runway Safety Area (RSA) standards set by the Federal Aviation Administration (FAA). Current federal regulations mandate that "airport operators that accept AIP funds for runway or taxiway renovations are obligated under grant assurances to ensure that such renovations meet current standards, including those for runway safety areas. Since 1988, many safety areas at FAR Part 139 airports have been brought up to current standards through this process." (Ref. U.S. Department of Transportation, 14 CFR Part 139 Certification of Airports, Final Rule, February 2004). In November 2005, Congress, in consultation with FAA, mandated that all Part 139 airport sponsors enhance passenger safety by improving their RSAs by 2015 and that FAA report annually on its progress toward improving RSAs.

According to the FAA definition, an RSA is "a surface surrounding the runway that has been prepared for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or excursion from the runway". It is "an area centered on the runway centerline (250 feet on each side)". This area must be "600 feet in length prior to the landing threshold and 1,000 feet in length beyond the runway threshold for departures".

The existing Runway 4L/22R's RSA is too short for both landings and takeoffs on Runway 4L and 22R. Indeed, the RSA is only 140 feet long for landings on Runway 4L versus 600 feet long according to the FAA definition. On the departure side, Runway 4L's RSA is 885 feet long and Runway 22R's RSA 140 feet long compared to the FAA standard of 1,000 feet. In addition, the current RSA on Runway 4L/22R presents other deficiencies. Runway 4L's Localizer antenna is located 929 feet from the end of Runway 22R (versus a minimum requirement of 1,000 feet according to FAA standards). Moreover, Runway 4L's Glide Slope antenna is located 245 feet from the runway centerline (versus a minimum of 250 feet according to FAA standards).

1.3 GOALS AND OBJECTIVES

The goal of this study will be to modify the current Runway 4L/22R infrastructure in order to comply with FAA RSA standards.

1.4 DEFINITION OF PROPOSED PROJECT

In order to achieve the identified goals and objectives, the Proposed Project includes the following elements (see **Figure 1-1**):

- Runway extension
- Runway Threshold Displacements
- Instrument Landing System (ILS) Glide Slope and Localizer antenna relocations
- North Boundary Road relocation

1.4.1 Runway Extension

Runway 4L/22R will be extended by 728 feet on the north side of the runway between Taxiway FB and Taxiway E.

1.4.2 Runway Threshold Displacements

Runway 22R displaced threshold will be moved 3,316 feet north of its current location, resulting in a 108-foot displaced threshold from the new 22R Runway End. Runway 4L threshold will be relocated 460 feet north of its current location.

1.4.3 ILS Antennas' Relocation

Several relocations will take place in order to comply with the FAA RSA standards. Runway 4L Glide Slope antenna will be relocated outside of Runway 4L/22R RSA. Runway 4L Localizer antenna will be moved 600 feet north of Taxiway E edge. Concerning Runway 22R, the ILS Glide Slope antenna will be relocated north of Runway 13L/31R. The new Glide Slope antenna will be located 471 feet north of Runway 13L/31R centerline and 380 feet east of Runway 4L/22R centerline. Runway 22R Localizer will be moved south to be aligned with the runway, 140 feet beyond the end of pavement for 4L and 600 feet from the relocated threshold.

1.4.4 North Boundary Road Relocation

Due to the runway extension, the north boundary road will have to be relocated north of its current location.

1.4.5 Wetland Impact

Due to the wetland north of Runway 22R, the entire land located between the localizer antenna and the runway end cannot be used as a Runway Safety Area (RSA). Consequently, the new RSA starts 50 feet south of the localizer antenna. This will have an impact on the overrun distances for take-off and landing on Runway 4L, as only 11,169 feet will be usable. Available distances for Runway 22R will not be impacted by this restriction: 11,219 feet will be available for take-offs and 11,111 feet for landings.

1.5 OTHER RUNWAY/TAXIWAY IMPROVEMENTS

In order to limit the impact of construction on aircraft operations on and around the runway, the RSA compliance task will be combined with other runway improvements and scheduled at the same time as the rehabilitation of Runway 4L/22R. A new rehabilitation of the runway is expected to occur in the near future in order to keep the runway to standards and improve overall capacity of the airfield. This rehabilitation would allow the PANYNJ to add various taxiway improvements to the runway in order to enhance the capacity of the airfield. These improvements include:

- Taxiway Construction and realignment
- Modified and new runway exits

1.5.1 Taxiway Construction

Due to the extension of Runway 4L/22R, various taxiways would be either modified or built in order to ease the flow of aircraft to/from and around the runway. These new taxiways will provide more flexibility to the FAA air traffic control tower (ATCT) to sequence aircraft and also provide bypass capability for aircraft taxiing or queuing around the runway.

Each section of Taxiway ZA will be realigned and extended through Taxiway E. The new Taxiway ZA will be located 550 feet west of Runway 4L/22R. A new taxiway will be added between Taxiway FB and Taxiway E. This new taxiway will be located 324 feet north of Taxiway FB.

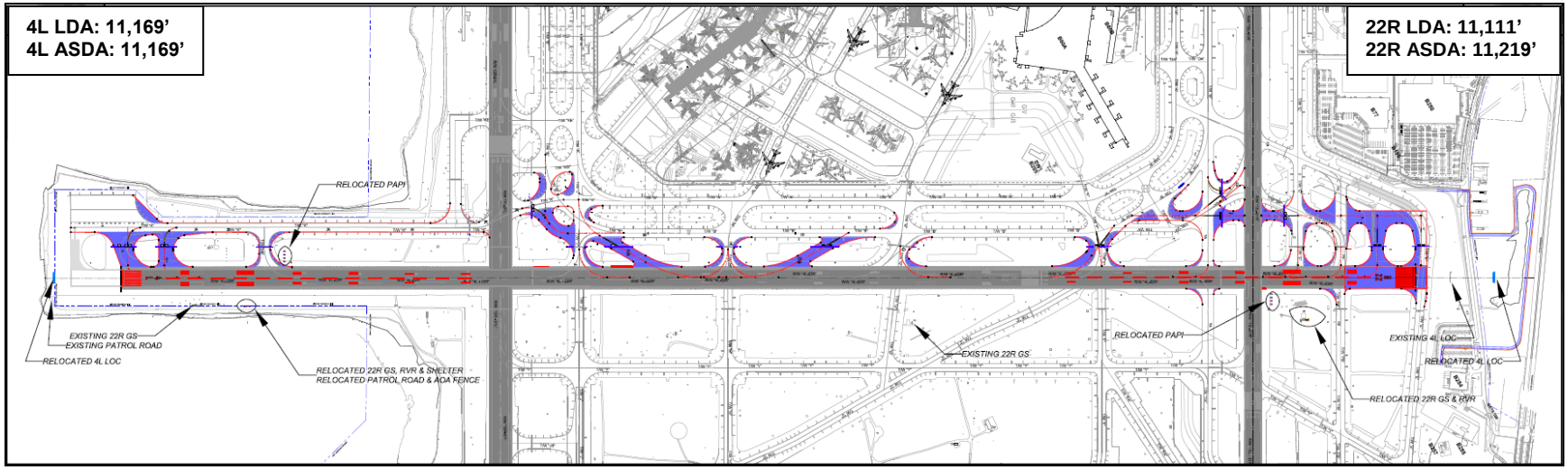
On the south side of the runway, Taxiway KC will be extended to Runway 4L/22R. A new Taxiway will be built south of Taxiway KB to help sequence departures.

1.5.2 Runway Exits

The project will include the construction of two new high-speed exits as well as various fillets on existing exits in order to reduce arrival runway occupancy time.

For arrivals on Runway 22R, fillets will be improved for Exits G, H, and J. This will allow arriving aircraft to exit the runway slightly faster at these locations than in current conditions. In addition, a new 30-degree exit HA will be added between Exit H and Exit J. This new exit will be located 6,690 feet from the new Runway 22R threshold. For arrivals on Runway 4L, fillet will be improved on Exit H. A new 30-degree angle exit GA will be built between Exit H and Exit G. Runway Exit F will be modified to a 45-degree angle exit. A new 'elbow' on Taxiway B will be added so that the new high-speed exits can be used properly.

FIGURE 1-1
PROPOSED PROJECT
John F. Kennedy International Airport



Source: Port Authority of New York and New Jersey.

2. EXISTING CONDITIONS AND BASE CASE

This section intends to present the current facilities and operational practices at JFK. These existing conditions will be used as a basis for the simulation model. Indeed, the existing conditions will be used to calibrate the simulation model and compare the results to FAA Aviation System and Performance Metrics (ASPM) data for selected days in summer 2010 to ensure proper representation of the airfield and its operations.

The Base Case scenario will be defined in the last part of this section. It will represent the reference point to which the proposed project will be compared to, in order to evaluate the benefits of the improvements presented in Sections 1.4 and 1.5.

2.1 EXISTING FACILITIES

JFK's current airfield consists of four runways: two widely spaced parallel runways oriented in a northwest/southeast direction (Runways 13L/31R and 13R/31L) and two closely spaced parallel runways oriented in a northeast/southwest direction (Runways 04L/22R and 04R/22L):

- Runway 13L/31R – 10,000' x 150'
- Runway 13R/31L – 14,511' x 200'
- Runway 04L/22R – 11,351' x 150'
- Runway 04R/22L – 8,400' x 200'

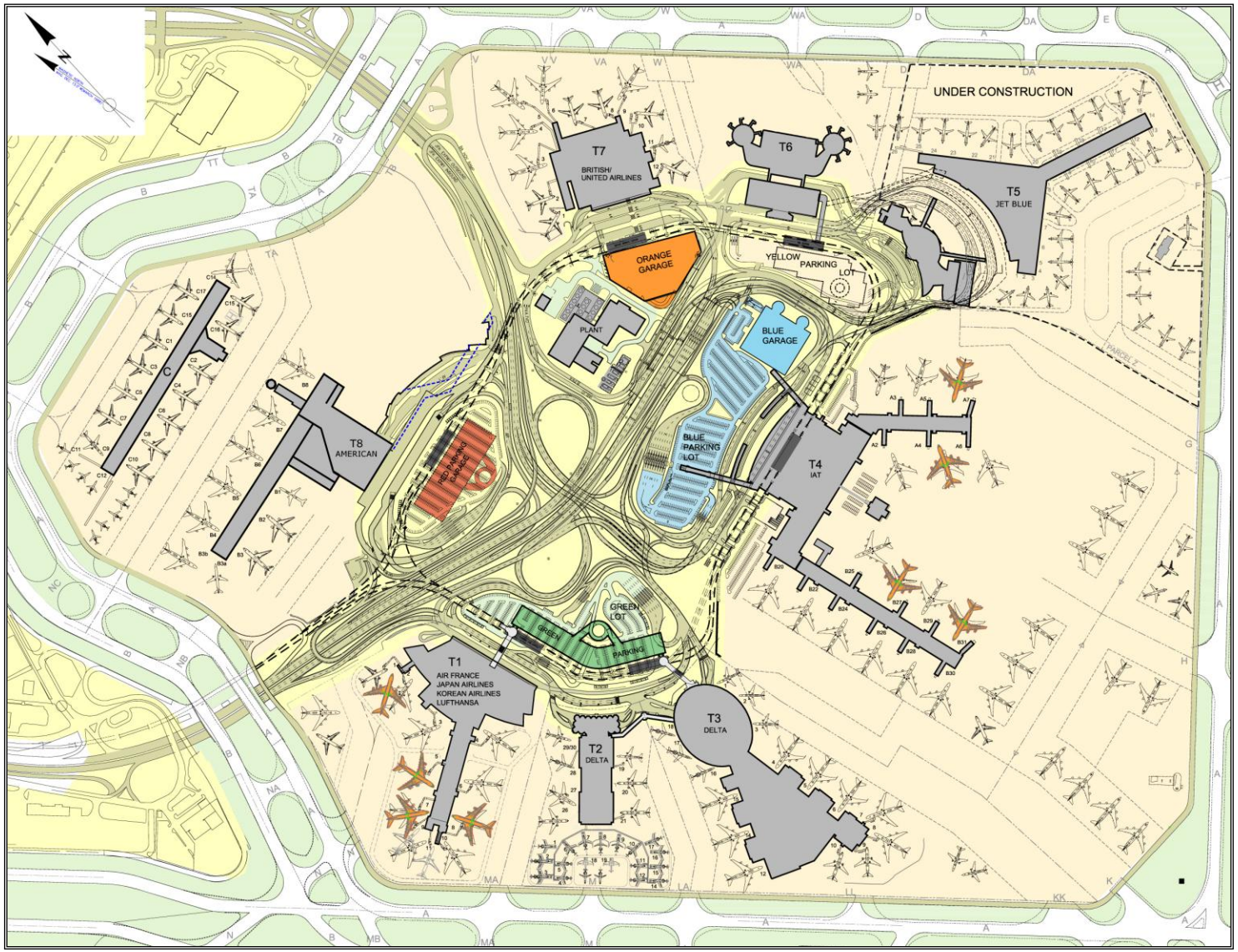
Currently the airport hosts 7 domestic airlines and 63 international airlines[1]. As shown in **Figure 2-1**, terminals are usually dominated by one carrier. International airlines are located mainly in Terminals 1, 4 and 7 but international operations also take place in the other terminals. JFK presently has 168 aircraft gates and parking positions located in the central area of the airport:

- Terminal 1 – 12 gates and parking positions
- Terminals 2/3 – 43 gates and parking positions
- Terminal 4 – 33 gates and parking positions
- Terminal 5/6 – 34 gates and parking positions
- Terminal 7 – 12 gates and parking positions
- Terminal 8 - 34 gates and parking positions

Gate counts for Terminals 1 and 4 could be lower considered the use of the alternate A380 gates.

[1] Based on Airport website and data from the *Official Airline Guide* for year 2010.

FIGURE 2-1
AIRPORT CURRENT GATE LAYOUT
John F. Kennedy International Airport



Source: Port authority of New York and New Jersey.

2.2 RUNWAY USE

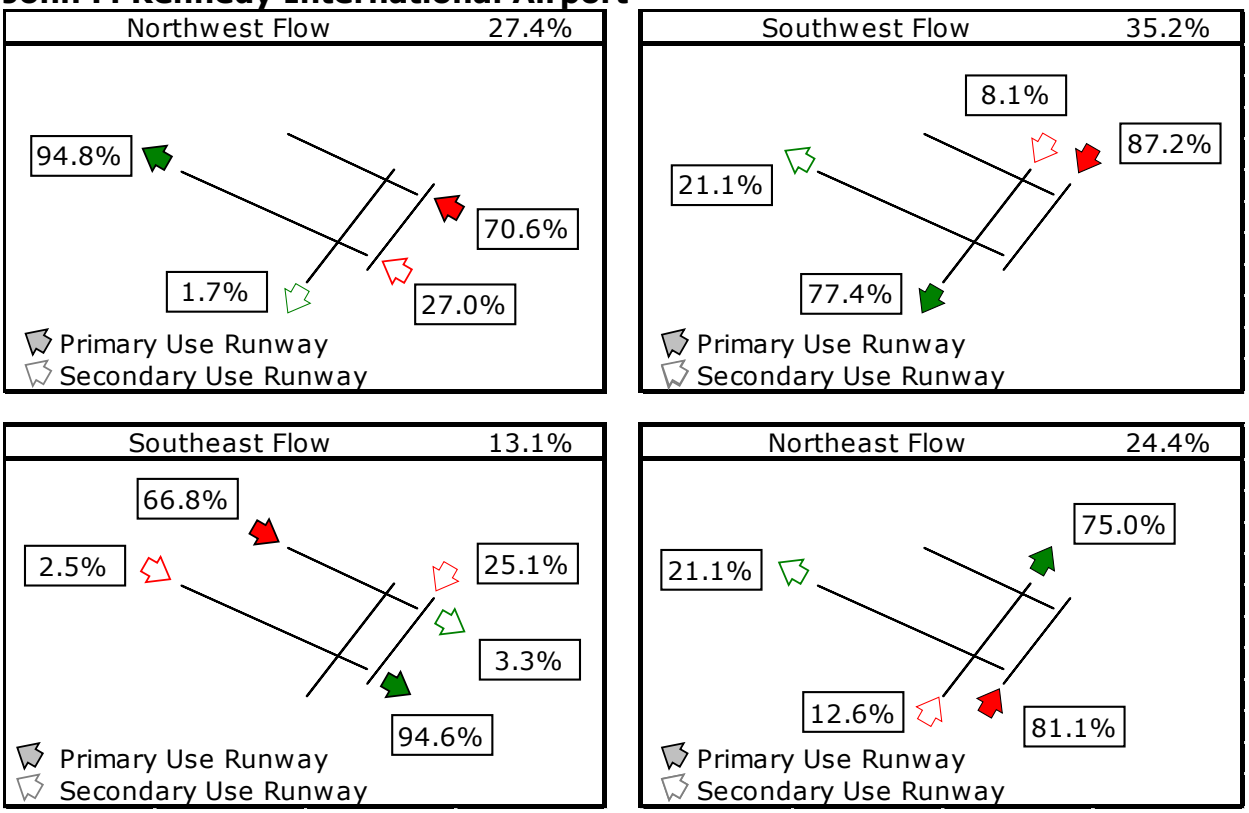
The FAA operates the JFK runway system in a large number of combinations of arrival and departure runways (configurations). JFK operations fall into one of four flow conditions as shown in **Figure 2-2**:

- Northwest Flow – Arrivals on Runway 31R, with Runway 31L used for arrivals during peak arrival traffic conditions. Virtually all departures occur on Runway 31L since the proximity of LaGuardia Airport precludes northbound turns of departing aircraft from Runway 31R.
- Southwest Flow – Arrivals on Runway 22L, with Runway 22R used for arrivals during peak arrival traffic conditions. Departures occur from Runway 22R, with Runway 31L being used in peak departure traffic conditions.
- Southeast Flow – Arrivals on Runway 13L, with Runway 22L used for arrivals during peak arrival traffic conditions. Departures occur from Runway 13R. A very few departures use Runway 13L.
- Northeast Flow – Arrivals on Runway 4R, with Runway 4L used for arrivals during peak arrival traffic conditions. Departures occur from Runway 4L, with Runway 31L being used in peak departure traffic conditions.

These four flow combinations are defined by the airspace used for approaching the arrival runways. The runway configuration use has changed over the past seven years as shown in **Table 2-1**. Indeed, there is more use of the Southwest flow configuration (higher departure capacity/lower departure delays). The usage of this configuration increased from 22.4 percent in 2005 to 34.6 percent in 2011. In contrast, there is less use of the Southeast flow configuration (lower departure capacity/higher departure delays) with a decrease in usage from 23.4 percent in 2005 to 10.6 percent in 2011. The use of the Northwest configuration has also declined. The use of the Northeast flow configuration remained relatively constant from 2005 through 2009 before increasing to 24.2 percent in 2011. This configuration is most frequently used in IMC.

The use of three-runway configurations has doubled since 2007 (see **Table 2-2**). Three runway configurations have an unbalanced capacity between arrivals and departures. These configurations provide "dynamic capacity" that switches between dual arrival runway configuration and dual departure runway configuration in response to demand. The process of switching back and forth between dual arrival and dual departure configurations degrades the capacity available from the configuration. The amount of degradation depends on how much the flow of aircraft must change in order to take advantage of the incremental capacity provided by the third runway.

FIGURE 2-2
AIRPORT RUNWAY FLOW CONFIGURATIONS – YEAR 2011 USAGE
John F. Kennedy International Airport



Note: Percent usage calculated based on total aircraft operations.
Sources: Port Authority of New York and New Jersey, eCater data; Landrum & Brown analysis.

TABLE 2-1
HISTORICAL RUNWAY FLOW USAGE
John F. Kennedy International Airport

	Percent of Time				
Year	**NW**	**SW**	**SE**	**NE**	**Unknown**
2005	35.6%	22.4%	23.4%	16.8%	1.9%
2006	41.0%	19.4%	25.2%	13.8%	0.7%
2007	37.3%	22.6%	25.6%	14.1%	0.4%
2008	34.1%	30.9%	18.1%	16.9%	0.0%
2009	30.8%	31.1%	15.0%	23.0%	0.0%
2010	24.1%	35.6%	11.6%	28.1%	0.6%
2011	30.4%	34.6%	10.6%	24.2%	0.2%

Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis

TABLE 2-2

RUNWAY USAGE
John F. Kennedy International Airport

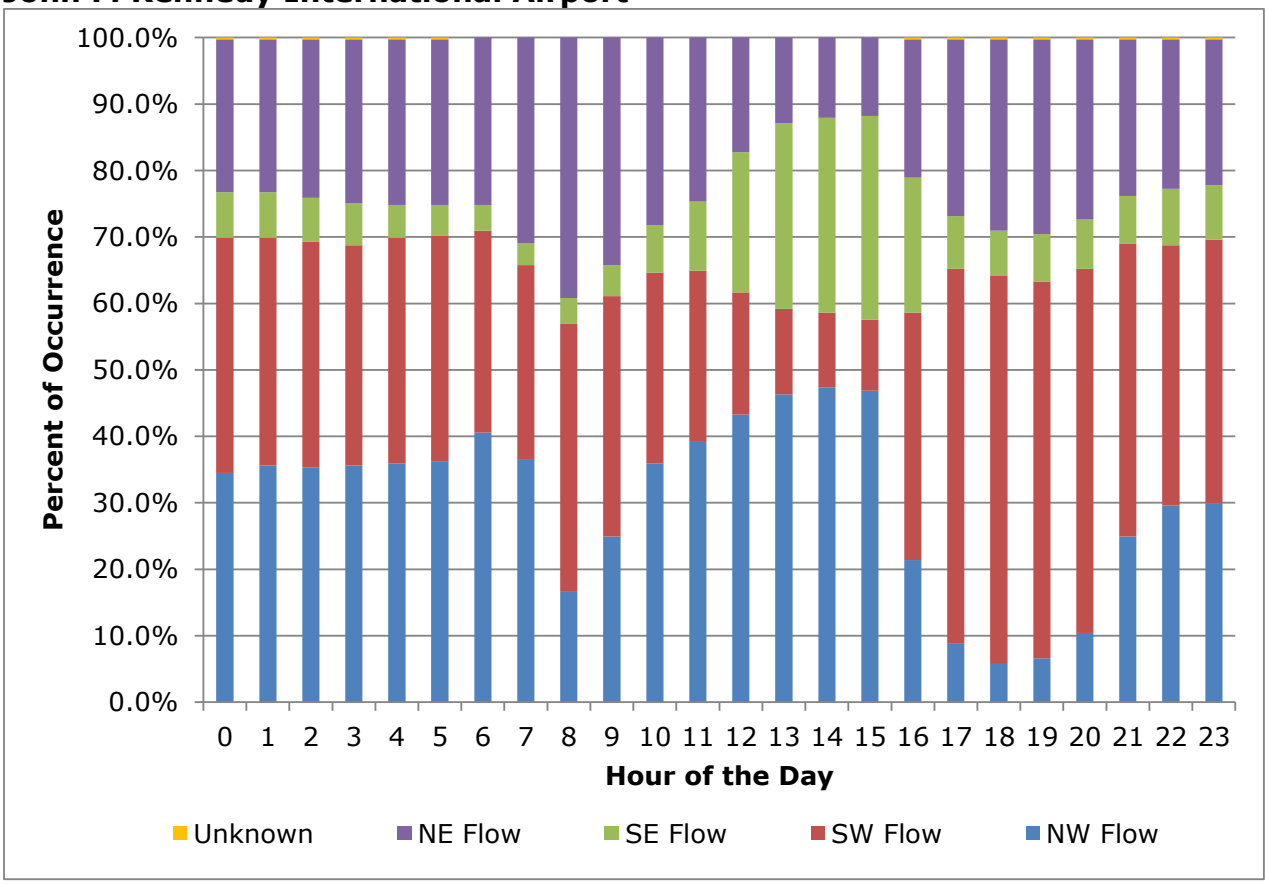
	Percent of Time			
Year	**One Rwy**	**Two Rwys**	**Three Rwys**	**Unknown**
2005	0.5%	78.3%	20.5%	0.8%
2006	0.7%	84.2%	14.6%	0.4%
2007	0.3%	60.1%	39.3%	0.4%
2008	0.6%	57.3%	42.1%	0.0%
2009	0.3%	60.0%	39.8%	0.0%
2010	1.7%	65.5%	32.2%	0.6%
2011	0.7%	64.5%	34.6%	0.2%

Note: Percent of Time calculated for a 24-hour day.
Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

It should be noted that Runway 13R/31L was closed for rehabilitation during a four- to five-month period starting in March 2010. As a result, usage of the NW flow configuration was drastically reduced in 2010 compared to other years. The closure of Runway 31L also precluded its use as secondary departure runway in SW and NE flows. This resulted in a lower usage of three-runway configurations in 2010 compared to other years as shown in Table 2-2. In order to more accurately reflect typical runway usage conditions at JFK, runway usage data for year 2011 was selected as basis for this study.

An analysis of hourly flow usage presented in **Figure 2-3** shows that FAA ATCT changes flow configurations during the day in order to respond to demand and capacity constraints. It is common at JFK to operate in NW or SE flow during the arrival peak hours from 13:00 through 15:00 and then switch to SW flow or NE flow during the departure peak hours (around 8:00-9:00 and from 17:00 to 21:00). SW and NE flows also provide the ability to run the airfield in a dual-arrival/dual-departure configuration such as the 22L, 22R|22R, 31L configuration and the 4R, 4L|4L, 31L configuration. These two configurations are particularly useful during the late afternoon peak.

FIGURE 2-3
2011 HOURLY RUNWAY FLOW USAGE
John F. Kennedy International Airport



Note: Percent of Time calculated for a 24-hour day.
Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis

2.3 DESCRIPTION OF TAXI FLOWS

Despite its comparatively large size, JFK has a surprisingly limited taxiway network. Three of its runways are separated from the terminal area by two taxiways, Taxiways A and B, which provide most of the taxiway flow between the gate apron areas and the runways. JFK has a large number of taxiways between Runways 4L and 4R which provide connectivity between Runway 4R/22L and the terminal area. In addition, these taxiways are used to queue departures to Runway 31L.

In addition to the taxiway structure in the terminal area, JFK has the following key taxiways:

- Taxiway C which parallels the north side of Runway 13L/31R and provides connections to the north cargo area. In addition, this taxiway provides queuing space for Runway 22R departures. Spaces in the departure queue are necessary to allow aircraft movements from the cargo aprons.
- Taxiways P and Q parallel Runway 13R/31L west of Terminal 1. Taxiway P serves the runway while Taxiway Q serves the cargo, general aviation and aircraft maintenance hangar aprons in the southwest part of the airport. In

addition, Taxiway Q provides some bypass capability to Taxiway P for departure queue sequencing purposes. However, FAA ATCT generally prefers to keep Taxiway Q clear so that it can serve the southwest area of the airport.

- Taxiways Z, J, H and G connect Runway 4R/22L to the terminal area. In addition, they are used to queue departures to Runway 31L from the full-length threshold.
- Taxiway K is the only Taxiway available for Runway 4L departures. It has a small holding bay which provides very limited bypass capability for departure queue sequencing operations.
- Taxiways R and S are used to access the west cargo area aprons.

One key issue for efficient aircraft flow at JFK is to keep aircraft on Taxiways A and B moving. However, Taxiway B in front of Terminals 2 and 3 is also used to stage departures for Runway 31L from the Taxiway KK intersection. When this occurs, Taxiway A is the only taxiway available for aircraft traveling from Terminals 1, 2 and 3.

Another key issue for efficient aircraft flow at JFK is to keep departing aircraft out of the way of arriving aircraft. This includes quickly clearing departing aircraft off of Taxiways A and B, and onto other taxiways to line up in a departure runway queue. In addition, this also includes quickly clearing departing aircraft from the gate areas so that the path to the gate is clear for the next arriving aircraft.

For purposes of avoiding frequency congestion, JFK has one-full time ground controller to deal with the entire runway/taxiway system supplemented by a secondary ground position responsible for coordinating flight information with the pilot such as runway information, climbing rates, headings, departure route, etc.

JFK air traffic controllers use Taxiways A and B (or the "inner and outer taxiways") in opposite directions. Taxiway A is used clockwise while Taxiway B is used counterclockwise. The main advantage of this taxiway flow configuration is that FAA ATCT can minimize aircraft taxi distances. The disadvantage of this system, in the case of airfield congestion on one of the two taxiways, is that JFK does not have bypass capability. In other words, congestion on Taxiway A or B could potentially lead to airfield gridlock.

The complexity of ground control also depends on the way the airspace is managed. JFK uses the "correct" way meaning that ground control sorts the departing flights depending on the departure route TRACON provides and assigns them to the "correct" runway. This procedure usually results in higher workload for the ground control and potential longer taxi times[2].

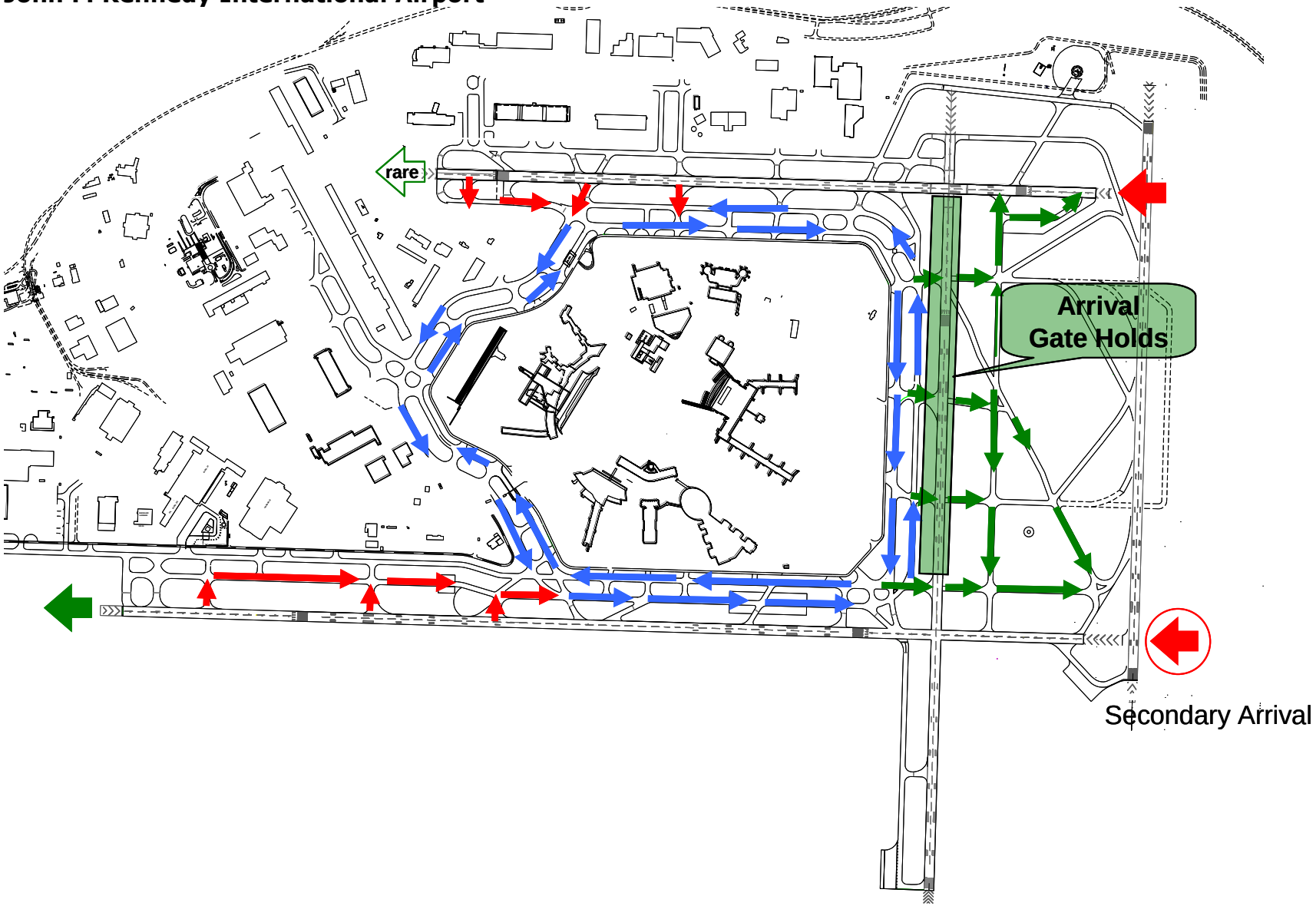
JFK ground control does not use separate Cargo/GA designated taxi routes. Cargo is concentrated on the north side of JFK in three areas: north of Runway 13L-31R (north of Taxiway C), the area served by Taxiway R and S, and the area served by

[2] The other way to manage the airfield would be for ground control to assign the departing flight to the closest runway and let TRACON sort the flights in the airspace. This practice called "easy" generates higher workload for TRACON but short taxi times.

Taxiway QB. General aviation (GA) and cargo traffic does not impact JFK operations. All their taxiway routes are dynamic in that the route is decided as the most advantageous at the moment. Cargo and GA flights get in the same flow as commercial passenger flights.

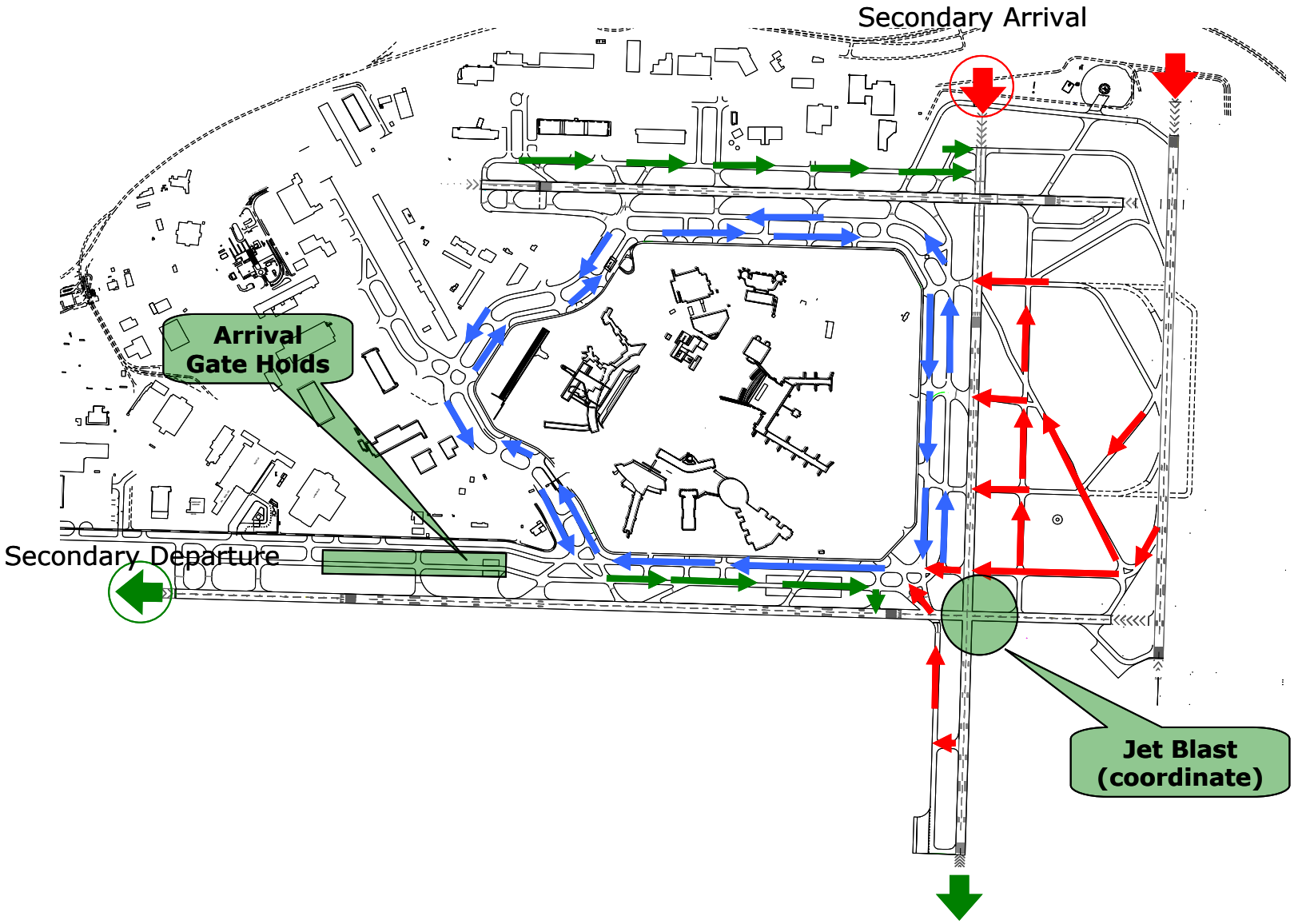
Figures 2-4 through **2-7** present the taxi routes for each runway flow configuration.

