FOIA #12163

MR LES GRODNICK

[redacted]

[redacted]

SHERREE VAN DUYNE 2/16/11

E.O.I. ADMIN

PORT AUTHORITY OF N.Y. / N.J.

225 PARK AVE SOUTH 17th FLOOR

N.Y., N.Y. 10003

02-23-11P10:33 RCVD

SHERREE VAN DUYNE,

I READ IN THE N.Y. POST ABOUT "THE REGIONAL PLAN ASSOC" 160 PAGE REPORT ABOUT PROPOSED CHANGES FOR FUTURE DEVELOPMENT ABOUT THE N.Y. AREA AIRPORTS — NEWARK IN PARTICULAR. THE STORY LISTED A WEBSITE WWW.RPA.ORG. I DON'T HAVE A COMPUTER SO I WAS WONDERING IF YOU COULD SEND ME THIS REPORT OR MAYBE PRINT ONE OUT FOR ME. IF YOU CAN, I WOULD APPRECIATE IT AND YOU CAN SEND IT TO THE ABOVE ADDRESS.

THANK YOU EVER SO KINDLY,

Les Grodnick

TEL NO. [redacted]

THE PORT AUTHORITY OF NY & NJ

Daniel D. Duffy
FOI Administrator

April 6, 2011

Mr. Les Gronick

Re: Freedom of Information Reference No. 12163

Dear Mr. Gronick:

This is a response to your February 16, 2011 request, which has been processed under the Port Authority's Freedom of Information Policy (the "Policy," copy enclosed) for a copy of the report related to proposed changes for future development at the New York area airports.

Material responsive to your request and available under the Policy, which consists of 80 pages, will be forwarded to your attention upon receipt of a photocopying fee of $20 (25¢ per page). Payment should be made in cash, certified check, company check or money order payable to "The Port Authority of New York & New Jersey" and should be sent to my attention at 225 Park Avenue South, 17th Floor, New York, NY 10003.

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

Sincerely,

Daniel D. Duffy
FOI Administrator

Enclosure

225 Park Avenue South, 17th Floor
New York, NY 10003
T: 212 435 2542 F: 212 435 7555

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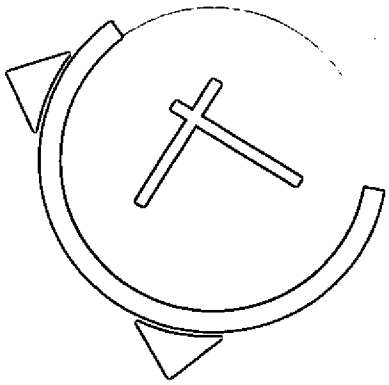
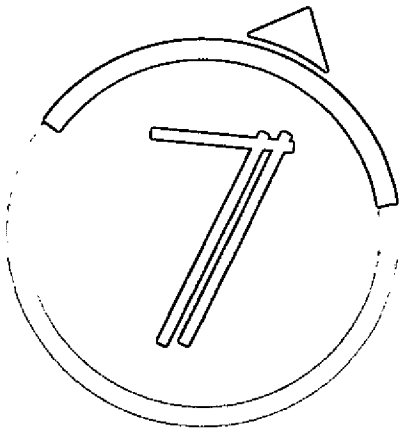
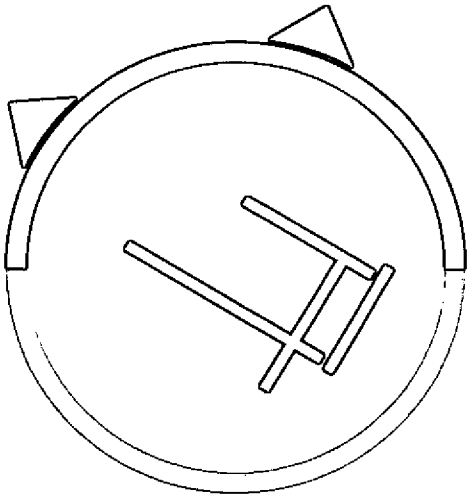


The Future *of the* New York Region's Airports





January 2011

by Jeffrey M. Zupan, Richard E. Barone and Matthew H. Lee

Regional Plan Association

This report is dedicated to the memory of **William DeCota**, Director of Aviation at the Port Authority of New York and New Jersey, who passed away during the early stages of this study. Despite his untimely passing, Bill's vision has remained our guiding light.

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The technical appendices will be available at www.rpa.org

Acknowledgements

This report was co-authored by Jeffrey M. Zupan, Senior Fellow for Transportation at Regional Plan Association; Richard E. Barone, Director of Transportation Programs at Regional Plan Association; and Matthew H. Lee of Landrum and Brown, Airport Consultants. In addition to the co-authors, the following people on the staff of Regional Plan Association and Landrum and Brown made significant contributions: Jeff Ferzoco, Creative Director, and Ben Oldenburg, Research Associate, Graphic Design; Rossana Ivanova and Juliette Michaelson, editing; Christopher Jones, co-author of summary and consultant on economic issues; Yoav Hagler, research for and co-author of intercity rail chapter, Robert J. Pirani, consultation on environmental issues, Frank Hebbert, Eric Bohn and Cristen Chinea, cartography; Lyor Dahan, Landrum and Brown aviation consultant, Megan Smirti Ryerson, aviation consultant, assisted in the research and co-authored the chapter on managing demand and Jackson Whitmore, intern.

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At critical junctures of the research, a committee of Regional Plan Association's Board of Directors, including Marilyn J. Taylor, Chair of the Committee and Dean, University of Pennsylvania School of Design; Kevin S. Corbett, Vice President, Corporate Development, AECOM USA; Timur F. Galen, Managing Director, Global Sales and Strategies, Goldman Sachs; Dylan Hixon, President, Arden Road Investments; Adam Isles, Director, Strategy and Policy Consulting, Raytheon; Matthew S. Kissner, President and CEO, The Kissner Group; and Elliot G. Sander, Chairman of RPA's Board of Directors, Group Chief Executive, Global Transportation, AECOM USA; provided key input and feedback.

Advice and guidance were provided throughout the study by a Steering Committee of representatives of the City of New York, the City of Newark, the New York City Partnership, the Newark Regional Business Partnership, Orange County and the Port Authority of New York and New Jersey.

An Airport Stakeholders Group comprised of government agencies, business, civic, and other organizations was formed by Regional Plan Association to provide feedback during the research process. The Better Airports Alliance was established by Regional Plan Association to provide input on issues related to the implementation of the recommendations. The Alliance was organized and directed by Neysa Pranger, RPA Director of Public Affairs, who was assisted by Katie Nosker, Steven Salzgeber and Nicholas and Lence Communications. A list of the members of the Airports Stakeholders Group and Better Airports Alliance is provided in the appendix.

Regional Plan Association is America's oldest and most distinguished independent urban research and advocacy group. Now in its 86th year, RPA prepares long range plans and policies to guide the growth and development of the New York- New Jersey-Connecticut metropolitan region. RPA also provides leadership on national infrastructure, sustainability, and competitiveness concerns. RPA enjoys broad support from the region's and nation's business, philanthropic, civic, and planning communities.

Regional Plan Association has a long history of involvement in planning the future of the Region's airports. In 1947, responding to the then growing airport capacity and governance crisis, RPA issued *Airports of Tomorrow*, a blueprint for airport development and governance that has guided the growth of the three airport system in the Region. The report's recommendations were adopted as official policy and led to the agreement to have the Port Authority of New York and New Jersey as the agency to guide the development of the Region's airports. The report was developed with the guidance of the partnership – The Regional Airport Conference – a consortium of the major federal, state, city and county government stakeholders and convened and staffed by RPA.

In 1969 RPA issued *The Region's Airports* that described the steps necessary to assist in accommodating airport passenger growth in the region focusing on pricing, alternative ground opportunities, and an eventual "fourth" airport. This report was updated four years later in *The Region's Airports Revisited*, which accounted for changing trends and the emergence of Stewart Airport as a viable option of added capacity.

In 1992 RPA issued a report, *Two Airport Issues*, which highlighted the issues of rail access to the airports and the potential role of Stewart Airport in the region.

Since *The Region's Airports Revisited* 33 years ago the aviation industry has changed in many ways. Airport passenger demand has grown by 60 million passengers a year, or by 150 percent, putting pressure on landside and ground access facilities. In response, RPA has campaigned for improved rail access to JFK and Newark Airports, and worked closely with the Port Authority to build public, media and political support for the JFK AirTrain.

Governed by a 65-member Board of Directors and three State Committees to provide strategic advice, RPA is a not-for-profit corporation with a staff of 30 planners, designers, and policy experts.

Robert D. Yaro, *President*
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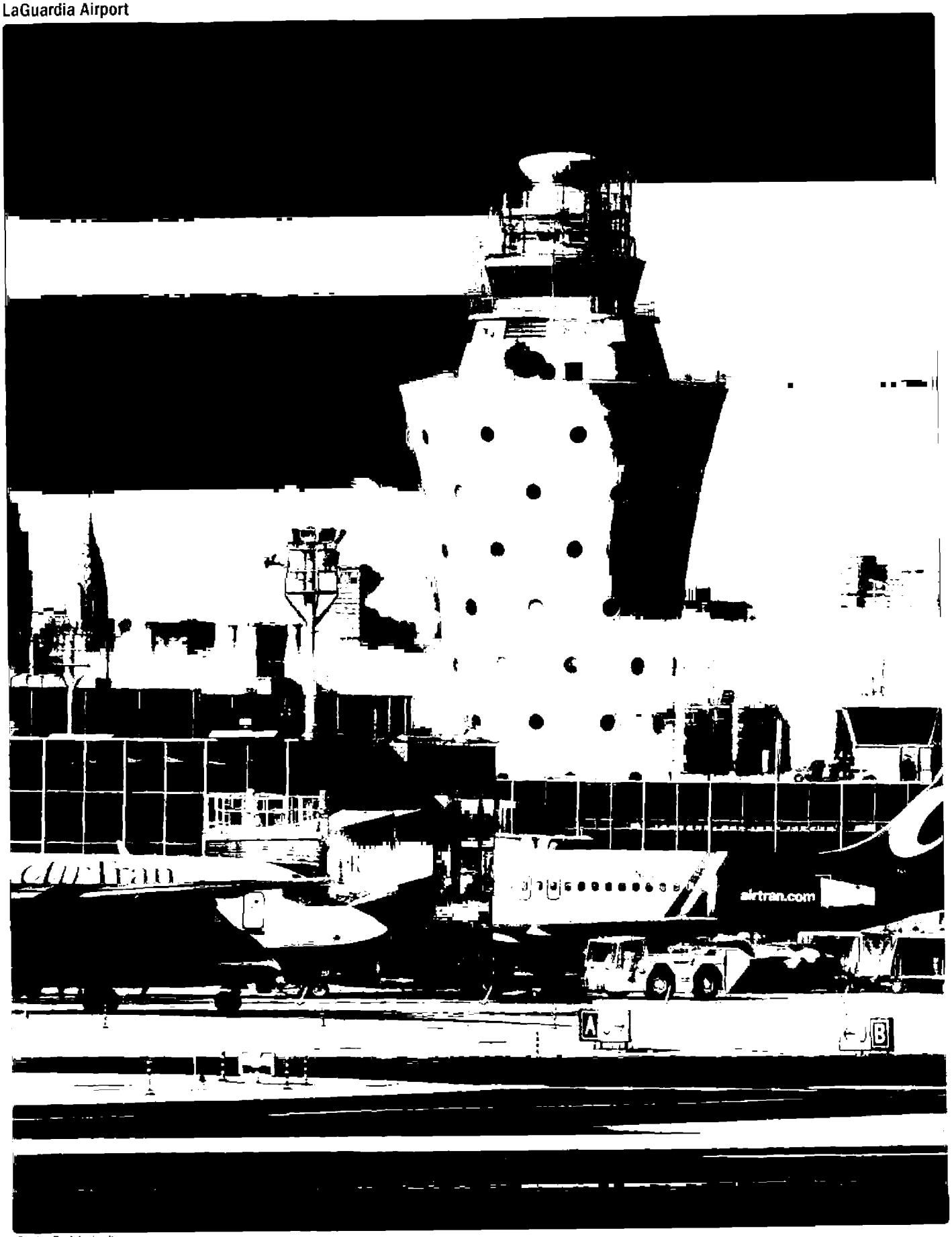
LaGuardia Airport