FIGURE 2-4
TAXI ROUTES - NORTHWEST FLOW
John F. Kennedy International Airport



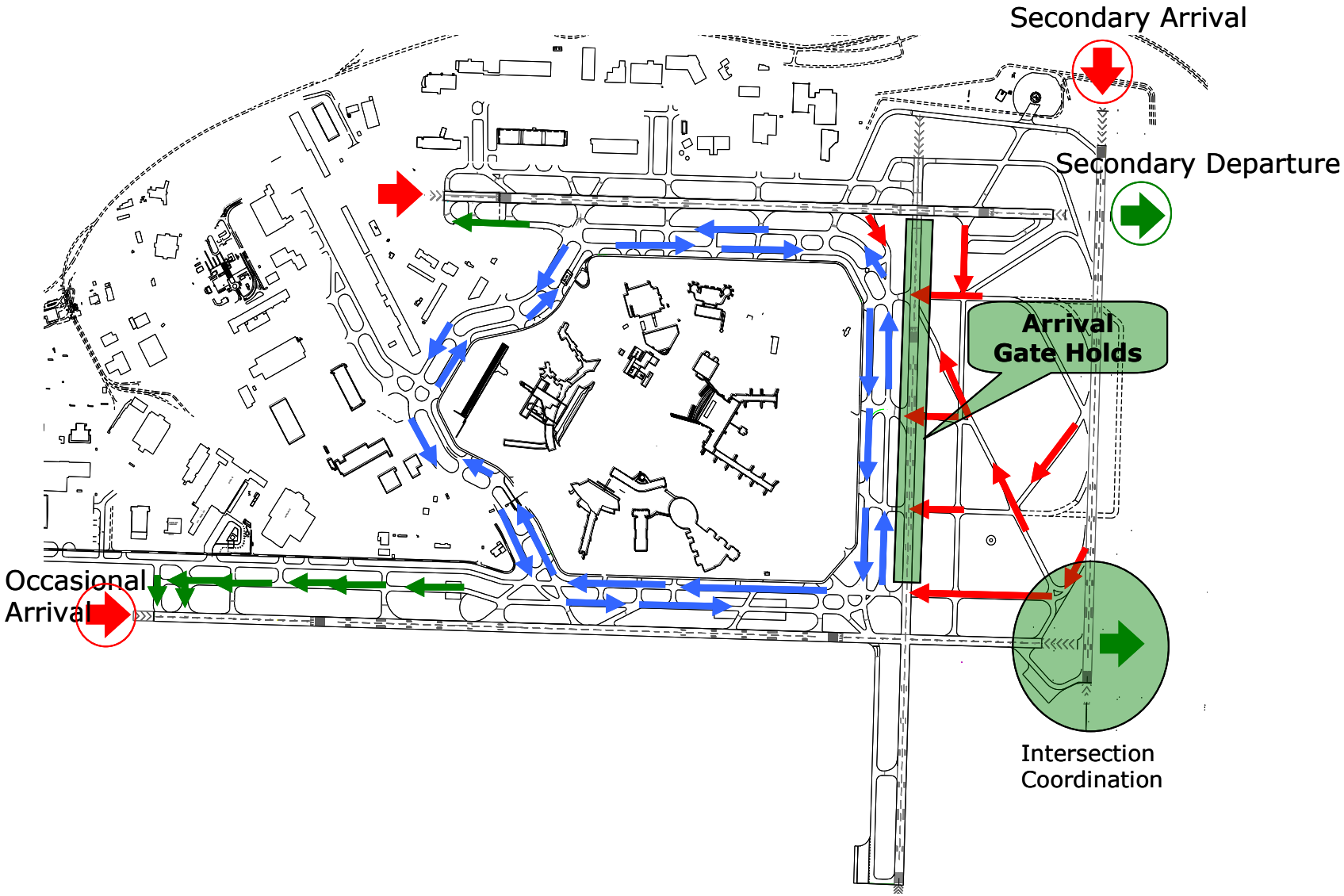
Source: Landrum & Brown analysis

FIGURE 2-5
TAXI ROUTES - SOUTHWEST FLOW
John F. Kennedy International Airport



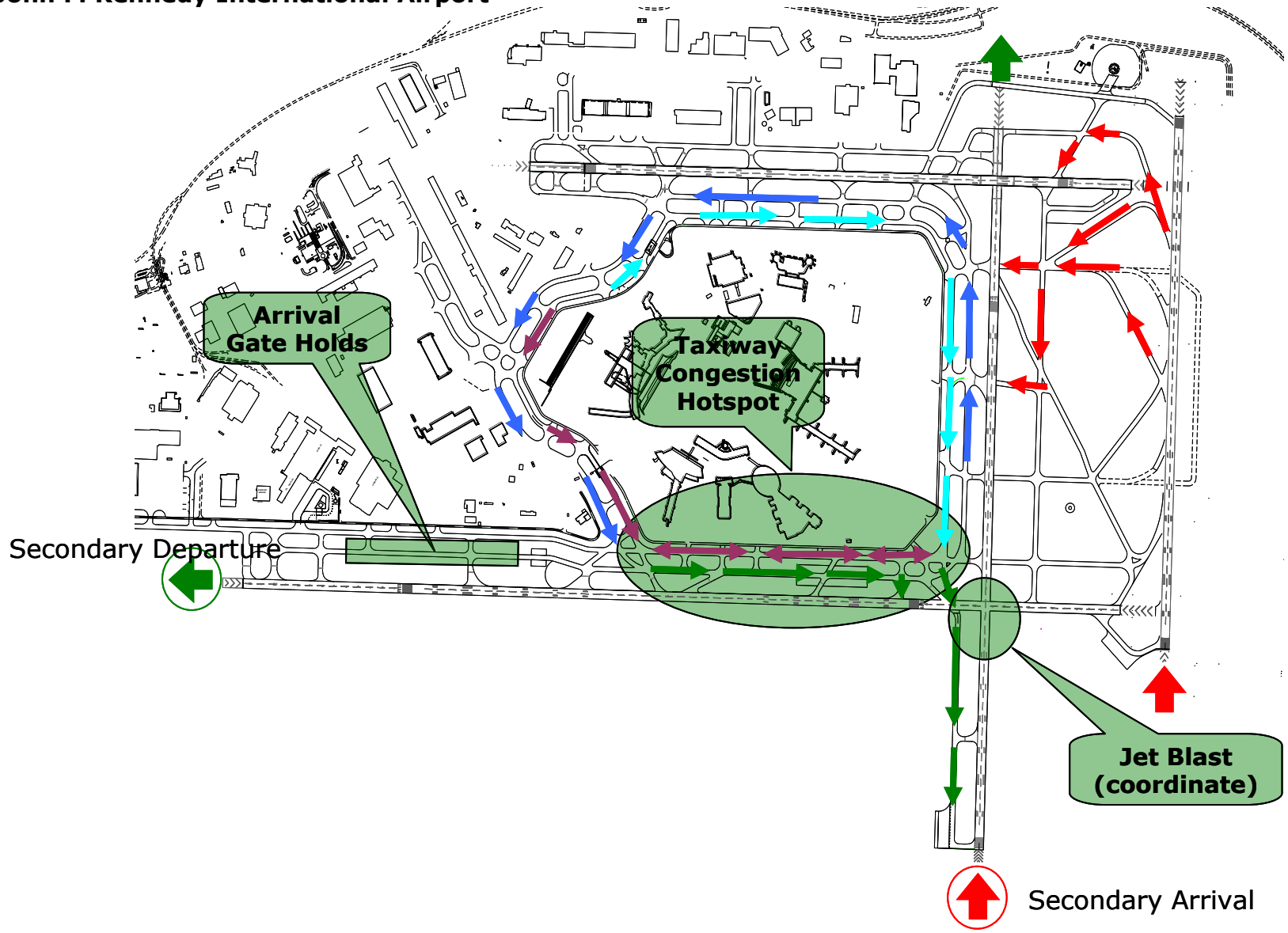
Source: Landrum & Brown analysis

FIGURE 2-6
TAXI ROUTES - SOUTHEAST FLOW
John F. Kennedy International Airport



Source: Landrum & Brown analysis

FIGURE 2-7
TAXI ROUTES - NORTHEAST FLOW
John F. Kennedy International Airport



Source: Landrum & Brown analysis

2.4 DESCRIPTION OF AIRSPACE FLOWS

The New York Terminal Radar Approach Control (TRACON) establishes the airspace available for JFK arrivals and departures, depending upon the mix of arrivals and departures and the airspace needs of other airports, especially LGA. Certain operations at LGA affect the airspace available to support JFK operations.

The New York regional airspace has three major zones. The west side airspace is allocated to EWR, TEB and other North New Jersey airports. The east side airspace is allocated to JFK, and the airspace in the middle is allocated to LGA. Essentially, all LGA arrivals must enter from the north and south, flying around the airspace allocated for EWR or JFK.

Due to the proximity between JFK and LGA airspace, certain operations at LGA require the use of some airspace that would normally be allocated to JFK. Generally, LGA needs this airspace to handle departures on LGA Runway 13, which is the most frequently used departure runway at LGA.

The airspace available for LGA depends on weather and the runways needed to support operations at JFK. If JFK has arrivals using Runways 22L and 22R, then LGA departures from Runway 13 turn south and climb out over the Canarsie VOR (Coney climbs). When LGA uses Coney climbs, JFK will not have Runway 31L for departures. If JFK has arrivals on the VOR approach to Runway 22L, LGA departures turn northbound after an initial southbound turn (Whitestone climbs). When LGA uses Whitestone climbs, JFK cannot use the ILS approaches to Runways 22R and 22L, but has Runway 31L available for departures.

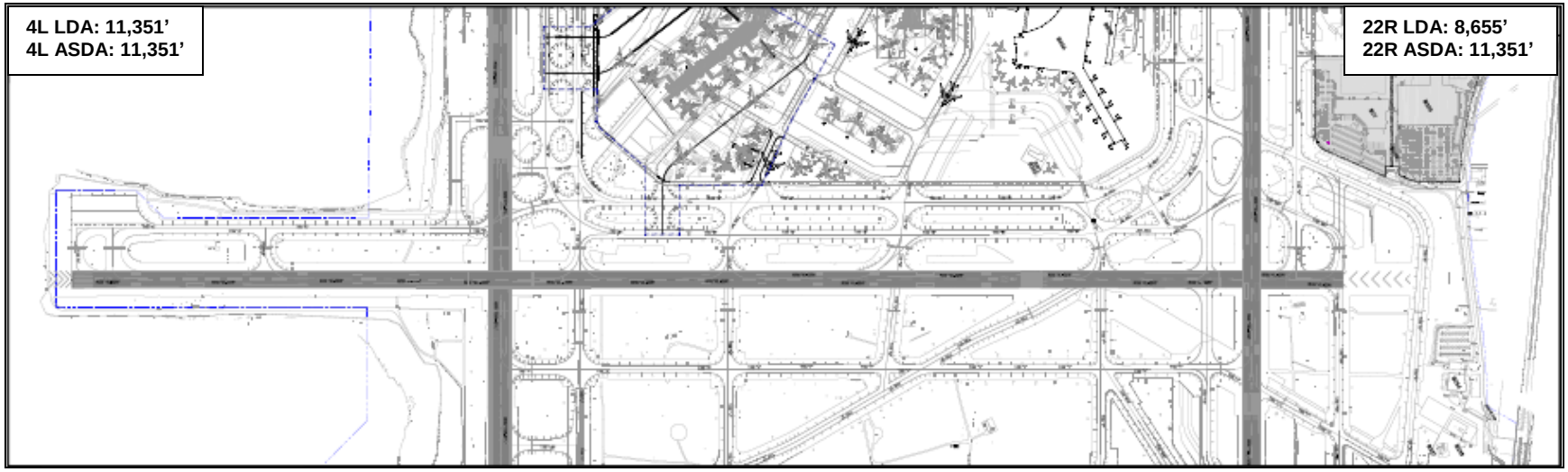
The JFK Runways 22L and 22R ILS airspace is constrained by the proximity of LGA airspace even when LGA does not use Runway 13 for departures or Runway 31 for arrivals. The maximum final approach course length is about 15 miles and the maximum altitude is 3,000 feet for Runway 22R and 2,000 feet for Runway 22L. The short length of the final approach course requires the TRACON to build the sequence on the downwind leg over the water, south of the Airport.

The Runway 13L ILS airspace also contains the final approach course for LGA Runway 4. Normally, approaches to Runway 13L use the Carnarsie VOR instead of the ILS to bypass this airspace conflict. If the airfield or weather conditions require for use of the Runway 13L ILS, then Runway 4 is not available for arrivals at LGA.

2.5 EXISTING CONDITIONS SCENARIO DEFINITION

The Existing Conditions scenario will assume no RSA compliance. The take-off distance available on Runway 22R is 11,351 feet. In Southwest flow, Runway 22R remains the main departure runway. Runway 31L is used as secondary departure runway during the departure peak for westbound departures. **Figure 2-8** presents the layout of Runway 4L/22R in the Existing Conditions scenario.

FIGURE 2-8
EXISTING CONDITIONS SCENARIO
John F. Kennedy International Airport



Source: Port Authority of New York and New Jersey.

3 DEFINITION OF THE BASE CASE SCENARIO

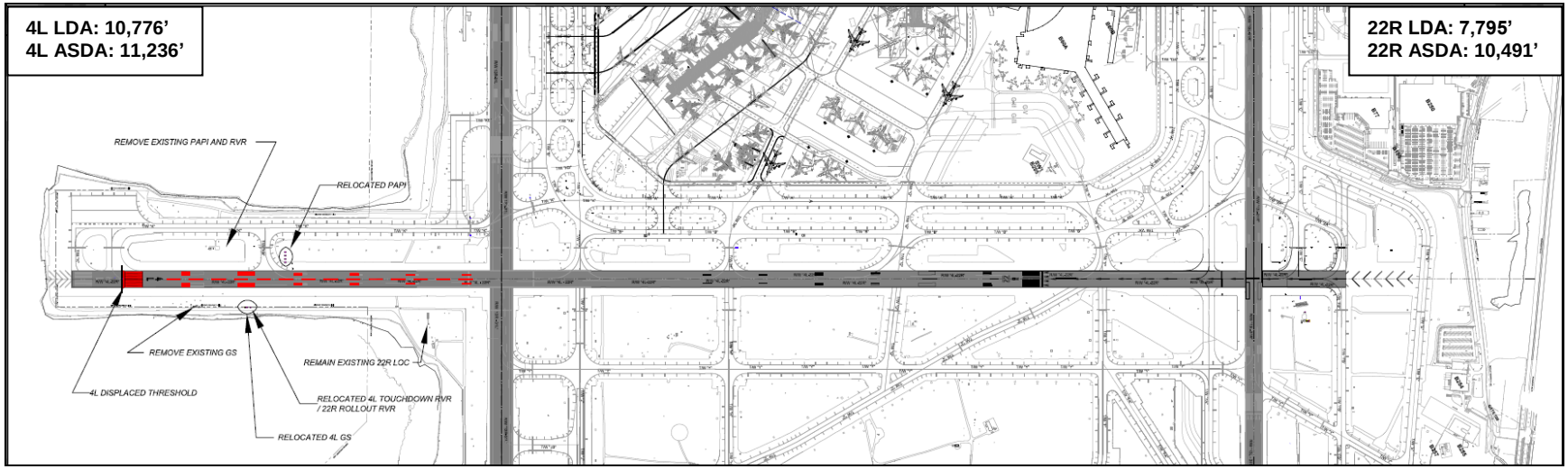
The Base Case, as described in the FAA's *Benefit Cost Analysis Guidance*, dated December 15, 1999 (the "BCA Guidance"), is intended to represent a reference point or benchmark against which the incremental benefits and incremental costs of the proposed alternative project can be measured. According to FAA guidance, it "should be the optimal course of action compatible with the specified project objectives that would be pursued in the absence of a major initiative". "It is especially important that the base case not be defined as a "do nothing" course of action where the current airport configuration and management are held static. BCAs based on this static base case will typically overstate the deterioration in delay, efficiency, safety, and other benefit measures as traffic grows."

The Base Case for this BCA is assumed to include minimum actions required to comply with runway safety area mandate and State of Good Repair (SGR) on runway. It does not include taxiways or runway extensions. However, the Base Case includes shortening the Runway 04L/22R for RSA compliance purposes. As a result, the takeoff distance available on Runway 4L would be 11,236 feet and 10,491 feet on Runway 22R. The takeoff length available on Runway 4L would not restrict the usage of this runway. However, during hot weather days, the shorter distance available on Runway 22R would raise issues for B747s, B777s, A340s, A330s, MD11, DC10, A300, A310, A380, B767-400, and other long-haul 767s to use the runway for take-off. A detailed payload-range analysis for all aircraft conducted as part of this BCA identified a series of flights, which would not be able to take-off from Runway 22R. These aircraft would have to use the full length of Runway 31L (not from Taxiway KK) to take-off. For arrivals, the landing distance available would be 10,776 feet and 7,795 feet for Runway 4L and Runway 22R, respectively (the 4L landing threshold gets displaced 460 feet north and the 22R displaced threshold stays as is). Similar to the departures, the landing distance does not impact operations on Runway 4L. Runway 22R landing distance might be critical for B747s, A340s, MD11s, and DC10s in wet conditions. These aircraft would have to land on Runway 22L.

Figure 3-1 presents the layout of the airfield in the Base Case.

While the shorter runway does not generate negative impacts on delays in Northeast flow, it creates capacity reductions in Southwest flow. Indeed, the departing flights heading to fixes other than RBV, DIXIE, and WHITE that are not able to take-off from the shorter Runway 22R will have to use Runway 31L, and consequently cross the 22R departure path. According to interviews with FAA ATCT at JFK, this would result in a loss of three departure slots on Runway 22R for every full-length departure on Runway 31L. Controllers are being conservative when operating both Runway 22R and Runway 31L for departures. Airspace constraints result in the merging of both departure flows. In order to ensure departures are properly spaced in the air, controllers have to apply lengthy wait times between an full-length departure on Runway 31L heading to fixes other than RBV, DIXIE and WHITE and a departure on Runway 22R. The loss of three departure slots on Runway 22R is quite dramatic on departure delays at JFK in Southwest flows. Resulting delay levels are presented in Section 7 of this report.

FIGURE 3-1
BASE CASE SCENARIO
John F. Kennedy International Airport



Source: Port Authority of New York and New Jersey.

4. PROJECT ALTERNATIVES

This section presents all alternatives considered as part of this project and the process used to select the preferred alternative.

4.1 ALTERNATIVES CONSIDERED

A total of 16 alternatives were considered in this analysis. Each alternative reflects a different length of the runway extension and/or a different location of Runway 22R threshold and/or a different location for the ILS antennas. The following is a brief presentation of each alternative.

Alternative 1
Runway 4L/22R would be extended 728 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 860 feet north of its current location. Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would remain in its existing location as shown in **Figure 4-1**.

Alternative 2
Runway 4L/22R would be extended 728 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 860 feet north of its current location. Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would be aligned with Runway 4L/22R (see Figure 4-1).

Alternative 3
Runway 4L/22R would be extended 728 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 1,626 feet north of its current location (at Taxiway YA). Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would remain in its existing location as shown in Figure 4-1.

Alternative 4
Runway 4L/22R would be extended 728 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 1,626 feet north of its current location (at Taxiway YA). Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would be aligned with Runway 4L/22R (see Figure 4-1).

Alternative 5
Runway 4L/22R would be extended 728 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 2,326 feet north of its current location (at Taxiway C). Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would remain in its existing location as shown in Figure 4-1.

Alternative 6
Runway 4L/22R would be extended 728 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 2,326 feet north of its current location (at Taxiway C). Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would be aligned with Runway 4L/22R (see Figure 4-1).

Alternative 7
Runway 4L/22R would be extended 728 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 3,161 feet north of its current location (465 feet north of Taxiway FB). Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would remain in its existing location as shown in Figure 4-1.

Alternative 8
Runway 4L/22R would be extended 728 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 3,161 feet north of its current location (465 feet north of Taxiway FB). Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would be aligned with Runway 4L/22R (see Figure 4-1).

Alternative 9
Runway 4L/22R would be extended 509 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 2,326 feet north of its current location (at Taxiway C). Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would remain in its existing location as shown in Figure 4-1.

Alternative 10
Runway 4L/22R would be extended 509 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 2,326 feet north of its current location (at Taxiway C). Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would be aligned with Runway 4L/22R (see Figure 4-1).

Alternative 11
Runway 4L/22R would be extended 324 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 2,326 feet north of its current location (at Taxiway C). Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would remain in its existing location as shown in Figure 4-1.

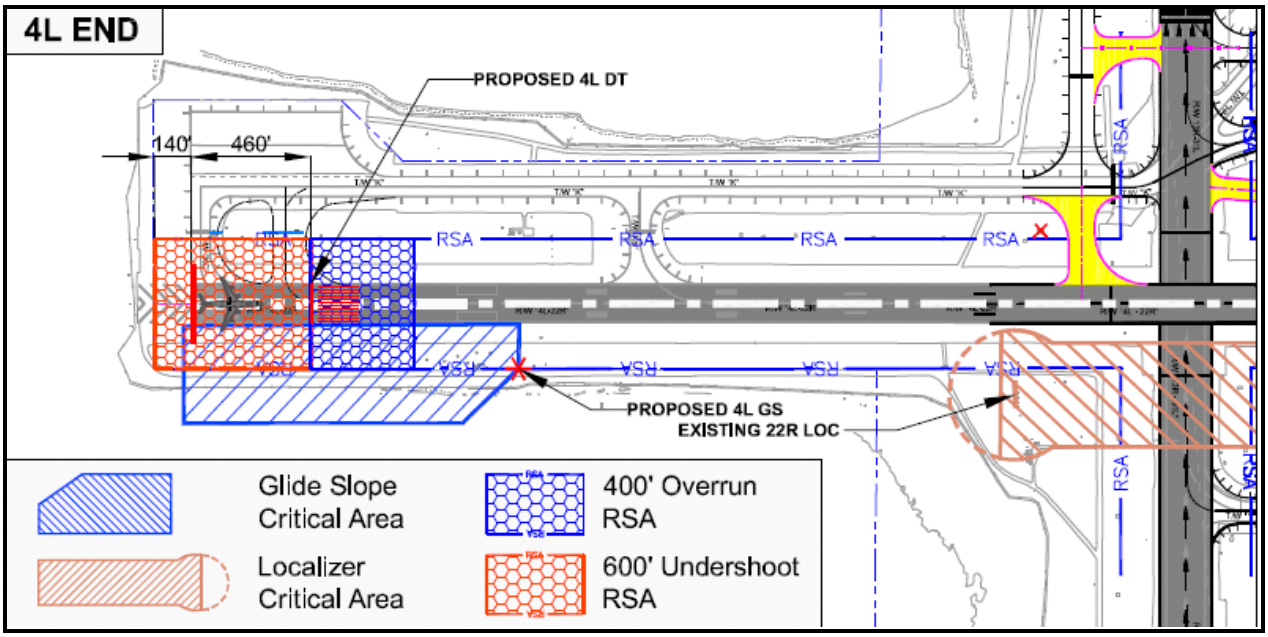
Alternative 12
Runway 4L/22R would be extended 324 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 2,326 feet north of its current location (at Taxiway C). Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would be aligned with Runway 4L/22R (see Figure 4-1).

Alternative 13
Runway 4L/22R would be extended 728 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 3,316 feet north of its current location (620 feet north of Taxiway FB). Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would remain in its existing location as shown in Figure 4-1.

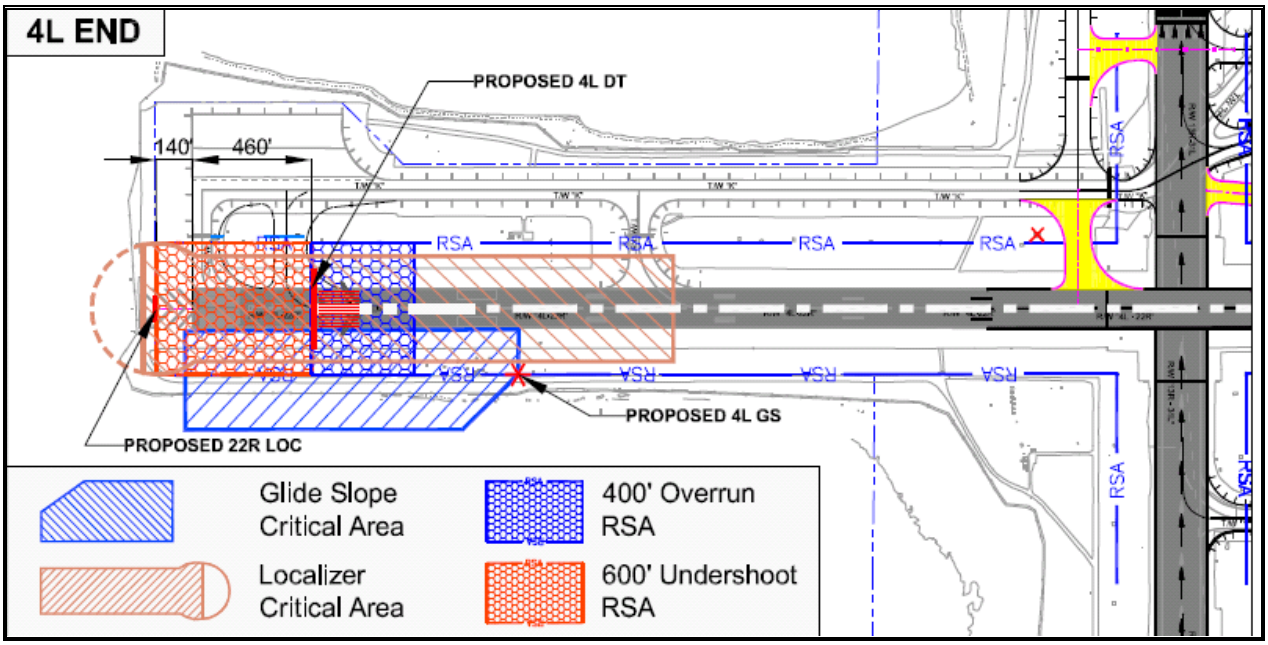
Alternative 14
Runway 4L/22R would be extended 728 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 3,316 feet north of its current location (620 feet north of Taxiway FB). Runway 4L threshold would be moved 460 feet north.

Runway 22R localizer antenna would be aligned with Runway 4L/22R (see Figure 4-1).

FIGURE 4-1
ALIGNED VS. OFFSET RUNWAY 22R LOCALIZER
John f. Kennedy International Airport
OFFSET LOCALIZER



ALIGNED LOCALIZER



Source: Landrum & Brown analysis.

Alternative 15

Runway 4L/22R would be extended 860 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 3,316 feet north of its current location (620 feet north of Taxiway FB). Runway 4L threshold would be moved 460 feet north.

Runway 22R localizer antenna would remain in its existing location as shown in Figure 4-1.

Alternative 16
Runway 4L/22R would be extended 860 feet north to Taxiway E. Runway 22R displaced threshold would be relocated 3,316 feet north of its current location (620 feet north of Taxiway FB). Runway 4L threshold would be moved 460 feet north. Runway 22R localizer antenna would be aligned with Runway 4L/22R (see Figure 4-1).

4.2 SELECTION OF PREFERRED ALTERNATIVE

A multi-step process was used to evaluate the preferred alternative and consisted in the following analyses:

- Runway Length Requirements
- Aligned vs. Offset Localizer
- Ground Taxi Flows
- NAVAIDS Siting

In addition, analyses of obstructions and noise impacts were conducted to validate the preferred alternative.

4.2.1 Runway Length Requirements

A runway length analysis was conducted for purpose of determining the best course of action or best alternative to select for the proposed project. The landing and take-off length requirements study covers the following conditions of temperature and pressure:

- Standard Temperature and Altitude Pressure (SLP)
- 85°F < T< 90°F and SLP<29.92” – occurred 22 Days across the year in the afternoon between 2pm and 5pm
- 91°F < T< 95°F and SLP<29.92” – occurred 12 Days across the year in the afternoon between 2pm and 5pm
- 95°F < T< 100°F and SLP<29.92” – occurred 5 Days across the year in the afternoon between 2pm and 5pm
- 85°F < T< 100°F and 29.92”<SLP<29.94” – occurred 3 Days across the year in the afternoon between 2pm and 5pm

The departure length available is the most demanding criteria based on the current usage of this runway. The following are the findings of the runway length requirement analysis presented in table 4-1:

- An 11,000-foot runway can accommodate all aircraft operating at JFK except the Boeing 747-200 under standard conditions.
- During the 22 days when 85°F<T<90°F and SLP<29.92”, an 11,169-foot runway would accommodate the fleet mix at JFK except the Boeing 747-200, 747-400, and Airbus 340-600. This affects 20 flights.

- During the 12 days when 91°F<T<95°F and SLP<29.92", an 11,169-foot runway would accommodate the fleet mix at JFK except the Boeing 747-200, 747-400, and Airbus 340-600. This affects 13 flights.
- A take-off length of 11,351 feet (the maximum take-off length the concepts could offer) would not accommodate the fleet mix better than a take-off length of 11,169 feet.

4.2.2 Aligned vs. Offset Localizer

This selection criterion evaluates the impact of aligned localizer antenna on Runway 4L/22R operations. Currently, Runway 22R Localizer antenna is located east of Runway 4L/22R (offset Localizer). The project considers realigning the localizer antenna with the runway. As a result, Runway 4L threshold will have to be relocated 460 feet north of its current location to protect against jet blast from aircraft departing on Runway 4L (600-foot buffer between the antenna and the start of take-off roll).

The main benefit is that this realignment potentially allows JFK to reduce the Runway 22R approach minimums as well as upgrade its ILS system to Category II/III; an offset localizer would directly prevent from such an improvement. It could also potentially benefit the LGA airspace as it would allow arrivals on Runway 22R to be more aligned with the runway, reducing the margin of error during approach.

However, the holding bay area west of Runway 4L threshold would be impacted by this relocation. Section 4.2.6 summarizes the results of the Kilo Pad operational study which was conducted in order to assess this impact and presents the physical conditions of the proposed project.

Finally, regardless of Offset or Aligned 22R Localizer, the Runway 22R available take-off length does not change. For Runway 4L, the available take-off distance after realigning the 22R localizer is reduced from 11,629 feet to 11,169 feet but still allows to accommodate the same aircraft fleet mix than when the localizer is offset.

Meanwhile, aligning the Runway 22R Localizer has the potential to get future Category II/III operations and potentially benefit the LGA airspace. Therefore, alternatives with localizer antennas aligned with the runway are preferable.

TABLE 4-1
RUNWAY 4L/22R TAKE-OFF LENGTH REQUIREMENTS
John f. Kennedy International Airport

	Aircraft	Runway 4L-22R Take-off Length Requirements (in feet)/Zero Wind					
% of Overall Volume	Critical Fleet Mix	Standard Temp. 59° F Sea Level Pressure (SLP) 29.92"	85° to 90° F SLP<29.92"	91° to 95° F SLP<29.92"	95° to 100°F SLP<29.92"	85° to 100°F 29.92"<SLP <29.94"	<100° SLP≥29.94"
0.34%	B737-900	9,800	10,780	11,270	11,760	10,780	9,800
9.79%	B757-200	9,600	10,560	11,040	11,520	10,560	9,600
0.12%	B757-300	9,900	10,890	11,385	11,880	10,890	9,900
2.44%	B767-200	7,800	8,580	8,970	9,360	8,580	7,800
6.50%	B767-300	10,400	11,440	11,960	12,480	11,440	10,400
3.35%	B777-200LR/ER	10,100	11,110	11,615	12,120	11,110	10,100
0.89%	B777-300	10,000	11,000	11,500	12,000	11,000	10,000
0.47%	B747-200	12,100	13,310	13,915	14,520	13,310	12,100
3.79%	B747-400	10,900	11,990	12,535	13,080	11,990	10,900
0.00%	B747-8	10,100	11,110	11,615	12,120	11,110	10,100
0.85%	A330-300	7,500	8,250	8,625	9,000	8,250	7,500
0.62%	A340-600	11,000	12,100	12,650	13,200	12,100	11,000
0.07%	A380-800	9,800	10,780	11,270	11,760	10,780	9,800
0.31%	MD11	10,400	11,440	11,960	12,480	11,440	10,400
Total: 29.54%							
Occurrences During 12 Months Up To 10/2010			22 Days Afternoon 2pm-5pm	12 Days Afternoon 2pm-5pm	5 Days Afternoon 2pm-5pm	3 Days Afternoon 2pm-5pm	Rest of The 12 Months

42 days

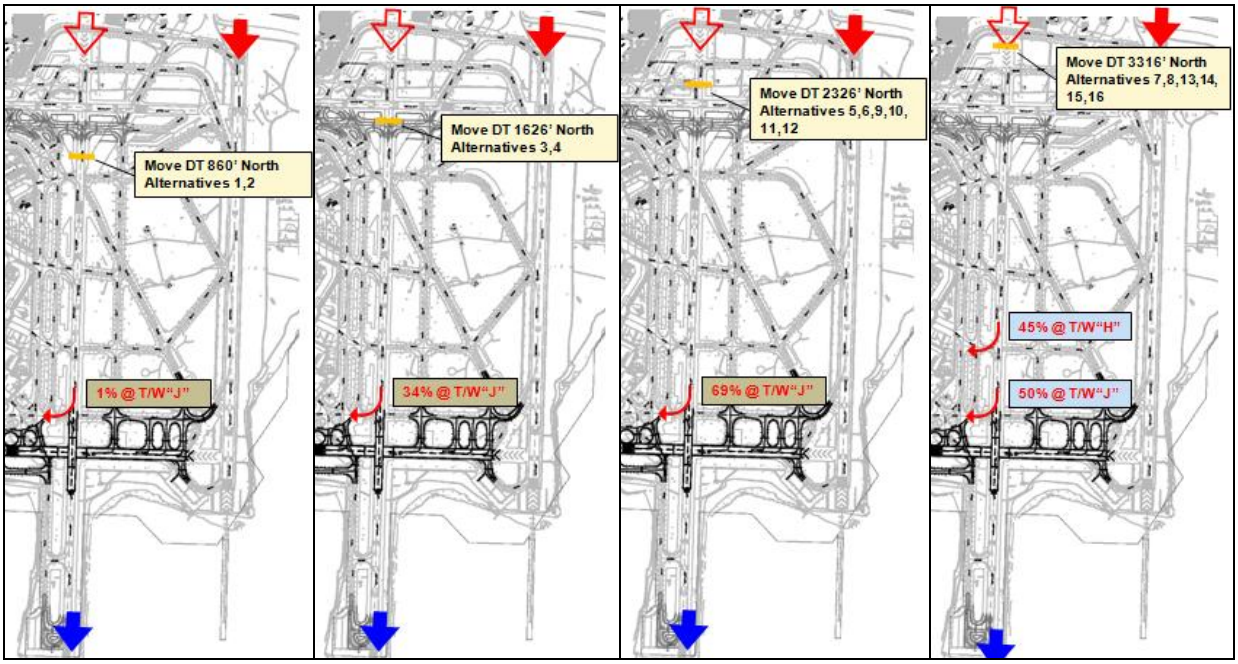
Note: The Koch Chart was used for runway take-off length estimates and adjustments were made to Koch formula based on known aircraft take-off requirements.
Source: Landrum & Brown analysis.

4.2.3 Ground Taxi Flows

Ground taxi flow analyses were conducted for both Southwest and Northeast flows using the Runway Exit Design Interactive Model (REDIM). These analyses focused on the impact of the location of runway thresholds on aircraft taxi flows and the ability for aircraft to use or exit the runway.

In Southwest flow, alternatives allowing Runway 22R displaced threshold to be moved north increases the probability of arriving aircraft exiting Runway 22R before crossing Runway 13R/31L. The reduction in runway crossings is crucial in maximizing capacity and shortening taxi time to the terminal area. With the existing Runway 22R displaced threshold, no arrival can exit the runway before Runway 13R/31L. For alternatives 1 and 2, only one percent of arrivals can exit the Runway 22R before Runway 13R/31L.

FIGURE 4-2
22R DISPLACED THRESHOLD ALTERNATIVES – RUNWAY EXITS COMPARISON
John f. Kennedy International Airport



This number increases to 34 percent for alternatives 3 and 4. For alternatives 5, 6, 9, 10, 11, and 12, 69 percent of arrivals on Runway 22R can exit before Runway 13R/31L. For alternatives 7, 8, 13, 14, 15, and 16, about 95 percent of arrivals would exit before Runway 13R/31L.

In Northeast flow, the relocation of Runway 4L threshold 460 feet north of its current location will not affect taxi flows.

Therefore, alternatives relocating Runway 22R displaced threshold at or above Runway 13L/31R generate the most efficient taxi flows.

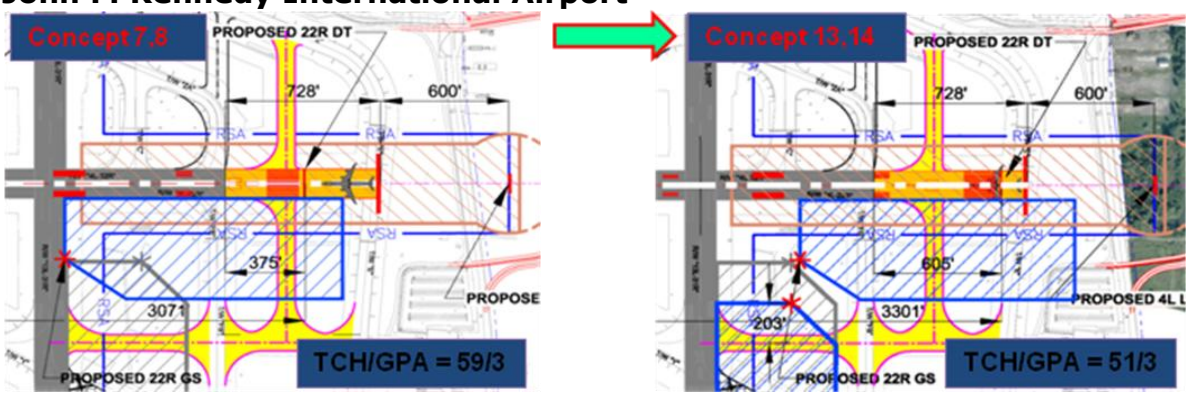
Note: placing Runway 22R displaced threshold south of Runway 13L/31R would restrict usage of Taxiway B (located 400 feet from the runway centerline) for Runway 22R arrivals if we have to consider in the future a Precision Obstacle Free Zone. Consequently, this would preclude the airport to upgrade the Runway 22R approach to a Category II/III instrument approach. Also, shifting the Runway 22R threshold north of Runway 13L/31R ensures that the Runway Protection Zone (RPZ) is clear of all taxiways or objects.

4.2.4 NAVAIDS Siting

On January 4th, 2011, a team led by the Port Authority Aviation Planning met with stakeholders from various FAA Divisions including members of JFK Tower, Tech Ops, NY ADO, and NAVAIDS Engineering to discuss NAVAIDS siting issues while in early planning stages.

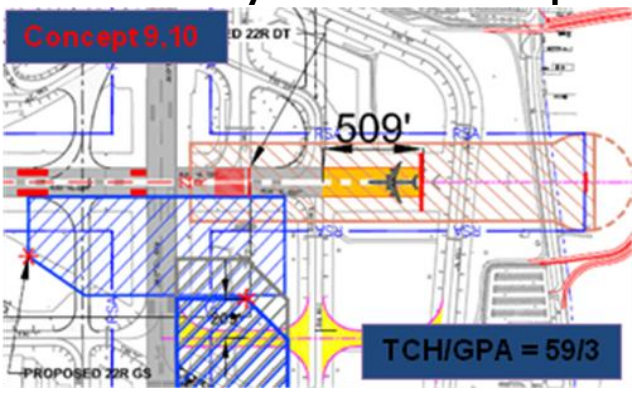
It was determined that concepts 7 and 8 should be eliminated due to a conflict between the proposed Runway 22R and the existing Runway 31R Glide Slope critical area; the team further refined this concept by displacing the threshold an additional 155 feet to the north (Concept 13, 14).

FIGURE 4-3
22R DISPLACED THRESHOLD ALTERNATIVES – 31R GS CRITICAL AREA
John F. Kennedy International Airport



Concepts 9 and 10 consist in extending the runway 509 feet to provide an 11,000-foot take-off length from Runway 22R. However, with this extension, the runway ends a few hundred feet short of Taxiway E, which consequently reduces the use of this taxiway.

FIGURE 4-4
22R DISPLACED THRESHOLD ALTERNATIVES – TAXIWAY 'E' CONNECTION
John f. Kennedy International Airport



4.2.5 Obstructions and Noise

As a result of the aforementioned selection process, four alternatives were determined to meet the project criteria: alternatives 6, 14, and 16. Analyses of potential obstructions and noise impacts were conducted to validate the alternative selection. The results of the study can be found in the *Environmental Assessment (EA)* report prepared by Landrum & Brown and submitted to the Port Authority in May 2012. The main conclusions are summarized in the following table:

TABLE 4-2
RUNWAY 4L/22R OBSTRUCTION AND NOISE ANALYSIS
John f. Kennedy International Airport

CONCEPTS	RWY EXTENSION	22R DT	ASDA		LDA		22R NAVAIDS		Noise Impact	Obstructions Impact	Note
			4L	22R	4L	22R	GS Angle	TCH			
6	728'	2326'	11169'	11219'	11169'	10121'	3°	58'	Low	OK	
14	728'	3316'	11169'	11219'	11169'	11111'	3°	51'	Some Risk	Tree Removal Required	
16	860'	3316'	11169'	11351'	11169'	11111'	3°	58'	Some Risk	Tree Removal Required	LOC in wetland

Based on obstruction data gathered, alternatives 14, and 16 will require tree removal to ensure that the arrival and departure paths are cleared of all objects.

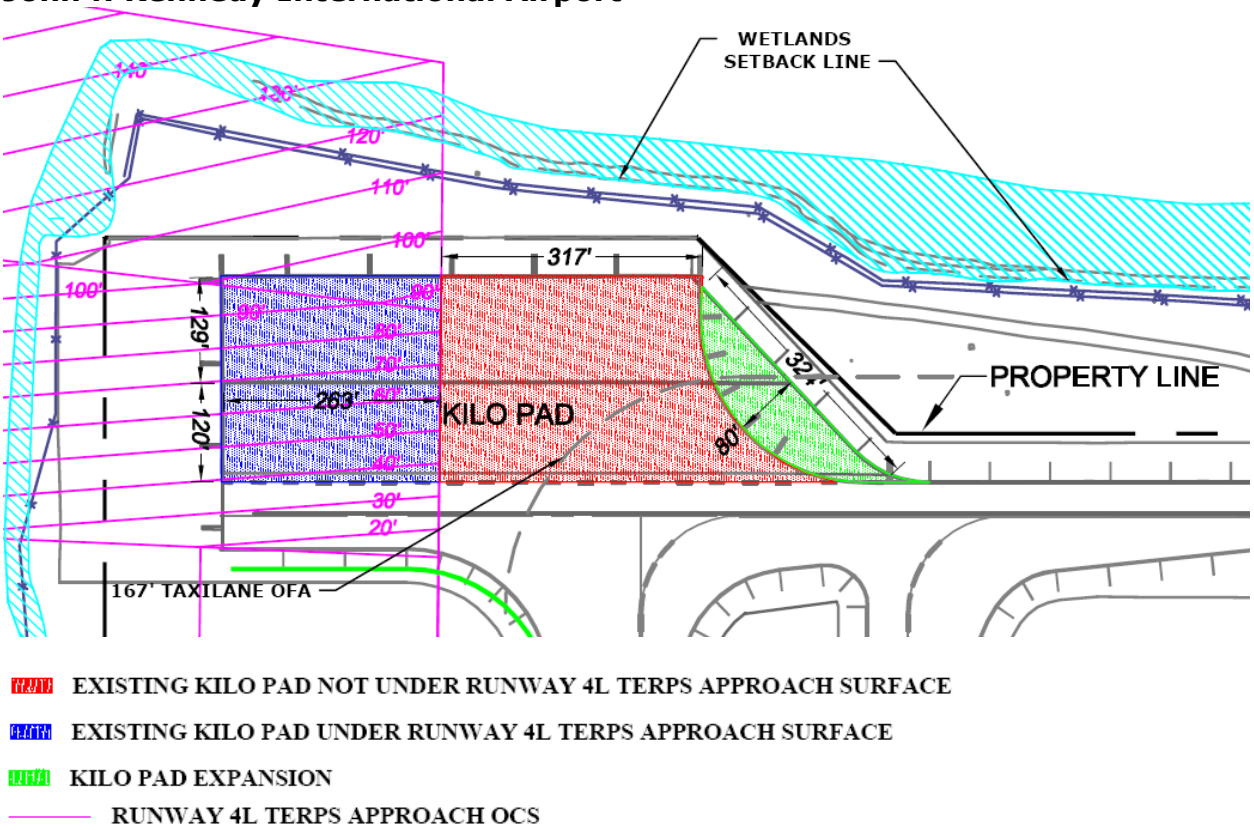
From a noise perspective, Alternative 6 is expected to have a relatively low impact due to the lower displacement of Runway 22R threshold. Alternatives 14 and 16 do present some risk of increased noise levels as Runway 22R threshold gets relocated at Taxiway E.

4.2.6 Runway 4L End Kilo Pad

The holding pad, north of Runway 4L end and commonly referred to as the "Kilo Pad," is located on the westerly side of the south end of Taxiway K and is surrounded by the Jamaica Bay.

An operational study was conducted in order to assess the future pad utilization after relocation of Runway 4L Threshold. The objective was to evaluate alternatives allowing to maintain the operational capability of the holding pad. The proposed geometry modification consists in a pavement extension in two different places as shown on **Figure 4-6**. The blue and red areas correspond to the existing pad, the green parts depict the proposed expansion.

FIGURE 4-5
RUNWAY 4L END KILO PAD EXTENSION
John f. Kennedy International Airport



Detailed results can be consulted in the *Runway 4L/22R Kilo Pad Operational Study* report released in July 2012.

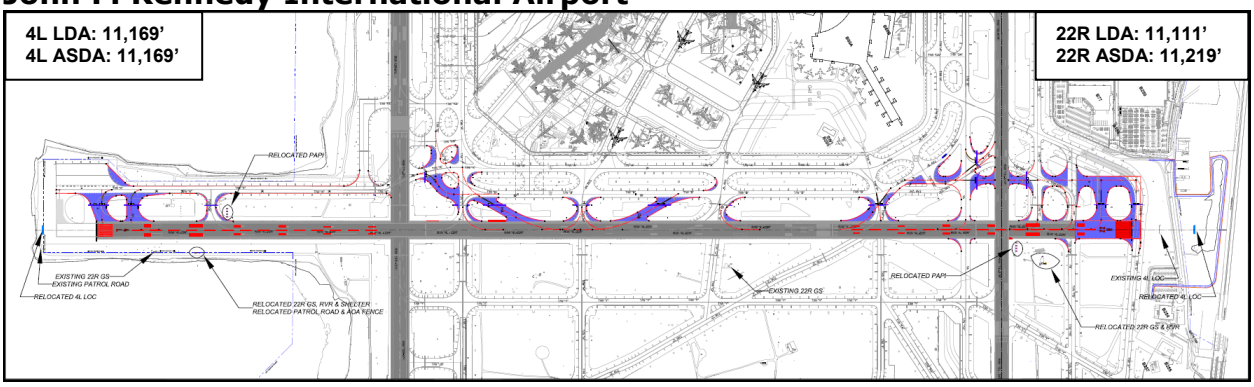
4.2.7 Preferred Alternative

Overall, Alternative 14 appears to be the most beneficial solution as it meets most of the project selection criteria. Therefore, Alternative 14 was selected as the proposed project in this analysis.

This alternative consists in extending Runway 4L/22R 728 feet to the north (to Taxiway E). Runway 22R displaced threshold is relocated 3,316 feet north of its current location and Runway 4L threshold 460 feet to the north.

The resulting available operational distances are 11,169 feet for take-offs and landings on Runway 4L, and 11,219 and 11,111 feet respectively for take-offs and landings on Runway 22R. 22R threshold is displaced by 108 feet from the end of the runway.

FIGURE 4-6
PREFERRED ALTERNATIVE
John F. Kennedy International Airport



The complete description of the project alternative is provided in Sections 1.4 and 1.5. The taxiway construction as well as the modified and new high-speed exits and runway exit fillets presented in Section 1.5 were designed specifically to improve taxi flows and reduce the runway occupancy time for the preferred alternative.

4.4 PREFERRED ALTERNATIVE SCENARIOS

Several scenarios were developed using the preferred alternative (Alternative 14) as a basis. Four scenarios (Scenario 2 through Scenario 5) include modifications of the airfield to comply with FAA RSA standards as well as various combinations of taxiway improvements and runway exits (as presented in Section 1.5) to improve the flows of aircraft to/from and around Runway 4L/22R.

<u>Scenario 2</u>

This scenario only considers extending Runway 4L/22R to comply with FAA RSA standards. No Runway exit or taxiway improvement is considered in this case.

<u>Scenario 3</u>

This scenario includes the extension of Runway 4L/22R and the runway threshold displacements as well as the following taxiway improvements: the new Taxiway ZA as well as half of the new Taxiway FC (on the west side of Runway 4L/22R).

Scenario 4

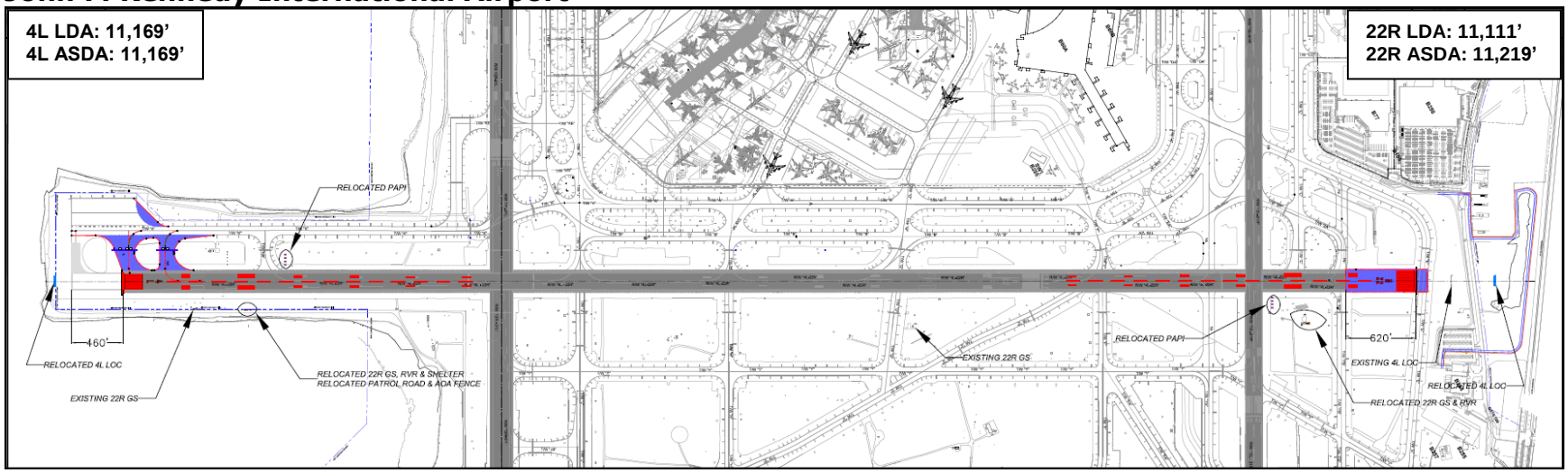
This scenario includes the extension of Runway 4L/22R and the runway threshold displacements as well as the following taxiway improvements: the new Taxiway ZA, half of the new Taxiway FC (on the west side of Runway 4L/22R), all new high-speed exits and fillets on Runway 4L/22R, and extension of Taxiway KC to the runway. Despite a reduction in runway occupancy time of 7-8 seconds with the new high-speed exits and fillets, a corresponding reduction in aircraft separations on approach is not deemed feasible. Indeed, arrivals on Runway 4L and Runway 4R use the same arrival stream. The same thing happens when in Southwest flow. Therefore, a reduction in aircraft separations on approach cannot take place without having a reduction in runway occupancy time on both runways (Runway 4L/22R and Runway 4R/22L). Therefore, in this scenario, only the benefits of the high-speed exits related to the shorter runway occupancy time and shorter taxi route are quantified.

Scenario 5

This scenario includes the runway and taxiway improvements described in Scenario 4 as well as two additional taxiway improvements: the second half of Taxiway FC on the east side of Runway 4L/22R and the straightening of Taxiway Y. Despite a reduction in runway occupancy time of 7-8 seconds with the new high-speed exits and fillets, a corresponding reduction in aircraft separations on approach is not deemed feasible. Indeed, arrivals on Runway 4L and Runway 4R use the same arrival stream. The same thing happens when in Southwest flow. Therefore, a reduction in aircraft separations on approach cannot take place without having a reduction in runway occupancy time on both runways (Runway 4L/22R and Runway 4R/22L). Therefore, in this scenario, only the benefits of the high-speed exits related to the shorter runway occupancy time and shorter taxi route are quantified.

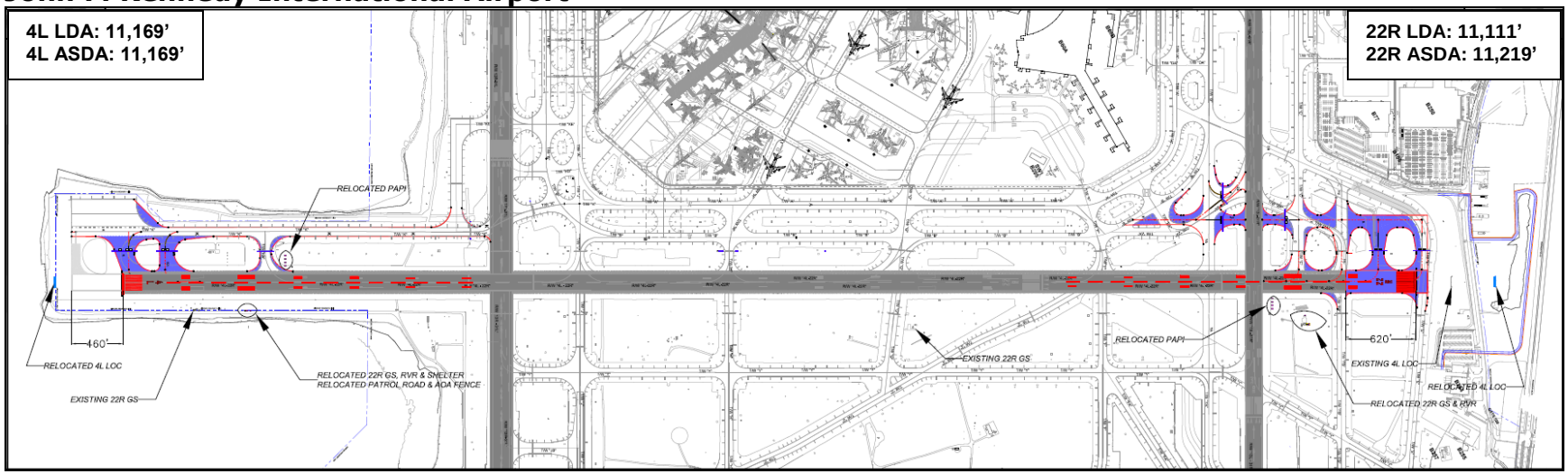
Figures 4-7 through **4-10** show the layout of Runway 4L/22R for Scenarios 2 through 5, respectively.

FIGURE 4-7
SCENARIO 2
John F. Kennedy International Airport



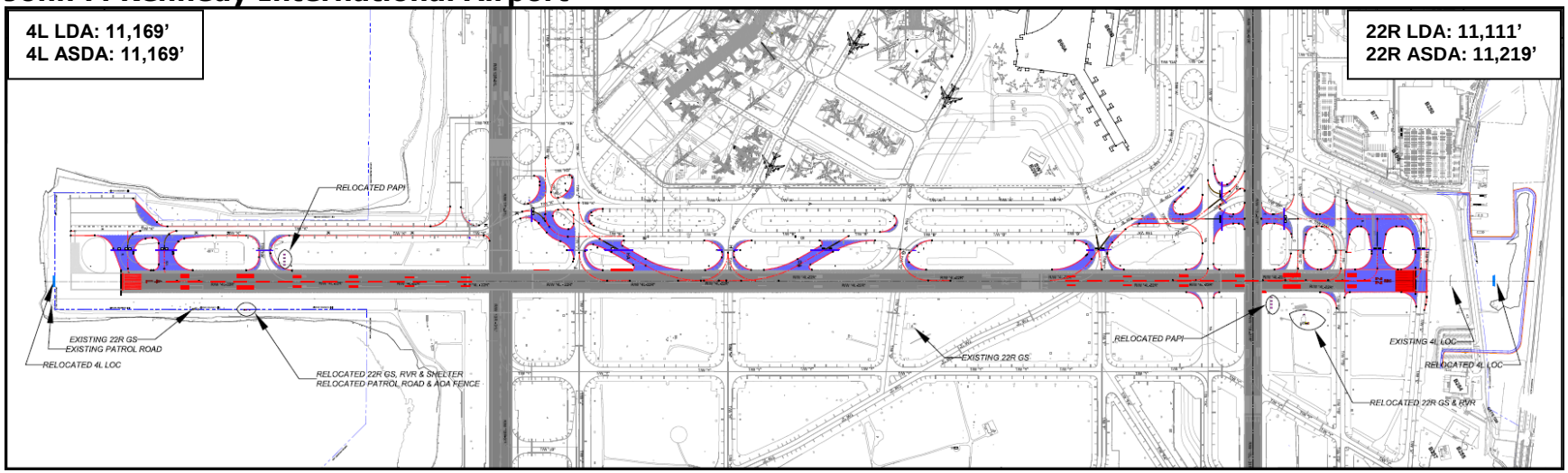
Source: Port Authority of New York and New Jersey.

FIGURE 4-8
SCENARIO 3
John F. Kennedy International Airport



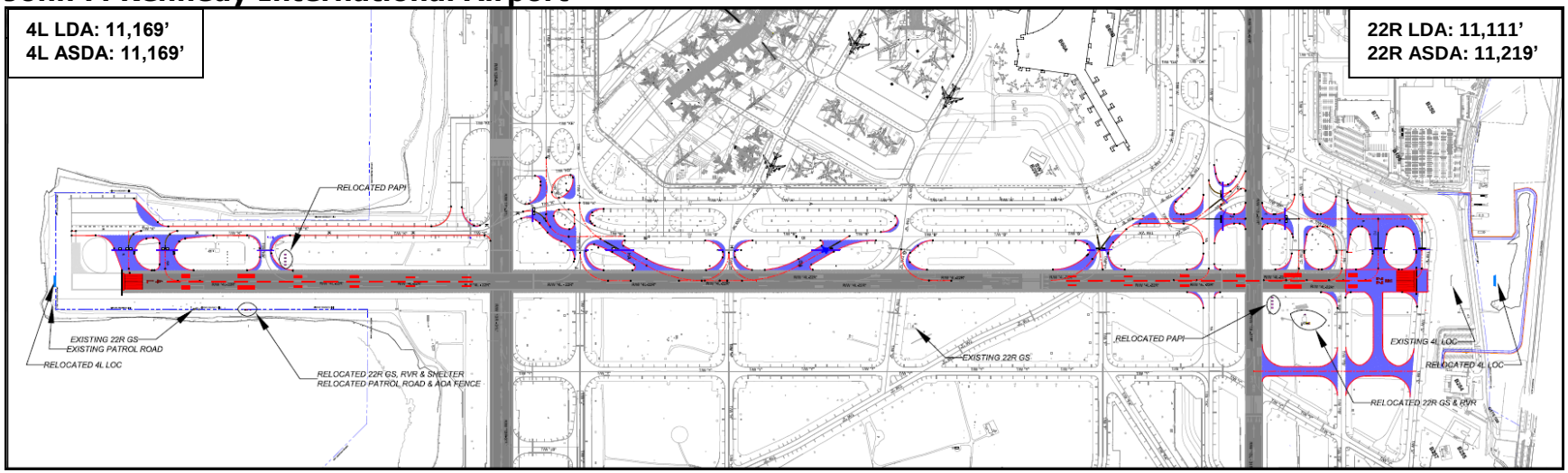
Source: Port Authority of New York and New Jersey.

FIGURE 4-9
SCENARIO 4
John F. Kennedy International Airport



Source: Port Authority of New York and New Jersey.

FIGURE 4-10
SCENARIO 5
John F. Kennedy International Airport



Source: Port Authority of New York and New Jersey.

5. BCA ASSUMPTIONS

5.1 FORECAST OF AVIATION DEMAND

As described in the FAA Airport Benefit-Cost Analysis Guidelines, December 15, 1999, all BCA analyses must be based on the latest available FAA Terminal Area Forecast (TAF). A local forecast can only be used if it is within 10 percent of the TAF for the first five years and within 15 percent of the TAF at 10 years. **Table 5-1** presents a comparison of the latest available Port Authority forecasts for JFK and the FAA 2010 TAF. The two forecasts of annual passengers are within 4.6 percent at five years and within 13.1 percent after ten years. The Port Authority forecast of annual aircraft operations are within 8.5 percent of the TAF after five years and within 16.2 percent after ten years. Despite not meeting the requirements for aircraft operations after 10 years, the Port Authority has chosen to use its own forecasts in lieu of the TAF for the following reasons:

- The Port Authority forecasts extend to the end of the analysis period.
- The Port Authority has already prepared a detailed fleet mix that supports its forecasts.
- The Port Authority forecasts were used to support other analyses at JFK. Using the same forecasts assures that this BCA is consistent with these other analyses.

The Port Authority aircraft operations forecasts, being lower than the FAA TAF, will demonstrate a slightly lower level of project benefits than an analysis based on the FAA TAF. Therefore, the use of the Port Authority forecasts represents a conservative assumption in the BCA analysis.

A baseline design day schedule was developed for JFK for year 2010. Data from the *Official Airline Guide* (OAG) was used as a basis for the development of this schedule, supplemented with data from the Port Authority's AirScene database to evaluate the amount of cargo, general aviation, and military activity. July 15, 2010 was selected as the Peak Month Average Weekday (PMAWD) for this analysis. The PMAWD is a busy day at the airport, but not the busiest day, and is the industry standard for analyzing airfield capacity and delay. **Figure 5-1** presents the hourly aircraft operations and passenger seats profiles for JFK baseline design day schedule.

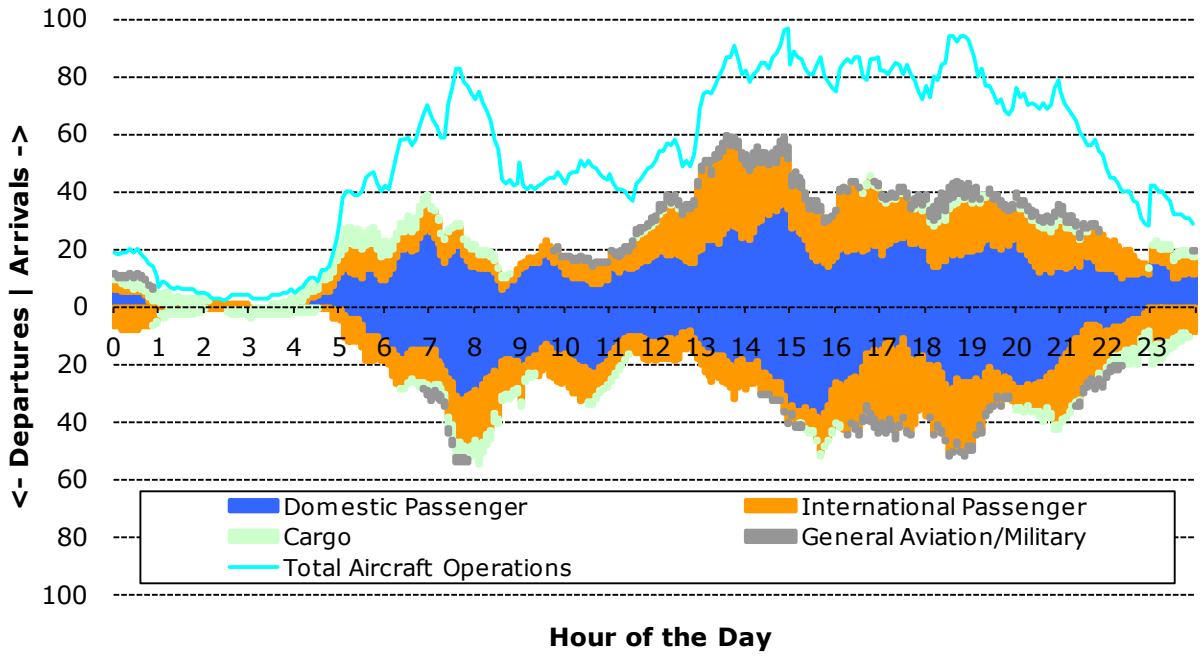
TABLE 5-1
COMPARISON OF PORT AUTHORITY AND FAA TERMINAL AREA FORECAST
John F. Kennedy International Airport

	Port Authority Forecasts		FAA 2010 TAF		PANYNJ vs. TAF	
Year	Passengers	Aircraft Operations	Passengers	Aircraft Operations	Passengers	Aircraft Operations
2009	45,915,000	414,928	45,537,018	431,364	0.8%	-3.8%
2010	46,476,564	411,409	43,927,932	403,094	5.8%	2.1%
2011	47,284,804	414,076	45,583,978	417,766	3.7%	-0.9%
2012	48,606,561	425,072	48,161,728	439,243	0.9%	-3.2%
2013	49,714,198	432,608	50,474,072	458,017	-1.5%	-5.5%
2014	50,581,167	438,672	52,996,574	479,418	-4.6%	-8.5%
2015	51,580,683	445,787	55,407,518	499,318	-6.9%	-10.7%
2016	52,513,341	452,592	57,458,204	515,386	-8.6%	-12.2%
2017	53,468,416	459,497	59,585,284	531,983	-10.3%	-13.6%
2018	54,515,545	467,083	61,791,622	549,127	-11.8%	-14.9%
2019	55,673,738	475,135	64,080,196	566,835	-13.1%	-16.2%
2020	56,909,981	484,713	66,454,088	585,128	-14.4%	-17.2%
2021	57,101,978	492,658	68,916,500	604,024	-17.1%	-18.4%
2022	57,294,622	500,800	71,470,750	623,542	-19.8%	-19.7%
2023	57,487,916	509,145	74,120,288	643,703	-22.4%	-20.9%
2024	57,681,862	517,697	76,868,692	664,530	-25.0%	-22.1%
2025	57,876,463	526,462	79,719,674	686,044	-27.4%	-23.3%
2030	58,859,585	536,300	95,653,336	804,752	-38.5%	-33.4%
2035	59,859,639	546,425				
2040	60,757,533	555,560				

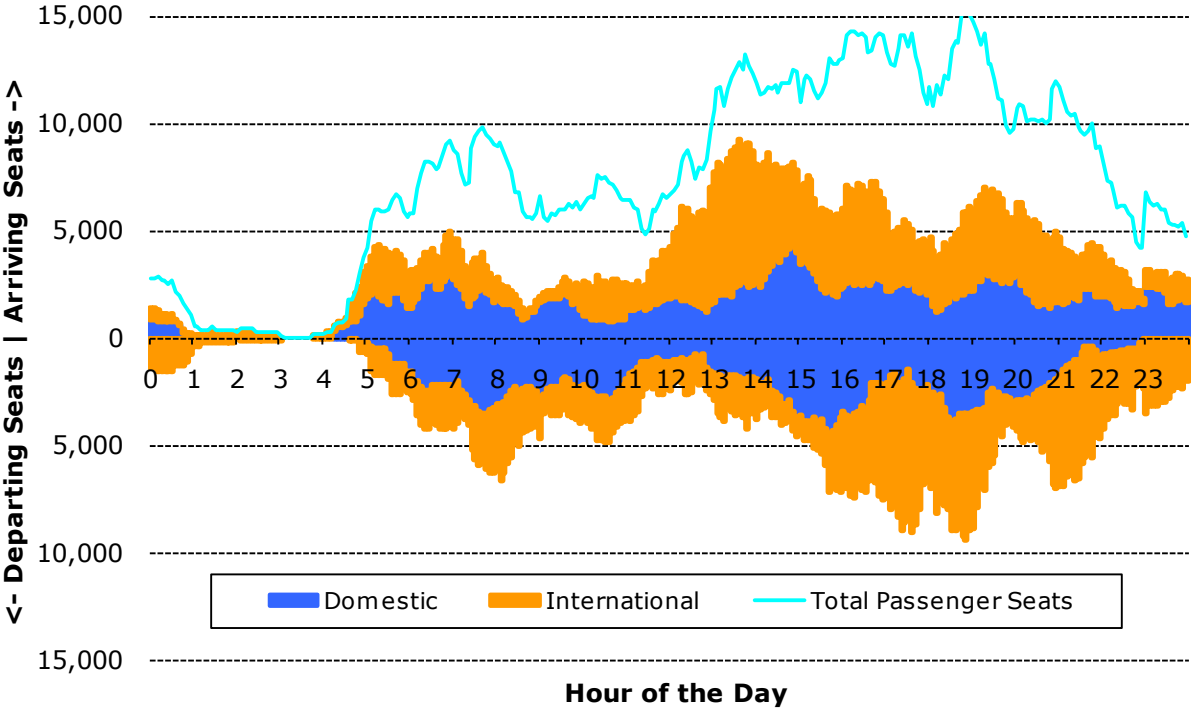
Sources: Port Authority of New York and New Jersey; FAA 2009 Terminal Area Forecast.

FIGURE 5-1
BASELINE DESIGN DAY SCHEDULE HOURLY PROFILES
John F. Kennedy International Airport

JFK July 2010 Design Day Schedule - Aircraft Operations Profile



JFK July 2010 Design Day Schedule - Passenger Seats Profile



Source: Landrum & Brown analysis.

5.2 EVALUATION PERIOD

As stated in its BCA guidance, the FAA generally uses a lifespan of 20 years after completion of construction. This analysis entails the quantification of annual costs and benefits of the project for at least 20 years after completion of construction. As a result, benefits and costs of the Proposed Project will be quantified through 2035.

In addition, the net benefit versus cost ratios were provided for interim years in order to provide an idea of the payback period related to each project.

5.3 ECONOMIC VALUES

Certain economic values are used in the quantification of benefits for the BCA. These values have been collected in the document, *Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs*, FAA-APO-98-8, dated June 1998. For this analysis, the economic values recommended by the FAA were reviewed and used as necessary. Some of them, such as the aircraft operating costs, were revised for sensitivity purposes as discussed in the following sections.

5.3.1 Aircraft Operating Costs

Aircraft operating costs were evaluated in order to quantify the benefits from the reduction in aircraft delays. Analyses of U.S. Department of Transportation Form 41 Airline Financial Statistics data were conducted for several timeframes to provide a range of aircraft operating costs. Over the past five years, the aviation industry experienced rapid increases in fuel costs which peaked in summer 2008 at more than three times the 2004 fuel cost levels. Despite a net decline of fuel costs in 2009 ($62 per barrel), the Energy Information Administration (EIA) evaluated the price per barrel (in 2009$) at $77.50 in 2010 and projects it would increase to $108.05 in 2020 and to $125 by 2035[3].

For purposes of reflecting more closely current and potential future fuel cost levels as well as changes in the fleet mix at JFK based on the PANYNJ forecast, aircraft operating costs for 2008, 2009, and the period from October 2009 through September 2010 (called 2010*) were considered in this analysis. This BCA computes benefits from reduced aircraft delays with different aircraft operating costs to compare the impact of variations in fuel costs on the BCA ratios. **Table 5-2** presents the aircraft operating costs used for each key year. The 2010* operating costs will be used in the core analysis of these BCAs to evaluate benefits. The 2008 and 2009 costs will be used in sensitivity analyses as a high case and low case, respectively.

Aircraft operating costs were further divided into ground operating costs. The industry standard for about the last 20 years assumed that airborne (airspace) operating costs per minute were 1.03 to 1.05 times the average block hour cost and that ground (taxi) operating costs per minute were 0.70 times the airborne

[3] EIA Annual Energy Outlook 2011, Updated in December 2010.

operating cost. These cost calculations were documented in the *Chicago Delay Task Force Technical Report Volume III Delay Reduction Alternative Analysis*. In light of the change in fuel prices in recent years, Landrum & Brown updated the airborne and ground operating costs for the JFK fleet. Using the 10 most heavily traveled markets to/from JFK, a representative sample of the aircraft that operate at JFK and a group of markets that approximate the average stage length were analyzed. Surprisingly, the percentage of block time represented by airborne and ground has not changed materially from the earlier study. In the late 1980s, taxiing represented approximately 17 percent of block time. In the city pairs that we analyzed, taxiing represented approximately 18 percent of block time. Principally because of the higher cost of fuel, airborne operating costs now represent 107 percent of average block hour costs. Ground operating costs now represent 60 percent of airborne operating costs. Since virtually all of the expected operating cost savings are expected on the ground, the ground operating costs were used for this project.

TABLE 5-2
COMMERCIAL PASSENGER AIRCRAFT OPERATING EXPENSES PER MINUTE
John F. Kennedy International Airport

ALL OPERATIONS

	Fuel Only			All Costs		
Year	**2008**	**2009**	**2010***	**2008**	**2009**	**2010***
2010	$51.81	$31.27	$35.54	$77.92	$59.76	$64.50
2013	$49.66	$30.08	$34.04	$75.38	$58.26	$62.65
2018	$48.41	$29.21	$32.91	$73.81	$57.20	$61.14
2020	$47.89	$28.85	$32.46	$73.13	$56.72	$60.51
2025	$47.41	$28.55	$32.10	$72.53	$56.31	$59.99
2030	$47.18	$28.40	$31.91	$72.22	$56.08	$59.70
2035	$46.95	$28.24	$31.72	$71.90	$55.84	$59.41

GROUND OPERATIONS ONLY

	Fuel Only			All Costs		
Year	**2008**	**2009**	**2010***	**2008**	**2009**	**2010***
2010	$33.26	$20.08	$22.81	$50.02	$38.37	$41.41
2013	$31.88	$19.31	$21.85	$48.39	$37.41	$40.22
2018	$31.08	$18.75	$21.13	$47.39	$36.72	$39.25
2020	$30.75	$18.52	$20.84	$46.95	$36.41	$38.84
2025	$30.44	$18.33	$20.61	$46.56	$36.15	$38.51
2030	$30.29	$18.23	$20.49	$46.36	$36.00	$38.33
2035	$30.14	$18.13	$20.37	$46.16	$35.85	$38.14

Note: 2010* corresponds to the time period from October 2009 through September 2010.
Sources: USDOT, Form 41; Landrum & Brown analysis.

5.3.2 Value of Passenger Time

The value of passenger time was taken from the recommendation from the U.S. Department of Transportation. In its guidance, *Economic Values for FAA Investment and Regulatory Decisions*, the U.S. DOT recommends the use of $28.60 per hour as the cost of passenger time (in 2000 dollars) for all purposes (leisure and business combined). Even though this value is expressed in 2000 dollars, the FAA recommends not adjusting the cost of passenger time to account for inflation.

5.3.3 Value of Meeter/Greeter Time

Passengers arriving at their final destination may be welcomed upon arrival by family, friends, or colleagues, referred to as "meeters/greeters". Meeters/greeters wait for the arriving passengers outside of the secure area of the terminal, usually in the baggage claim area. In its *Final Regulatory Impact Analysis of Rulemaking on Enhanced Airline Passenger Protections*, dated December 17, 2009, at page 20 (Docket DOT-OST-2007-0022), the U.S. DOT concluded that the time saved by meeters/greeters was valued at $10.60 per hour, the recommended value for local personal travel. Similar to the cost of passenger time, the cost of meeters/greeters time is expressed in 2000 dollars and is not to be adjusted for inflation.

In order to estimate the percentage of origin-destination (O&D) passengers at JFK, an analysis of U.S. DOT Air Passenger Origin/Destination Survey data was conducted. Based on U.S. DOT data, originating passengers accounted for about 75.4 percent of domestic traffic and 87.0 percent of international traffic at JFK from October 2009 through September 2010. Overall, O&D passengers at JFK accounted for 81.2 percent of total passenger traffic at the airport over this period. In the JFK Redevelopment Concept Design Final Report, dated April 2008, meeters and greeters were evaluated at 50 percent of domestic O&D arriving passengers (one meeter/greeter for every two domestic O&D arriving passengers) and 32 percent of international O&D arriving passengers (about one meeter/greeter for every three international O&D arriving passengers). This results in a weighted meeter/greeter ratio of about 40.4 percent of total O&D inbound passengers at JFK over the 12-month period ending September 2010.

Meeters/greeters benefits are not considered in the core of this analysis and would rather be part of the sensitivity analysis presented in Section 8.2.

5.3.4 Inflation

The FAA recommends evaluating benefits and costs of a project over the evaluation period and expressing them in constant dollars, usually the year during which the study is conducted. Therefore, no discounting of the benefit and cost streams is required.

In this analysis, the net present value of costs and benefits will be expressed in 2011 dollars.

5.3.5 Discount Rate

As the FAA recommends using constant dollar values, the discount rate is not adjusted for inflation. The FAA discount rate of 7 percent is used in this analysis. In the sensitivity analysis presented in Section 8.2, discount rates of 3.5 percent and 10 percent are considered to evaluate the impact on BCA ratios.

6. PROJECT COSTS AND SCHEDULE

6.1 TOTAL PROJECT COSTS AND O&M COSTS

Total project costs for each preferred alternative's scenario are presented in **Table 6-1**. Costs of the proposed project include construction costs, planning and engineering costs, site acquisition costs, general and administration costs, and project contingency. Planning and engineering costs were estimated at 8 percent of construction costs. General and administration costs were assumed to account for 15 percent of planning/engineering costs and acquisition costs combined. Contingency was estimated at 20 percent of all costs. A financial expense of 5 percent of all cost groups combined was added to evaluate the total project costs.

O&M costs were estimated taking into consideration the increased amount of pavement and new facilities that would require maintenance and incur additional operational costs. In previous BCAs conducted for the Port Authority, the increase in O&M costs was estimated at 1.46 percent of total project costs. This estimate takes into account pavement and facilities maintenance, but also airport personnel. **Table 6-1** presents the estimated annual increase in O&M costs generated by the proposed improvements at JFK for each scenario.