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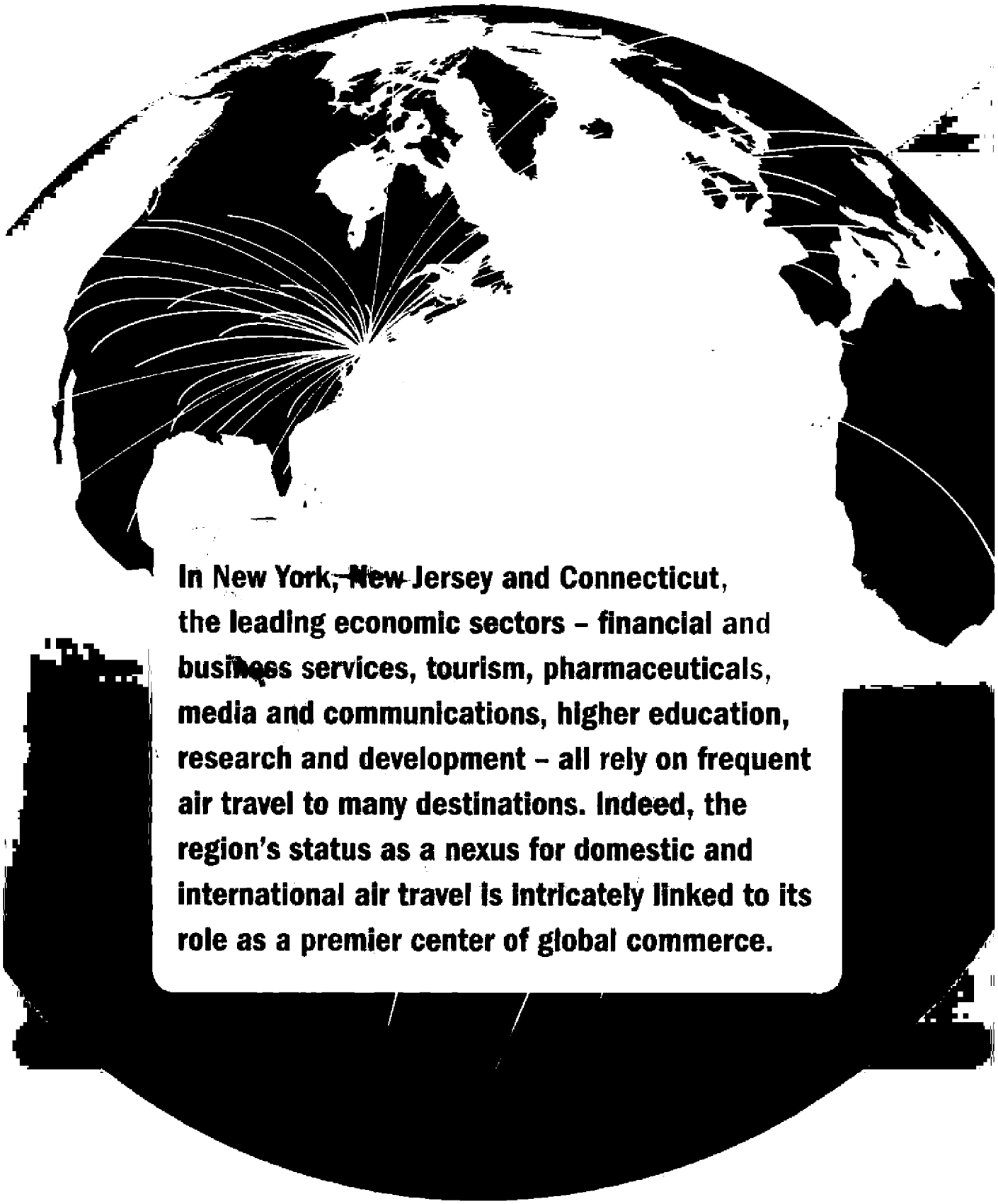


In New York, New Jersey and Connecticut, the leading economic sectors – financial and business services, tourism, pharmaceuticals, media and communications, higher education, research and development – all rely on frequent air travel to many destinations. Indeed, the region's status as a nexus for domestic and international air travel is intricately linked to its role as a premier center of global commerce.

Executive Summary

Intercity travel is at the core of an increasingly interconnected and competitive global economy. Without the ability to efficiently transport business and leisure travelers and time-sensitive cargo, both domestic and international business would grind to a halt. Since virtually all long-distance travel is by air, along with a high proportion of shorter distance travel between cities, metropolitan economies depend on their ability to provide high-quality airline service to many destinations. This is especially true for world-city regions like the New York metropolitan area that are even more dependent on industries with a high propensity for flying. In New York, New Jersey and Connecticut, the leading economic sectors – financial and business services, tourism, pharmaceuticals, media and communications, higher education, research and development – all rely on frequent air travel to many destinations. Indeed, the region's status as a nexus for domestic and international air travel is intricately linked to its role as a premier center of global commerce.

This crucial link between air travel and economic prosperity is threatened by a lack of adequate capacity in the region's aviation system, including air space, airports and landside connections. This is manifested in flight delays that greatly exceed those of every other major airport in the United States. These delays cost the region hundreds of millions of dollars each year in lost wages and business income. In the future, without additional capacity the impacts will be far more severe. While delays cost valuable time and can inhibit some from flying, having too few flights to handle demand will prevent millions from flying and cost the region thousands of jobs and billions of dollars.

Strained capacity at the airports is more than a local problem. Delays at the region's three major airports – Kennedy, Newark and LaGuardia – ripple through the national aviation network causing delays from Washington, DC, to Los Angeles, CA. Constraining the New York region's capacity for air travel growth would also weaken the nation's ability to compete for global business in finance, media and other industries for which New York is the nation's leading international center.

Solutions will require both short-term and long-term actions, as well as a coordinated strategy by a number of public and private sector participants, including the Port Authority of New York and New Jersey, which operates the three airports, the Federal Aviation Administration (FAA), which regulates and controls the nation's airspace, the private airlines that operate terminals and schedule flights, and the city and state agencies responsible for the roads and transit network connecting to the airports. The findings and recommendations that follow, while not necessarily representing the views of any organization other than Regional Plan Association, were developed in consultation with these and other stakeholders listed in the appendix.

Today, the region's three airports rank 1st, 2nd and 3rd for worst delays in the nation, a product of more flights than the region's constrained airports and airspace can handle. While delays at most airports in the nation averaged about 10 minutes, takeoff and landing delays at each of our airports exceeded an average of 20 minutes per flight. These averages mask the wide variability that can make flying times unpredictable and frustrating. To limit the delays created by the excessive flights scheduled during peak times, the FAA placed a cap on hourly flights at all three major airports. This action limits the ability of the three airports to meet current or projected growth.

While the rate of growth is difficult to predict, the demand for air travel is almost certain to continue to increase substantially over the coming decades. Air traffic has increased in every decade since commercial flights were introduced, and a growing international service economy will drive up demand in the future. In 2010, about 104 million people flew in and out of our three major airports. It is expected that the demand for passenger volumes would reach 150 million, if the capacity is available, as early as 2030. The growth is fueled by global economic expansion, the continuing attraction of the New York region for visitors, and growth in the region's population, from 22.4 million today to an expected 27.3 million by 2040.

If they can be accommodated, these additional air passengers represent a major source of growth for the region's economy. In 2009, air passengers and cargo generated $16.8 billion in wages and $48.6 billion in sales to the region, and supported nearly 415,000 jobs. Without additional capacity, the region will forego an increasing number of jobs, wages and sales each year. By the 2030s, these losses could reach as many as 125,000 jobs, $6 billion in wages and $16 billion in sales each year.

To both reduce delays and accommodate future demand for air travel, the region will need to expand capacity by 78 additional flights per hour during peak period, up from 236 today. This added capacity will be needed to serve an additional 39 million passengers, who without it, would be unable to fly into and out of the region's airports with reasonable predictability. Just to maintain the current uncompetitive level of 20-minute delays, there would still be a need for 45 more flights per peak hour to handle an additional 22 million passengers.

Creating this capacity will require a combination of actions, some of which can be implemented in the next few years while others could take two decades or more to complete. RPA examined six categories of potential investments and demand management.

1. Implement NextGen I and II, a phased implementation of technological investments and operational and procedural changes that would transform the nation's air traffic control system
2. Encourage the use of outlying airports – Stewart International in Orange County and MacArthur in Suffolk County – to free up capacity at the three major airports
3. Improve intercity rail service to free up capacity at the airports by shifting passengers from shorter-distance flights
4. Build a new airport to handle growing demand
5. Manage demand to reduce peak period flights
6. Expand runway capacity at the three major airports

These actions vary widely in terms of the capacity potential, cost, timeframes, implementation barriers and environmental impacts. Some actions have benefits beyond their potential to increase the effective capacity of the region's airports, and may be regional priorities even if their ability to relieve airport congestion is limited.

The potential to add capacity or reduce demand for peak-period flights was quantified for each set of actions, and the probable magnitude of costs and other impacts were considered in developing recommendations. Because of the costs and possible environmental impacts associated with runway expansion, all other possible actions were thoroughly examined to determine if, taken together, they could preclude the need to physically expand the airports.

Of all the actions considered, expansion at Kennedy and Newark airports provide the greatest potential for increasing capacity and reducing delays. The implementation of NextGen could potentially address capacity needs in the next five to ten years, but it would not alleviate the need for eventual airport expansion. Other actions would only slightly delay the need for airport expansion, yet many also provide other benefits. To ensure that New York maintains a world-class aviation system, it should strive for the dual objectives of meeting a projected demand of 150 million passengers by 2030 and reducing average delays from 20 minutes to the national norm of 10 minutes. The only way to meet these objectives is through the expeditious implementation of NextGen and immediate planning for the eventual expansion of Kennedy and Newark airports. Other short-and-intermediate-term actions, especially expanding service at Stewart and MacArthur airports, should be encouraged. Improving intercity rail service should also be implemented, both to increase traveler options and help relieve congestion before the expansion at KennedyK and Newark is completed.

The benefits and issues for each set of actions, including the potential of each to expand the capacity to handle peak-period demand is summarized below.