TABLE 6-1
PROJECT COSTS
John F. Kennedy International Airport

	Capital Costs	Annual O&M Costs
Base Case	$ 1,714,803	$ 25,000
Scenario 2	$ 91,094,655	$ 1,330,000
Scenario 3	$ 136,392,875	$ 1,991,000
Scenario 4	$ 172,503,213	$ 2,519,000
Scenario 5	$ 195,673,777	$ 2,857,000

Source: Port Authority of New York and New Jersey.

6.2 PROJECT SCHEDULE

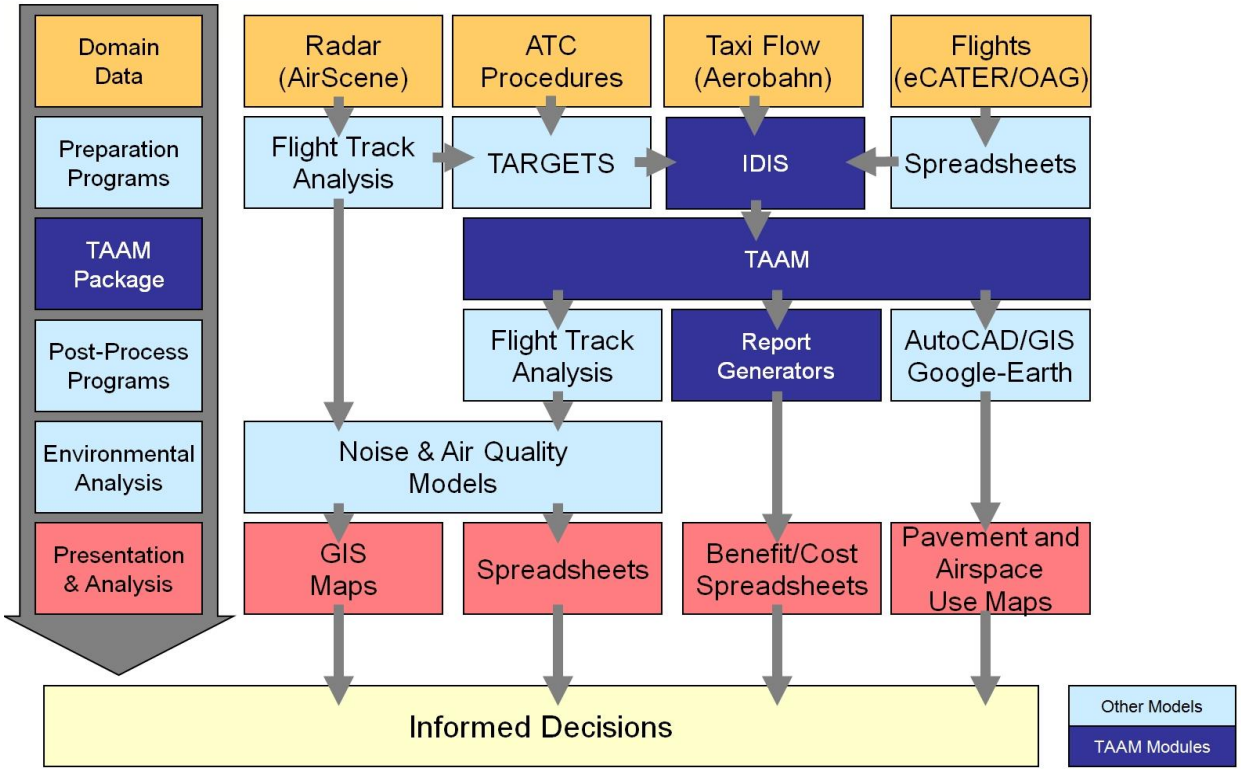
Construction of the 4L/22R improvements is expected to start around March 2013 and is expected to be completed in June 2013. For purpose of this analysis, the 4L/22R project costs were assumed to all occur in 2013. As recommended in the FAA BCA guidance, the cash flows were not adjusted to account for inflation and are expressed in 2011 dollars.

7. BENEFITS OF PROJECT ALTERNATIVES

7.1. ANALYSIS METHODOLOGY

The overall simulation process used in this BCA is presented in **Figure 7-1**.

FIGURE 7-1
SIMULATION PROCESS
John F. Kennedy International Airport



Source: Landrum & Brown analysis.

Computer simulation modeling is the analytical basis of this BCA. Airside simulation models use a description of the airport's facilities and operating environment as input, simulate air traffic movements through the defined environment, and provide as output the two critical measures that are used to determine airside capacity--throughput and delay. The analysis involved the simulation of the airfield and airspace system to quantify performance metrics associated with forecast demand. The airside includes the aircraft parking positions, apron area, taxiways, runways and all other aircraft movement areas of the Airport. The airspace system modeled included all the arrival and departure fixes. This analysis reflected input from air traffic controllers, airlines, Port Authority and airport staff. Key stakeholders were regularly consulted throughout the simulation study to ensure acceptance of the input assumptions, methodology, results and recommendations.

Jeppesen's Total Airspace and Airport Modeler (TAAM) was used for this analysis. TAAM is a simulation tool used to assess airport and airspace operations. It is capable of conducting large scale, detailed, fast-time simulations for modeling of entire air traffic systems. TAAM is a four-dimensional flight path simulation. TAAM

also produces high quality animations of the simulation. TAAM can be used to simulate aircraft movements in detail: a full individual airfield (including runways, taxiways and apron areas); an airfield and its associated terminal airspace; a regional system of airports and the associated airspace; or, a regional volume of airspace. It can produce detailed statistics on each aircraft operation simulated. Outputs include, but are not limited to: aircraft en route travel times; airport movements, operations on taxiways and runways, runway occupancy; airspace operation metrics such as usage of routes, sectors, fixes and coordination; throughput capacity per unit of time; delays by time of day and location on the airfield or in airspace, along with the reason for each delay; fuel consumption and potential conflicts.

It should be noted that airspace/airfield simulation modeling is not designed to produce an exact replication of all aspects of the real-world operating environment. To be effective, however, the model must reflect the logic applied by pilots and air traffic controllers to the greatest extent possible, and produce representative performance metrics associated with the most likely future operating conditions.

The general process for quantifying the benefits of the proposed project using simulation modeling consists of the following steps:

- Step 1 - Define the airport's operating environment, which consists mainly of the airside facilities, the associated operating procedures, and aircraft demand. The airside facilities are the runway and taxiway systems, and the aircraft parking areas. The operating procedures include the airspace, the runway uses, aircraft flows, gate allocations, and FAA Air Traffic Control (ATC) procedures. Aircraft demand consists of a 24-hour flight schedule representative of design day activity. The existing JFK facilities and operating environments are briefly discussed in Section 2 of this report. A more detailed analysis is presented in the Appendix.
- Step 2 - Calibrate the simulation model to ensure that the simulations reflect actual operations. The simulations calibration step used actual performance data from the Port Authority of New York and New Jersey and FAA to compare actual versus simulated hourly operations and airside travel times.
- Step 3 - Simulate a set of runway operating configurations which represent annual operations at the airport. Wind and weather conditions directly affect the use of the runway system and operating procedures, and therefore, affect airside capacity. Runway use and operating procedures can also be dictated by noise abatement procedures. The runway operating configurations simulated for JFK are the Northeast and Southwest flows as presented in Section 2.2. For purpose of this analysis, only Visual Flight Rules (VFR) conditions were simulated.
- Step 4 - Compute annual weighted averages of aircraft delay, taxi time, and throughput using the resulting simulation statistics for each runway operating configuration at the same air traffic demand level. Each runway operating configuration is assigned an annual hourly percentage use based on wind/weather conditions (see Table 2-3).
- Step 5 – Compare the base case results against the proposed project scenarios to evaluate the delay and taxi time savings.

The key parameters used to measure the performance of an airport system are as follows:

- Peak Hour Throughput - Throughput is reported for each 60-minute interval in a 24-hour period. Peak hour throughput provides a measure of the practical capacity of an airport system during periods of constant demand for a given operating scenario. Delays tend to increase exponentially when demand nears or exceeds an airport's maximum peak hour throughput. For this study, three throughput values are presented: Peak Arrival Hour Throughput, Peak Departure Hour Throughput, and Peak Operation Hour Throughput. Peak hour throughputs for arrival, departure, and total operations sometimes occur in three different hours because of the variation in the distribution of scheduled aircraft demand.
- Unimpeded Flight / Taxi Times - Delay and travel time is reported throughout the 24-hour period for different phases of the operation. Therefore, operational performance characteristics for each phase of operation can be easily identified. Unimpeded travel time represents the time it would take an aircraft to travel from Point A to Point B if it were the only aircraft in the system. Ground travel time is comprised of unimpeded ground time and delay time and is influenced by the taxi speed and the travel distance between the runway and the gate. On the other hand, flight time is the sum of the unimpeded flight time and airspace delay:
    - Avg. Taxi Time = Unimpeded Avg. Taxi Time + Avg. Taxi Delay
    - Avg. Flight Time = Unimpeded Avg. Flight Time + Avg. Airspace Delay
- Runway Crossing - Runway crossing operations not only negatively affect the throughput of a runway, they also are a potential cause of runway incursions. Furthermore, runway crossing operations also contributes to increased controller workload. Runway crossing statistics are monitored in the simulations, together with the delay and flight time.
- Delay - Delay is the operating time attributable to any impediment to the free flow of aircraft through the system. Delay increases the total travel time from Point A to Point B as a result of interactions with other aircraft. As a result, total delay for any given aircraft is the difference between the actual time it takes the aircraft to get from Point A to Point B while interacting with other aircraft and the unimpeded time it would theoretically take the aircraft to get from Point A to Point B without other aircraft in the system.
    - Arrival ground delay is incurred between the runway exit and the gate as a result of taxiway congestion, runway crossings, and the availability of the assigned gate.
    - Arrival airspace delay time is incurred between the arrival fix and runway exit due to aircraft sequencing or holding.
    - Departure ground delay is incurred between the time the aircraft is cleared for push-back from its assigned gate and the time it is released for runway departure.
    - Departure delay includes gate push-back blocking, runway crossings, airfield congestion and departure queue delay.
    - Departure airspace delay is incurred after takeoff until the aircraft reach the departure fix.

7.2 SIMULATION INPUTS AND CALIBRATION

An initial step in the simulation process is to develop inputs to the TAAM simulation models for each runway operating configuration and each project alternative. Simulation assumptions were based upon various data that were collected and analyzed in order to better understand the current operational procedures at JFK. The data collected are presented in detail in the Appendix and include:

- Historical weather conditions
- Airspace geometry and routings
- Aircraft speed at takeoff and final approach
- Aircraft wake turbulence separation rules
- Runway usage rules and procedures
    - Aircraft to runway assignment rules
    - Departure queue balancing techniques
    - Arrival rate balancing techniques
    - Runway crossing procedures
    - Runway coordination/dependencies
    - Landing and take-off roll (runway occupancy)
    - Runway exit utilization
- Aircraft taxi procedures including taxi routing, taxi speed limit, and aircraft safe taxi distance
- Gate definitions and usage procedures
    - Aircraft stand dimensions and characteristics
    - Airline gate allocation plans
    - Aircraft push-back procedures
    - Time required between stand uses
    - Long-term parking positions
    - Aircraft holding bays

The Port Authority of New York and New Jersey, the airlines, and FAA ATCT were very cooperative in providing the data required for this analysis. Various Port Authority and FAA databases were used such as the Port Authority AirScene and eCater databases, FAA Aviation System Performance Metrics (ASPM), and FAA Air Traffic Activity Data System (ATADS).

The air traffic demand used as input in computer simulation analyses normally consists of a schedule of arrivals and departures for a 24-hour period. These flight schedules represent activity for a "design day" (planning level) of a given annual level of aircraft operations. A daily profile of aircraft activity is a key input to the simulation models because performance can be directly affected by the characteristics of aircraft demand. For this analysis, the July 2010 design day schedule presented in Section 5.1 was used. All commercial passenger flights in the design day schedule were gated in each of the seven terminals using a Gate Management System (GMS) and inputs from airlines and Port Authority staff. Arrivals and departures were assigned to an arrival or departure fix based on their origin/destination airport. Data from the Port Authority AirScene database was used to determine what fix is currently used for each airport served to/from JFK.

The FAA standard aircraft wake turbulence separations were used as a basis for this analysis. However, during interviews with JFK FAA ATCT personnel, it was deemed reasonable to add a 0.5 to 1 nautical mile buffer to the FAA standard separation in order to more closely reflect current operational practices at the airport.

7.3 SIMULATION RESULTS

This section provides a summary of the TAAM simulation results. It includes a discussion of the calibration of the model followed by a presentation of the delay results for the Existing Conditions scenario, the Base Case, and Scenarios 2 through 5. The impact of the new high-speed exits was quantified and presented in Section 7.5.

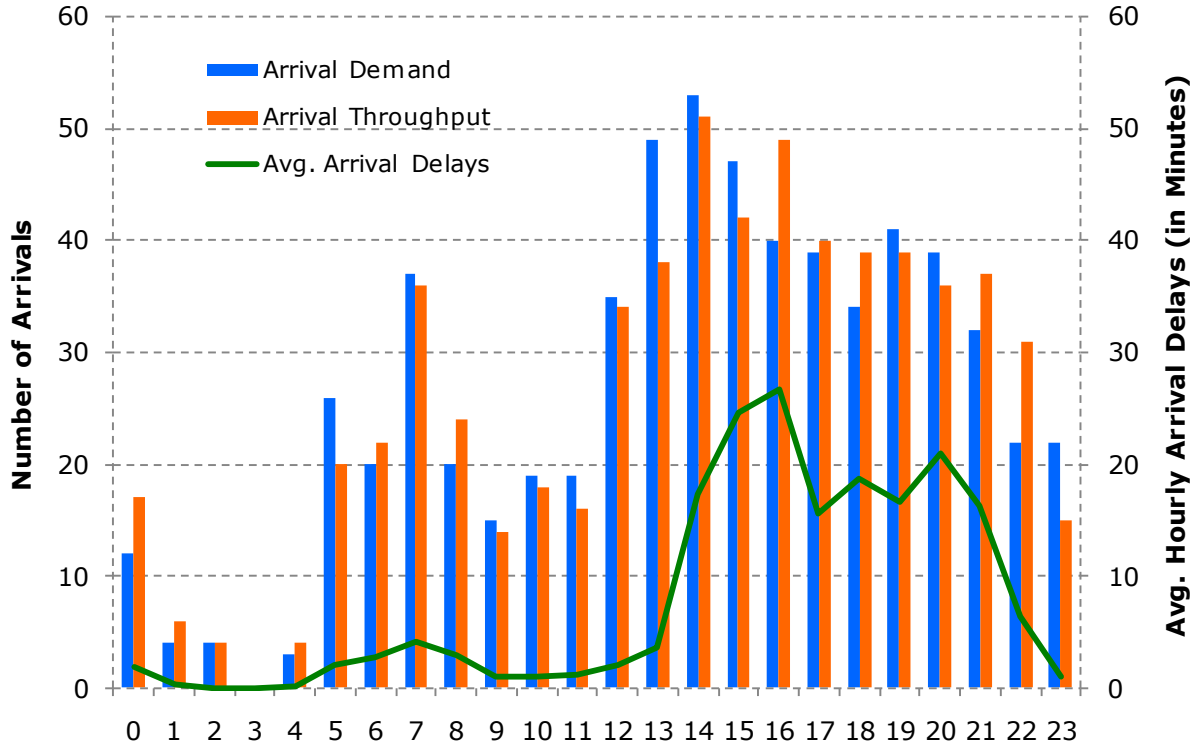
7.3.1 TAAM Model Calibration

The model calibration process involved several important steps:

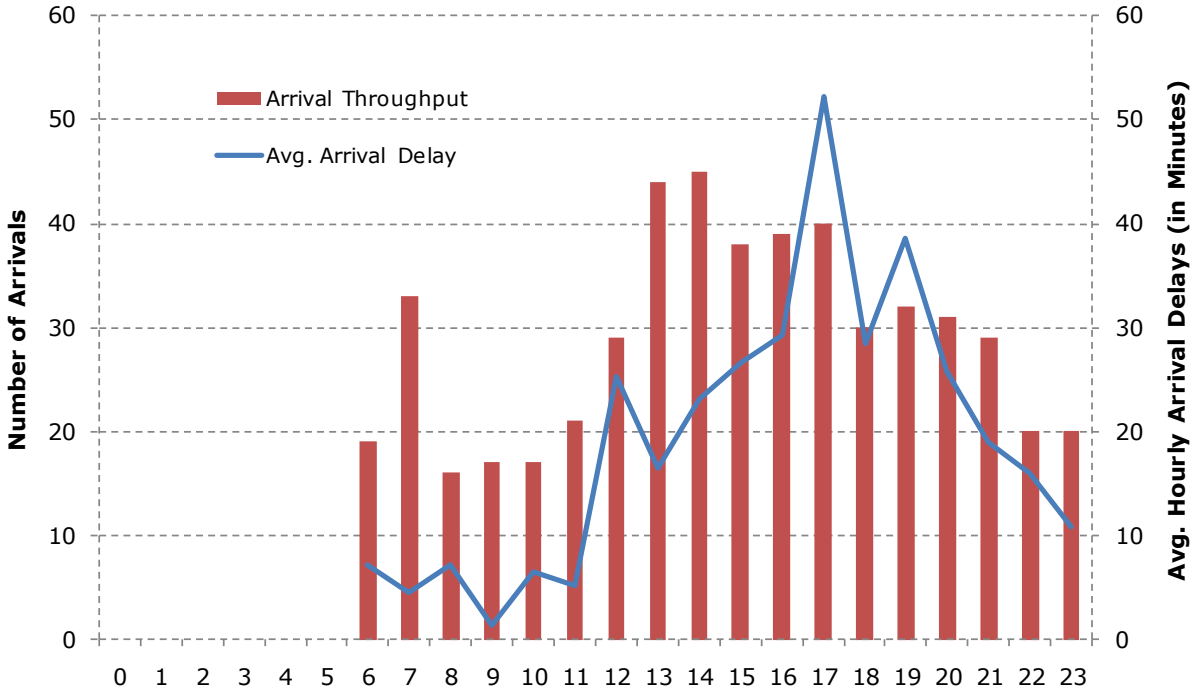
- Visits to the FAA ATCT and discussions with JFK ATCT staff
- Visits to the JFK Metering Desk and discussions with the Metering staff
- Detailed statistical analysis using FAA ASPM data
- Data analysis and model validation workshops with the PANYNJ and JFK staff
- Data analysis and model validation workshops with FAA ATCT

The Existing Conditions scenario was calibrated against selected days in summer 2010 reflecting the runway operating configurations considered (Southwest and Northeast flows) and VFR conditions. A comparison of the TAAM arrival and departure throughputs and delays for each flow against FAA ASPM data is provided in **Figures 7-2** through **7-5**. These figures present a comparison of the arrival/departure demand and corresponding throughput from TAAM. Avg. total arrival/departure delays (Air Delay + Ground Delay + Gate Delay) are also plotted for comparison purposes.

FIGURE 7-2
TAAM CALIBRATION
John F. Kennedy International Airport
EXISTING CONDITIONS – NE FLOW/VFR ARRIVALS

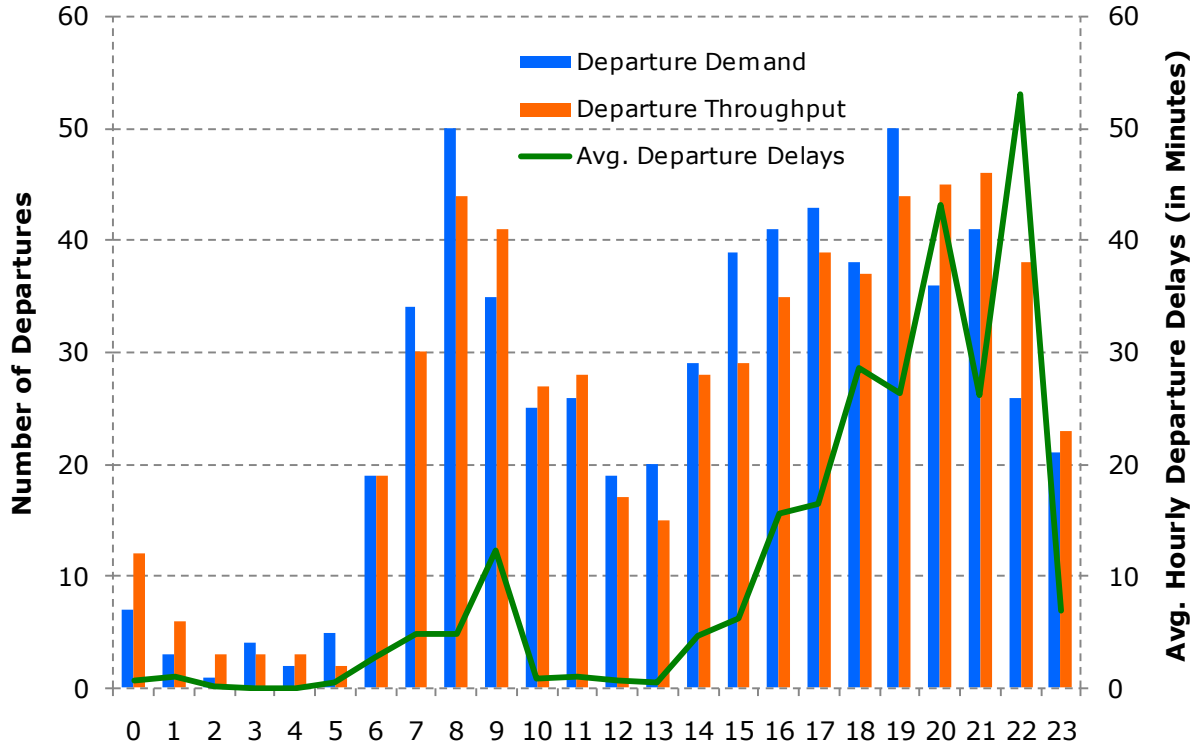


FAA ASPM – NE FLOW/VFR ARRIVALS

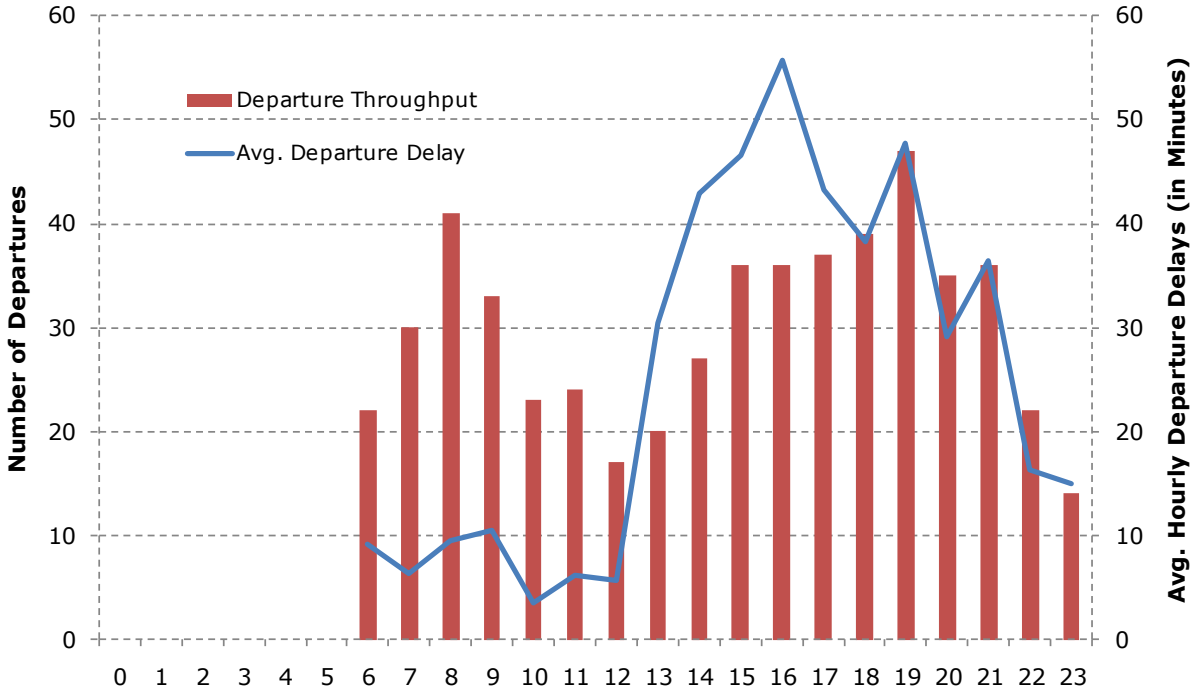


Note: FAA ASPM data shown from 6am to midnight only.
Source: Landrum & Brown analysis.

FIGURE 7-3
TAAM CALIBRATION
John F. Kennedy International Airport
EXISTING CONDITIONS – NE FLOW/VFR DEPARTURES

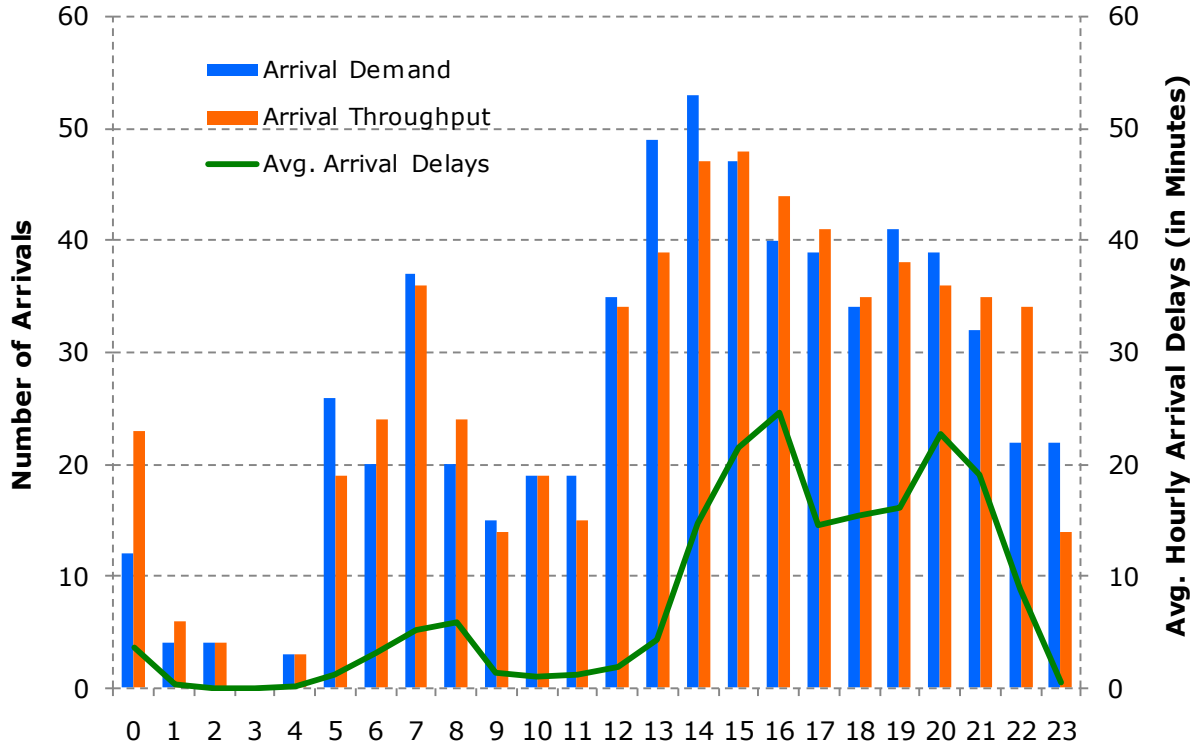


FAA ASPM – NE FLOW/VFR DEPARTURES

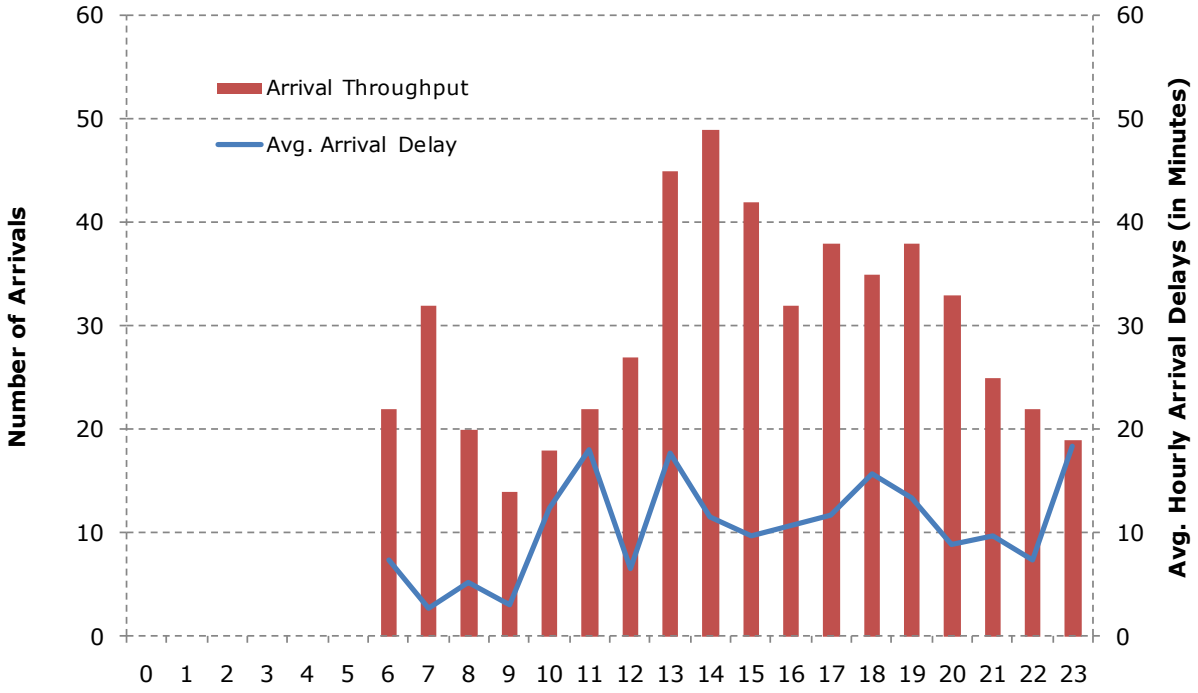


Note: FAA ASPM data shown from 6am to midnight only.
Source: Landrum & Brown analysis.

FIGURE 7-4
TAAM CALIBRATION
John F. Kennedy International Airport
EXISTING CONDITIONS – SW FLOW/VFR ARRIVALS

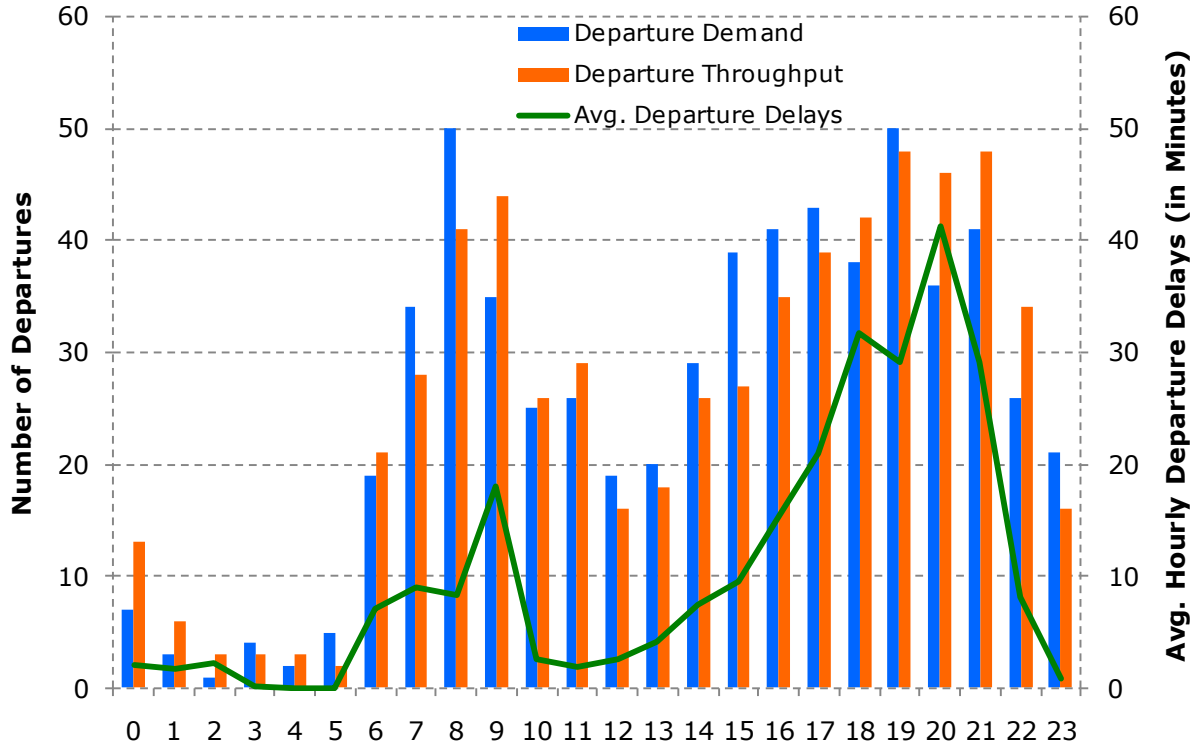


FAA ASPM – SW FLOW/VFR ARRIVALS

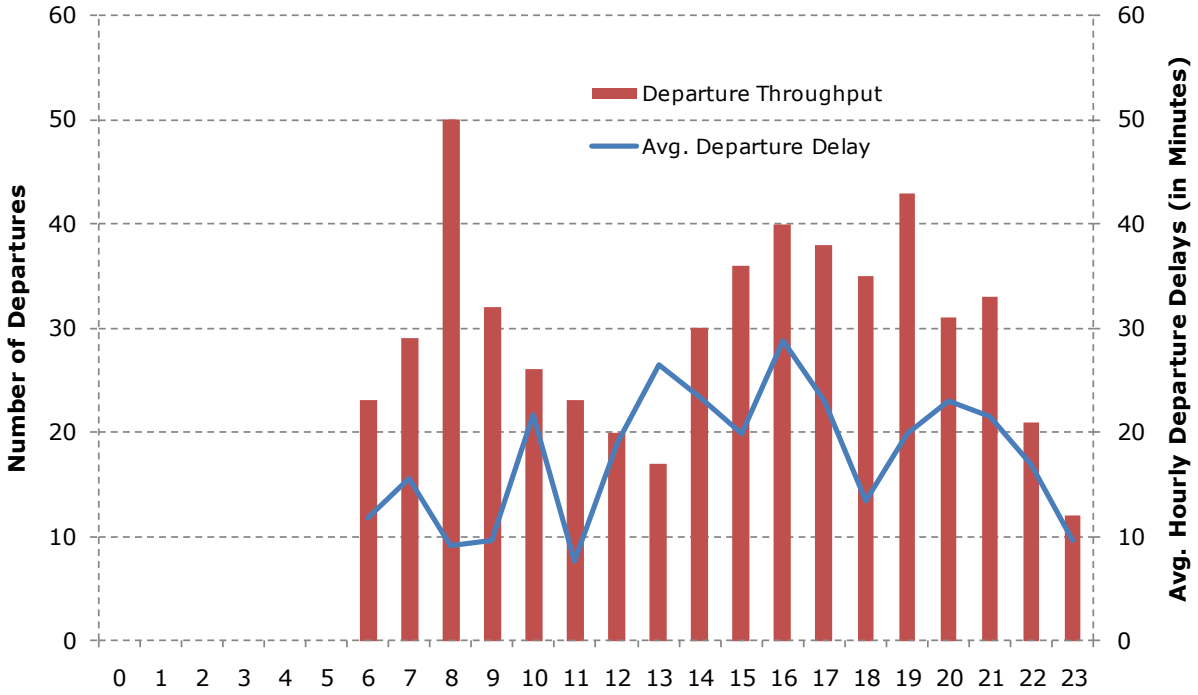


Note: FAA ASPM data shown from 6am to midnight only.
Source: Landrum & Brown analysis.

FIGURE 7-5
TAAM CALIBRATION
John F. Kennedy International Airport
EXISTING CONDITIONS – SW FLOW/VFR DEPARTURES



FAA ASPM – SW FLOW/VFR DEPARTURES



Note: FAA ASPM data shown from 6am to midnight only.
Source: Landrum & Brown analysis.

Table 7-1 presents an overview of the results for the Existing Conditions scenario. The summary table shows both air and gate delays as well as total taxi time (unimpeded taxi time + ground delay).

TABLE 7-1
TAAM RESULTS SUMMARY – EXISTING CONDITIONS
John F. Kennedy International Airport

Alternative	Avg. Gate Delay	Avg. Taxi Time	Avg. Air Delay	Avg. Taxi + Delay
NE FLOW - EXISTING CONDITIONS				
Arrivals	0.1	8.8	9.5	18.4
Departures	8.9	18.4	0.0	27.3
Total	4.4	13.5	4.8	22.8
SW FLOW - EXISTING CONDITIONS				
Arrivals	0.0	7.5	9.5	17.1
Departures	8.8	17.3	0.0	26.1
Total	4.3	12.3	4.8	21.5

Source: Landrum & Brown analysis.

7.3.2 TAAM Simulation Results

In order to accurately evaluate the benefits of the runway and taxiway improvements at JFK, the calibrated TAAM model was used to simulate arriving and departing traffic at JFK for each project scenario. **Tables 7-2** through **7-6** present the results of the TAAM simulation for the Base Case and Scenarios 2 through 5, respectively.

In the Base Case, taxi times and delays remain the same in NE flow. SW flow taxi times and delays, however, are expected to increase compared to the Existing Conditions scenario driven by a substantial increase in taxi-out times and departures gate delays due to the shortening of Runway 22R for RSA compliance purposes. Indeed, the shortening of Runway 22R makes the use of the runway impossible for about 40 eastbound departures based on the 2010 design day schedule at maximum takeoff weight during 50 hot weather days. As a result, these departures have to use Runway 31L for take-off. This results in a loss of three slots on Runway 22R for every eastbound departure on Runway 31L. It is therefore estimated that, in 2010, a maximum of 6,000 slots would be lost annually in the Base Case. The reduction in slots on Runway 22R generates an increase in taxi-out times (19.1 minutes per departure versus 17.3 minutes per departure in the Existing Conditions scenario) as aircraft have to queue for a longer period of time before being cleared for take-off on Runway 22R after each Runway 31L departure. The metering system in place at JFK ensures that only a limited number of departures are taxiing or queuing on the airfield at any given time of day. Therefore, metering allows FAA ATCT to distribute the additional departure delays due to the loss of slots between the gates and the taxiway system. The Base Case gate departure delays also show an increase compared to the Existing Conditions scenario as departures have to be held at the gate for a longer period of time before being cleared to taxi to the runway. On the other hand, the reduction in

departure slots on Runway 22R improves the efficiency of the arrival flow from Runway 22L. This translates into a decrease of arrival delays in the Base Case compared to the Existing Conditions scenario.

TABLE 7-2
TAAM RESULTS SUMMARY – BASE CASE
John F. Kennedy International Airport

Alternative	Avg. Gate Delay	Avg. Taxi Time	Avg. Air Delay	Avg. Taxi + Delay
NE FLOW - BASE CASE				
Arrivals	0.1	8.8	9.5	18.4
Departures	8.9	18.4	0.0	27.3
Total	4.4	13.5	4.8	22.8
SW FLOW - BASE CASE				
Arrivals	0.0	8.2	8.5	16.7
Departures	9.3	19.1	0.0	28.4
Total	4.6	13.6	4.3	22.5

Source: Landrum & Brown analysis.

In Scenario 2, Runway 22R is extended to Taxiway E. The departing flights heading to fixes other than RBV, DIXIE, and WHITE that had to use Runway 31L for take-off in the Base Case can now use Runway 22R (as they do in the Existing Conditions scenario). As a result, taxi-in times and arrival delays go back to the levels shown in the Existing Conditions scenario. On the departure side, Taxiway E can be used as a new departure entry point on Runway 22R which improves the sequencing of aircraft on the runway and increases departure capacity at the airport. In addition, the extension of Runway 22R provides more space for queuing departures and also improves the efficiency of taxi flows.

TABLE 7-3
TAAM RESULTS SUMMARY – SCENARIO 2
John F. Kennedy International Airport

Alternative	Avg. Gate Delay	Avg. Taxi Time	Avg. Air Delay	Avg. Taxi + Delay
NE FLOW - SCENARIO 2				
Arrivals	0.1	8.5	9.7	18.4
Departures	8.4	18.0	0.0	26.5
Total	4.2	13.2	4.9	22.3
SW FLOW - SCENARIO 2				
Arrivals	0.0	7.3	9.6	16.9
Departures	6.3	18.5	0.0	24.8
Total	3.1	12.8	4.8	20.8

Source: Landrum & Brown analysis.

In Scenario 3, the new Taxiway FC provides an additional entry point to Runway 22R for departures. The reconfiguration of Taxiway ZA improves the flows of aircraft to Runway 22R and provides for more adequate staging space. These

improvements result in a decrease of taxi-out times of 1.3 minutes per departure on average compared to Scenario 2. The improved departure flow also generates a reduction in taxi-in times and a slight reduction in arrival delays.

TABLE 7-4
TAAM RESULTS SUMMARY – SCENARIO 3
John F. Kennedy International Airport

Alternative	Avg. Gate Delay	Avg. Taxi Time	Avg. Air Delay	Avg. Taxi + Delay
NE FLOW - SCENARIO 3				
Arrivals	0.0	8.4	9.7	18.1
Departures	8.4	18.0	0.0	26.3
Total	4.1	13.1	4.9	22.2
SW FLOW - SCENARIO 3				
Arrivals	0.0	7.3	9.3	16.6
Departures	6.6	17.2	0.0	23.8
Total	3.2	12.2	4.7	20.1

Source: Landrum & Brown analysis.

The addition of high-speed exits results in a very negligible reduction of arrival delays in both NE flow and SW flow due to the small percentage of arrivals using Runway 4L/22R and the single arrival stream for landings on both runways that prevents reductions in aircraft separations on approach. On the departure side, however, departing aircraft can take-off sooner as arrivals exit the runway sooner with the new high-speed exits. While this does not affect taxi-out times, it does allow departures to leave their gate sooner, resulting in lower departure gate delays in both NE and SW flows.

TABLE 7-5
TAAM RESULTS SUMMARY – SCENARIO 4
John F. Kennedy International Airport

Alternative	Avg. Gate Delay	Avg. Taxi Time	Avg. Air Delay	Avg. Taxi + Delay
NE FLOW - SCENARIO 4				
Arrivals	0.0	8.1	9.6	17.7
Departures	7.6	17.9	0.0	25.6
Total	3.8	12.9	4.9	21.6
SW FLOW - SCENARIO 4				
Arrivals	0.0	7.4	9.3	16.7
Departures	5.8	17.3	0.0	23.1
Total	2.8	12.3	4.7	19.8

Source: Landrum & Brown analysis.

The taxiway improvements proposed in Scenario 5 do not provide a significant incremental benefit over Scenario 4 on taxi times or delays at the airport.

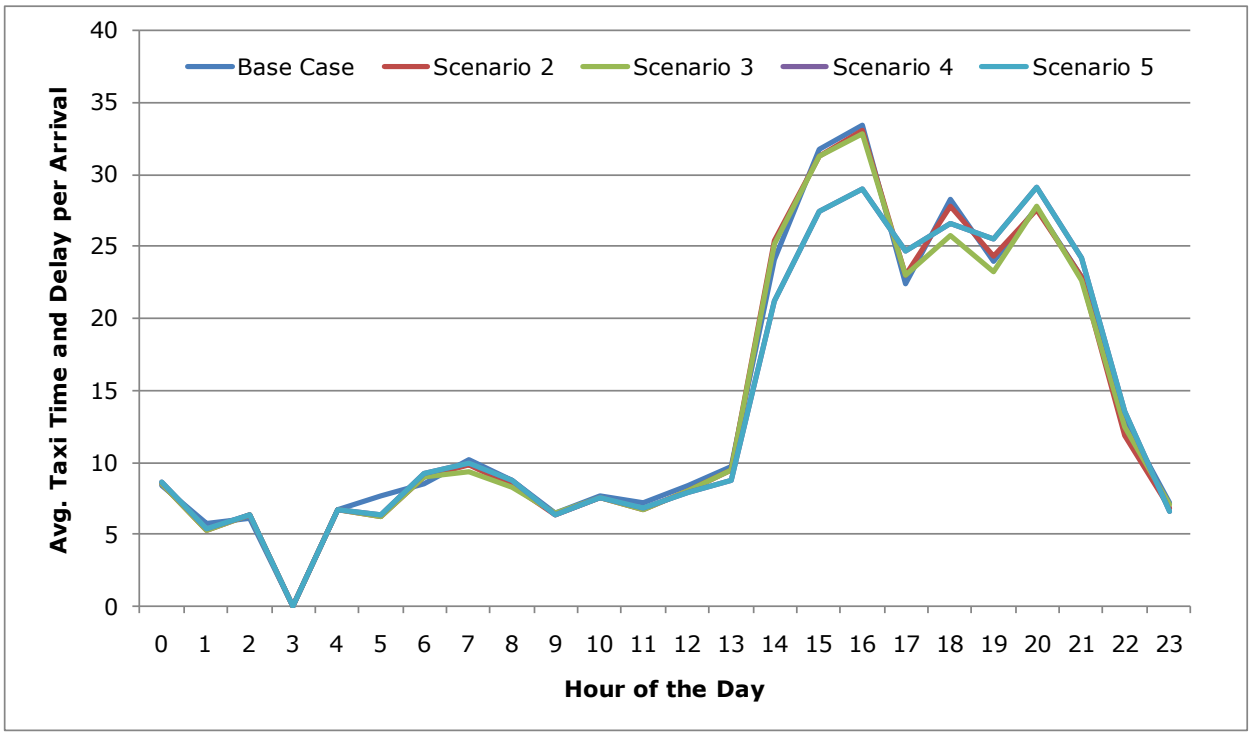
TABLE 7-6
TAAM RESULTS SUMMARY – SCENARIO 5
John F. Kennedy International Airport

Alternative	Avg. Gate Delay	Avg. Taxi Time	Avg. Air Delay	Avg. Taxi + Delay
NE FLOW - SCENARIO 5				
Arrivals	0.0	8.1	9.6	17.7
Departures	7.6	17.9	0.0	25.6
Total	3.8	12.9	4.9	21.6
SW FLOW - SCENARIO 5				
Arrivals	0.0	7.4	9.3	16.7
Departures	5.7	17.3	0.0	23.0
Total	2.8	12.3	4.7	19.8

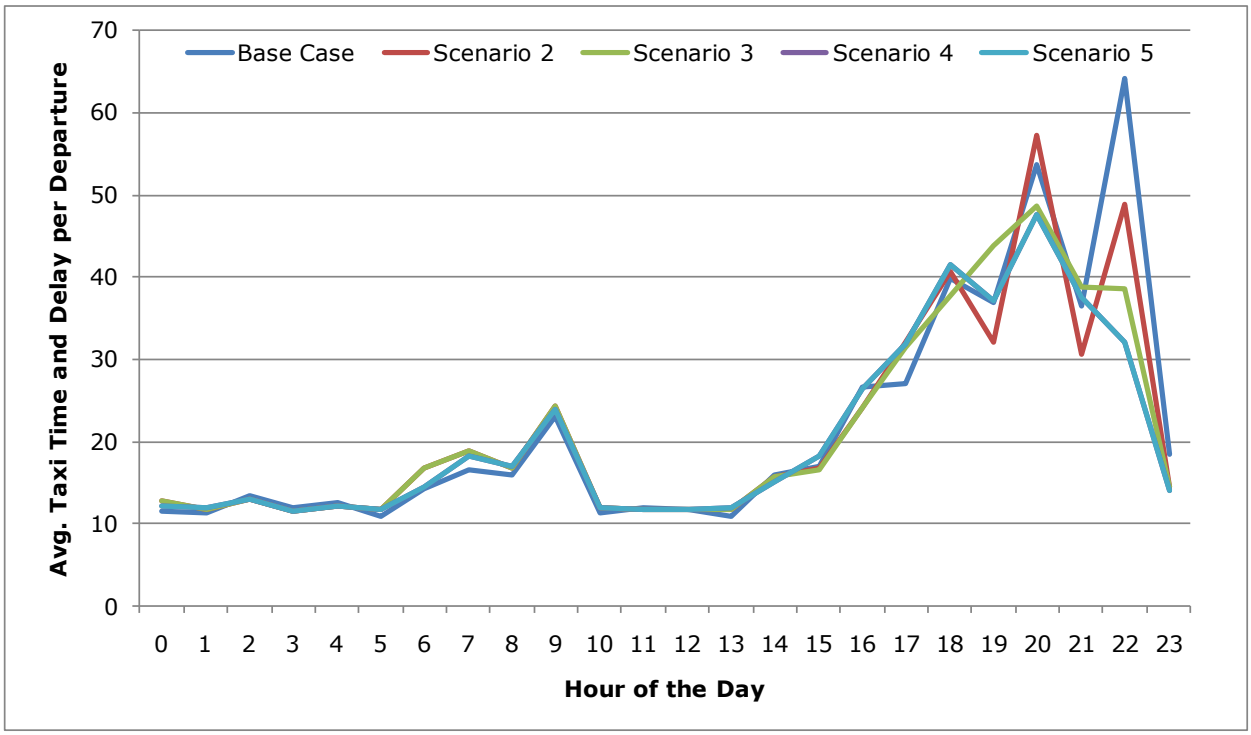
Source: Landrum & Brown analysis.

Figures 7-6 and **7-7** provide a comparison of hourly arrival and departure taxi times and delays for both NE and SW flows.

FIGURE 7-6
TAXI TIME AND DELAY COMPARISON – NE FLOW
John F. Kennedy International Airport
NE FLOW ARRIVALS

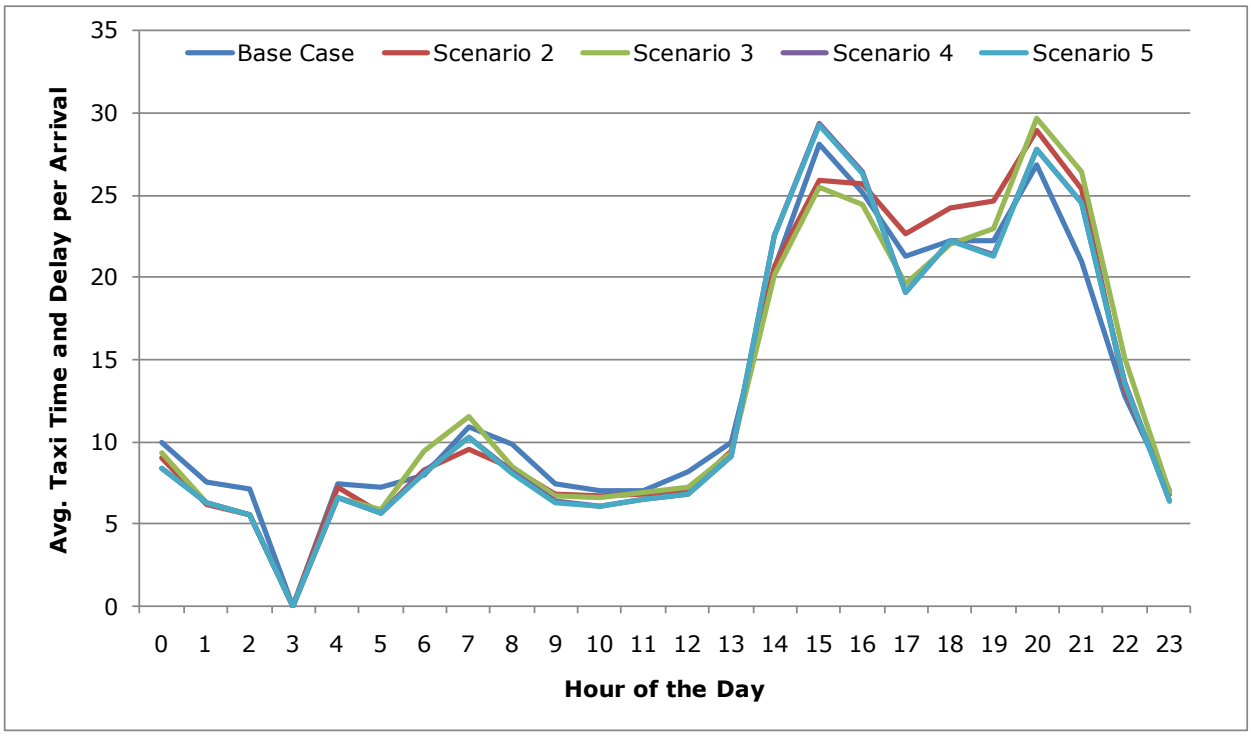


NE FLOW DEPARTURES

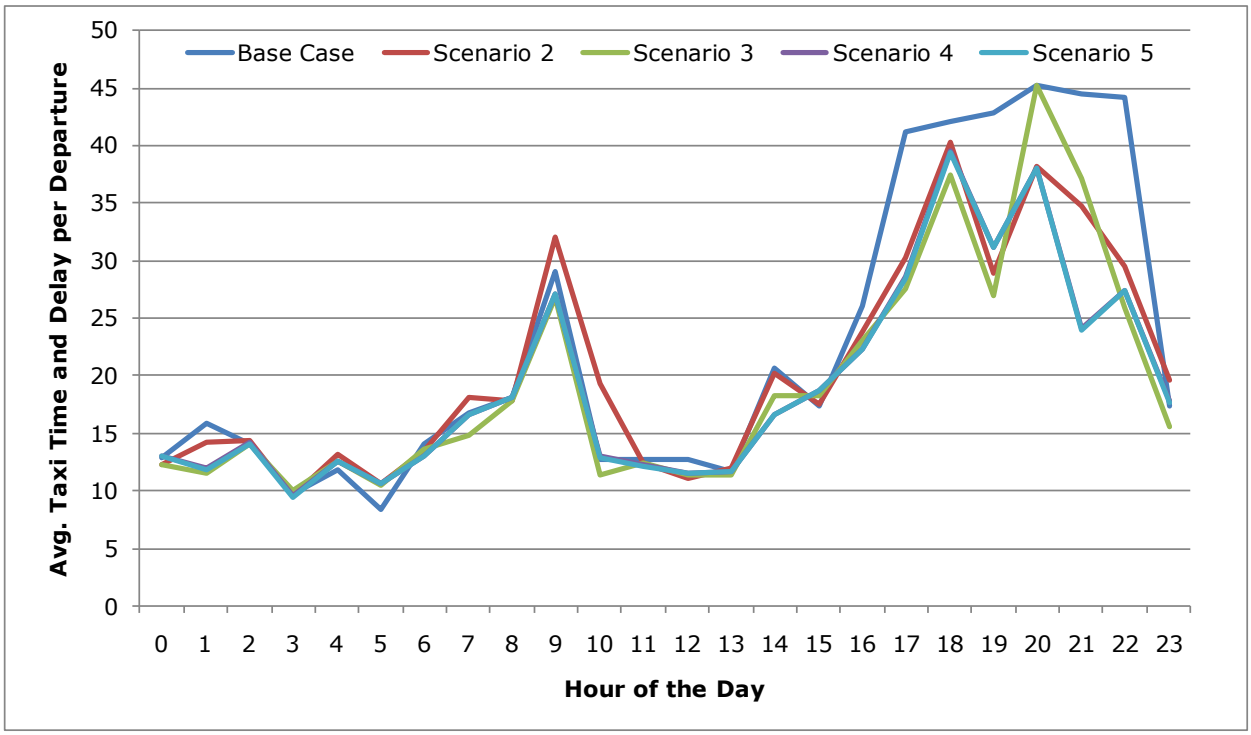


Source: Landrum & Brown analysis.

FIGURE 7-7
TAXI TIME AND DELAY COMPARISON – SW FLOW
John F. Kennedy International Airport
SW FLOW ARRIVALS



SW FLOW DEPARTURES



Source: Landrum & Brown analysis.

7.4 TAXI TIME AND DELAY ANNULIZATION AND ASSOCIATED BENEFITS

Taxi times and delays generated by TAAM on an hourly basis for the July 2010 design day schedule were annualized using Table 2-3. The annualization process takes into account the flows considered (NE and SW flows). Since only VFR conditions were considered in this analysis, an 85.2 percent factor was applied. As stated previously, it is assumed that the 85.2 percent factor for VFR conditions across the year would remain constant over the evaluation period. **Table 7-7** presents the resulting average annual taxi times and delays for each scenario.

TABLE 7-7
ANNUALIZED TAXI TIMES AND DELAYS
John F. Kennedy International Airport

	Average Annual Taxi Times and Delays (in Minutes)			Comparison Against Base Case		
Scenario	**Air Delay**	**Taxi Time**	**Gate Delay**	**Air Delay**	**Taxi Time**	**Gate Delay**
Existing	1.9	5.8	2.4			
Base Case	1.7	6.2	2.4	0.0	0.0	0.0
Scenario 2	1.9	5.9	1.9	0.2	-0.3	-0.5
Scenario 3	1.9	5.7	1.9	0.2	-0.5	-0.5
Scenario 4	1.8	5.7	1.8	0.1	-0.5	-0.6
Scenario 5	1.8	5.7	1.8	0.1	-0.5	-0.6

Source: Landrum & Brown analysis.

Benefits associated with each project scenario were quantified separately for air delays, gate delays, and taxi times. Indeed, the costs of operating the aircraft at the gate, during taxi, or in the air vary significantly, mainly due to variations in fuel consumption and associated costs. Table 5-2 was used to quantify the benefits associated with aircraft taxi time and delay savings as follows:

- Air Delays: All Operations and All Costs
- Taxi Times: Ground Operations and All Costs
- Gate Delays: Ground Operations and No Fuel Costs

The U.S. DOT recommended value of $28.6 per hour was used to evaluate the passenger benefits.

Tables 7-8 and **7-9** provide an example of the calculations used to evaluate aircraft and passenger benefits for Scenario 2 compared to the Base Case. The equations used to calculate the benefits associated with taxi time and delay savings are provided in the footnotes of these tables.

TABLE 7-8
AIRCRAFT TAXI TIME AND DELAY BENEFITS
John F. Kennedy International Airport

		Scenario 2 vs. Base Case						Aircraft Benefits		
Year	Annual Aircraft Operations	Air Delay Savings	Taxi Time Savings	Gate Delay Savings	Avg. Total Aircraft Operating Costs ($/min)	Avg. Ground Aircraft Operating Costs ($/min)	Avg. Ground Non-Fuel Aircraft Operating Costs ($/min)	Air Delay Benefits	Taxi Time Benefits	Gate Delay Benefits
2009	414,928	-0.2	0.3	0.5						
2010	411,409	-0.2	0.3	0.5	$64.50	$41.41	$18.60			
2011	414,076	-0.2	0.3	0.5	$63.36	$40.68	$18.43			
2012	425,072	-0.2	0.3	0.5	$62.91	$40.39	$18.41			
2013	432,608	-0.2	0.3	0.5	$62.65	$40.22	$18.37	-$6,110,000	$5,319,000	$4,034,000
2014	438,672	-0.2	0.3	0.5	$62.31	$40.00	$18.32	-$6,161,000	$5,364,000	$4,078,000
2015	445,787	-0.2	0.3	0.5	$62.02	$39.81	$18.27	-$6,232,000	$5,426,000	$4,134,000
2016	452,592	-0.2	0.3	0.5	$61.69	$39.61	$18.22	-$6,294,000	$5,480,000	$4,185,000
2017	459,497	-0.2	0.3	0.5	$61.40	$39.42	$18.17	-$6,360,000	$5,537,000	$4,237,000
2018	467,083	-0.2	0.3	0.5	$61.14	$39.25	$18.12	-$6,437,000	$5,604,000	$4,297,000
2019	475,135	-0.2	0.3	0.5	$60.80	$39.03	$18.06	-$6,512,000	$5,670,000	$4,356,000
2020	484,713	-0.2	0.3	0.5	$60.51	$38.84	$18.00	-$6,611,000	$5,756,000	$4,429,000
2021	492,658	-0.2	0.3	0.5	$60.36	$38.75	$17.98	-$6,703,000	$5,836,000	$4,495,000
2022	500,800	-0.2	0.3	0.5	$60.27	$38.69	$17.96	-$6,804,000	$5,924,000	$4,565,000
2023	509,145	-0.2	0.3	0.5	$60.18	$38.63	$17.94	-$6,907,000	$6,013,000	$4,637,000
2024	517,697	-0.2	0.3	0.5	$60.08	$38.57	$17.92	-$7,012,000	$6,105,000	$4,710,000
2025	526,462	-0.2	0.3	0.5	$59.99	$38.51	$17.91	-$7,119,000	$6,198,000	$4,784,000
2026	528,408	-0.2	0.3	0.5	$59.93	$38.48	$17.89	-$7,139,000	$6,215,000	$4,799,000
2027	530,364	-0.2	0.3	0.5	$59.87	$38.44	$17.88	-$7,158,000	$6,232,000	$4,813,000
2028	532,332	-0.2	0.3	0.5	$59.82	$38.40	$17.87	-$7,178,000	$6,249,000	$4,827,000
2029	534,310	-0.2	0.3	0.5	$59.76	$38.37	$17.85	-$7,198,000	$6,267,000	$4,842,000
2030	536,300	-0.2	0.3	0.5	$59.70	$38.33	$17.84	-$7,218,000	$6,284,000	$4,856,000
2031	538,302	-0.2	0.3	0.5	$59.64	$38.29	$17.83	-$7,237,000	$6,301,000	$4,871,000
2032	540,316	-0.2	0.3	0.5	$59.58	$38.25	$17.81	-$7,257,000	$6,318,000	$4,885,000
2033	542,341	-0.2	0.3	0.5	$59.53	$38.22	$17.80	-$7,277,000	$6,336,000	$4,900,000
2034	544,377	-0.2	0.3	0.5	$59.47	$38.18	$17.79	-$7,298,000	$6,354,000	$4,915,000
2035	546,425	-0.2	0.3	0.5	$59.41	$38.14	$17.78	-$7,318,000	$6,371,000	$4,930,000

Notes: The following are the equations used to calculate the aircraft benefits.
Air Delay Benefits = Annual Aircraft Operations x Air Delay Savings x Avg. Total Acft Op. Costs
Taxi Time Benefits = Annual Aircraft Operations x Taxi Time Savings x Avg. Ground Acft Op. Costs
Gate Delay Benefits = Annual Aircraft Operations x Gate Delay Savings x Avg. Ground Non-Fuel Acft Op. Costs
Source: Landrum & Brown analysis.

TABLE 7-9
PASSENGER TAXI TIME AND DELAY BENEFITS
John F. Kennedy International Airport

		Scenario 2 vs. Base Case			Cost of	Passenger Benefits		
Year	Annual Commercial Passengers	Air Delay Savings	Taxi Time Savings	Gate Delay Savings	Passenger Time ($/min)	Air Delay Benefits	Taxi Time Benefits	Gate Delay Benefits
2009	45,915,000	-0.2	0.3	0.5	$0.48			
2010	46,476,564	-0.2	0.3	0.5	$0.48			
2011	47,284,804	-0.2	0.3	0.5	$0.48			
2012	48,606,561	-0.2	0.3	0.5	$0.48			
2013	49,714,198	-0.2	0.3	0.5	$0.48	-$5,379,000	$7,295,000	$12,112,000
2014	50,581,167	-0.2	0.3	0.5	$0.48	-$5,473,000	$7,422,000	$12,323,000
2015	51,580,683	-0.2	0.3	0.5	$0.48	-$5,581,000	$7,569,000	$12,566,000
2016	52,513,341	-0.2	0.3	0.5	$0.48	-$5,682,000	$7,706,000	$12,794,000
2017	53,468,416	-0.2	0.3	0.5	$0.48	-$5,785,000	$7,846,000	$13,026,000
2018	54,515,545	-0.2	0.3	0.5	$0.48	-$5,899,000	$7,999,000	$13,281,000
2019	55,673,738	-0.2	0.3	0.5	$0.48	-$6,024,000	$8,169,000	$13,563,000
2020	56,909,981	-0.2	0.3	0.5	$0.48	-$6,158,000	$8,351,000	$13,865,000
2021	57,101,978	-0.2	0.3	0.5	$0.48	-$6,178,000	$8,379,000	$13,911,000
2022	57,294,622	-0.2	0.3	0.5	$0.48	-$6,199,000	$8,407,000	$13,958,000
2023	57,487,916	-0.2	0.3	0.5	$0.48	-$6,220,000	$8,436,000	$14,005,000
2024	57,681,862	-0.2	0.3	0.5	$0.48	-$6,241,000	$8,464,000	$14,053,000
2025	57,876,463	-0.2	0.3	0.5	$0.48	-$6,262,000	$8,493,000	$14,100,000
2026	58,071,765	-0.2	0.3	0.5	$0.48	-$6,283,000	$8,521,000	$14,148,000
2027	58,267,726	-0.2	0.3	0.5	$0.48	-$6,305,000	$8,550,000	$14,195,000
2028	58,464,348	-0.2	0.3	0.5	$0.48	-$6,326,000	$8,579,000	$14,243,000
2029	58,661,634	-0.2	0.3	0.5	$0.48	-$6,347,000	$8,608,000	$14,291,000
2030	58,859,585	-0.2	0.3	0.5	$0.48	-$6,369,000	$8,637,000	$14,340,000
2031	59,058,250	-0.2	0.3	0.5	$0.48	-$6,390,000	$8,666,000	$14,388,000
2032	59,257,586	-0.2	0.3	0.5	$0.48	-$6,412,000	$8,695,000	$14,437,000
2033	59,457,594	-0.2	0.3	0.5	$0.48	-$6,433,000	$8,725,000	$14,485,000
2034	59,658,278	-0.2	0.3	0.5	$0.48	-$6,455,000	$8,754,000	$14,534,000
2035	59,859,639	-0.2	0.3	0.5	$0.48	-$6,477,000	$8,784,000	$14,583,000

Notes: The following are the equations used to calculate the passenger benefits.
Air Delay Benefits = Annual Commercial Passengers x Air Delay Savings x Cost of Passenger Time
Taxi Time Benefits = Annual Commercial Passengers x Taxi Time Savings x Cost of Passenger Time
Gate Delay Benefits = Annual Commercial Passengers x Gate Delay Savings x Cost of Passenger Time

Source: Landrum & Brown analysis.

7.5 BENEFITS RELATED TO NEW HIGH-SPEED EXITS ON RUNWAY 4L/22R

In order to evaluate the impact of the new high-speed exits on runway occupancy times at JFK, the FAA Runway Exit Design Interactive Model (REDIM) was used for both runway operating configurations using JFK current and future fleet mix provided in the Port Authority latest aviation activity forecast.

The model was calibrated and adjusted based on actual runway exit usage data obtained from Sensis' Aerobahn database. **Table 7-10** presents the results of the REDIM analysis for each alternative and runway flow. Using the average approach speeds from the Port Authority AirScene database (see Appendix), the reduction in runway occupancy time would generate a reduction in approach aircraft separations of 0.23 nautical miles on Runway 4L and 0.27 nautical miles on Runway 22R. However, current arrival streams preclude any reduction in arrival separations unless this reduction applies to both Runway 4L/22R and Runway 4R/22L. Indeed, in Northeast flow, arrivals on Runway 4L and on Runway 4R use the same approach path. The same thing occurs in Southwest flow with Runways 22L and 22R approach paths being combined. Therefore, a reduction in runway occupancy on one of the two parallel runways cannot result into a reduction in aircraft separations on approach. As such, it was deemed reasonable not to include the reductions in aircraft separations due to the new high-speed exits in this BCA analysis. However, the taxi time reduction benefits associated with the reduction in runway occupancy time are already included in the taxi time and delay results presented in Section 7.4.

TABLE 7-10
AVERAGE RUNWAY OCCUPANCY TIME
John F. Kennedy International Airport

	Runway 4L	Runway 22R
Base Case	65.3 s	65.6 s
Proposed Project - without high speed exits	66.8 s	66.5 s
Proposed Project - with high speed exits	59.9 s	59.3 s
High-Speed Exits ROT Savings	6.9 s	7.2 s

Source: PANYNJ, REDIM Model with 2020 Fleet Mix

With the proposed High-Speed Exits, Runway 4L-22R can expect ROT savings of 6.9 seconds and 7.2 seconds respectively for Runway 4L and Runway 22R. It should be noted that the average runway occupancy time at air carrier airports is about 55 seconds. Airports generally aim to achieve ROTs of less than 55 seconds. Although these improvements will not meet the desired ROT, they will improve existing ROTs for Runway 4L-22R.

7.6 OTHER BENEFITS

Other benefits related to the project include:

- Benefits to the National Airspace System – Although it is difficult to quantify the impact that the proposed project will have on delays throughout the

National Airspace System, it is a known fact that delays at major commercial airports promulgate beyond the root cause airport worsening conditions throughout the airport system. The proposed project at JFK will not only reduce delays at the airport, but could also reduce delays at other airports. This scenario is considered in the sensitivity analysis (Section 8.2).

- Improved On-Time Performance - Better on-time performance benefits both passengers and airlines. Passenger benefits were quantified in this BCA and discussed in the previous section. From an airline perspective, this translates into improved ground handling performances through a better use of resources and staff allocation and reduced need for additional staff for delayed flights. Improved on-time performance also results in higher service quality to ensure the continued growth of air service and passenger demand at JFK.
- Increased Ground Operations Efficiency and Safety - The airfield improvements would provide better, more efficient taxi routes by helping controllers sequence aircraft. These improved traffic flows on the ground could then increase operational efficiency and safety.
- Improved Poor Weather Operations – Activity at the airport is often affected by thunderstorm weather conditions that can generate delays at JFK as well as surrounding major commercial airports. The new improvements will assist the FAA ATCT during Severe Weather Avoidance Program (SWAP) conditions as well as in reducing the time to return to normal operations following these events.
- Reduced Air Emissions - While benefits from reduced aircraft delays and taxi times are quantified, reductions in gas emissions are also a contributing factor to this BCA. Indeed, taxiing aircraft usually produce emissions that could be quite significant depending on the level of delay at the airport. Reductions in delay in the air and on the ground can significantly reduce these emissions. This scenario is considered in the sensitivity analysis (Section 8.2).

8. BENEFIT-COST COMPARISON OF PROJECT ALTERNATIVES

8.1 BENEFIT-COST RATIO OF PROJECT ALTERNATIVES

8.1.1 Overall BCA Ratio

The critical component of the BCA entails the quantification of annual costs and benefits over the evaluation period. The net present value (NPV) of costs and benefits is then calculated and expressed in 2011 dollars. The NPV of benefits divided by the NPV of costs yields a BCA ratio that can be used to evaluate the benefits of the project versus the associated costs. A BCA ratio with a value greater than one (1.0) indicates that the project has economic justification given that the benefits yielded by the project outweigh the costs of developing the project. A BCA ratio of 2.0, for example, indicates that the net present value of the benefits is twice as large as the net present value of the costs. The higher the BCA ratio, the greater the benefits provided by the project.

Table 8-1 presents the overall BCA Ratio (NPV of benefits over NPV of costs) for each project scenario based on the assumptions discussed in Section 6 and Section 7 and expressed in 2011 dollars.

TABLE 8-1
NET BENEFITS VERSUS COSTS – OVERALL COMPARISON
John F. Kennedy International Airport

	Benefits [1/]	Costs [1/]	BCA Ratio [1/]
Scenario 2	$ 194,818,000	$ 91,246,000	2.14
Scenario 3	$ 311,135,000	$ 137,487,000	2.26
Scenario 4	$ 408,862,000	$ 174,359,000	2.34
			(w/o 'KC') 2.46
Scenario 5	$ 413,556,000	$ 198,007,000	2.09
			(w/o 'KC') 2.17

[1/] Net Present Value of total benefits and costs over evaluation period expressed in 2011 U.S. dollars
Source: Landrum & Brown analysis.

8.1.2 Differential BCA Ratio

While the extension of Runway 4L-22R provides significant taxi time and delay savings, subsequent improvements assumed in Scenario 3 and 4 also generate substantial benefits. Taxiways ZA and FC provide significant improvements in the way departures taxi to the runway and queue for take-off. Comparing Scenario 3 and Scenario 2, these taxi flow improvements would generate a BCA ratio of 2.52.

The addition of high-speed exits allows arrivals to exit the runway sooner. A comparison of Scenarios 3 and 4 reveals that the high-speed exits would generate substantial benefits resulting in a BCA ratio of 2.65. Improvements considered in

Scenario 5 do not provide enough benefits to outweigh the additional costs to the project. As a result, the corresponding BCA ratio decreases to 2.1.

Table 8-2 presents the differential BCA Ratio, which allows a clear comparison of individual improvements.

TABLE 8-2
NET BENEFITS VERSUS COSTS – INDIVIDUAL IMPROVEMENTS COMPARISON
John F. Kennedy International Airport

Scope Elements	Benefits [1/]	Costs [1/]	Differential BCA [1/]
TXY 'ZA' & 'FC' West of RWY 4L-22R	$ 116,317,000	$ 46,241,000	2.52
TXY 'GA' (High Speed Exit)	$ 28,641,000	$ 11,139,000	2.57
TXY 'HA' (High Speed Exit) + TWY 'B' Elbow	$ 69,085,000	$ 20,211,000	3.42
TXY 'GA', 'HA' & TWY 'B' Reconfiguration	$ 97,727,000	$ 29,048,000	3.36
TWY 'FC' East of RWY 4L-22R & Straightening of 'Y'	$ 4,694,000	$ 23,651,000	<1.5
Taxiway 'K', 'KA'	Necessary Improvement - No BCA Ratio		
Taxiway 'KC'	Has No Direct Impact to RWY 4L-22R Operations		
Taxiway 'KD'	Has No Direct Impact to RWY 4L-22R Operations		

[1/] Net Present Value of total benefits and costs over evaluation period expressed in 2011 U.S. dollars
Source: Landrum & Brown analysis.

Notes:

- The evaluation period of this BCA is 20 years after construction period (through 2035)
- Aircraft operating costs are reflective of 2010 aircraft operating costs
- The value of passenger time is $28.60 per hour or $0.48 per minute
- 7% discount rate is used to calculate NPV of benefits and costs per FAA BCA guidance
- The PA recommended discount rate of 3.5% was tested in subsequent sensitivity analysis

8.2 SENSITIVITY ANALYSIS

The analysis has been expanded to test the sensitivity of the overall BCA ratio on changes in key parameters. The evaluations are based on variations of the following factors:

- Project costs
- Discount rates
- Aircraft operating costs
- Delay propagation factor
- Meeters and Greeters
- Reduction in gas emissions

A summary of the resulting BCA ratios is presented at the end of this section.

8.2.1 Variations in Project Costs

Sensitivity analysis was developed based on variations in capital costs. A 20 percent increase or decrease in costs was assumed in this section. These variations in capital costs also generated an increase or a decrease in O&M costs. **Table 8-3** and **Table 8-4** present the corresponding BCA ratios for each project. Other assumptions used in Section 8.1 remain the same.

TABLE 8-3
NET BENEFITS VERSUS COSTS – 20 PERCENT INCREASE IN PROJECT COSTS
John F. Kennedy International Airport

Scenario	Benefits 1/	Costs 1/	BCA Ratio
Scenario 2	$194,818,000	$109,493,000	1.78
Scenario 3	$311,135,000	$164,991,000	1.89
Scenario 4	$408,862,000	$209,218,000	1.95
Scenario 5	$413,556,000	$237,608,000	1.74

1/ Net Present Value of total benefits and costs over evaluation period expressed in 2011 U.S. dollars
Source: Landrum & Brown analysis.

TABLE 8-4
NET BENEFITS VERSUS COSTS – 20 PERCENT DECREASE IN PROJECT COSTS
John F. Kennedy International Airport

Scenario	Benefits 1/	Costs 1/	BCA Ratio
Scenario 2	$194,818,000	$72,998,000	2.67
Scenario 3	$311,135,000	$109,991,000	2.83
Scenario 4	$408,862,000	$139,485,000	2.93
Scenario 5	$413,556,000	$158,400,000	2.61

1/ Net Present Value of total benefits and costs over evaluation period expressed in 2011 U.S. dollars
Source: Landrum & Brown analysis.

A sensitivity analysis was also conducted focusing on the extension of Taxiway KC from Taxiway K to Runway 4L/22R. This taxiway extension included in Scenarios 4

and 5 intends to provide an additional exit for arrivals on Runway 22R. However, this additional piece of pavement does not generate any taxi time or delay benefits since all arrivals on Runway 22R exit before reaching Runway 13R/31L thanks to the new high-speed exits. BCA ratios were calculated for Scenarios 4 and 5 without the cost associated with the extension of Taxiway KC. Other assumptions used in Section 8.1 remain the same. The corresponding BCA ratios are shown in **Table 8-5**.