NextGen I and II

The FAA's *NextGen* program is a package of new technologies, such as Global Positioning Systems, that is used to track and guide aircraft, as well as a suite of operational and procedural changes. NextGen, which is being deployed by the FAA over the next few years, is capable of reducing delays and expanding airport landing and take-off capacity. This report concludes that NextGen could have a favorable effect on capacity if deployed for that purpose, but only for the next five to ten years. NextGen I, with full implementation expected by 2018, could add the capacity for 21 flights an hour in the peak period. The impact of NextGen II is more difficult to predict, but would both reduce delay and add flight capacity following its projected implementation in 2025. Even with the most optimistic projections, however, growing air passenger volumes will overwhelm its ability to keep pace with demand.

Expanding Outlying Airpor

The report examined the potential for shifting demand to the region's outlying airports, opening up more capacity at the core airports. We concluded that Stewart Airport in Orange County, acquired by the Port Authority in 2007, and MacArthur Airport in Suffolk County, each would have a positive effect, but would only attract slightly more than 2.5 million of the 150 million passengers expected in the 2030s, or about 5 of the 80 additional peak-periods flights needed by the 2030s. Expansion of air service at these airports would bring other benefits, including better access for locally generated traffic in the Hudson Valley and Long Island, and give a boost to those local economies. A longer-term action could include the introduction of passenger service at Monmouth Airport, which could divert as many as 3 million passengers from Newark Airport.

Improved and High-Speed Intercity R

Higher speed intercity rail service is another means to attract air passengers, as it has done in recent years with improved service on the Northeast Corridor. The promise of still faster trains could attract still more customers. The expected progress in rail speeds by 2030 could shift 2 million air passengers, or the equivalent of about nine peak period flights. Truly high-speed trains, which would require significant investments in new rights-of-way, would expand rail's attractive power to over 4 million passengers. A number of factors prevent these estimates from being higher. In particular, only 15 percent of the air passenger trips to and from the airports in the region are to locations within 500 miles, and a large share of air passengers flying short distances are connecting at the New York airports to other places, making their use of rail to reach New York inconvenient for making connections. In addition to these modest improvements in flight capacity, high-speed rail would add a new dimension to intercity travel with a number of other travel and economic benefits.

Building a New Airport

Building an entirely new airport is difficult in a region as densely developed as the tri-state metropolitan area. There must be sufficient land in locations that are both suitable for development and accessible to enough potential passengers that would choose it over existing airports. An exhaustive search for parcels large enough to hold a new airport within 40 miles of the Manhattan central business district (CBD) located no appropriate sites. The possibility of expanding existing outlying airports was also examined, but these sites were either too small or too far from the CBD. Finally, the concept of constructing an airport island to serve the region was evaluated. It was concluded that the costs for a project of this scale, along with the requirement to close either Kennedy or Newark to open up airspace for the new airport, made this option untenable at this time.

Managing Demand

A number of potential demand management tools have been suggested to use existing capacity at the three major airports more effectively by encouraging higher capacity aircraft and by better utilizing the times when airport capacity is not fully used. These include bans of small-sized aircraft (under 50 seats), ban of short flights (under 250 miles), a cap on the frequency in over-served markets, pricing of peak flights to encourage shifts to the off-peak, and auctions. Most of these either proved unworkable or had only a small impact on freeing capacity. A limited number of recommendations emerged from this investigation, including the possibility of thinning out service in saturated markets. These recommendations, most of which would be resisted by some constituencies, deserve consideration for their beneficial effects on the margin, particularly in the long term at La Guardia, since physical expansion is not feasible there.

Regulation can play another role though. As passengers respond to higher speed rail service or shift to outlying airports, there is no guarantee that airlines will respond by dropping peak-hour flights. The establishment of a process to encourage airlines to drop peak-hour flights would make these other travel options more effective to free up peak airport capacity.

Ground Access and Impact on Airport Capacity

The report concludes that the limitations of ground access, while in need of attention, do not limit growth. While traffic conditions may cause additional delay and may deter some prospective passengers, they will not discourage a large number from flying if the imperatives to fly are there. Collaboration among the transportation agencies is recommended to ease traffic congestion and to develop the promising short- and long-term bus and rail transit options to all three airports outlined in this report.

Expand Existing Airports

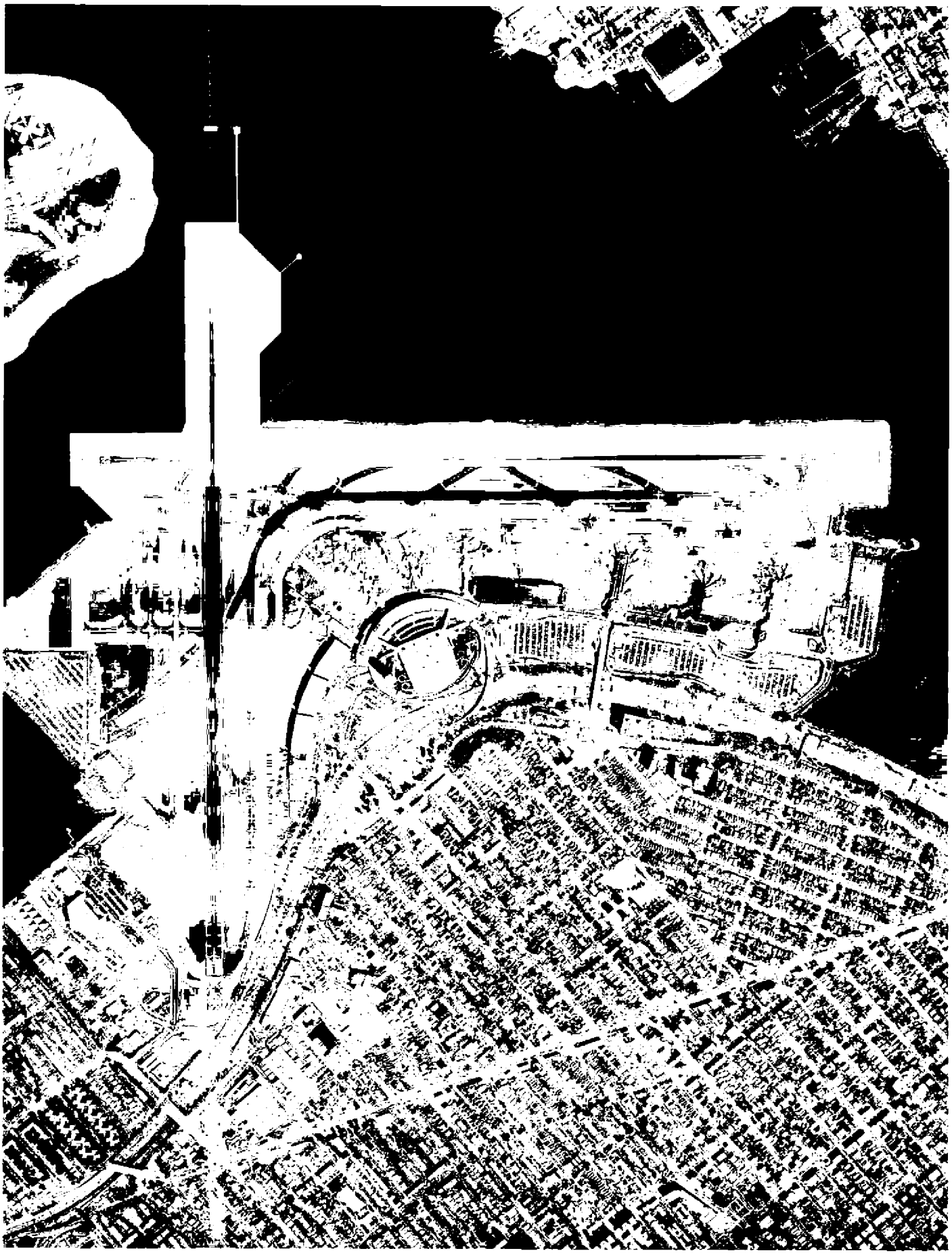
After consideration of all the potential capacity-increasing and delay-reducing actions – NextGen, outlying airports, intercity rail, and regulatory actions – this report concludes that expansion of the capacity at Kennedy and Newark will be necessary. Options to expand La Guardia, with a smaller footprint in a more developed area, would result in less new capacity with greater impacts on local communities and navigation of surrounding waterways.

The Port Authority should begin to plan now since airport expansion will not happen overnight and serious capacity deficiencies will become even more apparent in the next ten years. At Kennedy, four alternative configurations meet basic airspace and capacity criteria. Each has its advantages and disadvantages. The choice among them, or with possible variations and phasing plans, should be made by the Port Authority, working with the local and environmental communities, in the next few years. At Newark, one configuration stands out. It is within the airport footprint, minimizing impacts off-site, but it would require the redesign and relocations of one or more of three terminals on the airport.

Conclusion

A successful expansion or reconfiguration at Kennedy and Newark, along with NextGen, can meet the twin goals of capacity and delay reduction in the 2030s and beyond. Choosing inaction will result in an economic drain on the region. It will discourage business, limit visits, and prevent our region from fully participating in the global economy.

The inability of the combined impacts of NextGen, outlying airports and faster intercity rail to stem the need for eventual airport capacity expansion should not be viewed as a reason to deemphasize these actions. To the contrary, they are each of great value. NextGen will allow the reduction of delays and the expansion of capacity through more accurate tracking and more flexible airspace opportunities. Outlying airports such as Stewart and MacArthur will serve localized areas, building up local economies and offering air travel options. Faster rail travel, particularly in the Northeast Corridor, will divert travelers from the highways and knit together the economies of the Northeast.



The Region's Airports Today

Most of the New York region's residents and businesses rely on the Port Authority of New York and New Jersey's three commercial airports – John F. Kennedy International (JFK), Newark Liberty International (EWR) and LaGuardia Airport (LGA).[1] These three airports serve over 100 million passengers annually and account for the 95 percent of the 3,700 daily scheduled commercial airline aircraft operations in the region,[2] and about two-thirds of the 5,000 daily commercial operations at airports within 100 miles of Columbus Circle in Manhattan. The three major airports have only a limited general aviation function; however, JFK and EWR airports are among the largest, by volume, air cargo facilities in the world.

The Port Authority also owns and operates Teterboro (TEB) airport, a "reliever" facility located in Bergen County, New Jersey, and in 2007 acquired the lease to operate Stewart International Airport (SWF) in Orange County, New York. TEB is predominantly used by private corporate jets (69%), last year serving almost 140,000 aircraft. SWF currently has three commercial passenger airlines that combined served almost 400,000 passengers in 2009, a significant drop from a high of over 900,000 in 2007 before the recession.

The Growth of Air Travel: 1948-2009

History

In 1948, the three major airports in the tri-state New York-New Jersey-Connecticut metropolitan region[3] – LaGuardia or LGA (originally known as New York Municipal Airport), New York International (commonly known then as Idlewild and now JFK International or JFK), and Newark (now Newark-Liberty International or EWR) carried 3.6 million passengers per year, or about 1,000 a day.[4] Most of this traffic was at LGA; JFK had opened for commercial service only that July (1948).

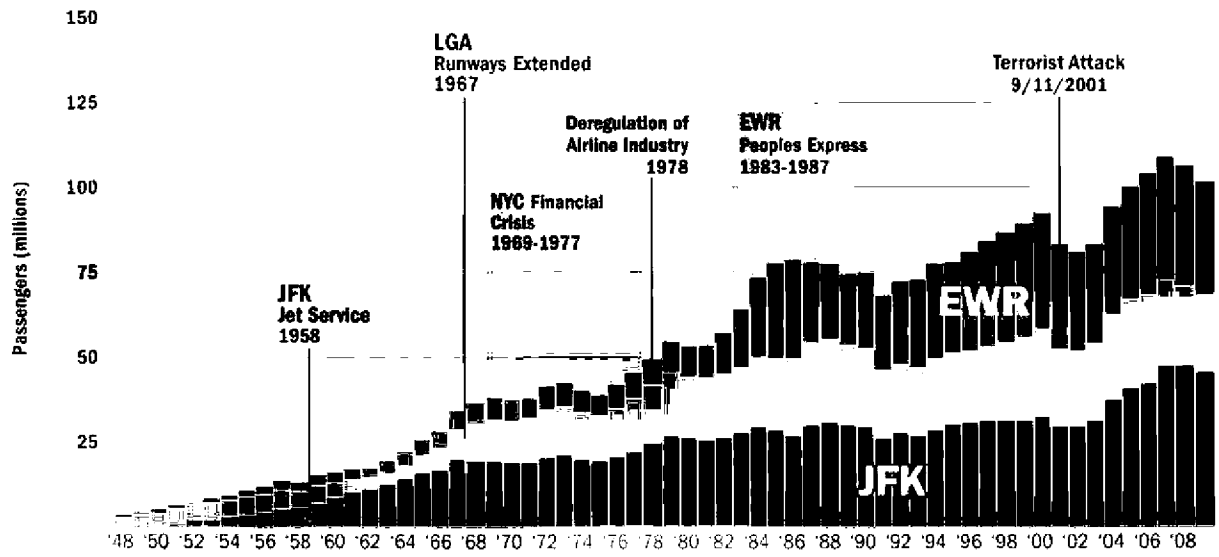
In the sixty years that followed, combined traffic at the three airports increased by a factor of 30, a rate far surpassing population growth in either the region or the United States. By 2007, over 109 million passengers, an average of almost 30,000 per day traveled through these three airports, although it has declined to 101.6 million in the last two years in response to the deep recession.

This phenomenal growth has been fueled by many factors:

Figure 1.1

Air Travel Demand at New York Airports: 1948 to 2009

Source: Port Authority and Regional Plan Association



1 The Port Authority is a bi-state agency with responsibility for airports, ports, interstate water crossings and other transportation facilities within the core of the New York metropolitan area.

2 The FAA's ASPM dataset only includes scheduled operations for EWR, JFK, LGA, Westchester County, Teterboro, MacArthur and Stewart Airports (Allentown, Tweed New Haven and Atlantic City are not included).

3 The region is defined by Regional Plan Association as the 31-county, three-state, metropolitan area centered in New York City and extending to central Connecticut, all of Long Island, the Hudson Valley to include Dutchess and Ulster counties, and to central and western New Jersey.

4 In this report these three airports will be referred to as JFK, LGA and EWR, using the official three-letter airport designations.

- the expansion of incomes that makes air travel more affordable;
- the development of faster and more comfortable jet aircraft with greater flying range to serve more places;
- air fares that grew much more slowly than the rate of inflation, owing in part to deregulation of the airline industry starting in 1978;
- the growing national economy;
- a growing immigrant population who retains ties to its homelands, and globalization of the world's economy.

Figure 1.1 depicts the growth of passenger traffic at the three major airports individually and collectively. The growth has been relentless, but uneven, fueled by several key events.

In the early years – 1948 to 1969 – the three major airports under the management of the Port Authority, saw rapid growth from 3.6 million to almost 40 million annually, or an average of about 12 percent per year. This period was characterized by successively more attractive passenger aircraft. In 1950, eight years before the first jets were introduced at JFK, scheduled airlines flew non-stop to only 51 destinations. Then the workhorse aircraft was the DC-3 with an effective range of 500 miles and a cruising speed of 150 miles per hour. This led to "puddle-jumper" routings that stopped at many cities on the way to the Midwest and beyond, which made for time consuming and unattractive choices.

By the early 1950s, the newly introduced Douglas DC-6 and the Lockheed Constellation in the longer distance markets expanded the range, but it still took eight hours to travel coast to coast at about 325 mph. The Constellation required two stops for refueling to reach continental Europe. For trips to Central and South America, refueling took place in Havana, Cuba, and Port of Spain, Trinidad.

Jets arrived at JFK in the form of the Boeing 707 and DC-8 in the late 1950s. They were able to cut coast-to-coast and trans-Atlantic travel time by almost half and had a range to allow non-stop flights to and from many more places. Flying also became a more pleasant experience since jets fly at higher altitudes where the ride is smoother and quieter than their propeller driven predecessors. In the ten years after the introduction of jets, air passenger traffic at the New York airports almost tripled. JFK grew the fastest, as international travel became more commonplace, reinforced by the location of the United Nations in New York and its standing as the sole gateway across the Atlantic to the rest of the United States.

The effect of the introduction of new services is reflected in the growth of each of the airports and the share of travel they captured. In 1954 JFK captured only 31 percent of the air travel in the region, but by 1964, with the advent of the jet, its share had grown to 64 percent. Similarly, the lengthening of the LGA runways in 1966 to accommodate the new smaller jet aircraft like the Boeing 727 led to a rising share of the region's air travel at LGA, rising from 15 percent in 1963 to 34 percent in 1972. This growth at LGA was limited by the perimeter rule, which limited flights from LGA to distances of no more than 1,500 miles.[5]

Another factor that affected the relative use of the three airports was airline deregulation. Put in effect in 1978, it produced new airlines, stiff competition and lower fares. One of the first and most locally notable low cost carriers in the New York area was Peoples' Express. The advent of Peoples' Express at EWR, brought about much lower fares. The resulting bump in traffic at EWR is evident in Figure 1.1. This bubble collapsed in the late 1980s, and traffic subsequently dropped. During this bubble, EWR's share of the New York traffic jumped from 19 percent in 1980 to a high of 37 percent in 1986, before the collapse of that airline brought EWR's share down to the low 30 percent range where it sits today.

While People Express[6] was one of the most notable new carriers in the New York region, it was not alone. Other airlines such as New York Air, also started new services. These carriers ultimately went bankrupt or were bought by other airlines. Deregulation had achieved its objectives of increasing competition, lowering fares and increasing air travel.

The latest and most notable new entrant carrier is JetBlue, which started service at JFK in 1999. Between 2003 and 2008, JFK grew from 38 percent to 45 percent share of the three major New York airports as JetBlue increased its service volume and other carriers responded with new flights of their own.

This history suggests that the region's airports cannot be planned monolithically. Changes in the way the airports function have varied in the past and are likely to do so in the future.

Today, scheduled airlines fly directly from the New York airports to 226 locations around the world to places as far removed as Honolulu, Moscow and Beijing.

The Impact of the Economy on Air Passenger Demand

Upgrades in aircraft drove the growth of air travel, but economic conditions were no less important. Starting in the late 1960s and continuing to 1977, New York City experienced a major economic downturn – Manhattan alone lost 20 percent of its jobs from 1969 to 1977. During this period air traffic averaged an annual growth of only 1.0 percent. Higher fares and fuel shortages brought on by the energy supply crisis of 1973 – 1974 also had an effect on air traffic.

The 1990s brought consistent growth, interrupted by the tragedy of 9/11 and the economic downturn of 2000-2002. Air traffic continued to track the economy, expanding through 2007 before declining in 2008 and 2009 in response to the deep international recession.

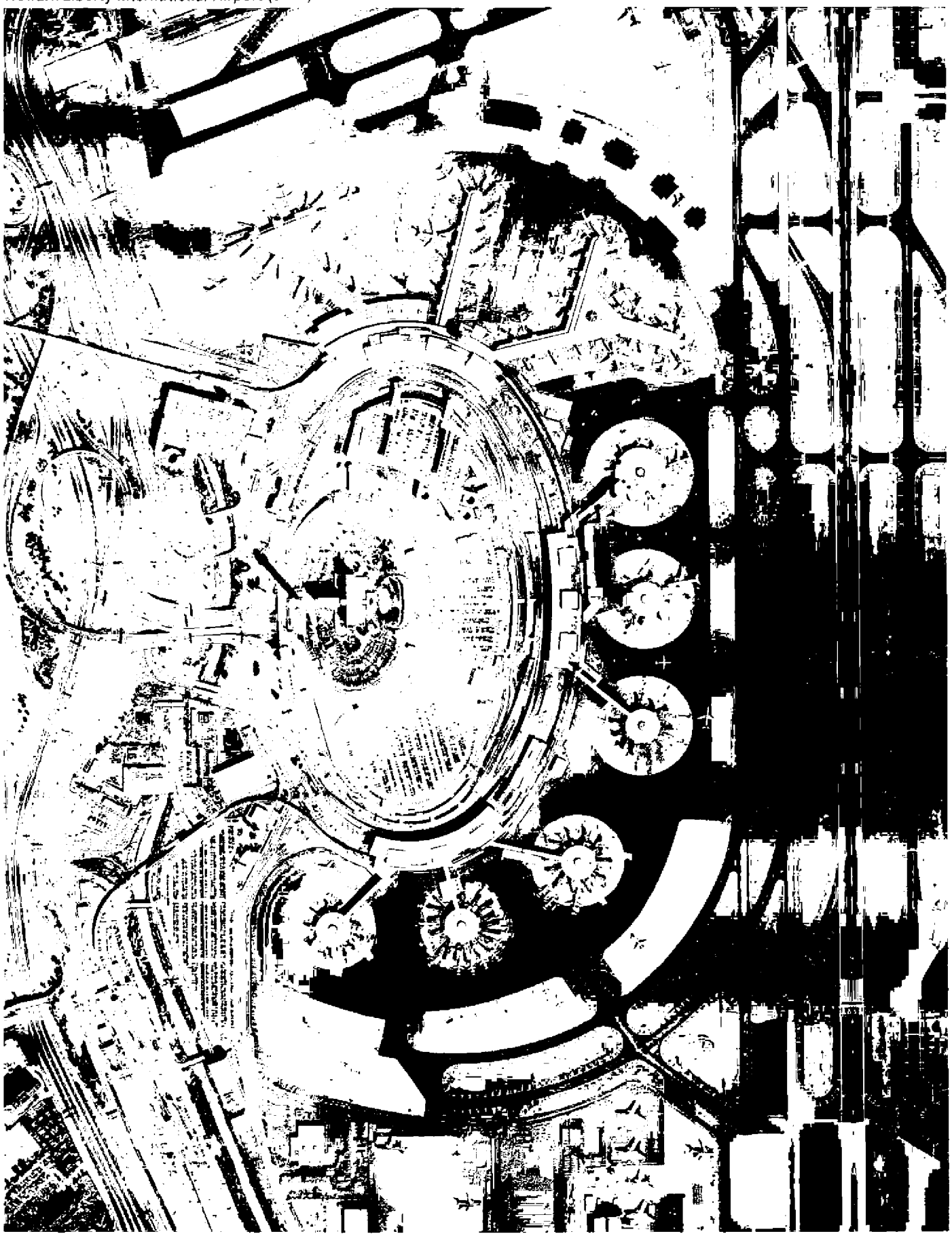
The impact of the economy on air travel has been evident throughout, even during periods of other positive and negative events. Since 1948 there has been nine recessions, each coinciding with either slower growth rates or declines in air traffic. In Table 1.1 the air passenger changes are shown for these nine instances and are contrasted with the growth in the years immediately before and after the recession years. In every instance the growth was higher in both the before and after years. This suggests that air traffic growth generally tracks cycles in the region's economy.