TABLE 8-5
NET BENEFITS VERSUS COSTS – NO TAXIWAY KC
John F. Kennedy International Airport

Scenario	Benefits 1/	Costs 1/	BCA Ratio
Scenario 4	$408,862,000	$166,535,000	2.46
Scenario 5	$413,556,000	$190,186,000	2.17

1/ Net Present Value of total benefits and costs over evaluation period expressed in 2011 U.S. dollars
Source: Landrum & Brown analysis.

8.2.2 Discount Rate of 3.5 Percent and 10 Percent

This section considers variations in the discount rate used to calculate the net present value of benefits and costs. In Section 8.1, a discount rate of 7 percent was used as recommended by the FAA. In this sensitivity, a high case and a low case were evaluated with a discount rate of 3.5 percent (see **Table 8-6**) and 10 percent (see **Table 8-7**), respectively.

TABLE 8-6
NET BENEFITS VERSUS COSTS – 3.5 PERCENT DISCOUNT RATE
John F. Kennedy International Airport

Scenario	Benefits 1/	Costs 1/	BCA Ratio
Scenario 2	$285,329,000	$102,526,000	2.78
Scenario 3	$455,727,000	$154,476,000	2.95
Scenario 4	$598,892,000	$195,907,000	3.06
Scenario 5	$605,767,000	$222,483,000	2.72

1/ Net Present Value of total benefits and costs over evaluation period expressed in 2011 U.S. dollars
Source: Landrum & Brown analysis.

TABLE 8-7
NET BENEFITS VERSUS COSTS – 10 PERCENT DISCOUNT RATE
John F. Kennedy International Airport

Scenario	Benefits 1/	Costs 1/	BCA Ratio
Scenario 2	$146,490,000	$83,865,000	1.75
Scenario 3	$233,948,000	$126,371,000	1.85
Scenario 4	$307,421,000	$160,259,000	1.92
Scenario 5	$310,952,000	$181,996,000	1.71

1/ Net Present Value of total benefits and costs over evaluation period expressed in 2011 U.S. dollars
Source: Landrum & Brown analysis.

8.2.3 Aircraft Operating Costs

This section aims at reflecting potentially higher or lower fuel cost levels than currently anticipated. As discussed in Section 5.3.1, 2010* fuel costs were considered in the core analysis of this BCA. This sensitivity analysis assumes the use of higher and lower aircraft operating costs in line with the 2008 and 2009 levels, respectively, in the quantification of benefits. Other assumptions used in Section 8.1 remain the same. **Table 8-8** and **Table 8-9** present the corresponding BCA ratios.

TABLE 8-8
NET BENEFITS VERSUS COSTS – 2008 AIRCRAFT OPERATING COSTS
John F. Kennedy International Airport

Scenario	Benefits 1/	Costs 1/	BCA Ratio
Scenario 2	$188,490,000	$91,246,000	2.07
Scenario 3	$315,751,000	$137,487,000	2.30
Scenario 4	$417,841,000	$174,359,000	2.40
Scenario 5	$422,765,000	$198,007,000	2.14

1/ Net Present Value of total benefits and costs over evaluation period expressed in 2011 U.S. dollars
Source: Landrum & Brown analysis.

TABLE 8-9
NET BENEFITS VERSUS COSTS – 2009 AIRCRAFT OPERATING COSTS
John F. Kennedy International Airport

Scenario	Benefits 1/	Costs 1/	BCA Ratio
Scenario 2	$195,042,000	$91,246,000	2.14
Scenario 3	$308,044,000	$137,487,000	2.24
Scenario 4	$403,996,000	$174,359,000	2.32
Scenario 5	$408,603,000	$198,007,000	2.06

1/ Net Present Value of total benefits and costs over evaluation period expressed in 2011 U.S. dollars
Source: Landrum & Brown analysis.

8.2.4 Delay Propagation Factor

The FAA recommends using a delay propagation factor in benefit-cost analyses to account for the impact of the reduction in delays at the studied airport could have on the delay levels at other airports in the National Airspace System. Since the proposed project is expected to reduce delays at JFK, it is likely that these delay reductions would improve delays at other airports in the U.S. In its addendum to the BCA guidance, the FAA in collaboration with MITRE present how these delay propagation factors can be calculated and also provide factors for the main airports in the country. For this analysis, the delay propagation factor for JFK is 1.45.

Other assumptions used in Section 8.1 remain the same. Table 8-10 presents the associated BCA ratios.

TABLE 8-10
NET BENEFITS VERSUS COSTS – DELAY PROPAGATION FACTOR
John F. Kennedy International Airport

Scenario	Benefits 1/	Costs 1/	BCA Ratio
Scenario 2	$282,487,000	$91,246,000	3.10
Scenario 3	$451,149,000	$137,487,000	3.28
Scenario 4	$592,849,000	$174,359,000	3.40
Scenario 5	$599,657,000	$198,007,000	3.03

1/ Net Present Value of total benefits and costs over evaluation period expressed in 2011 U.S. dollars
Source: Landrum & Brown analysis.

8.2.5 Meeters and Greeters

As stated in Section 5.3.3, meeters and greeters were estimated at 40.4 percent of O&D arriving passengers at JFK over the October 2009 through September 2010 period. O&D arriving passengers were estimated at 81.2 percent of total arriving passengers at JFK over this period. According to the U.S. DOT, the cost of meeters/greeters time is evaluated at $10.60 per hour. The meeter/greeter benefits associated with the taxi time and delay savings were computed for each project scenario. Other assumptions used in Section 8.1 remain the same. The resulting BCA ratios are presented in **Table 8-11**.

TABLE 8-11
NET BENEFITS VERSUS COSTS – MEETERS AND GREETERS
John F. Kennedy International Airport

Scenario	Benefits 1/	Costs 1/	BCA Ratio
Scenario 2	$204,552,000	$91,246,000	2.24
Scenario 3	$324,862,000	$137,487,000	2.36
Scenario 4	$426,244,000	$174,359,000	2.44
Scenario 5	$431,124,000	$198,007,000	2.18

1/ Net Present Value of total benefits and costs over evaluation period expressed in 2011 U.S. dollars
Source: Landrum & Brown analysis.

8.2.5 Reduced Gas Emissions

This section presents the reduction in fuel consumption and corresponding reduction in gas emissions due to the taxi time and delay savings generated by the proposed project. Since most of the benefits are generated from taxi time savings and gate savings, only the reduction in fuel consumption and gas emissions during taxi were quantified in this analysis.

The total fuel consumption during taxi was estimated using the 2010 design day schedule and fuel burn rates from ICAO standard fuel burn rates for the landing and take-off cycle (LTO) which includes take-off, landing, climb-out, and taxi. The fuel burn rate during taxi was estimated at 0.31 kg of fuel per second.

Two types of gas emissions were considered: carbon dioxide (CO_2) and nitrogen oxide (NOx). Based on ICAO data, CO_2 emissions were estimated at 9.57 kg per gallon of jet fuel and NOx emissions at 0.03 kg per gallon of jet fuel.

Table 8-12 presents the cumulative fuel burn savings, CO_2 emission savings, and NOx emission savings for each project scenario over the evaluation period.

TABLE 8-12
REDUCED GAS EMISSIONS
John F. Kennedy International Airport

Scenario	Fuel Burn Savings (lbs)	CO_2 Emission Savings (lbs)	NOx Emission Savings (lbs)
Base Case	0	0	0
Scenario 2	142,403,631	439,249,438	1,378,467
Scenario 3	240,579,251	742,075,891	2,328,807
Scenario 4	242,450,721	747,848,510	2,346,923
Scenario 5	246,278,300	759,654,824	2,383,974

Notes: The table above represents the aircraft ground fuel burn and gas emission savings. b) Fuel burn rates are based upon ICAO standard fuel burn rates for the landing and take-off cycle (LTO) which includes take-off, landing, climb-out, and taxi. CO_2 emissions estimated at 9.57 kg per gallon of jet fuel based on information from the U.S. Energy Information Administration.
Sources: ICAO; U.S. Energy Information Administration; Landrum & Brown analysis.

8.2.6 Combined Scenarios

Based on the results of the various sensitivity analyses, an upper scenario and a lower scenario were developed to account for a combination of realistic assumptions that would provide a reasonable range above and below the base BCA scenario.

The combined upper scenario was developed based on the following set of assumptions (see **Table 8-13**):

- 20 percent decrease in project costs
- Use of 2008 aircraft operating costs
- Use of a 3.5 percent discount rate
- Delay Propagation Factor
- Meeters and Greeters benefits

The combined lower scenario was created based on the following assumptions (see **Table 8-14**):

- 20 percent increase in project costs
- Use of 2009 aircraft operating expenses
- Use of a 10 percent discount rate

Other assumptions used in Section 8.1 remain the same.

TABLE 8-13
NET BENEFITS VERSUS COSTS – COMBINED UPPER SCENARIO
John F. Kennedy International Airport

Scenario	Benefits 1/	Costs 1/	BCA Ratio
Scenario 2	$420,943,000	$82,020,000	5.13
Scenario 3	$699,787,000	$123,585,000	5.66
Scenario 4	$924,437,000	$156,725,000	5.90
Scenario 5	$935,300,000	$177,976,000	5.26

1/ Net Present Value of total benefits and costs over evaluation period expressed in 2011 U.S. dollars
Source: Landrum & Brown analysis.

TABLE 8-14
NET BENEFITS VERSUS COSTS – COMBINED LOWER SCENARIO
John F. Kennedy International Airport

Scenario	Benefits 1/	Costs 1/	BCA Ratio
Scenario 2	$146,643,000	$100,643,000	1.46
Scenario 3	$231,592,000	$151,649,000	1.53
Scenario 4	$303,718,000	$192,304,000	1.58
Scenario 5	$307,185,000	$218,392,000	1.41

1/ Net Present Value of total benefits and costs over evaluation period expressed in 2011 U.S. dollars
Source: Landrum & Brown analysis.

8.2.7 Summary of Sensitivity Analysis

Table 8-15 presents a summary of the BCA analysis for the Runway 4L-22R improvements at JFK along with its sensitivity.

TABLE 8-15
PROJECT BCA SUMMARY
John F. Kennedy International Airport

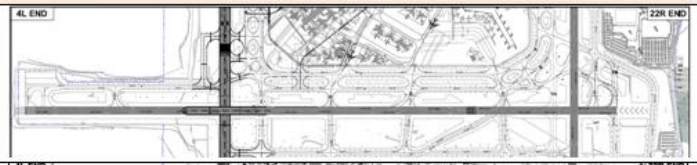
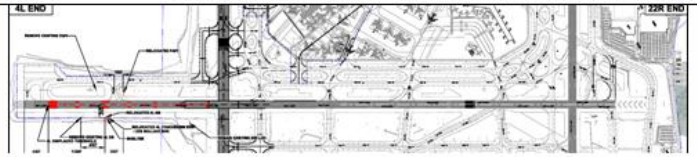
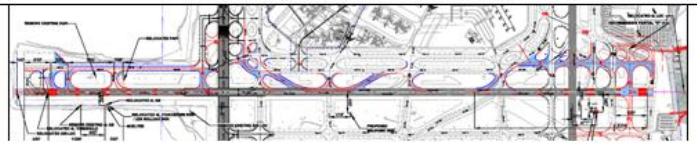
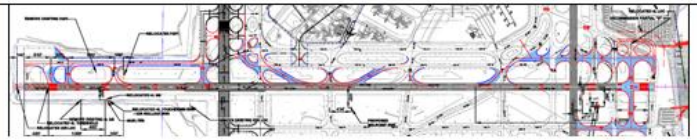
	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Base	2.14	2.26	2.34	2.09
Combined High	5.13	5.66	5.90	5.26
Delay Propagation Factor	3.10	3.28	3.40	3.03
3.5 Percent Discount Rate	2.78	2.95	3.06	2.72
20 Percent Decrease in Costs	2.67	2.83	2.93	2.61
Meeters and Greeters	2.24	2.36	2.44	2.18
2008 Aircraft Operating Costs	2.07	2.30	2.40	2.14
2009 Aircraft Operating Costs	2.14	2.24	2.32	2.06
20 Percent Increase in Costs	1.78	1.89	1.95	1.74
10 Percent Discount Rate	1.75	1.85	1.92	1.71
Combined Low	1.46	1.53	1.58	1.41

Source: Landrum & Brown analysis.

8.3 CONCLUSION

Based on the sensitivity analysis presented above, all scenarios generate substantial benefits to outweigh costs, resulting in BCA ratios ranging from 1.4 to 5.9. Out of the four project scenarios considered in this analysis, Scenario 4 provides the highest overall BCA ratio. **Figure 8-1** provides a summary of the taxi time/delay savings for each scenario considered in this analysis and corresponding BCA ratios.

FIGURE 8-1
BCA SUMMARY
John F. Kennedy International Airport

Scenarios		TAAM Results			Overall Benefit-Cost Analysis vs Base Case		
		Alternative	Avg. Taxi + Delay (in min)	Savings (in min)	NPV of Benefits	NPV of Costs	BCA Ratio
Existing Conditions		*NE Flow*					
		Arrivals	18.4				
		Departures	27.3				
		SW Flow					
		Arrivals	17.1				
		Departures	26.1				
Base Case		*NE Flow*					
		Arrivals	18.4				
		Departures	27.3				
		SW Flow					
		Arrivals	16.7				
		Departures	28.4				
Scenario 2		*NE Flow*					
		Arrivals	18.4	0			
		Departures	26.5	-0.8	$194,818,000	$91,246,000	**2.14**
		SW Flow					
		Arrivals	16.9	+0.2			
		Departures	24.8	-3.6			
Scenario 3		*NE Flow*					
		Arrivals	18.1	-0.3			
		Departures	26.3	-1.0	$311,135,000	$137,487,000	**2.26**
		SW Flow					
		Arrivals	16.6	-0.1			
		Departures	23.8	-4.6			
Scenario 4		*NE Flow*					
		Arrivals	17.7	-0.7			
		Departures	25.6	-1.7	$408,862,000	$174,359,000 $166,535,000*	**2.34** **2.46***
		SW Flow					
		Arrivals	16.7	0			
		Departures	23.1	-5.3			
Scenario 5		*NE Flow*					
		Arrivals	17.7	-0.7			
		Departures	25.6	-1.7	$413,556,000	$198,007,000 $190,186,000*	**2.09** **2.17***
		SW Flow					
		Arrivals	16.7	0			
		Departures	23.0	-5.4			

*Scenario without taxiway "KC"

Source: Landrum & Brown analysis.

Technical Appendix

Data Collections/Simulation Inputs

A. TECHNICAL APPENDIX

This appendix presents the various data collected, analyzed, and used as inputs in the TAAM simulation. The following sections will provide and analyze data concerning:

- Historical weather trends
- Historical air service trends
- Historical delay trends
- Aircraft speed assumptions
- Aircraft wake turbulence separations
- Origin/arrival fix allocations
- Destination/departure fix allocations

A.1 WEATHER SUMMARY

Generally, according to FAA definition, instrument meteorological conditions (IMC) occur when pilots can no longer see each other in the airspace and maintain visual separation from each other. The FAA sets cloud ceiling and visibility minimums in order to establish limits for VMC (visual meteorological conditions) and IMC. These IMC minimums vary between airports. At JFK, this FAA definition is a cloud ceiling of less than 2,000 feet and visibility of less than four statute miles.

These conditions occurred 11 percent to 17 percent of the time over the past six years (24-hour observation days) as shown in **Table A-1**. Overall, 2010 had the lowest amount of IMC weather in the past six years. The amount of IMC weather varies considerably from month to month. Summer months in 2010 had very low percentages. The causes of IMC weather vary seasonally, with winter IMC events being caused by longer and more predictable rain or snow storms, while summer events are caused by more unpredictable thunderstorms.

TABLE A-1
WEATHER ANALYSIS – IMC
John F. Kennedy International Airport

	Percent of Time					
Month	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
January	24.9%	21.5%	17.3%	8.1%	12.5%	5.4%
February	15.5%	9.1%	10.1%	21.0%	5.8%	21.4%
March	16.1%	6.0%	12.5%	13.8%	12.9%	24.2%
April	16.4%	10.4%	21.5%	22.5%	19.0%	10.8%
May	7.1%	23.3%	7.7%	12.2%	30.5%	10.3%
June	25.1%	21.1%	9.3%	15.4%	27.4%	6.9%
July	28.0%	6.5%	14.9%	12.2%	15.7%	5.4%
August	9.3%	9.0%	14.7%	2.3%	12.0%	7.5%
September	10.6%	13.9%	10.3%	18.6%	6.8%	10.3%
October	33.1%	10.2%	29.7%	4.8%	18.4%	10.6%
November	7.5%	26.3%	9.6%	21.7%	19.0%	9.0%
December	14.7%	13.6%	24.2%	22.2%	11.7%	6.5%
Total	**17.4%**	**14.2%**	**15.2%**	**14.5%**	**16.0%**	**10.6%**

Note: IMC corresponds to a ceiling lower than 3,000 feet and a visibility of less than 4 miles. Percent of Time calculated for a 24-hour day.
Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

A.2 AIR SERVICE TRENDS

Table A-2 provides historical market shares by main airline alliance from 2005 through 2010. SkyTeam remains the largest alliance at JFK in terms of traffic thanks to the expansion of Delta. The increased competition and current economic crisis have had significant impact on carriers with smaller presence at JFK.

The strongest growth in aircraft traffic has occurred at Terminals 2/3 and 5 (see **Table A-3**). Delta (T2/T3) and jetBlue (T5) increased their activity by 46.5 percent and 24.7 percent respectively in 2007 compared to 2006 levels, accounting for two-thirds of the aircraft operations at JFK. By contrast, activity at Terminals 7 (British Airways and United) and Terminal 8 (American) has remained virtually unchanged.

The lack of change in Terminal 7 hides a traffic decline by United and traffic growth by international carriers using British Airways gates. Amid the current economic recession, jetBlue traffic dropped 7.2%, 3.1%, and 4.0% in 2008, 2009, and 2010, respectively. Despite the current recession, Delta Air Lines traffic remained constant in 2008 but declined 4.5% in 2009 and 9.6% in 2010. International traffic at Terminals 1 and 4 grew robustly from 2005 to 2008. However, this growth was slower than the very strong growth at Terminals 2/3 and 5.

Table A-4 provides historical commercial passenger fleet mix at JFK from 2005 through 2010. Narrow-body jets remain the largest portion of the traffic at JFK with an increase of A320 aircraft with jetBlue's expansion at the airport and the replacement of B-757 aircraft with B-737 aircraft in trans-continental and Florida air service. Despite a declining percentage of the total fleet, wide-body aircraft activity has remained relatively constant from 2005 through 2008, before declining in 2009 and 2010.

Small regional jet activity (50 seats or less) have continued to make up about 17-20% of total activity but has grown by 7,000 annual operations from 2005 through 2009. Nearly 8,100 annual operations by large regional jets (70-76 seats) resulting in total regional jets accounting for almost 25% of JFK aircraft activity in 2009. Delta Air Lines and American Airlines provide most of the regional jet air service at JFK. Prop aircraft have disappeared from the JFK fleet.

TABLE A-2
CARRIER MARKET SHARE
John F. Kennedy International Airport

		Scheduled Aircraft Operations						AAGR
Alliance	**Carrier**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**05-10**
SkyTeam	Delta	40,084	43,418	63,398	64,292	62,481	58,600	7.9%
	Other	5,033	5,421	5,977	5,953	5,782	5,602	2.2%
	Total	**45,117**	**48,839**	**69,375**	**70,245**	**68,263**	**64,202**	**7.3%**
OneWorld	American	34,240	33,945	33,274	33,189	31,384	33,446	-0.5%
	British	2,853	2,890	3,097	3,055	2,654	2,715	-1.0%
	Other	3,735	4,074	4,493	5,428	5,544	5,311	7.3%
	Total	**40,828**	**40,909**	**40,864**	**41,672**	**39,582**	**41,472**	**0.3%**
Star Alliance	United	8,069	7,640	6,584	7,036	6,627	6,132	-5.3%
	US Airways	-	-	2,623	3,012	2,416	2,184	n.a.
	Other	6,034	7,805	8,727	8,070	6,048	5,959	-0.2%
	Total	**14,103**	**15,445**	**17,934**	**18,118**	**15,091**	**14,275**	**0.2%**
Other	jetBlue	38,492	49,951	62,278	57,771	55,985	53,729	6.9%
	Virgin America	-	-	827	3,054	3,675	3,504	n.a.
	Other	20,331	22,583	22,652	21,830	19,654	14,377	-6.7%
	Total	**58,823**	**72,534**	**85,757**	**82,655**	**79,314**	**71,610**	**4.0%**
Total		**158,871**	**177,727**	**213,930**	**212,690**	**202,250**	**191,559**	**3.8%**
		Percent of Total Aircraft Operations						
SkyTeam	Delta	25.2%	24.4%	29.6%	30.2%	30.9%	30.6%	
	Other	3.2%	3.1%	2.8%	2.8%	2.9%	2.9%	
	Total	**28.4%**	**27.5%**	**32.4%**	**33.0%**	**33.8%**	**33.5%**	
OneWorld	American	21.6%	19.1%	15.6%	15.6%	15.5%	17.5%	
	British	1.8%	1.6%	1.4%	1.4%	1.3%	1.4%	
	Other	2.4%	2.3%	2.1%	2.6%	2.7%	2.8%	
	Total	**25.7%**	**23.0%**	**19.1%**	**19.6%**	**19.6%**	**21.6%**	
Star Alliance	United	5.1%	4.3%	3.1%	3.3%	3.3%	3.2%	
	US Airways	0.0%	0.0%	1.2%	1.4%	1.2%	1.1%	
	Other	3.8%	4.4%	4.1%	3.8%	3.0%	3.1%	
	Total	**8.9%**	**8.7%**	**8.4%**	**8.5%**	**7.5%**	**7.5%**	
Other	jetBlue	24.2%	28.1%	29.1%	27.2%	27.7%	28.0%	
	Virgin America	0.0%	0.0%	0.4%	1.4%	1.8%	1.8%	
	Other	12.8%	12.7%	10.6%	10.3%	9.7%	7.5%	
	Total	**37.0%**	**40.8%**	**40.1%**	**38.9%**	**39.2%**	**37.4%**	
Total		**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Notes: Market share based on scheduled passenger aircraft operations. 2010 is an estimate based on airline schedules.
Sources: *Official Airline Guide*; Landrum & Brown analysis.

TABLE A-3
COMMERCIAL PASSENGER FLEET MIX
John F. Kennedy International Airport

	Scheduled Aircraft Operations						AAGR
Aircraft Type	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**05-10**
Wide-Body	50,813	51,058	53,995	51,995	46,450	46,760	-1.6%
Boeing 757	25,790	22,501	19,750	19,125	20,864	22,951	-2.3%
Narrow-Body	48,502	64,661	84,069	87,403	84,742	80,623	10.7%
Large Regional Jet	789	2,652	4,633	10,984	8,130	8,234	59.8%
Small Regional Jet	32,977	30,749	40,761	39,324	39,753	32,991	0.0%
Turboprop	-	3,783	7,090	317	-	-	n.a.
Helicopter	-	2,323	3,632	3,542	2,311	-	n.a.
Total	**158,871**	**177,727**	**213,930**	**212,690**	**202,250**	**191,559**	**3.8%**
	Percent of Total Aircraft Operations						
Wide-Body	32.0%	28.7%	25.2%	24.4%	23.0%	24.4%	
Boeing 757	16.2%	12.7%	9.2%	9.0%	10.3%	12.0%	
Narrow-Body	30.5%	36.4%	39.3%	41.1%	41.9%	42.1%	
Large Regional Jet	0.5%	1.5%	2.2%	5.2%	4.0%	4.3%	
Small Regional Jet	20.8%	17.3%	19.1%	18.5%	19.7%	17.2%	
Turboprop	0.0%	2.1%	3.3%	0.1%	0.0%	0.0%	
Helicopter	0.0%	1.3%	1.7%	1.7%	1.1%	0.0%	
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Notes: AAGR=Average Annual Growth Rate. 2010 is an estimate based on airline schedules.
Sources: *Official Airline Guide*; Landrum & Brown analysis.

TABLE A-4
AIRCRAFT OPERATION ACTIVITY BY TERMINAL
John F. Kennedy International Airport

	Scheduled Aircraft Operations						AAGR
Terminal	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**05-10**
T1	8,240	8,663	9,328	9,539	8,976	8,760	1.2%
T2/T3	40,084	45,741	67,030	67,834	64,792	58,600	7.9%
T4	20,495	21,559	24,277	25,324	23,715	21,188	0.7%
T5/T6	38,492	49,951	62,278	57,771	55,985	53,729	6.9%
T7	16,289	16,437	16,136	16,890	15,289	13,850	-3.2%
T8	35,185	35,107	34,627	35,097	33,408	35,432	0.1%
Other	86	269	254	235	85	-	-100.0%
Total	**158,871**	**177,727**	**213,930**	**212,690**	**202,250**	**191,559**	**3.8%**
	Percent of Total Aircraft Operations						
T1	5.2%	4.9%	4.4%	4.5%	4.4%	4.6%	
T2/T3	25.2%	25.7%	31.3%	31.9%	32.0%	30.6%	
T4	12.9%	12.1%	11.3%	11.9%	11.7%	11.1%	
T5/T6	24.2%	28.1%	29.1%	27.2%	27.7%	28.0%	
T7	10.3%	9.2%	7.5%	7.9%	7.6%	7.2%	
T8	22.1%	19.8%	16.2%	16.5%	16.5%	18.5%	
Other	0.1%	0.2%	0.1%	0.1%	0.0%	0.0%	
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Notes: AAGR=Average Annual Growth Rate. 2010 is an estimate based on airline schedules.
Sources: *Official Airline Guide*; Landrum & Brown analysis.

A.3 JFK DELAY ANALYSIS

A.3.1 Data Sources and Analysis Methods

This study used delay and taxi time information from the FAA Aviation System Performance Metrics (ASPM) database. The FAA gathers flight time information from the Enhanced Traffic Management System (ETMS) database that records flight plan and actual travel times from the radar systems that track aircraft flight activity. The FAA compares flight planned and actual travel times to compute airborne delays. The FAA computes standard taxi-in and taxi-out times for the runways that the aircraft used and compares these times to the actual times from either the Aviation System Quality Performance database (15 airlines provide this data for domestic flights) or from gate to gate times manually recorded in the flight plan information.

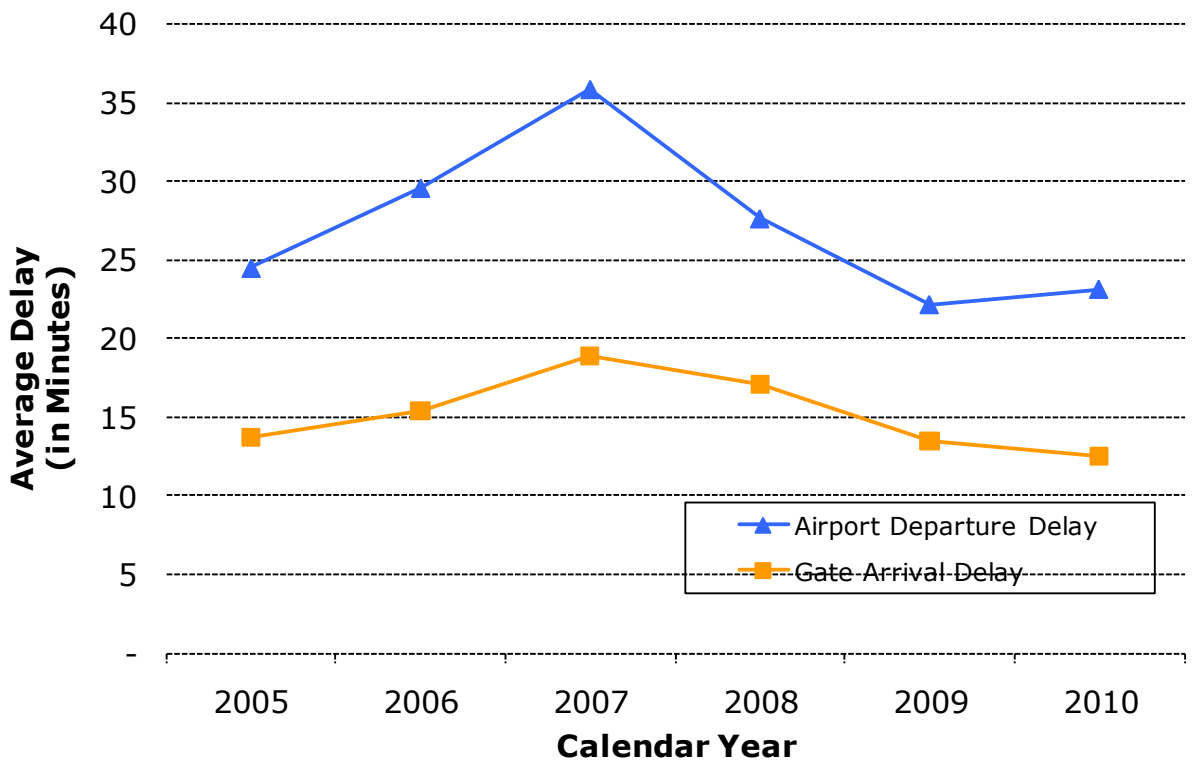
Four delay metrics were used from the ASPM database:

- Gate Arrival Delay – The time the aircraft actually arrived at the gate versus the time expected in the flight plan. The expected gate arrival time differs from the scheduled time since it will include adjustments for the late departure of the flight or headwinds en-route.
- Airport Departure Delay – The time actually required to depart the airport from the expected gate departure time in the flight plan to the actual time the aircraft was first reported as airborne from the departure runway. The expected gate departure time differs from the scheduled time since the expected time considers the late arrival of inbound equipment or other operational issues that may delay a departing aircraft.
- Taxi-Out Delay – The time actually required to travel from the gate to the runway compared to a standard taxi out time for the given runway.
- Taxi-In Delay – The time actually required to travel from the runway to the gate compared to a standard taxi in time for the given runway.

A.3.2 Historical Delays

Delays escalated rapidly from 2005 to 2007 as traffic grew 34 percent over this period (Delta and jetBlue). Total departure delays increased from 24 to 36 minutes while total arrival delays grew from 14 to 19 minutes (see **Figure A-1**). After a cap was imposed by the FAA on hourly activity at JFK in June 2008, departure delays declined by 20 percent. Although the cap may have contributed to the improved delay conditions in 2008, IFR weather occurred less frequently in 2008 than in 2007, especially in August 2008. Arrival delays declined only slightly from 2007 to 2008. The drop in 2009 and 2010 delays was most likely due to significant cuts in airline schedules as a response to lower passenger demand.

FIGURE A-1
HISTORICAL AIRPORT WIDE DELAYS
John F. Kennedy International Airport

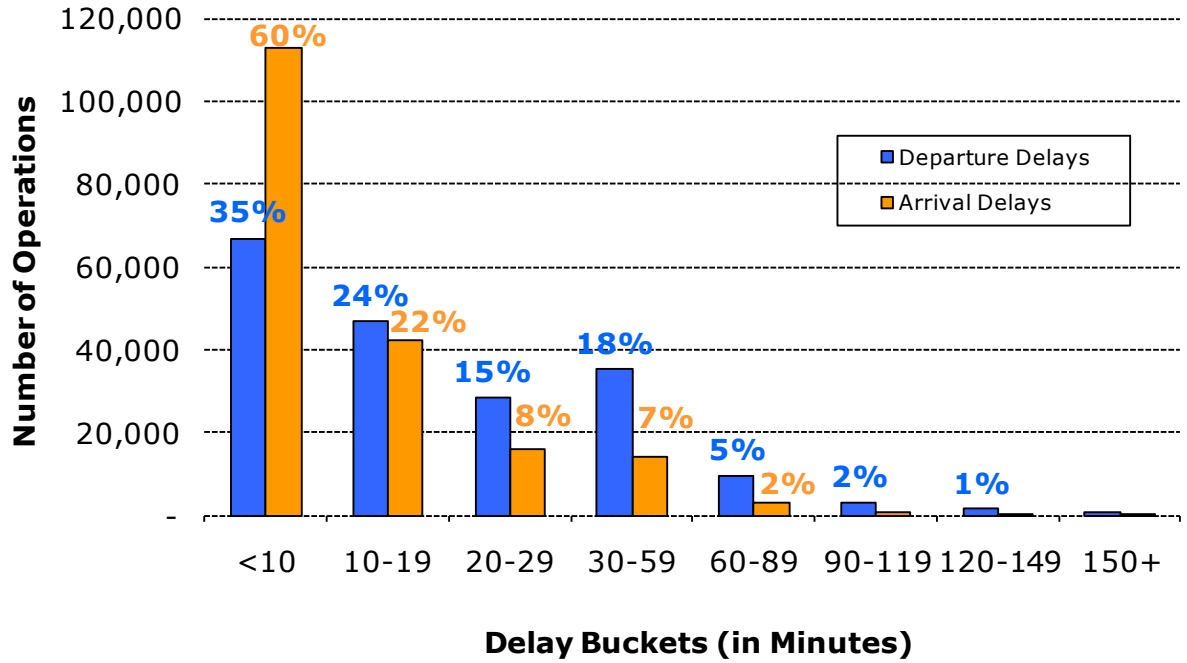


Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

In 2010, the following delay levels were observed (see **Figure A-2**):

- 82 percent of inbound flights were delayed less than 20 minutes.
- 2 percent of inbound flights were delayed at least 60 minutes.
- 59 percent of outbound flights encountered less than 20 minutes of delay.
- 8 percent of outbound flights were delayed at least 60 minutes.

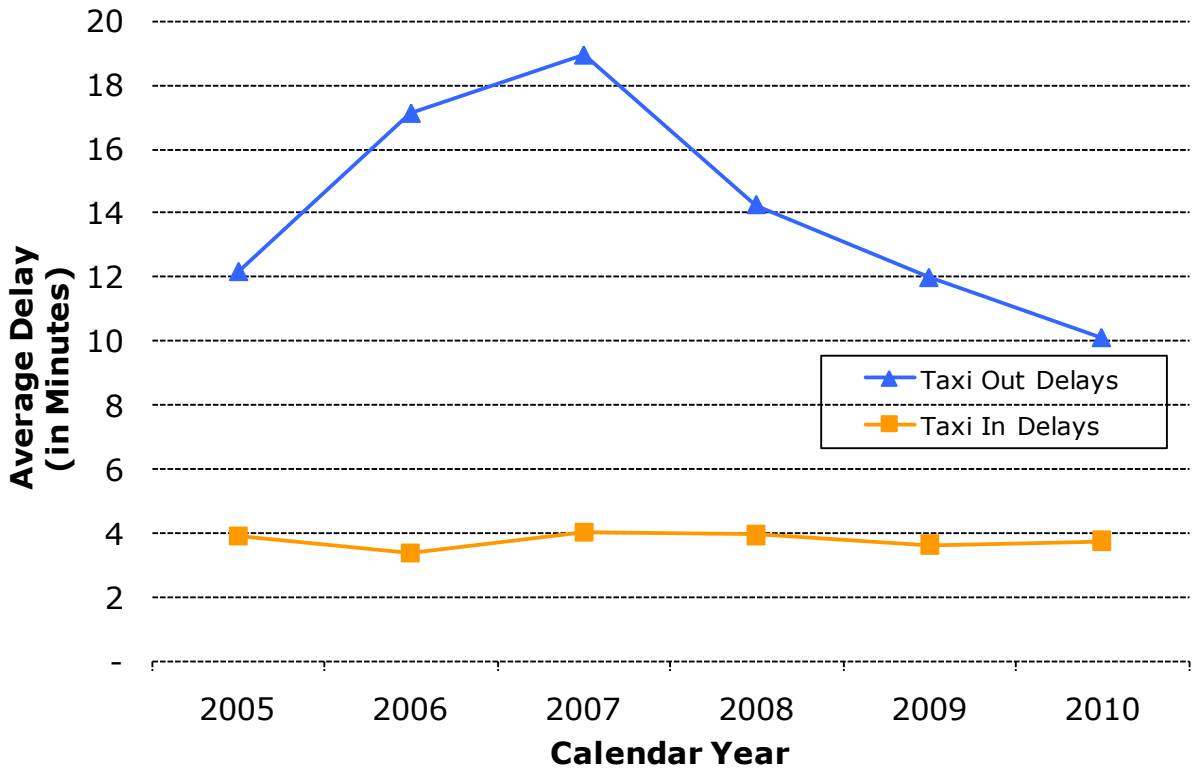
FIGURE A-2
2010 DELAY SUMMARY
John F. Kennedy International Airport



Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

Figure A-3 shows the evolution of taxi delays at JFK from 2005 through 2010. Taxi-Out Delays showed a similar pattern of increase and decrease from 2005 to 2009 as Airport Departure Delays except for 2010. Half of Airport Departure Delays are Taxi-Out Delays. The remaining portion of Airport Departure Delays is taken at the gate prior to aircraft movement. The drop in taxi-out delays in 2010 is due to the implementation of metering at the airport. This metering system helps the FAA ATCT manage flights by limiting the number of aircraft taxiing on the airfield for departure at any given time of day. This drastically reduces aircraft taxi times and ground congestion at JFK. Taxi-In Delays virtually unchanged from 2005 through 2010: therefore, all of the Gate Arrival Delay increases from 2005 through 2007 occurred either at the airport of departure or in the air prior to arrival. JFK Taxi-In Delays indicate a fairly high level of ground congestion that prevents an unimpeded flow from the arrival runway to the gate. Since relatively few runway crossings occur at JFK, these delays are caused either by congestion on Taxiways A and B or in the gate areas.