Even as air passenger growth rates are buffeted by economic conditions, there is an underlying trend as the industry matures. The annual growth rate averaged 12 percent prior to 1969, but only about 2.5 percent since. Each ten-year period since 1969 registered a lower rate than the decade before; 3.6 percent from 1969 to 1979, 3.1 percent from 1979 to 1989, 1.8 percent from 1989 to 1999, and 1.5 percent from 1999 to 2009. These data track the maturation of the aviation industry. While the future

5 This rule was in place informally since the 1950s to encourage greater use of JFK, and was formally imposed in 1984, but excludes flights to and from Denver, which were "grandfathered."

6 The official name was PEOPLE Express but this report will use the more often-used spelling.

Newark Liberty International Airport (EWR)



could vary from these past trends, they provide context for the evaluation of future demand and its implications.

Regional Economic Impacts

In December 2009, the FAA published *The Economic Impact of Civil Aviation on the U.S. Economy*. According to this study, in 2007, civil aviation generated $1.7 trillion in sales and wages and supported about 11,512,000 jobs throughout the country.

A recent Port Authority study completed by Landrum and Brown estimated that in 2009 passenger aviation traffic at the three airports in our region generated a total of $16.8 billion in wages and $48.6 billion in sales to the region and supported nearly 415,000 jobs. This economic impact falls in three categories:

- Operating impact of the aviation industry: on- and off-airport services rendered to passengers.
- Economic impact of air visitors to the region, including tourists and business travelers.
- Economic impact from investment in airport infrastructure

Details from this analysis are presented as Table 1.2.

Airports Today: Too Little Capacity for Growing Demand

Measured by the percentage of flights that are delayed, the New York metropolitan region's three major airports are the worst performing among the 31 largest in the nation.[7] The reasons for their poor performance can be put simply – very high demand and too little capacity. This region has more air passengers than any other metropolitan region in the nation because it has more people and more economic activity than any other metropolitan area. And New York City is the most attractive destination for tourists in the nation, overtaking Orlando in 2008.

Meanwhile, the three airports each have limitations on their abilities to handle the demands placed on them. They are limited in size and surrounded by residential and commercial development, constraining expansion options. Runway layouts thwart their full use because of intersecting or closely spaced parallel runways. The three airports (plus Teterboro, Islip and to some extent Westchester County airport) share much of the same airspace – all within a twelve-mile radius, which creates conflicts that lower their individual and collective capacity. A more detailed technical discussion on how the physical configurations and operational environments of our three airports contribute to aircraft delays will be presented in Chapter 2.

In the most recent full year of data (2009), EWR ranked first (worst) with 34 percent of their flights arriving late, LGA second worst with at 31 percent and JFK fourth worst at 26 percent. In 2007 when passenger volumes were higher before the impacts of the recession were felt, late arrivals and departures had reached their all-time peak. That year the New York airports performed at their worst levels, with the arrivals late 41 percent of the time at LGA, 40 percent at EWR, and 37 percent at JFK. The share of departure operations leaving late at the three airports ranked slightly higher than late arrivals, since the airlines schedule excess time, referred to as "padding," at the gate before they depart. When arrivals and departures are combined, in 2009 EWR ranked worst among the 31 largest airports in the nation, LGA second worst, and JFK ranked sixth from the bottom.

[7] A delayed flight is defined by the FAA as being more than 15 minute behind the scheduled arrival or departure time..

TABLE 1.1

Air Passenger Growth Dampens During Recessions

Recession Year(s)	Previous Year	Year(s) of Recession	Following Year
	Annual Growth Rates, Percent		
1954	20.6	12.1	16.3
1958	10.8	0.8	14.9
1960, 1961	14.9	3.8, 3.8	6.7
1970	20	-2.6	2.1
1974, 1975	4.1	-4.7, -3.5	7.8
1980, 1981	10.7	-2.2, +1.1	5.5
1991	0.5	-8.8	5.3
2001, 2002	3.6	-9.6, -2.9	3.0
2008, 2009	4.7	-2.6, -4.4	NA

Source: Port Authority and Regional Plan Association

TABLE 1.2

Passenger Economic Impact Summary for the NY/NJ Region

In Million $ 2009		JFK	EWR	LGA	TOTAL
Passenger Operating Impact	Wages	$3,509	$5,929	$2,042	$11,480
	Sales	$9,898	$16,483	$5,779	$32,160
	Jobs	67,134	112,685	38,798	$218,617
Visitor Economic Impact	Wages	$2,092	$3,531	$2,151	$7,774
	Sales	$5,551	$9,391	$5,707	$20,649
	Jobs	52,552	89,117	53,834	$195,503
Total of Passenger & Visitor Impact	Wages	$5,601	$9,460	$4,193	$19,254
	Sales	$15,449	$25,874	$11,486	$52,809
	Jobs	119,686	201,802	92,632	$414,120
Annual Passengers (Millions)	O&D Pax	25.1	36.8	20.0	$82
	Connecting Pax	8.4	9.3	1.8	$20
	Total Pax	33.5	46.1	21.8	$101
Impact per 1,000,000 Passengers/Visitors	Wages	$167	$205	$192	$190
	Sales	$461	$561	$527	$521
	Jobs	3,573	4,377	4,249	4,084

Sources: Port Authority; Landrum & Brown analysis

The Cost of Congestion and Delay

The economic costs to the region of delays at the three major New York airports were documented for the Partnership for New York City (NYCP) by consultants in February 2008[8] The report estimated that in 2008 business travelers lost almost $700 million from delays and personal or tourist travelers lost about $1 billion. These estimates were made assuming a value of time, i.e. what travelers would be willing pay to avoid the delays, which is a standard practice in transportation analysis.[9] These value-of-time estimates were set at $40.10 per hour for business travelers and $23.30 for the personal travelers. The NYCP study also calculated the annual cost to shippers ($136 million) and to the airlines in higher labor costs and the greater fuel costs from delays ($834 million). Their estimates do not include delays associated with poor weather since they cannot be attributed to the airports themselves.

8 The Economic Costs of Congestion at New York's Principal Airports: Final Report: October 22, 2008; HDR/HLB Decision Economics, Inc.

9 U.S. Department of Transportation. Revised Department Guidance: Valuation of Travel Time in Economic Analysis," 2003, tables 4 and 5.

The delays calculated for the NYCP were based on the average departure and arrival delays at the three airports for the sample months of February, March, July and August 2007. These averages are reported for peak weekdays in Table 1.3. The estimates based costs of passenger delays on these averages. The methodology includes the time difference between actual and scheduled departure times. The passenger plans his or her journey based on an expectation that a flight will depart on time. The lateness of a flight's departure is added to the passenger delay, even though the new flight has not yet experienced any delays. The analysis showed that on-time performance deteriorates as the day progresses. In 2007, passenger delays escalated from 20 minutes during early morning hours to over 90 minutes during evening hours.

In addition to the cost of passenger delays, airlines incur costs too, with higher fuel costs and payroll. The FAA tracks these delays in its aviation system performance database (ASPM) as the difference between actual travel time and the travel time estimated in the flight plan for the flight. Flight plans consider winds and the actual routes of flight and are better estimates of planned times than published scheduled times since schedules include allowances or "pads" for delays while flight plans do not.

Table 1.4 shows that 2007 annual aircraft delays at the three airports were 561,000 hours. The typical aircraft at the three airports costs about $2,865 per hour to operate for crew costs, fuel, and maintenance. In 2007, delays in the New York region cost the airlines over $1.5 billion. By 2009, reductions in air traffic due to the recession, cut delays per aircraft and total delays to 384,000 annual hours and delay driven costs fell to about $1.1 billion.

These cost-of-delay estimates are conservative in that they do not account for some delays and costs that are difficult to estimate monetarily, but nonetheless are real. These include:

- The value of the time lost by ground access services such as black cars and limousines that are forced to spend extra time on the ground waiting for late arriving passengers;
- The value of the time lost by friends and relatives waiting for arriving passengers;
- The value of the time lost because of flight cancellations; 2.2 percent of all flights in 2007. Some of these could be attributed to the New York airports.
- Expenses associated with traveling early, including overnight expenses in anticipation of unreliable arrivals in other cities the next day.
- The value of the extra time that travelers schedule when making connections to provide a margin to avoid missing a connecting flight;
- The losses of business to the airlines as travelers choose to travel by a different mode because of air travel's unreliability. This loss might be offset by the economic gain accrued to other modes.
- The cost to the traveler of any additional time spent on an alternative mode chosen to avoid the potential unreliability of air travel.
- Finally, and perhaps most importantly, the economic loss of business opportunities never taken as businesses (and individuals) choose not to expand or relocate into the region because of the poor air service quality.

TABLE 1.3

NYCP Estimates of Passenger Delays during Peak Weekdays, 2007 (in minutes)

	Arriving	Departing
EWR	51.0	67.2
JFK	55.7	78.7
LGA	51.0	49.8

Source: Grounded, a New York City Partnership report, 2008

TABLE 1.4

Annual Aircraft Delay Hours at the Region's Airports

Year	JFK	EWR	LGA	Regional Total
2007	202,000	204,000	155,000	561,000
2008	161,000	185,000	135,000	481,000
2009	126,000	151,000	107,000	384,000

Source: FAA Aviation System Performance Metrics Database and Regional Plan Association Analysis

To these material costs must be added the incalculable psychological costs brought about by the uncertainties associated with the air travel experience that could lead to ruined vacations or aborted business meetings. Many of these additional costs are difficult to put in quantitative terms, yet they cannot be ignored. They are indicative of real time and real costs to the businesses and residents of the New York metropolitan region.

Long-Term Consequences of Delay

Since air travel corresponds very closely with economic activity, when the economy improves there will almost certainly be a decline in on-time performance. However, growth would likely not materialize, as added traffic would lead to the imposition of caps on the number of flights per hour by the Federal Aviation Administration, as it seeks to prevent delays in New York from reverberating throughout the country.

The net effect of the FAA cap will be to limit passenger and airline delay costs to the levels experienced in 2009 or $2.7 billion. However, flight activity in the New York area will no longer grow along with the economy. Our airports support economic activity within the region and lack of growth at the airports will translate directly to fewer visitors and fewer jobs for the region. As described earlier, the airports currently contribute over $73 billion per year to the region's economy.

As air passenger demand grows, the inability to accommodate that growth will negatively impact the region's economy. As will be detailed in Chapter 4, each passenger lost to the region has an impact on the economy; every 10 million passengers not served will result in a $6.5 billion loss to the economy. By the time air travel reached 150 million annually, in the absence of bold steps, approximately 40 million passengers will not be served, bringing the loss to $26 billion annually. These future economic losses will dwarf the current losses from delays. The purpose of this report is to find the best way to serve these passengers.

Photo: Port Authority

The Region's Airport System

How It Works and What Needs Fixing

To ensure that the airport system operates at its optimum level, the capacity of all the components discussed in this chapter – runways, taxiways, aprons, gates, terminals, ground access – must be adequate. The failure of just one of these components can potentially cripple operations at all of our airports. This is true not only for the airport proper, but for the surrounding airspace; if the airspace cannot safely deliver the capacity that the airport is capable of, then the system is constrained. Runways require supporting taxiways to quickly clear arriving aircraft and circulate traffic between them and the gates, while also providing the flexibility for aircraft to navigate throughout the airport. Aircraft operators need aprons to store aircraft or else gates and taxiways become de facto parking lots and congestion is likely to occur, impeding the flow of traffic to and from the runways. There might be sufficient runway and ancillary airfield capacity, but no available gates. The airfield and terminals might be able to support a level of service that landside transit connections and roadways are unable to receive or transport offsite.

In the New York region, the capacity of this complex system is faced with four fundamental constraints that no other region in the United States experiences to the same degree:

- **Land Constraints:** Each of the three major airports is located in a dense urban area with very limited capacity to expand either within its current boundaries or by expanding outward.
- **Airspace Constraints:** Collectively, these three high-volume airports (plus Teterboro) operate within a small area, with the airspace of each airport overlapping with the others to create a tremendous air traffic management challenge.
- **Landside Access:** Congested highways and limited transit options further reduce options for expanding capacity, and need to be considered in tandem with airport and airspace issues.
- **Older Facilities:** While in many ways the region's aviation system is as advanced as any in the world, some of the facilities are in need of updating. Both landside and airside components require continuing modernization and maintenance, with many of these components being in need of periodic replacement. A recent example is the complete reconstruction and expansion of Bay Runway (13R/31L) at JFK in 2010. Later in this chapter, a more detailed description of the investments made to update the airports is provided.

This chapter describes the functions of the different components of this system, the capacity challenges facing the system as a whole, and the particular issues of each airport.

How It Works – Components and Integration of the New York Aviation System

Today's modern airports are complex systems with interdependent components that are owned and managed by various public agencies and private corporations. While the technologies and techniques have evolved since the early days of commercial aviation, the basic configuration of an airport has not. Simply stated, the airside components of an airport are where aircraft operations take place and landside components are where passenger handling occur. The point where these two converge is at the terminal gates where passengers enter or leave the aircraft. The major airside components are the gates, aprons, taxiways, runways and airspace (air traffic control). On the landside there is curb space, internal roadways, parking facilities and transit connections/facilities (ground access), and the passenger processing portion of the terminals – check-in, baggage handling, security functions, passenger convenience facilities, lounges, and gates.

FIGURE 2.1
Elements of the Airport System
Source: Regional Plan Association

Vehicles	People	Aircraft
Ground Access	Terminal	Apron
Internal Roadways	Gates	Taxiway
Parking		Runway
Curb Space		Airspace

These airport system elements are further identified in Figure 2.1 as those that serve:

a. Ground vehicles that facilitate people traveling to or from the airport:

b. People once they leave those vehicles or before they enter them, and

c. The aircraft.

These three categories represent the modes that interact with the various airport components: a private automobile taking up curb space, pedestrians navigating on foot through a terminal concourse or an aircraft taxiing-out to a runway.

Responsibilities Assigned for Airport Elements
Source: Regional Plan Association

Vehicles		People		Aircraft	
		Airlines		FAA	
Ground Access	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Various	Port Authority				

Vehicles clearly fall on the landside and aircraft on the airside, but people are the transitional element, navigating between both faces of the airport.

Figure 2.2 takes these elements and assigns the responsible organization for each. Many of these elements overlap, requiring these various organizations to coordinate efforts to maintain, improve and operate the airports. For example, the Port Authority is responsible for the airside components of the airport along with both the airlines and FAA. The aprons are managed by the airlines and the taxiways by the FAA[1], both of these components and the runways are maintained by the Port Authority. Many of the terminals at our airports are owned and/or operated by the airlines, with some exceptions that will be discussed later. The Port Authority is also charged with maintaining and operating the internal roadways and some of the transit connections, the EWR and JFK AirTrains.

The components where responsibility it less clear are the access roadways and transit connections and ground access components, where departments of transportation (New Jersey, New York State and City) and transit agencies play a role in providing capital for improvements and maintenance.

The three major airports in our region are predominantly owned by the municipalities in which they are located – by New York City for JFK and LGA and by Newark and Elizabeth for EWR. They are operated by the Port Authority.

Figure 2.2 serves as a reference to identify the organizations responsible for the development, implementation and funding of the various solutions that this study will recommend.

Characteristics of the Region's Airports

John F. Kennedy International Airport (JFK)

At 4,390 acres JFK is the largest airport in the region. It is also the busiest, serving over 46 million passengers in 2009. In the past JFK was the primary international gateway to the region, and it still carries almost two-thirds of the region's international passengers, with EWR carrying most of the others. It is a major domestic hub too. In the last few years its domestic volumes have grown rapidly, serving as the domestic hub for JetBlue and Delta Airlines.

The airport has four runways, the longest in the region at 14,572 feet, and eight terminals, with 141 gates, the most in the region. There are 17,150 parking spaces at the airport. On a typical day in 2009 there were 1,260 operations (arrivals and departures); 97% commercial, 2% cargo and 0.5% general aviation. In 2008 the United States Department of Transportation (USDOT) capped scheduled traffic at 81 operations per hour per 16-hour period, in an attempt to limit delays.

1 In some limited cases the taxiways are also controlled by the Airline ramp towers. For example a number of taxiways connecting the terminal C apron to the runways at EWR are controlled by Continental Airlines.

Newark Liberty International Airport (EWR)

EWR is the second largest (2,207 acres) airport in the region and predominantly serves air passengers starting or ending their trips west of the Hudson River. In 2009 over 33 million passengers chose EWR, with a growing number of flights destined for international markets. EWR is the domestic hub for Continental Airlines, which operates Terminal C – the largest terminal at the airport.

The airport has three runways, the longest measuring 11,000 feet, and three terminals, 104 gates, and 22,000 parking spaces, the largest number in the region. On a typical day in 2009 there were 1,150 operations (arrivals and departures); 93% commercial, 5.4% cargo and 1.1% general aviation. As at JFK, in 2008 the USDOT capped peak-hour scheduled traffic to 81 operations.

LaGuardia Airport (LGA)

LaGuardia opened in 1939 and was the first modern airport in the region. It is the most land constrained airport of the three major airports, with a footprint of only 680 acres. In 2009 LGA served 22 million passengers, most of them on domestic flights; with the only international destinations served in Canada and the Caribbean. The airport has two intersecting runways that are only 7,000-ft long and four terminals; the Central Terminal Building is the largest with half of the 74 gates. On a typical day in 2009 there were 1,126 operations (arrivals and departures), 99% commercial and 0.7% general aviation. In 2008, the USDOT capped peak-hour scheduled traffic to 74 (71 commercial and up to 3 general aviations slots) operations. LGA had served 75 flights per hour during the peak, and still does for much of the day. The number of operations per peak-hour will further decrease to 71 as slots are retired.

Table 2.1 summarizes the major characteristics of the three airports, giving a sense of scale of the three airports individually and combined.

Table 2.2 summarizes the number and type of aircraft operations at the three major airports. Despite their varied function and size they serve approximately the same number of aircraft operations.

Smaller Airports

There are 67 other airports in or near the region with six – Stewart International (the Port Authority took over Stewart's lease in 2007), White Plains-Westchester County, MacArthur-Islip, Tweed-New Haven, Atlantic City and Lehigh Valley-Allentown – having some scheduled passenger airline service. Prospectively,

TABLE 2.1

Summary Statistics for the Three Major Regional Airports

Airport	Acres	Daily Movements	Runways	Longest Runway (ft)	Gates	Parking Spaces
JFK	4,390	1,260	4	14,572	141	17,150
EWR	2,207	1,150	3	11,000	104	22,000
LGA	680	1,126	2	7,000	74	11,344
TOTAL	7,277	3,536	9	14,572	319	50,494

Source: Port Authority

TABLE 2.2

Arrival and Departure Operations by Type on a Typical Day in 2009

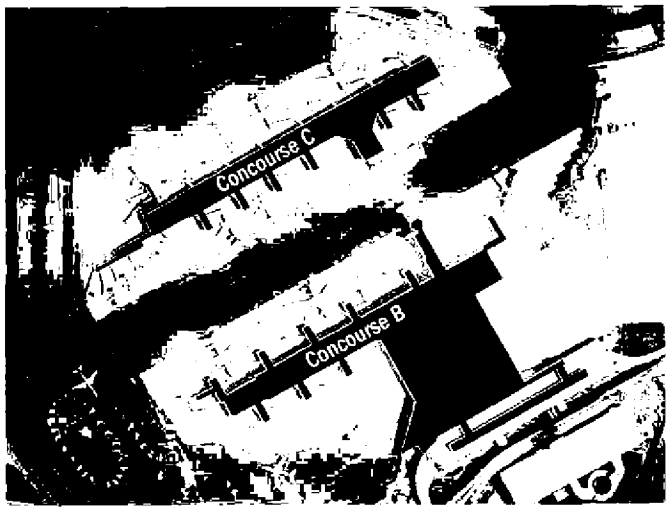
	Commercial		Cargo		General Aviation		Other		Total
Airport	Ops	%	Ops	%	Ops	%	Ops	%	Ops
JFK	1,224	97.1	25	2.0	6	0.5	5	0.4	1,260
EWR	1,150	93.3	67	5.4	14	1.1	2	0.2	1,233
LGA	1,118	99.3	0	0.0	8	0.7	0	0.0	1,126
Total:	3,492	96.5%	92	2.5%	28	0.8%	7	0.2%	3,619

Source: FAA Enhanced Traffic Management System (ETMS).

FIGURE 2.3

American Airlines Terminal 8 at JFK with Remote Concourse

Source: Regional Plan Association



the role that these and other smaller airports might play in alleviating delays at the three major airports will be examined later in this report.

Landside Elements and Constraints

The landside component of airport operations can be divided into two parts – the terminals where passengers embark and disembark, and the vehicle, roadway and transit systems that provide access to the terminals. Each of these is described separately below.

Terminal Function and Capacity Issues

The terminal serves a series of functions – passenger ticketing, baggage check-in and pick up, security checking, passport control and customs inspection, circulation space to permit passengers to move from gate to gate and elsewhere in the terminal, holding areas for departing and connecting passengers waiting at gates to board aircraft, areas for "meet-and-greeters" and areas for the convenience of passengers so they may dine or shop. Primarily, a terminal must facilitate the movement of passengers between ground transportation and awaiting aircraft.

These passenger-related features in a terminal must be designed in concert with the airside-related functions, especially where the landside and airside meet, at the gates. Terminals are designed to accommodate these gates and allow for the effective movement of the aircraft in and out of the gate areas.

The terminals in our region mostly use the finger pier or satellite (w/finger piers) configurations; the only remote concourse is Terminal 8 at JFK (accessible from the terminal via an underground passageway), as shown in Figure 2.3.

The design, ownership and operation of terminals at the three major airports vary. Table 2.3 shows the year each terminal was built, and who owns and operates it. At JFK, its private ownership and management of its eight terminals has led to a variety of designs and configurations, arranged in a circular pattern (surrounded by the airfield). The iconic TWA Terminal, designed by Eero Saarinen, is being rehabilitated and restored and will eventually be redeveloped for an alternative use. Terminal 5 opened in 2008. Terminals 1, 4 and 8 are also relatively new, having opened in the past fifteen years. Terminal 7 is older but in good condition. Terminal 2 was opened in 1962. Terminal 3 was opened in 1960 and was constructed by Pan American Airlines. Today, Delta Airlines has assumed control of both of these terminals. Terminal 6 (1970) is presently closed and its future role is currently undetermined; it will likely be razed and the site used to expand Terminal 5.

Terminal 4 is the main international terminal that serves 42 airlines, mostly smaller international ones. Terminals 1[2] and 4 are common-use[3] facilities, where airlines share gates, check-in and baggage claim areas. Unlike a conventional carrier controlled facility where gates sit idle unless the airline has a scheduled flight, this configuration allows the terminal to be used more efficiently, with gate assignments being adjusted based on the demand of all of the carriers.