FIGURE A-3
TAXI DELAY SUMMARY
John F. Kennedy International Airport



Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

A.3.3 Detailed Delay Analysis

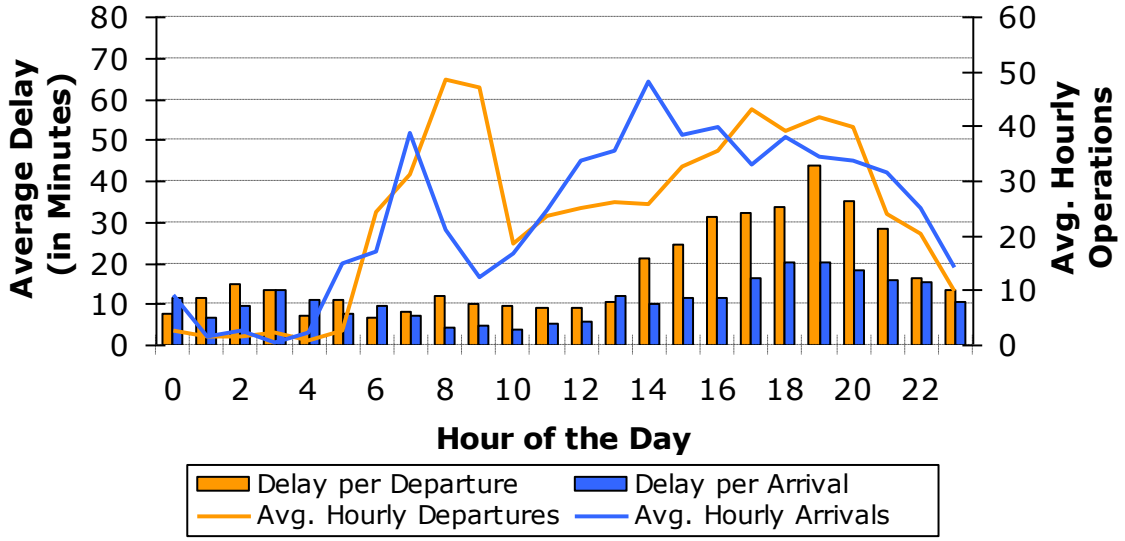
Figures A-4 through **A-13** provide arrival and departure delays by hour and by day for the period of May through October 2008 and the same period in 2009.

The hourly detail shows that delays tend to develop in the afternoon after 14:00. Afternoon peak delays rapidly reach significant levels particularly in the summer months (June through August). In September and October, departure delays do not exceed 40 minutes per flight during the afternoon peak while arrival delays remain in the 20-30 minutes range. In summer, however, delays can reach 60-80 minutes for departures and 40-50 minutes for arrivals.

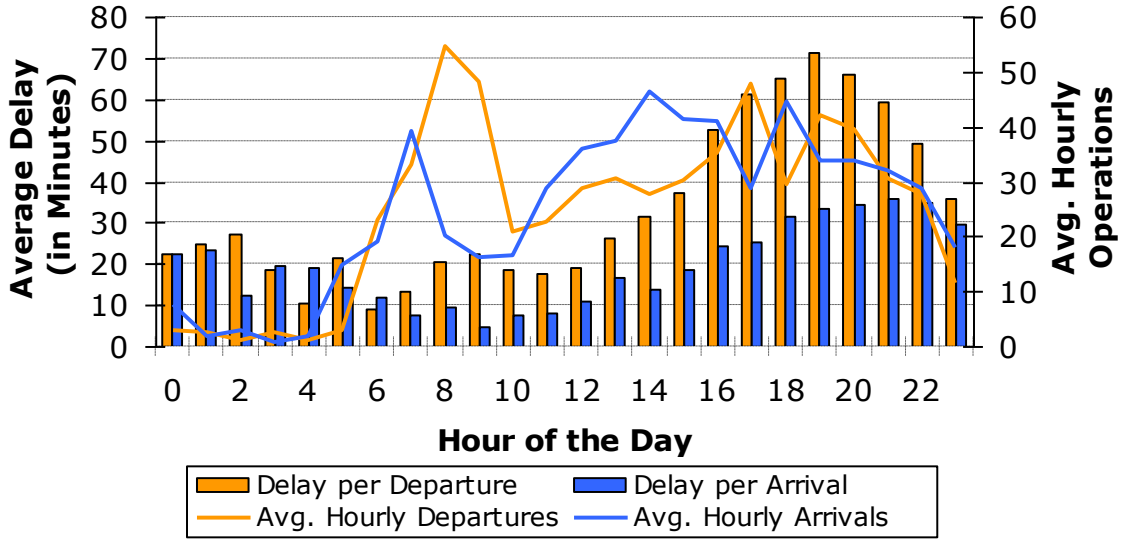
When looking at the delays on a daily basis, the summer months show a high concentration of high-delay days, particularly in June and July. Contrary to previous years, delays in August were noticeably lower mainly due to better weather conditions than in the past. Most days in May, September and October show delays lower than 20 minutes on average for departures and 10 minutes in average for arrivals.

FIGURE A-4
2008 MONTHLY DELAY SUMMARY BY HOUR
John F. Kennedy International Airport

Delay Per Operations - May 2008



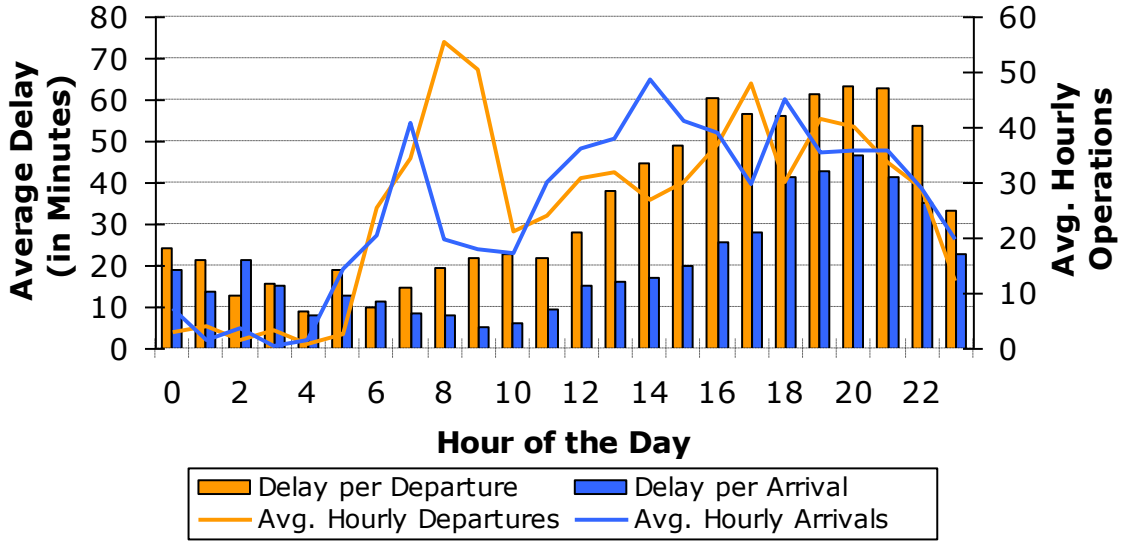
Delay Per Operations - June 2008



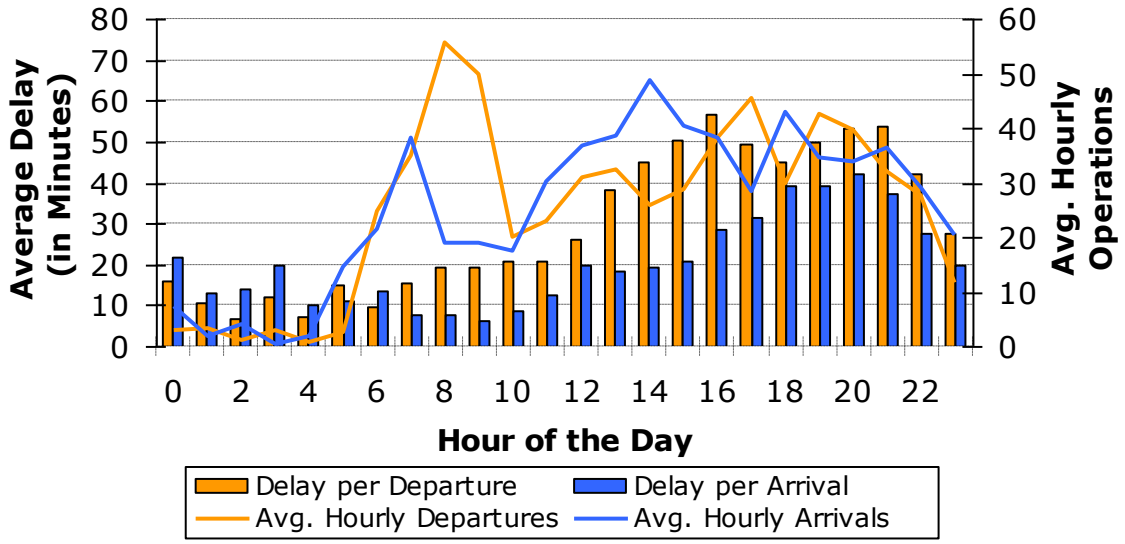
Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

FIGURE A-5
2008 MONTHLY DELAY SUMMARY BY HOUR (Cont.)
John F. Kennedy International Airport

Delay Per Operations - July 2008



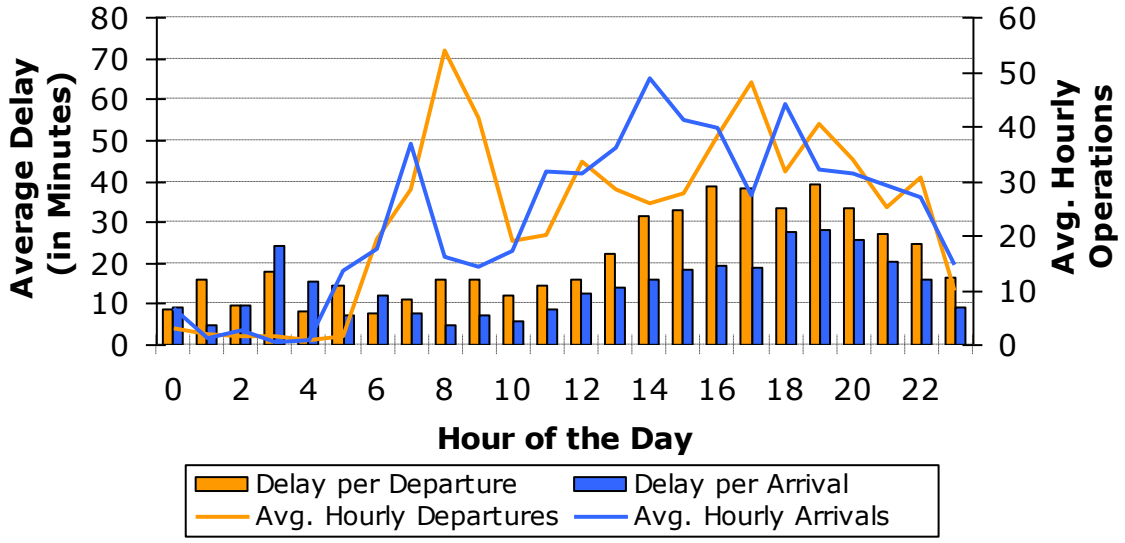
Delay Per Operations - August 2008



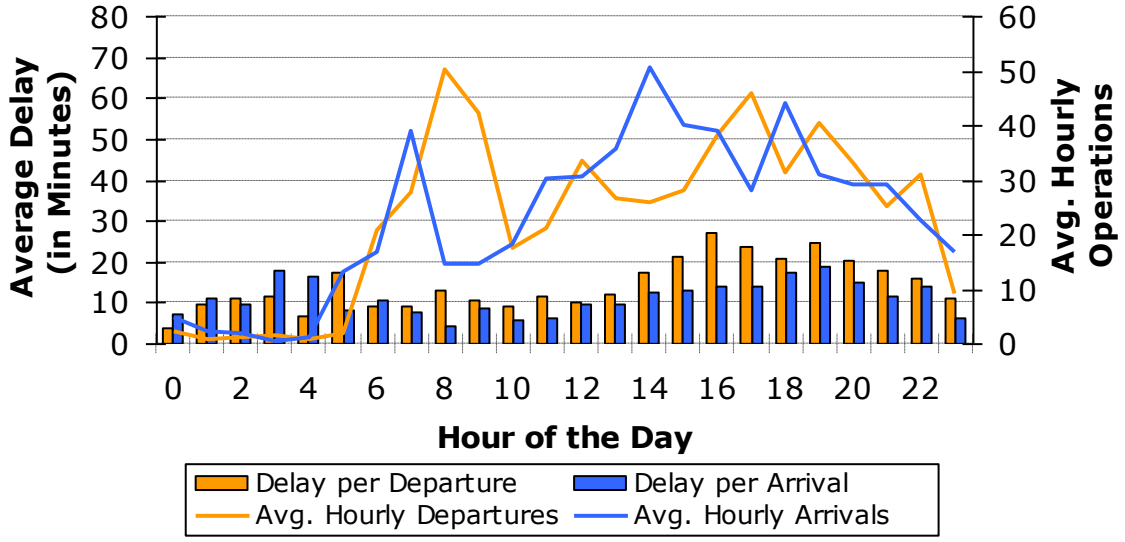
Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

FIGURE A-6
2008 MONTHLY DELAY SUMMARY BY HOUR (Cont.)
John F. Kennedy International Airport

Delay Per Operations - September 2008



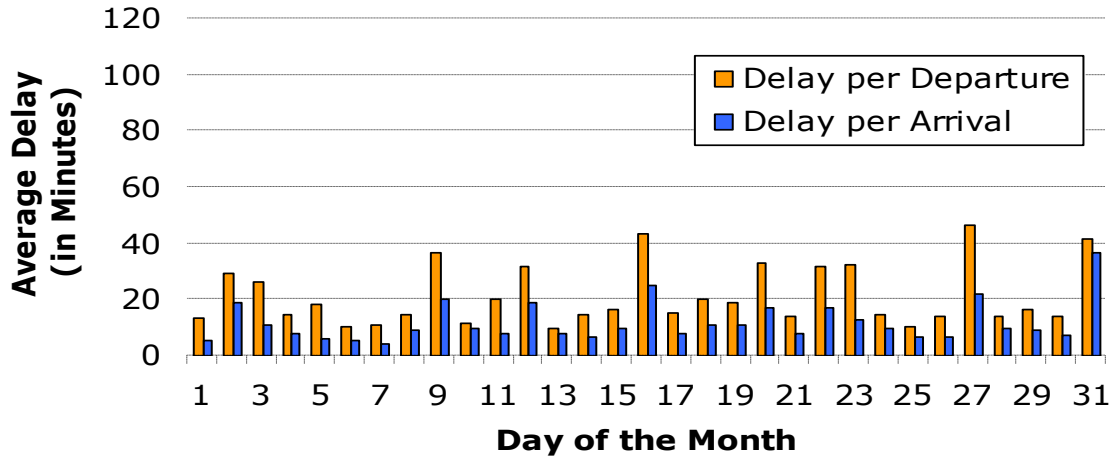
Delay Per Operations - October 2008



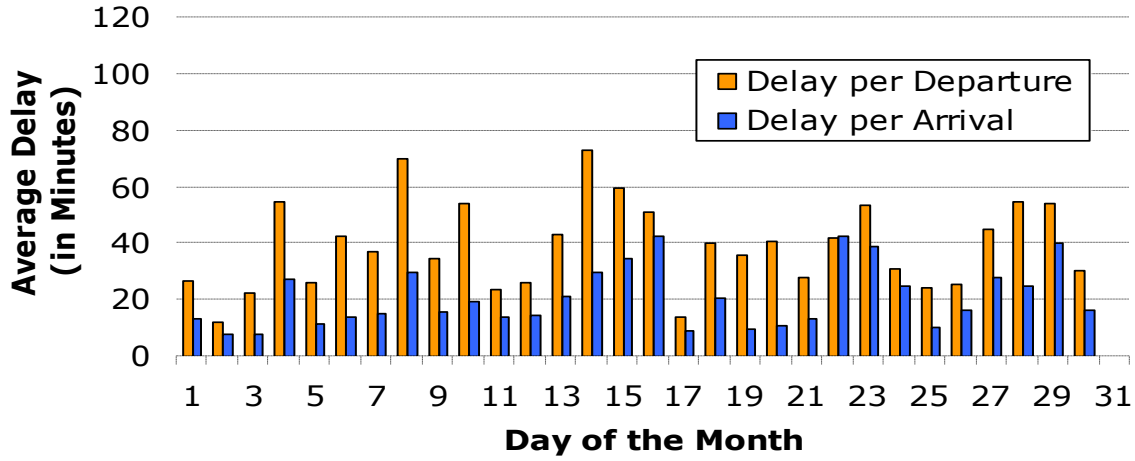
Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

FIGURE A-7
2008 MONTHLY DELAY SUMMARY BY DAY
John F. Kennedy International Airport

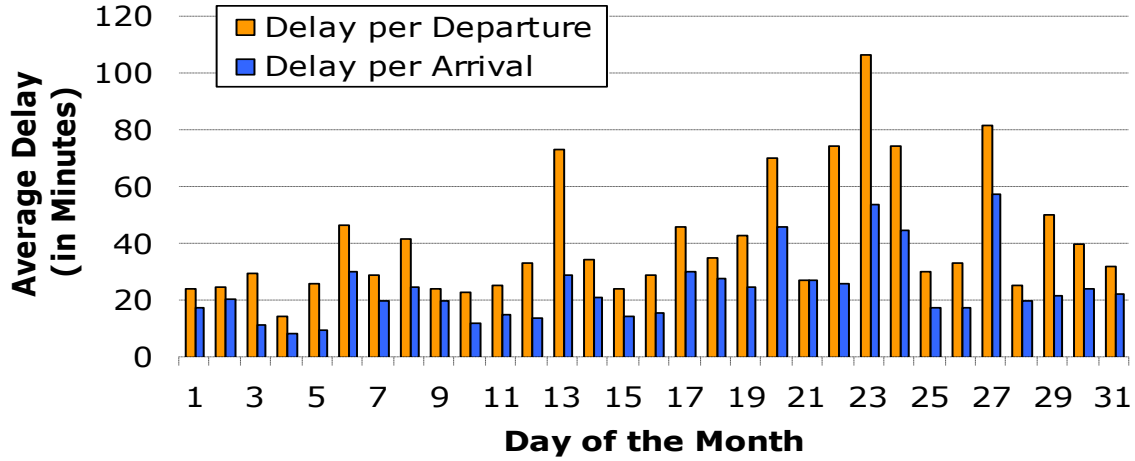
Delay Per Operations - May 2008



Delay Per Operations - June 2008



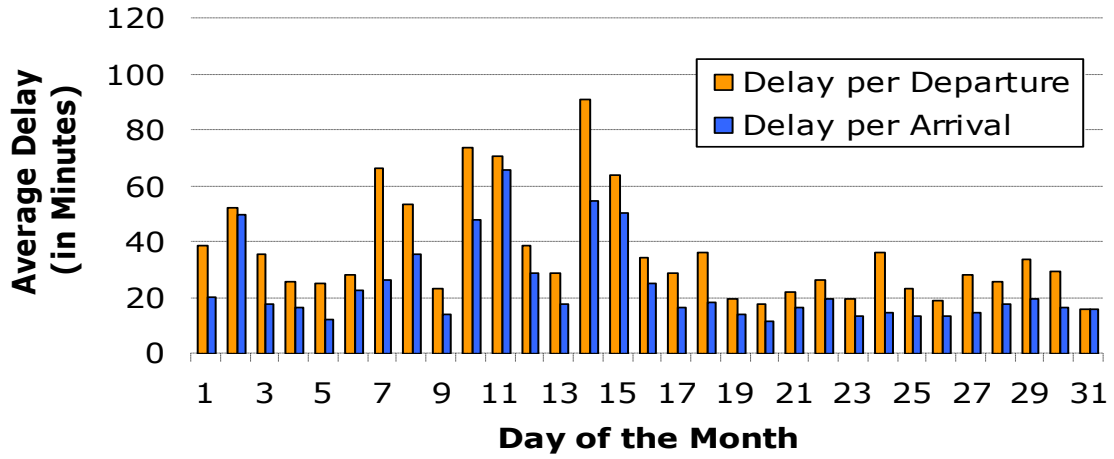
Delay Per Operations - July 2008



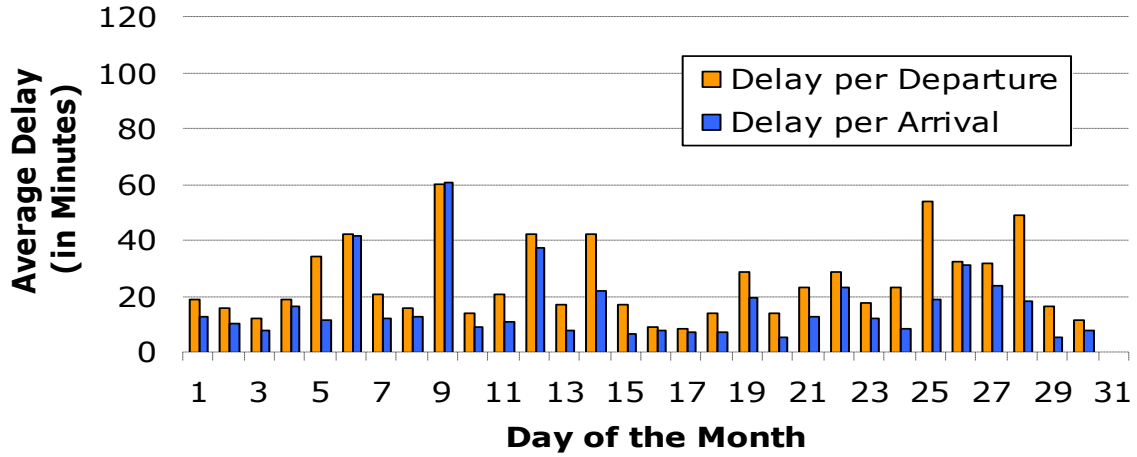
Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

FIGURE A-8
2008 MONTHLY DELAY SUMMARY BY DAY (Cont.)
John F. Kennedy International Airport

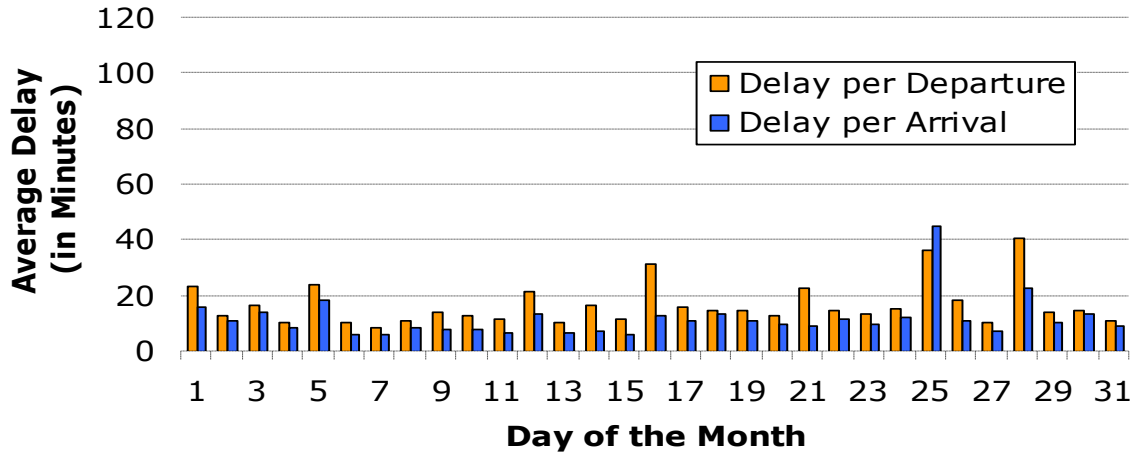
Delay Per Operations - August 2008



Delay Per Operations - September 2008



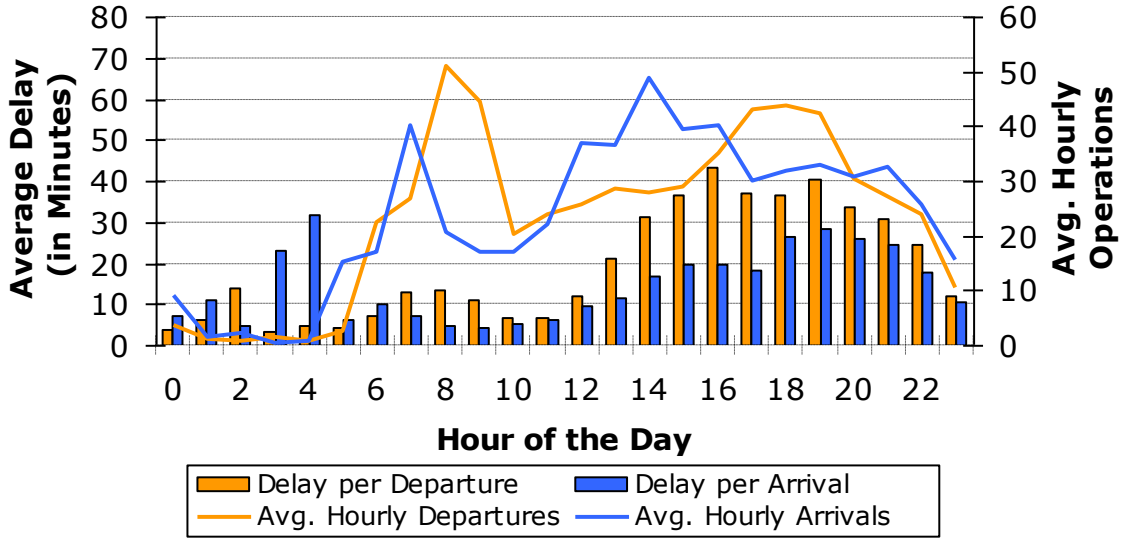
Delay Per Operations - October 2008



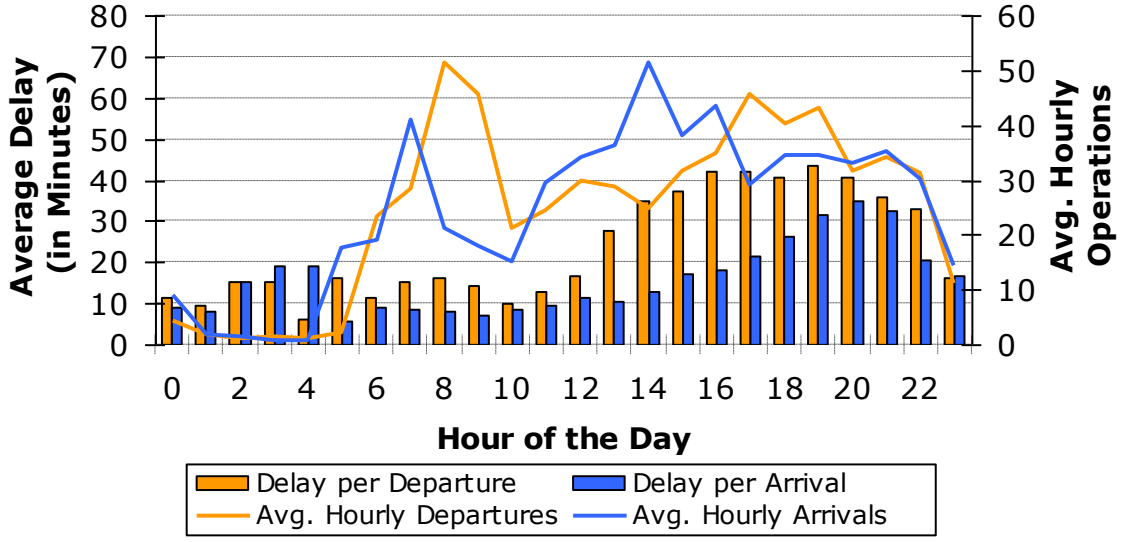
Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

FIGURE A-9
2009 MONTHLY DELAY SUMMARY BY HOUR
John F. Kennedy International Airport

Delay Per Operations - May 2009



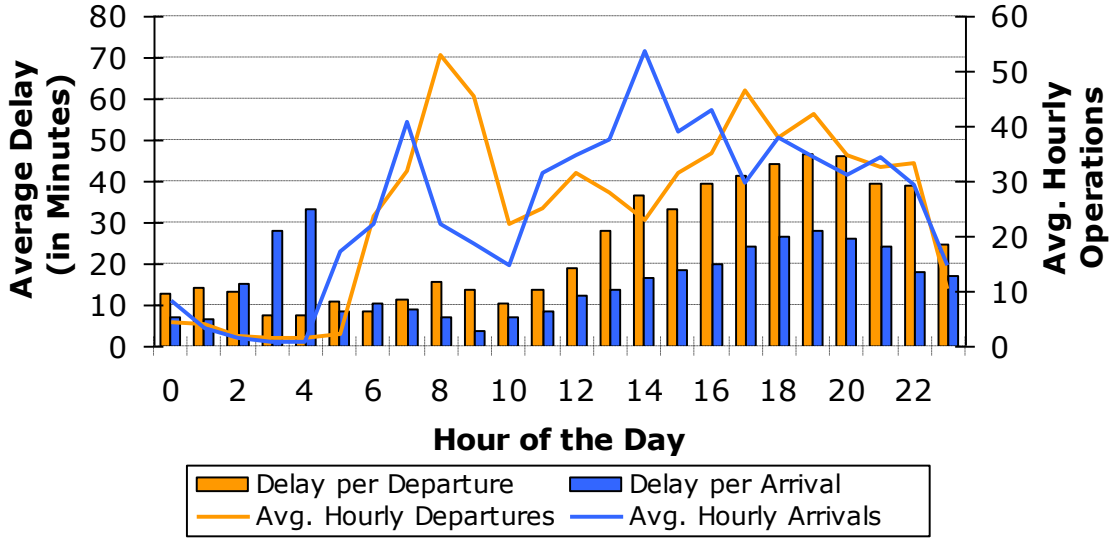
Delay Per Operations - June 2009



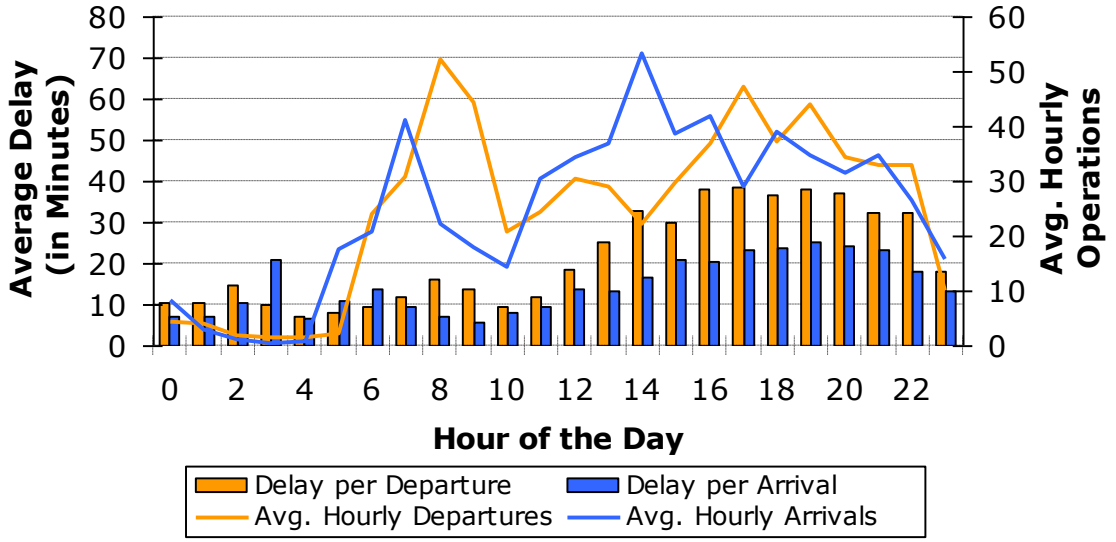
Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

FIGURE A-10
2009 MONTHLY DELAY SUMMARY BY HOUR (Cont.)
John F. Kennedy International Airport

Delay Per Operations - July 2009



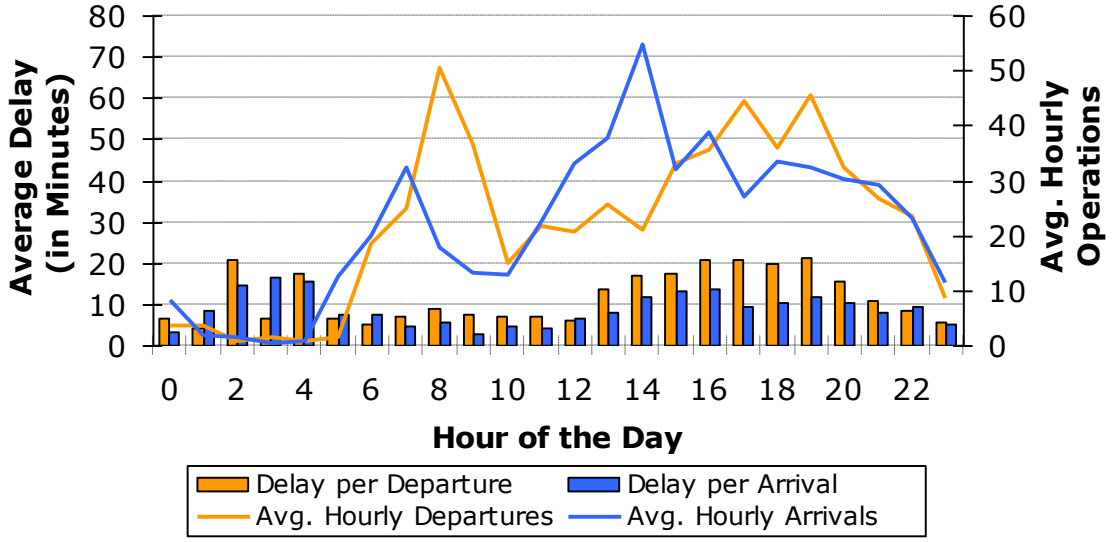
Delay Per Operations - August 2009



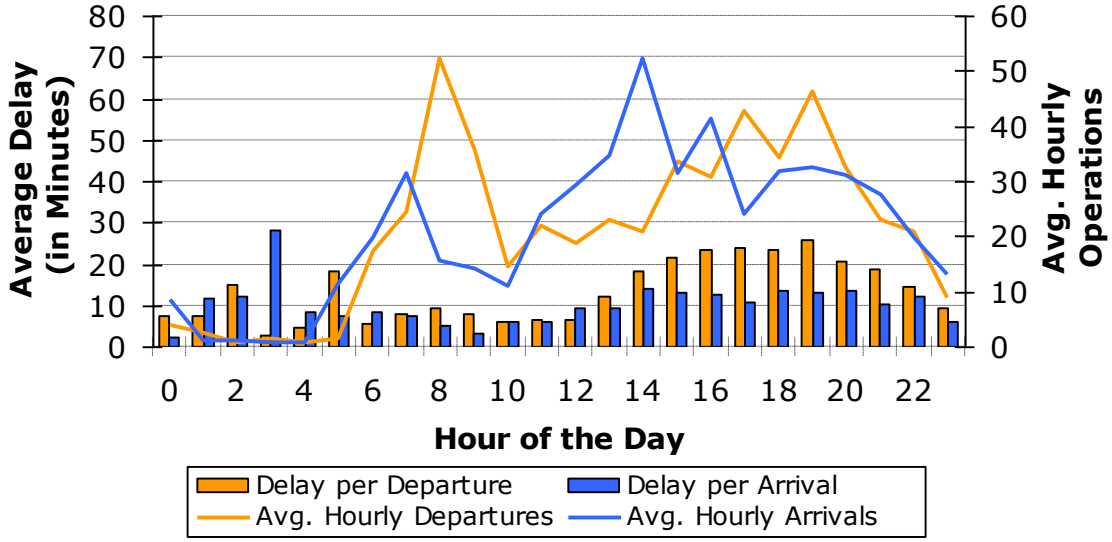
Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

FIGURE A-11
2009 MONTHLY DELAY SUMMARY BY HOUR (Cont.)
John F. Kennedy International Airport

Delay Per Operations - September 2009



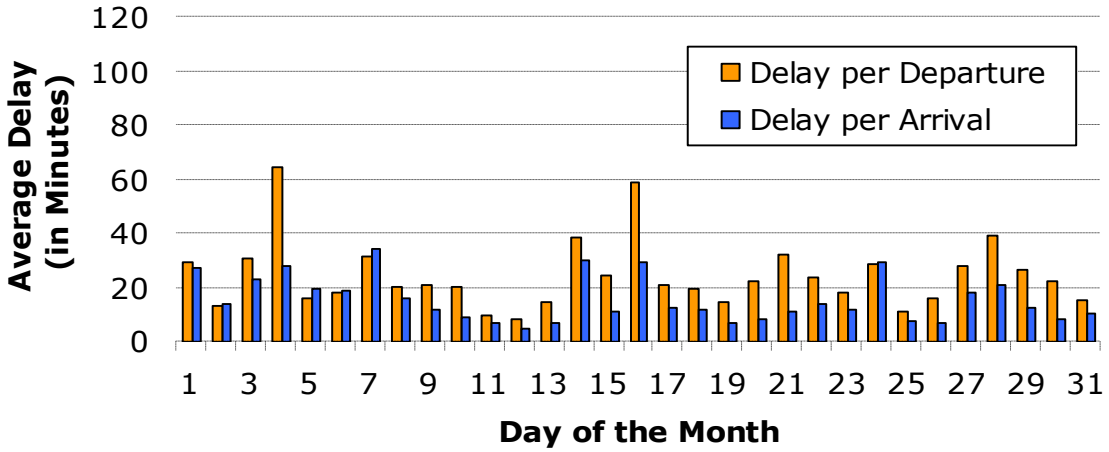
Delay Per Operations - October 2009



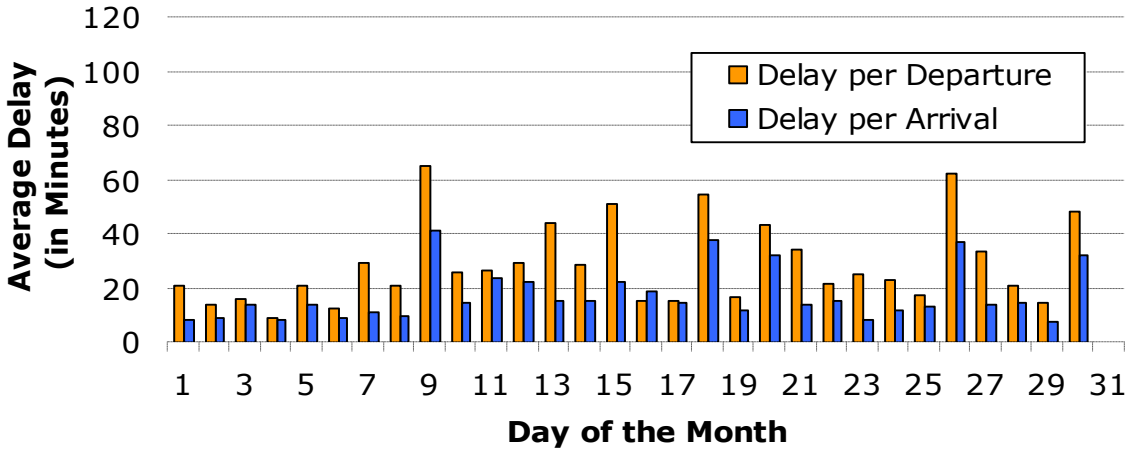
Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