The design of EWR's three terminals is largely uniform having been designed and built together in the 1970s. Terminals A and B were completed in 1973 and Terminal C in 1988[4]. They all have finger/pier concourses. Terminals A and B concourses have a "banjo" configuration where all of the gates are within a circular pod at the end of the concourse, while Terminal C has more traditional straight-sided concourses. Terminal C has twice the number of gates as the other two terminals. It serves both domestic and international flights, and was remodeled in 2003. EWR is a hub for Continental Airlines, which manages Terminal C. Terminal A is currently managed by United Airlines. The Port Authority plans to renovate or a completely replace it over the next few years. Terminal B, managed by the Port Authority, serves the majority of international traffic. This terminal is currently undergoing renovations and is the only terminal capable of accommodating Boeing 747 aircraft. All of the terminals at EWR are owned by the Port Authority.

LGA has four terminals, with over half of its traffic served by the Central Terminal Building (CTB). This structure is owned and operated by the Port Authority and has circulation constraints and limited gate capacity, with narrow alleyways obstructing access to innermost gates. The historic Marine Air

2 While Terminal 1 does operate in the common use mode, the four airlines that own the terminal have priority at check-in and each has its own lounge.

3 This is not a pure "common-use" configuration, as airlines are assigned positions at check-in. This will be discussed in more detail later in the report.

4 Most of Terminal C's structure was constructed simultaneously with Terminals A and B. However it was not fully completed until People Express expressed interest in moving its operations there in the 1980's.

Terminal has cramped holding areas, has inadequate bagging facilities and limited curbside space and parking, and lacks modern amenities. The more modern Delta (1983) and U.S. Airways terminals (1992) are improved facilities, but still are relativity small and have a limited gate capacity. All of LGA's terminals are configured with finger piers to varying degrees, the largest type of aircraft that LGA can serve are Boeing 767s.

A summary of the entities that constructed, own and operate the terminals at the three airports is provided in Table 2.3.

Terminal capacity and efficiency depend on the successful design and implementation of five critical terminal components – passenger and baggage check-in, passenger security screening, baggage handling, passenger circulation/amenities and information systems. A full description of these functions and their capacity issues are described in Appendix A. In particular, three issues are likely to drive terminal reconfiguration and expansion in the future:

- Security operations are replacing passenger check-in as the primary driver of space requirements in the front end of the terminal.
- New technologies require a constant need for upgrading facilities, many of which are quite old compared to other regions.
- Growth in airport passengers will require an expansion of terminal capacity.

Terminal Expansion and Reconfiguration Plans

As activities at the three airports grow, their limited available airside and landside space will require greater innovation. Terminals in particular must be designed with more gates and space for transit and amenities for passengers. Building on recent investments such as the construction of JetBlue's Terminal 5, the Port Authority is proceeding with plans for expansion and reconfiguration of terminals at all three airports:

- Renovating **and Replacing Terminals at EWR:** The Port Authority is planning to significantly redevelop ($50M has been authorized for planning) Terminal A to improve its circulation and gate capacity, likely through razing the existing structure and replacing it will a new facility. A complete modernization of Terminal B is currently underway. This will include a new in-line baggage system, a rehabilitated and expanded connector, a completely renovated lower level arrivals expansion, a mid-level domestic check-in, and the upper level international check-in. There are several options for further terminal reconfigurations. The Port Authority could construct one large terminal in phases to replace the three existing facilities or increase the size of the planned Terminal A by demolishing Terminal B, creating two larger terminals (Terminal A and Terminal C).

- **Plans to Replace Central Terminal Building at LGA:** The Port Authority completed an unpublished study that documented that constraints of the existing Central Terminal Building and started design of a new terminal to replace the CTB. The 2010 capital plan includes $75 million for planning and design. The new building could be connected to the U.S. Airways Terminal. A bridge could then be construct between the U.S. Airways Terminal and the Delta Termi creating three fully connected facilities.

Terminals at Our Region's Airports – Constructed, Owned and Operated

Airport	Terminal	Constructed	Owned	Operated
JFK	Terminal 1	1998	Terminal One Group*	Terminal One Group
	Terminal 2	1962	Delta	Delta
	Terminal 3	1960	Delta	Delta
	Terminal 4	2001	Consortium	Schiphol Group
	Terminal 5	2008	JetBlue	JetBlue
	Terminal 6	1970	Inactive	Inactive
	Terminal 7	1972	British Airways	BAA
	Terminal 8	2007	American Airlines	American Airlines
EWR	Terminal A	1973	Port Authority	United Airlines
	Terminal B	1973	Port Authority	Port Authority
	Terminal C	1988	Port Authority	Continental Airlines
LGA	Central Terminal Building	1964	Port Authority	Port Authority
	Marine Air Terminal	1940	Port Authority	Delta
	Delta Terminal	1983	Delta	Delta
	U.S. Airways Terminal	1992	U.S. Airways	U.S. Airways

* A consortium of 4 carriers: Air France, Japan Airlines, Korean Air and Lufthansa
Source: Port Authority

- **Terminal Expansion at JFK:** Terminal reconfiguration at JFK is more complex because of the number of existing terminals. The eight separate terminals tend to result in shorter walks to the gates, but they are less efficient and in combination take up more space than just one facility with equivalent capacity (gates). Currently, there are plans to expand both of Terminal 4's concourses, construct the remaining portions of Terminal 8, and expand Terminal 5 to the site currently occupied by Terminal 6, which would be demolished. Additionally, JFK's outmoded and inefficient Terminals 2 and 3 could be demolished, providing space for future expansion of Terminal 1 and additional airside capacity for aircraft parking. Over time, JFK would have five larger terminals, Terminals 1, 4, 5, 7 and 8.

Landside Access Elements and Constraints

The landside access elements must be designed for all the vehicles arriving or leaving the airport, or circulating within it – autos, taxis, buses, trucks, and in some cases rail. These vehicles require curb space and staging areas for pick up and drop off of passengers, places to park, space for entering and leaving the airport, spaces to circulate within it, and clearances for trucks and efficient connections to regional highway network.

Space for each of these vehicles must be sized for the projected use of the airport to provide enough capacity to limit delays and congestion. Circulation among these modes, parking facilities and the terminals must be carefully planned, along with the mobility of people and handling of baggage.

In particular, three aspects of landside acc ferent but overlapping sets of challenges:

- Ground access to the airports for passeng
- Internal airport circulation and parking
- Air cargo storage and transport

Ground Access and Terminal Connections

As Table 2.4 shows, almost 90 percent of air passengers from non-Manhattan locations arrive by private car, taxi, or limousine. For Manhattan-oriented trips, the percentage of private vehicle trips varies by airport – 80 percent for JFK, 66 percent for EWR and a high of 91 percent to LGA. Many of the roads leading to the three major airports suffer from serious traffic congestion for much of the day, clogged not only by the airport-bound vehicles but also by those commuting to and from work and traveling for other purposes.

Traffic engineers use a Level of Service metric to describe traffic conditions, where A is traffic that is totally unfettered by other vehicles at one extreme and F is stop-and-go, with gradations in between. Level C is usually the standard of acceptability. Table 2.5 indicates the poor level of service throughout the day at some of the key roadways in Queens that serve JFK and LGA. As air passenger traffic grows, the reliability of the roadway system is likely to decline even further, and options using autos, taxis and car services will become even more problematic.

The quality of service on the Van Wyck Expressway (VWE), a primary highway feeder to JFK, is particularly poor. Reliance on the highway network will hamper the growth anticipated at JFK from occurring. Given the surrounding community impacts and tight geometry of the VWE, expansion of the road is unlikely. Other road and transit options are examined in Chapter 11.

As the modal share data implies, the transit options to the three airports from Manhattan are considerably better than from other locations at least for JFK and EWR. For access to JFK, the AirTrain delivers passengers (and employees) via four subway lines with connections at Jamaica Center and Howard Beach and via the Long Island Rail Road (LIRR) at Jamaica Center. Both the New York City subway system and the LIRR offer frequent connecting service.

The current configuration consists of two-car trains (with potential of up to four cars) that can carry a maximum of 97 passengers per car. These services provide a number of choices for trips to Manhattan, and to a lesser extent to parts of Queens and Brooklyn and via the LIRR to portions of Nassau and Suffolk counties. Figure 2.4 illustrates the strong growth in ridership since it opened, almost doubling from the first full year, 2004 to 2009. The growth continued even in 2009, with 11 percent more use over 2008, even as overall traffic at JFK declined by four percent. This augurs well for continued growth in AirTrain use as more passengers become familiar with it. Currently, about 15 percent of Manhattan's air passengers use AirTrain, but only 8.4 percent to or from other locations. Local buses are available too, but are limited in frequency, coverage and speed, and little used except by airport employees who live nearby. There are also a number of privately operated express buses that serve Manhattan's central business district, providing direct service from transportation hubs like Grand Central Terminal and Penn Station.

The automated AirTrain system, which opened in 2003, also functions as in internal circulator among terminals, stopping at six terminals, and at the long-term parking lot, the rental car area and employee parking at the periphery of the airport. The AirTrain has significantly reduced circulation traffic on the airport, replacing internal bus services and increasing transit use to and from JFK.

How Do Passengers Get To the Airport?

	JFK		EWR		LGA	
Mode	Manhattan	Other	Manhattan	Other	Manhattan	Other
Rail	15.4%	8.4%	24.7%	5.9%	0.0%	0.0%
Bus (Private & Public)	5.0%	4.2%	9.8%	2.5%	8.8%	11.7%
Van/Shuttles	12.1%	14.5%	15.9%	7.9%	7.3%	6.7%
Taxi & Limo	35.0%	20.5%	34.0%	19.1%	74.5%	45.6%
Rental Car	2.7%	4.0%	1.1%	11.9%	1.3%	7.4%
Drove or Dropped Off	29.9%	48.5%	14.6%	52.7%	8.0%	28.6%

Source: 2008 Port Authority Survey

TABLE 2.5

Levels of Service for Major Highways That Serve JFK & LGA

		Average Level of Service			
		AM		PM	
Airport	Roadway	EB/NB	WB/SB	EB/NB	WB/SB
JFK	Van Wyck	F	E	F	F
	Nassau Expressway	B	E	C	D
	Belt Parkway	E	E	D	E
LGA	Grand Central Parkway	D	F	E	E

Source: 2007 NYSDOT Managed Use Lane LOS Vehicle Density Analysis prepared by Skycomp Inc.

Note: Trucks are prohibited on the Belt and Grand Central Parkways

Historically, there has been a discussion about more direct rail service to the airport to obviate the need for a two-seat ride from Manhattan; this will be discussed in Chapter 11 on ground access.

At EWR, Manhattan air passengers can use the Northeast Corridor line of NJ TRANSIT from Penn Station to connect to the Newark AirTrain, which was extended to a new Northeast Corridor station in 2001, previously serving as only an internal circulator. Eighty-two NJ TRANSIT trains a day stop at the stations during weekdays, but only nine trains by Amtrak make that stop, limiting its usefulness for intercity connecting passengers. The station makes it possible to connect to midtown Manhattan at Penn Station, to Newark, and to central New Jersey communities, including New Brunswick, Princeton and Trenton and via a transfer at Newark Penn Station to PATH to Jersey City and Lower Manhattan. As a result a large share of Manhattan to EWR passengers – 25 percent use the rail line. Figure 2.5 shows the annual ridership volumes for the connections to NJ TRANSIT trains, which grew rapidly until the economic recession in 2009.