FIGURE A-12
2009 MONTHLY DELAY SUMMARY BY DAY
John F. Kennedy International Airport

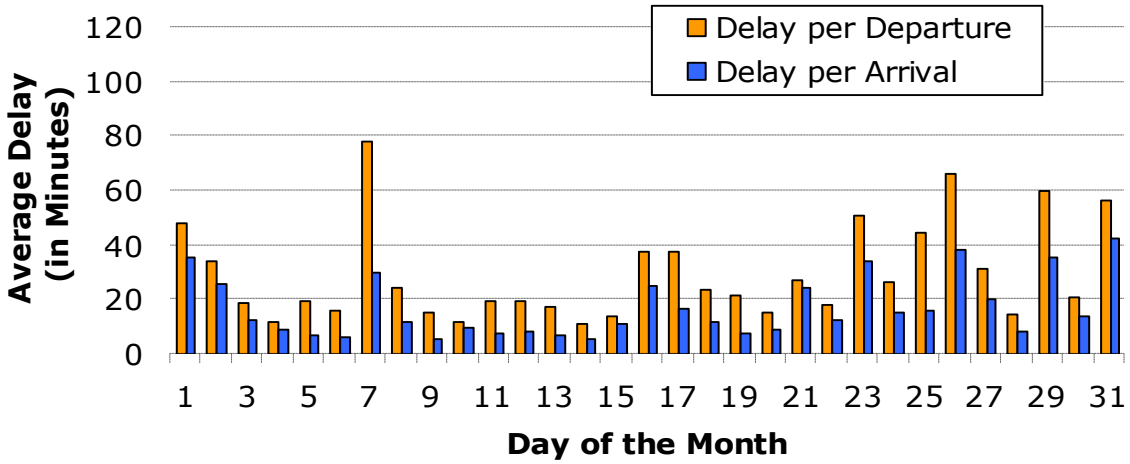
Delay Per Operations - May 2009



Delay Per Operations - June 2009



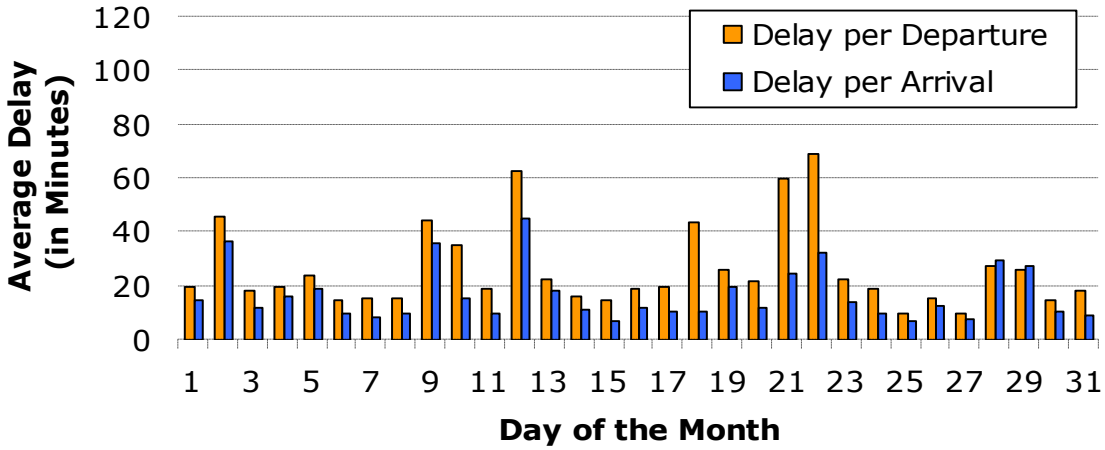
Delay Per Operations - July 2009



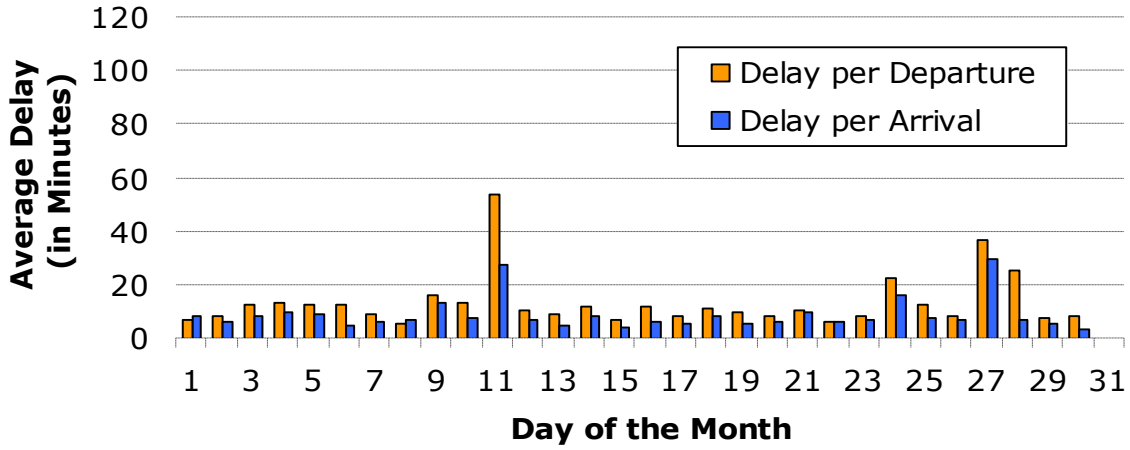
Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

FIGURE A-13
2009 MONTHLY DELAY SUMMARY BY DAY (Cont.)
John F. Kennedy International Airport

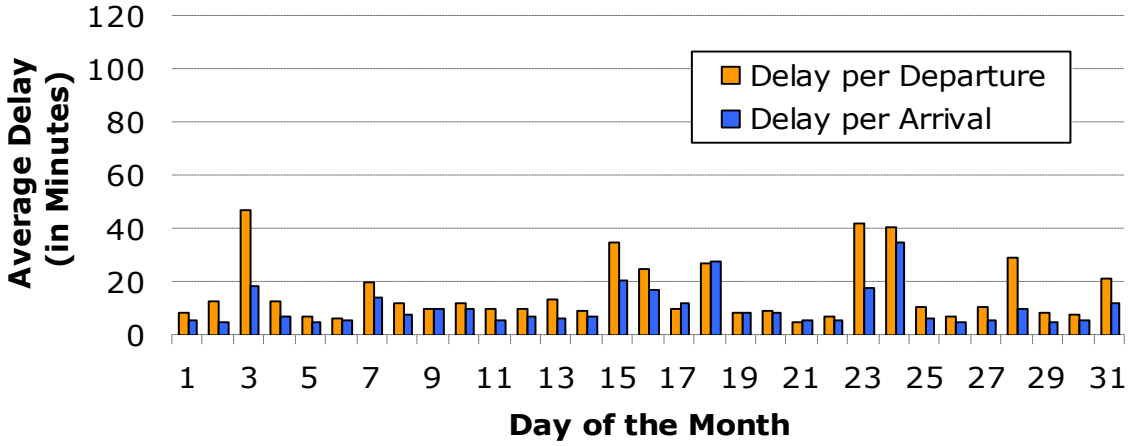
Delay Per Operations - August 2009



Delay Per Operations - September 2009



Delay Per Operations - October 2009



Sources: FAA Aviation System Performance Metrics (ASPM); Landrum & Brown analysis.

A.4 AIRCRAFT SPEED ASSUMPTIONS

Data from the Port Authority AirScene database for the months of March, April, May, and July through December 2009 were analyzed to evaluate the average approach speed of inbound aircraft at JFK. Based on **Table A-5**, approach speed varies quite significantly between runways. Indeed, aircraft landing on Runways 13L and 13R tend to have a higher approach speed than arrivals on other runways. This phenomenon is mainly due to the shape of the final approach pattern on these runways that favor higher speeds in the last couple miles before touchdown.

In addition to approach speeds, various taxi speeds were assumed and used as inputs in the TAAM simulation. Due to the lack of data (and more particularly, access to Sensis' Aerobahn database), actual taxi speeds for various areas of the airfield were not readily available for this analysis. As such, the following taxi speed assumptions were considered:

- Apron Area - 5.0 knots
- Push-Back/Taxi-In - 3.0 knots
- Taxiways - 10.0 to 22.0 knots depending on the taxi distance covered and the level of congestion in the area considered

Concerning approach speeds, actual speed by aircraft type were used in the TAAM simulation rather than aircraft group averages.

A.5 AIRCRAFT WAKE TURBULENCE SEPARATIONS

Data from the Port Authority AirScene database were analyzed in order to evaluate current aircraft wake turbulence separations at JFK. These statistics were compared to the FAA standard aircraft separations presented in **Tables A-6** and **A-7**. It revealed that FAA ATCT at the airport usually adds a buffer of 0.5 to 1 nautical miles to standard FAA aircraft separations. Further interviews with JFK FAA ATCT personnel corroborated these findings.

TABLE A-5
AVERAGE APPROACH SPEED BY RUNWAY
John F. Kennedy International Airport

	Aircraft Speed on Approach (in knots)								
Acft Type	**Rwy 04L**	**Rwy 04R**	**Rwy 13L**	**Rwy 13R**	**Rwy 22L**	**Rwy 22R**	**Rwy 31L**	**Rwy 31R**	**Avg.**
A380	118.5	132.3	125.5	129.6	121.2	133.4	126.9	n.a.	125.9
Heavy	125.3	133.0	137.5	138.7	125.8	134.2	135.3	132.0	130.8
B757	122.0	124.7	131.9	130.9	123.9	127.8	126.2	124.2	125.7
Large	125.2	130.7	136.8	134.6	125.5	132.5	133.7	129.2	130.1
Small	119.9	124.2	129.9	125.3	118.5	122.7	123.4	120.3	122.4

Note: Data analyzed for the months of March, April, May, and July through December 2009.
Sources: Port Authority of New York and New Jersey, AirScene data; Landrum & Brown analysis.

TABLE A-6
FAA STANDARD AIRCRAFT APPROACH SEPARATIONS (in Nautical Miles)
John F. Kennedy International Airport

	Trailing			
Leading	**Heavy**	**757**	**Large**	**Small**
Heavy	4	5	5	6
757	4	4	4	5
Large	3	3	3	4
	2.5	2.5	2.5	3
Small	3	3	3	3
	2.5	2.5	2.5	2.5

Sources: FAA ATC Order JO 7110; Landrum & Brown analysis.

TABLE A-7
FAA STANDARD AIRCRAFT TAKEOFF SEPARATIONS (in Seconds)
John F. Kennedy International Airport

	Trailing			
Leading	**Heavy**	**757**	**Large**	**Small**
Heavy	90	120	120	120
757	90	90	90	120
Large	60	60	60	60
Small	45	45	45	45

Sources: FAA ATC Order JO 7110; Landrum & Brown analysis.

A.6 AIRPORT/AIRSPACE FIX ALLOCATIONS

This section provides a description of the methodology used to assign an arrival and a departure fix to each airport served to/from JFK based on the July 2010 design day schedule. The Port Authority of New York and New Jersey eCater database was used in order to provide accurate information on JFK airspace fixes. **Tables A-8** through **A-11** provides the allocation of arrival fix to each origin airport, while **Tables A-12** through **A-15** presents the allocation of their corresponding departure fix.

TABLE A-8
ORIGIN/ARRIVAL FIX ALLOCATION
John F. Kennedy International Airport

IATA	ICAO	Rwy 04L	Rwy 04R	Rwy 13L	Rwy 13R	Rwy 22L	Rwy 22R	Rwy 31L	Rwy 31R
ACC	DGAA	CAM		CAM		CAM	CAM	CAM	CAM
ACK	KACK		CCC/IAA	CCC/IAA		CCC/IAA			CCC/IAA
AGP	LEMG		CCC	CAM		CCC		CCC	CCC
ALB	KALB		LEN	LEN		LEN	LEN	LEN	
AMM	OJAI	CCC/LEN	CCC/LEN	CCC/LEN		CCC	CCC	CCC	CCC
AMS	EHAM		CCC			CCC	CCC		CCC
ANC	PANC	LEN	LEN	LEN		LEN	LEN	LEN	LEN
ATH	LGAV	CCC	CCC	CCC		CCC	CCC		CCC
ATL	KATL	CAM	CAM	CAM		CAM	CAM	CAM	CAM
AUA	TNCA		CAM	CAM		CAM	CAM		
AUH	OMAA		CCC	LEN		CAM/LEN	LEN		CAM/LEN
AUS	KAUS		CAM/LEN	CAM/LEN		CAM/LEN	CAM/LEN	CAM/LEN	CAM/LEN
BCN	LEBL		CCC	CAM		CCC	CCC		CCC
BDA	TXKF	CAM	CAM	CAM		CAM	CAM	CAM	CAM
BDL	KBDL		CCC	CCC		CCC	CCC	CCC	CCC
BGI	TBPB	CAM	CAM			CAM	CAM		CAM
BGR	KBGR	CAM	CAM	CAM		CAM		CAM	CAM
BNA	KBNA	CAM	CAM/LEN	CAM/LEN	CAM/LEN	CAM/LEN	CAM/LEN	CAM/LEN	CAM/LEN
BOG	SKBO	CAM	CAM	CAM		CAM	CAM	CAM	CAM
BOM	VABB		CCC/LEN	CCC		CCC	CCC		CCC
BOS	KBOS	CCC	CCC	CCC		CCC	CCC		CCC
BQN	TJBQ	CAM	CAM	CAM		CAM	CAM	CAM	CAM
BRU	EBBR		CCC/LEN	CCC/LEN		CCC/LEN	CCC		CCC/LEN
BTV	KBTV	LEN	LEN	LEN		LEN	LEN	LEN	LEN
BUD	LHBP		CCC	CCC		CCC	CCC		CCC
BUF	KBUF	LEN	LEN	LEN		LEN	LEN	LEN	LEN
BUR	KBUR	LEN	LEN	LEN		LEN	LEN	LEN	LEN
BWI	KBWI	CAM	CAM	CAM		CAM	CAM		CAM
CAI	HECA		CCC	LEN		CCC			CCC
CDG	LFPG		CCC/LEN	CCC/LEN		CCC/LEN	CCC/LEN	CCC/LEN	CCC/LEN
CLE	KCLE	LEN	LEN	LEN		LEN	LEN	LEN	LEN
CLT	KCLT	CAM	CAM	CAM		CAM	CAM	CAM	CAM
CMH	KCMH	LEN	LEN	LEN		LEN	LEN	LEN	LEN
CMN	GMMN		CCC	CAM		CCC			CCC
CUN	MMUN	CAM	CAM	CAM		CAM	CAM	CAM	CAM
CVG	KCVG	LEN	LEN	LEN		LEN	LEN	LEN	LEN
DCA	KDCA	CAM	CAM	CAM		CAM	CAM	CAM	CAM
DEL	VIDP		CCC/LEN			CCC			CCC

Sources: Port Authority of New York and New Jersey, eCater data; Landrum & Brown analysis.

TABLE A-9
ORIGIN/ARRIVAL FIX ALLOCATION (Cont.)
John F. Kennedy International Airport

IATA	ICAO	Rwy 04L	Rwy 04R	Rwy 13L	Rwy 13R	Rwy 22L	Rwy 22R	Rwy 31L	Rwy 31R
DEN	KDEN	LEN	LEN	LEN		LEN	LEN	LEN	LEN
DFW	KDFW	CAM		CAM/LEN		CAM/LEN	CAM/LEN	CAM/LEN	CAM/LEN
DKR	GOOY	CAM	CAM	CAM		CAM	CAM	CAM	CAM
DOH	OTBD		CCC	LEN		CCC/LEN	LEN	LEN	CCC/LEN
DTW	KDTW	LEN	LEN	LEN		LEN	LEN	LEN	LEN
DUB	EIDW		CCC	CCC		CCC	CCC		CCC
DUS	EDDL		CCC			CCC			CCC
DXB	OMDB	CCC	CCC/LEN	CCC/LEN		CCC/LEN	LEN	LEN	CCC/LEN
EDI	EGPH								
EZE	SAEZ	CAM	CAM			CAM			CAM
FCO	LIRF		CCC	CCC		CCC	CCC		CCC
FLL	KFLL	CAM	CAM	CAM		CAM	CAM	CAM	CAM
FRA	EDDF	CCC	CCC	CCC		CCC	CCC	CCC	CCC
GCM	MWCR		CAM			CAM			
GEO	SYCJ	CAM	CAM	CAM		CAM	CAM	CAM	CAM
GIG	SBGL		CAM	CAM		CAM			CAM
GND	TGPY		CAM	CAM		CAM		CAM	CAM
GRU	SBGR	CAM	CAM	CAM		CAM		CAM	CAM
GVA	LSGG		CCC	CAM		CCC		CAM	CCC
GYE	SEGU								
HEL	EFHK		CCC			CCC			CCC
HKG	VHHH		LEN	LEN		LEN	LEN		LEN
HOU	KHOU		CAM/LEN	CAM		CAM/LEN	CAM/LEN		CAM/LEN
IAD	KIAD	CAM	CAM	CAM		CAM	CAM	CAM	CAM
IAH	KIAH	CAM	CAM	CAM		CAM	CAM	CAM	CAM
ICN	RKSI		LEN	LEN		LEN			LEN
IND	KIND	LEN	LEN	LEN		LEN	LEN	LEN	LEN
IST	LTBA		CCC/LEN	LEN		CCC/LEN	CCC/LEN	CCC/LEN	CCC/LEN
JAX	KJAX	CAM	CAM	CAM		CAM	CAM	CAM	CAM
KBP	UKBB		CCC	CCC		CCC		CCC	CCC
KEF	BIKF		CCC	CCC		CCC			CCC
KIN	MKJP	CAM	CAM	CAM		CAM	CAM		CAM
KWI	OKBK					CCC			CCC
LAS	KLAS	LEN	LEN	LEN		LEN	LEN	LEN	LEN
LAX	KLAX	LEN	LEN	LEN		LEN	LEN	LEN	LEN
LGB	KLGB	LEN	LEN	LEN		LEN	LEN	LEN	LEN
LGW	EGKK								

Sources: Port Authority of New York and New Jersey, eCater data; Landrum & Brown analysis.

TABLE A-10
ORIGIN/ARRIVAL FIX ALLOCATION (Cont.)
John F. Kennedy International Airport

IATA	ICAO	Rwy 04L	Rwy 04R	Rwy 13L	Rwy 13R	Rwy 22L	Rwy 22R	Rwy 31L	Rwy 31R
LHR	EGLL	CCC	CCC	CCC		CCC	CCC	CCC	CCC
LIM	SPIM		CAM	CAM		CAM			CAM
LYS	LFLL								
MAD	LEMD		CAM/CCC	CAM/CCC		CAM/CCC	CCC	CCC	CAM/CCC
MAN	EGCC		CCC			CCC	CCC	CCC	CCC
MBJ	MKJS	CAM	CAM	CAM		CAM	CAM	CAM	CAM
MCI	KMCI	LEN	LEN	LEN		LEN	LEN	LEN	LEN
MCO	KMCO	CAM	CAM	CAM		CAM	CAM	CAM	CAM
MDE	SKRG	CAM	CAM	CAM		CAM			CAM
MEM	KMEM	CAM	CAM	CAM		CAM/LEN	CAM	CAM	CAM
MEX	MMMX	CAM	CAM	CAM		CAM	CAM	CAM	CAM
MIA	KMIA	CAM	CAM	CAM		CAM	CAM	CAM	CAM
MKE	KMKE								
MSP	KMSP	LEN	LEN	LEN		LEN	LEN	LEN	LEN
MSY	KMSY	CAM	CAM	CAM		CAM	CAM	CAM	CAM
MUC	EDDM		CCC	LEN		CCC	LEN		CCC
MXP	LIMC		CCC			CCC	CCC		CCC
NAS	MYNN	CAM	CAM	CAM		CAM	CAM	CAM	CAM
NCE	LFMN		CCC	CAM		CCC	CCC		CCC
NRT	RJAA	LEN	LEN	LEN		LEN	LEN	LEN	LEN
OAK	KOAK	LEN	LEN	LEN		LEN	LEN	LEN	LEN
ORD	KORD	LEN	LEN	LEN		LEN	LEN	LEN	LEN
ORF	KORF	CAM	CAM	CAM		CAM	CAM		CAM
ORY	LFPO								
PAP	MTPP	CAM	CAM	CAM		CAM	CAM	CAM	CAM
PBI	KPBI	CAM	CAM	CAM		CAM	CAM		CAM
PDX	KPDX	LEN	LEN	LEN	LEN	LEN	LEN	LEN	LEN
PEK	ZBAA	LEN	LEN	LEN		LEN	LEN	LEN	LEN
PHL	KPHL	CAM	CAM	CAM		CAM	CAM	CAM	CAM
PHX	KPHX	LEN	LEN	LEN		LEN	LEN	LEN	LEN
PIT	KPIT	LEN	LEN	LEN		LEN	LEN	LEN	LEN
PLS	MBPV		CAM			CAM			
POP	MDPP	CAM	CAM	CAM		CAM	CAM	CAM	CAM
POS	TTPP	CAM	CAM	CAM		CAM	CAM	CAM	CAM
PRG	LKPR		CCC	CCC		CCC	CCC		CCC
PSE	TJPS	CAM	CAM	CAM		CAM			CAM
PTY	MPTO		CAM			CAM			CAM

Sources: Port Authority of New York and New Jersey, eCater data; Landrum & Brown analysis.

TABLE A-11
ORIGIN/ARRIVAL FIX ALLOCATION (Cont.)
John F. Kennedy International Airport

IATA	ICAO	Rwy 04L	Rwy 04R	Rwy 13L	Rwy 13R	Rwy 22L	Rwy 22R	Rwy 31L	Rwy 31R
PUJ	MDPC	CAM	CAM	CAM		CAM	CAM	CAM	CAM
PVG	ZSPD	LEN	LEN	LEN		LEN	LEN		LEN
PWM	KPWM	CCC	CCC	CCC		CCC	CCC		CCC
RDU	KRDU	CAM	CAM	CAM		CAM	CAM	CAM	CAM
RIC	KRIC	CAM	CAM	CAM		CAM	CAM	CAM	CAM
ROC	KROC	CAM	CAM	CAM		CAM	CAM	CAM	CAM
RSW	KRSW	CAM	CAM	CAM		CAM	CAM	CAM	CAM
SAL	MSLP	CAM	CAM	CAM		CAM	CAM	CAM	CAM
SAN	KSAN	LEN	LEN	LEN		LEN	LEN	LEN	LEN
SCL	SCEL		CAM	CAM		CAM			CAM
SDQ	MDSD	CAM	CAM	CAM		CAM	CAM	CAM	CAM
SEA	KSEA	LEN	LEN	LEN		LEN	LEN	LEN	LEN
SFO	KSFO	LEN	LEN	LEN		LEN	LEN	LEN	LEN
SJC	KSJC	LEN	LEN			LEN			LEN
SJU	TJSJ	CAM	CAM	CAM		CAM	CAM	CAM	CAM
SKB	TKPK		CAM	CAM		CAM			
SLC	KSLC	LEN	LEN	LEN		LEN	LEN	LEN	LEN
SMF	KSMF	LEN	LEN	LEN		LEN			LEN
SNN	EINN		CCC	CCC		CCC	CCC	CCC	CCC
SRQ	KSRQ	CAM	CAM	CAM		CAM	CAM	CAM	CAM
STI	MDST	CAM	CAM	CAM		CAM	CAM	CAM	CAM
STL	KSTL	LEN	LEN	CAM/LEN		CAM/LEN	CAM/LEN	LEN	LEN
STT	TIST		CAM	CAM		CAM	CAM		
SVO	UUEE		CCC/LEN	CCC/LEN		CCC/LEN			CCC/LEN
SXM	TNCM		CAM	CAM		CAM	CAM		CAM
SYR	KSYR	LEN	LEN	LEN		LEN	LEN	LEN	LEN
TLV	LLBG	CCC/LEN	CCC/LEN	CCC/LEN		CCC/LEN	CCC	CCC	CCC/LEN
TPA	KTPA	CAM	CAM	CAM		CAM	CAM	CAM	CAM
TXL	EDDT		CCC	CCC		CCC			CCC
VCE	LIPZ		CCC	LEN		CCC			CCC
VIE	LOWW		CCC			CCC			CCC
WAW	EPWA		CCC	CCC		CCC			CCC
YHZ	CYHZ		CCC	CCC		CCC	CCC		CCC
YUL	CYUL	LEN	LEN	LEN		LEN	LEN	LEN	LEN
YVR	CYVR	LEN	LEN	LEN		LEN			LEN
YYZ	CYYZ	LEN	LEN	LEN	LEN	LEN	LEN	LEN	LEN
ZRH	LSZH		CCC	CCC		CCC	CCC	CCC	CCC

Sources: Port Authority of New York and New Jersey, eCater data; Landrum & Brown analysis.

TABLE A-12
DESTINATION/DEPARTURE FIX ALLOCATION
John F. Kennedy International Airport

IATA	ICAO	Rwy 04L	Rwy 04R	Rwy 13L	Rwy 13R	Rwy 22L	Rwy 22R	Rwy 31L	Rwy 31R
ACC	DGAA	SHI			SHI		SHI	SHI	
ACK	KACK	BAY		BAY	BAY		BAY	BAY	
AGP	LEMG	HAP/SHI			HAP/SHI		HAP/SHI		
ALB	KALB	BDR			BDR		BDR	BDR	
AMM	OJAI	BET/HAP			BET/HAP		BET/HAP	BET/HAP	BET/HAP
AMS	EHAM	BET/MER			BET/MER		BET/MER	BET/MER	GRE
ANC	PANC	GAY		GAY	GAY		GAY	GAY	GAY
ATH	LGAV	BET/HAP			BET/HAP		BET/HAP	BET/HAP	GRE
ATL	KATL	RBV			RBV		RBV/WAV	RBV	RBV
AUA	TNCA	SHI/WAV			SHI/WAV		SHI/WAV	SHI/WAV	SHI/WAV
AUH	OMAA	BET/MER			BET/MER		BET/MER	BET/MER	GRE
AUS	KAUS	RBV			RBV		RBV	RBV	RBV
BCN	LEBL	HAP/SHI			HAP/SHI		HAP/SHI	HAP/SHI	
BDA	TXKF	SHI			SHI		SHI	SHI	SHI
BDL	KBDL	BDR			BDR		BDR	BDR	BDR
BGI	TBPB	SHI			SHI		SHI	SHI	
BGR	KBGR	GRE			GRE		GRE	GRE	
BNA	KBNA	RBV			RBV		RBV	RBV	RBV
BOG	SKBO	SHI/WAV			SHI/WAV		SHI/WAV	SHI/WAV	SHI/WAV
BOM	VABB	MER			MER		MER	MER	
BOS	KBOS	BAY/MER		BAY/MER	BAY/MER		BAY/MER	BAY/MER	BAY/MER
BQN	TJBQ	SHI			SHI		SHI	SHI	SHI
BRU	EBBR	BET/MER			BET/MER		BET/MER	BET/MER	
BTV	KBTV	GRE		GRE	GRE		GRE	GRE	GRE
BUD	LHBP	BET/MER			BET/MER		BET/MER	BET/MER	
BUF	KBUF	NEI		NEI	NEI		NEI	NEI	NEI
BUR	KBUR	COA/RBV			COA/RBV		COA/RBV	COA/RBV	RBV
BWI	KBWI	RBV			RBV		RBV	RBV	RBV
CAI	HECA	BET/HAP			BET/HAP		BET/HAP	BET/HAP	
CDG	LFPG	BET/HAP			BET/HAP		BET/HAP	BET/HAP	BET/HAP
CLE	KCLE	RBV		RBV	RBV		RBV	RBV	RBV
CLT	KCLT	RBV		RBV	RBV		RBV/WAV	RBV	RBV
CMH	KCMH	RBV		RBV	RBV		RBV	RBV	RBV
CMN	GMMN	BET					BET		
CUN	MMUN	RBV/WAV			RBV/WAV		RBV/WAV	RBV/WAV	RBV
CVG	KCVG	RBV		RBV	RBV		RBV	RBV	RBV
DCA	KDCA	RBV/WAV			RBV/WAV		RBV/WAV	RBV/WAV	RBV
DEL	VIDP	GRE/MER			GRE/MER		GRE/MER	MER	

Sources: Port Authority of New York and New Jersey, eCater data; Landrum & Brown analysis.

TABLE A-13
DESTINATION/DEPARTURE FIX ALLOCATION
John F. Kennedy International Airport

IATA	ICAO	Rwy 04L	Rwy 04R	Rwy 13L	Rwy 13R	Rwy 22L	Rwy 22R	Rwy 31L	Rwy 31R
DEN	KDEN	COA			RBV		COA	RBV	RBV
DFW	KDFW	RBV			RBV		RBV	RBV	RBV
DKR	GOOY	SHI			SHI		SHI	SHI	
DOH	OTBD	BET/MER					BET/MER		
DTW	KDTW	GAY			GAY		GAY	GAY	GAY
DUB	EIDW	BET/MER			BET/MER		BET/MER	BET/MER	
DUS	EDDL	BET/MER					BET/MER		
DXB	OMDB	MER			MER		BET/MER	MER	
EDI	EGPH	MER			BET		MER		
EZE	SAEZ	SHI			SHI		SHI	SHI	
FCO	LIRF	BET/HAP			BET/HAP		BET/HAP	BET/HAP	
FLL	KFLL	WAV			WAV		WAV	RBV/WAV	RBV/WHI
FRA	EDDF	BET/MER			BET/MER		BET/MER	BET/MER	
GEO	SYCJ	SHI			SHI		SHI	SHI	SHI
GIG	SBGL	SHI			SHI		SHI	SHI	
GND	TGPY	SHI			SHI		SHI	SHI	
GRU	SBGR	SHI			SHI		SHI	SHI	SHI
GVA	LSGG	BET/HAP					BET/HAP		
GYE	SEGU	WAV			WAV		WAV	WAV	
HEL	EFHK	GRE			GRE		GRE	GRE	
HKG	VHHH	GRE/MER			GRE/MER		GRE/MER	GRE/MER	
HOU	KHOU	RBV			RBV		RBV	RBV	RBV
IAD	KIAD	RBV			RBV		RBV	RBV	RBV
IAH	KIAH	RBV			RBV		RBV	RBV	RBV
ICN	RKSI	GAY/GRE			GAY/GRE		GAY/GRE	GAY/GRE	
IND	KIND	RBV			RBV		RBV	RBV	RBV
IST	LTBA	BET/MER			BET/MER		BET/MER	BET/MER	
JAX	KJAX	WAV			WAV		WAV	WAV/RBV	RBV
JNB	FAJS	SHI			SHI		SHI	SHI	
KBP	UKBB	MER			MER		BET/MER	MER	
KEF	BIKF	GRE			GRE		GRE	GRE	
KIN	MKJP	WAV			WAV		WAV	WAV	
KWI	OKBK	BET/MER			MER		BET/MER		
LAS	KLAS	COA/RBV			RBV		COA/RBV	RBV	RBV
LAX	KLAX	COA/RBV			RBV		COA/RBV	RBV	RBV
LGB	KLGB	COA/RBV			RBV		COA/RBV	RBV	RBV
LGW	EGKK								
LHR	EGLL	BET/MER			BET/MER		BET/MER	BET/MER	

Sources: Port Authority of New York and New Jersey, eCater data; Landrum & Brown analysis.

TABLE A-14
DESTINATION/DEPARTURE FIX ALLOCATION
John F. Kennedy International Airport

IATA	ICAO	Rwy 04L	Rwy 04R	Rwy 13L	Rwy 13R	Rwy 22L	Rwy 22R	Rwy 31L	Rwy 31R
LIM	SPIM	WAV			WAV		WAV	WAV	
MAD	LEMD	HAP/SHI			BET/HAP		BET/HAP	SHI	
MAN	EGCC	BET/MER			BET/MER		BET/MER	BET/MER	
MBJ	MKJS	WAV			WAV		WAV	WAV	WAV
MCI	KMCI	RBV			RBV		RBV	RBV	RBV
MCO	KMCO	WAV			WAV		WAV	RBV/WAV	RBV
MDE	SKRG	WAV			WAV		WAV	WAV	
MEM	KMEM	RBV			RBV		RBV	RBV	RBV
MEX	MMMX	RBV			RBV		RBV	RBV	RBV
MIA	KMIA	WAV			WAV		WAV	RBV/WAV	RBV/WHI
MKE	KMKE	COA			COA		COA	COA	
MSP	KMSP	COA/GAY			GAY		COA/GAY	COA/GAY	
MSY	KMSY	RBV			RBV		RBV	RBV	RBV
MUC	EDDM	BET/MER			BET/MER		BET/MER	MER	
MXP	LIMC	BET/HAP			BET/HAP		BET/HAP	BET/HAP	
NAP	LIRN	MER					BET/MER		
NAS	MYNN	WAV			WAV		WAV	WAV	
NCE	LFMN	BET/HAP			BET/HAP		BET/HAP	BET/HAP	
NRT	RJAA	GAY/GRE			GAY/GRE		GAY/GRE	GAY/GRE	
OAK	KOAK	COA			COA/RBV		COA	COA/RBV	RBV
ORD	KORD	COA		COA	COA		COA	COA	COA
ORF	KORF	WAV			WAV		WAV	WAV/WHI	WHI
ORY	LFPO								
OTP	LROP								
PAP	MTPP	SHI/WAV			SHI/WAV		SHI/WAV	SHI/WAV	
PBI	KPBI	WAV			WAV		WAV	WAV/WHI	WAV/WHI
PDX	KPDX	COA/GAY			GAY/RBV		COA/GAY	GAY/RBV	RBV
PEK	ZBAA	GRE/MAR			GRE/MAR		GRE/MAR	GRE/MAR	
PHL	KPHL	CYN			CYN		CYN	CYN	CYN
PHX	KPHX	RBV			RBV		RBV	RBV	RBV
PIT	KPIT	COA		COA	COA		COA	COA	
PLS	MBPV	SHI			SHI		SHI	SHI	
POP	MDPP	SHI/WAV			SHI		SHI	SHI/WAV	
POS	TTPP	SHI			SHI		SHI	SHI	SHI
PRG	LKPR	BET/MER			BET/MER		BET/MER	BET/MER	
PRN	LYPR								
PSA	LIRP	BET/HAP			BET/HAP		BET/HAP	BET/HAP	
PSE	TJPS	SHI		SHI	SHI		SHI	SHI	SHI

Sources: Port Authority of New York and New Jersey, eCater data; Landrum & Brown analysis.

TABLE A-15
DESTINATION/DEPARTURE FIX ALLOCATION
John F. Kennedy International Airport

IATA	ICAO	Rwy 04L	Rwy 04R	Rwy 13L	Rwy 13R	Rwy 22L	Rwy 22R	Rwy 31L	Rwy 31R
PTY	MPTO	WAV			WAV		WAV	WAV	
PUJ	MDPC	SHI/WAV			SHI		SHI/WAV	SHI	SHI
PWM	KPWM	GRE/MER			GRE/MER		GRE/MER	GRE/MER	
RDU	KRDU	WAV			WAV		WAV	RBV/WAV	RBV/WAV
RIC	KRIC	WAV			WAV		WAV	WAV	WAV/WHI
ROC	KROC	NEI		NEI	NEI		NEI	NEI	NEI
RSW	KRSW	RBV			RBV		RBV/WAV	RBV	RBV
SAL	MSLP	WAV			WAV		WAV	WAV	
SAN	KSAN	RBV			RBV		COA/RBV	RBV	RBV
SCL	SCEL	WAV			WAV		WAV	WAV	
SDQ	MDSD	SHI/WAV			SHI		SHI/WAV	SHI	SHI
SEA	KSEA	COA/GAY			COA/GAY		COA/GAY	GAY/RBV	RBV
SFO	KSFO	GAY/RBV		GAY/RBV	GAY/RBV		GAY/RBV	GAY/RBV	RBV
SJC	KSJC	COA/WAV			RBV		COA/RBV	RBV	RBV
SJU	TJSJ	SHI/WAV			SHI		SHI/WAV	SHI	SHI
SKB	TKPK	SHI					SHI		
SLC	KSLC	GAY/RBV			GAY/RBV		GAY/RBV	GAY/RBV	RBV
SMF	KSMF	COA			COA/RBV		COA/GAY	COA/RBV	RBV
SNN	EINN	BET/MER			BET/MER		BET/MER	BET/MER	
SRQ	KSRQ	RBV			RBV		RBV	RBV	RBV
STI	MDST	SHI/WAV			SHI/WAV		SHI/WAV	SHI/WAV	SHI
STL	KSTL	RBV			RBV		RBV	RBV	RBV
STT	TIST	SHI/WAV			SHI		SHI/WAV	SHI/WAV	
SVO	UUEE	GRE/MER			GRE/MER		GRE/MER	GRE/MER	
SXM	TNCM	SHI			SHI		SHI	SHI	SHI
SYR	KSYR	NEI		NEI	NEI		NEI	NEI	NEI
TLV	LLBG	BET/HAP			BET/HAP		BET/HAP	BET/HAP	
TPA	KTPA	RBV			RBV/WAV		RBV/WAV	RBV	RBV
TXL	EDDT	BET/MER			BET/MER		BET/MER	BET/MER	
VCE	LIPZ	BET/HAP			BET/HAP		BET/HAP	BET/HAP	
VIE	LOWW	BET/MER			BET/MER		BET/MER	BET/MER	
VLC	LEVC	BET/HAP			BET/HAP		BET/HAP	BET/HAP	
WAW	EPWA	GRE/MER			MER		GRE/MER		
YHZ	CYHZ	MER			MER		MER	MER	
YUL	CYUL	GRE			GRE		GRE	GRE	
YVR	CYVR	GAY			GAY		GAY	GAY	
YYZ	CYYZ	GAY			GAY		GAY	GAY	GAY
ZRH	LSZH	BET/HAP			BET/HAP		BET/HAP	BET/HAP	

Sources: Port Authority of New York and New Jersey, eCater data; Landrum & Brown analysis.