A second option for Manhattan transit access is via NJ TRANSIT bus service from the Port Authority Bus Terminal at Eighth Avenue and 41st Street[5]. This service is susceptible to roadway delays at the Lincoln Tunnel and its use has declined since the advent of the rail connection in 2001. Locally, there is bus service from Newark and surrounding communities, mostly used by airport employees. Among Manhattan associated trips, 10 percent use the bus bringing the total transit use for these trips to an impressive 35 percent.

The AirTrain that connects the rail station on the Northeast Corridor to the terminals and parking facilities is relatively slow and more importantly is limited in capacity, threatening its ability to function acceptably as traffic at the airport grows. Among trips not associated with Manhattan 8 percent use transit. Options for the replacement of the AirTrain system and improved ground access to EWR will be discussed in Chapter 11.

[5] www.njtransit.com

FIGURE 2.4

AirTrain Ridership at JFK - 2004 to 2009 (CY)

Source: Port Authority

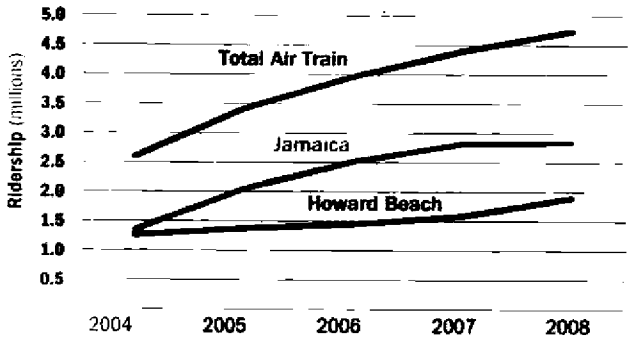
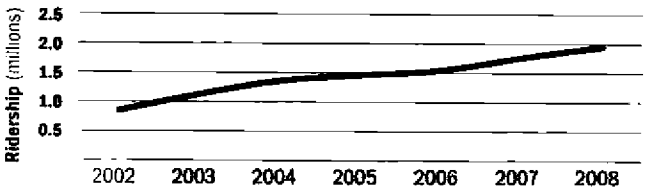


FIGURE 2.5

Annual NJ TRANSIT Ridership at Newark Liberty Station - 2002 to 2010 (FY)

Source: NJ TRANSIT



LGA has the most limited selection of transit options, with buses being the only transit choice. The Q33, Q47, Q48 & M60[6] bus routes serve LGA's terminals, with connections to a number of subway lines en route. Bus service is slow and frequency averages only about every 20 minutes. Consequently, transit shares are low; only 9 percent to Manhattan and 12 percent to other destinations in the region. The provision of rail access to LGA has been studied in the past, but without resolution. This also will be discussed in Chapter 11.

Parking and Internal Circulation

The amount of curb space available has a direct impact on how well a terminal operates. Approximately three-quarters of passengers arrive by car at the three major airports. With curb space at a premium, debilitating congestion can be avoided only if sufficient space is provided to accommodate the continuous flow of automobiles that are pulling-over and discharging their passenger(s) and luggage during the peak-periods. Curb space is typically segmented for taxis (taxi stands for arrivals), private autos and public transit. The configuration of internal roadways can lessen the number of idling vehicles waiting to pick-up arriving passengers at the curb by creating a circulation route/loop or pull-over area. There should be a sufficient number of lanes to allow vehicles to access terminals and parking areas without impeding the flow of thru-traffic. There must also be an adequate number of connections to surrounding highways and local streets (ideally arterials) to ensure redundancy and to balance capacity during periods of peak demand.

Curb space and the internal roadways at LGA are especially constrained. Landside congestion at EWR's might worsen in the future due to the limited capacity of certain segments of its internal loop roadway. JFK has some limited curb space issues at

TABLE 2.6

On-Site Parking by Type by Airport

		Short-Term		Long-Term		Employee		Total	Regio
Airport	Facilities	spaces	%	spaces	%	spaces	%	Spaces	Sh
JFK	9	7,852	46	7,598	44	1,702	10	17,152	3
EWR	12	6,153	28	12,955	59	2,896	13	22,004	4
LGA	8	8,716	77	914	8	1,714	15	11,344	22
Total	29	22,721	45	21,467	43	6312	12	50,500	100%

Source: Port Authority and Five Star Parking Corporation

its older terminals (2/3 & 7). Expressway ramps connecting JFK to the Van Wyck Expressway are strained and the level of service on these critical connections will likely worsen.

Like curb space, the airport must provide enough parking to serve most of the private automobiles that access the airport. Short-term lots are typically closer to the terminals since they are used by those who are dropping off or picking up air travelers. Long-term lots are located away from terminals and provide parking for air travelers that drive themselves to the airport and offer a lower rate. Many of these facilities are operated by private companies under a lease with the airport operator. New technologies are innovating parking management, allowing companies to provide the real-time status of available spaces in garages over the internet and on variable messaging signs located on key approaches to the airport, along with more efficient methods of payment. These new technologies will likely lead to a reduction in cruising and congestion of internal airport roadways, but will not add to parking capacity.

As Table 2.6 shows, the mix of parking at the three airports varies: at LGA 77 percent is short-term parking, at EWR 60 percent is long-term parking and at JFK parking is evenly distributed between the two types. LGA's role as a regional airport for short-haul flights, combined with its proximity to the Central Business District makes it less likely to serve those taking longer trips or driving themselves to the airport. By contrast, EWR has a higher share of customers starting or ending their trips outside New York City, which results in high auto use to EWR, and hence more parking spaces needed. There is currently an adequate supply of parking at all three airports; JFK and EWR on average utilized only half their parking at one time, but EWR's long-term parking lots have a higher usage rate of almost 80%. LGA's rate is lower at 70%. In 2009, over nine million cars paid to park at our region's airports, lower by eight percent from 2008, tracking the recession losses for air passengers.

However, as passenger demand at the airports increases over time, the existing supply of parking will become inadequate, without a significant shift to public transit. The Regional Air Service Demand Study (RASDS)[7] assessed that over the next 10-15 years demand for long-term parking will surpass the current supply at all three airports. Based on the projected passenger volumes that will be detailed in Chapter 3, parking deficiencies will become more obvious in the next few years. EWR will likely experience a shortage of daily parking some time in the 2015 to 2021 period and both EWR and LGA will have inadequate long-term parking by then. By the 2021 to 2034 period, depending on the pace of air passenger growth, the short-term parking situation at LGA will become even more severe. So will the long-term parking deficit at EWR, and some time in the 2030 to 2042 period JFK will begin to hit the ceiling for its short-term

6 www.mta.info

7 FAA Regional Air Service Demand Study, 2007 - Task E - EWR, LGA & JFK Ground Access Surveys

parking and lack sufficient long-term parking (almost 1,000 spaces), while the situation at LGA and EWR will only further deteriorate.

One way of mitigating this shortage will be through the use of technology to manage this resource more effectively. An example of a relatively recent improvement at our airports through new technology is the use of EZ-Pass to pay for parking. This innovation simplifies the payment process and improves the flow of traffic within the airport. Alternative ground access options would also reduce parking demand. Transit options to all three airports that were attractive enough to lure drivers could help to mitigate the parking shortages. These transit options will be discussed in more detail in Chapter 11. Meanwhile, incremental improvements at JFK's AirTrain system and parking management technologies at each of the airports might shift parking demand within each airport, but these improvements are unlikely to reduce overall parking demand appreciably.

Air Cargo Facilities and Landside Transport

Our region relies on an efficient air cargo system to deliver time sensitive packages, ranging from business documents to fresh seafood. JFK and EWR serve as the region's primary cargo hubs; LGA has very limited cargo service. In the United States, JFK (#6) and EWR (#9) rank among the top ten[8] domestic cargo airports, globally JFK is ranked 17th and EWR is 23rd.

JFK is the primary international cargo facility for the region. The entire 1,700 acre cargo area is designated a Foreign-Trade-Zone (FTZ) and includes over four million square-feet of warehousing and handling facilities. JFK, located just 15 miles outside of Manhattan, is well positioned to serve residents and business in Manhattan and on Long Island. The airport is surrounded by over 1,000 freight-related businesses, providing considerable economic stimulus and employment for the local communities in Queens.[9] EWR is the region's express carrier cargo facility, serving as a hub for FedEx, UPS, and Continental Airlines. These three cargo carriers account for 82 percent of the freight traffic. At 290 acres and containing only 1.4 million square-feet of facilities, it's considerably smaller than JFK. There are more daily cargo-only aircraft operations at EWR than JFK. At EWR the express cargo service dictates more flights to a greater number of destinations (smaller planes, shared space with baggage and overall smaller loads). At JFK much of the cargo is carried by commercial passenger airlines in their baggage holds. Most of the all-cargo flights at EWR occur overnight and do not burden the peak periods during the day when most of the commercial passenger operations take place. EWR is well located adjacent to the New Jersey Turnpike, Routes 1 and 9, 21 and 22 and Interstates 78 and 278, with the Port of Newark to the east, and just 9 miles from Manhattan, making it well positioned to serve the cargo needs of businesses and residents in New Jersey.[10]

Stewart International Airport (SWF), located 60 miles northeast of Manhattan near the intersection of Interstates 87 and 84, is well positioned to serve future cargo needs in the northern portions of the region and points north. The Port Authority plans to invest in this facility in the future to attract cargo operators that cannot access the existing airports or wish to avoid the congestion that is prevalent in the region's core. Major carriers like Federal Express and UPS are already operating at SWF and account for 71 percent of its annual air cargo traffic. To date SWF has had relatively little air cargo traffic, only 17,721 short tons in 2008 compared to EWR's 869,450 short tons the same year, but its available land area and proximity to a highway network much less congested than the highways closer to JFK and EWR suggest growth potential. In addition, the high growth in the Hudson Valley indicates that locally generated activities will drive the demand for air cargo at SWF. However, if commercial passenger demand does not grow in parallel, robust air cargo growth at SWF might not materialize.

TABLE 2.7

Air Cargo Carriers in Region (JFK, EWR, LGA & SWF)

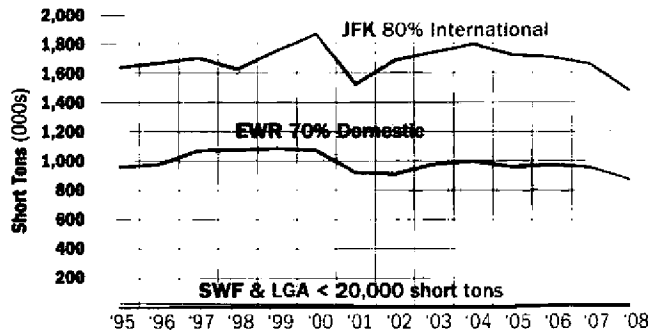
Cargo Carriers	Total Freight (short tons)	Share	# of Cargo Carriers
Federal Express	589,067	25%	1
United Parcel Services	**183,895**	**8%**	**1**
Other Air-Freight Carriers	224,687	9%	17
Commercial Passenger A[redacted]	[redacted]	**58%**	[redacted]3
Total - All Carriers	2,370,884	100%	112

Source: Port Authority - 2008 Air Traffic Report

FIGURE 2.6

Annual Freight in Short Tons by Airport: 1995 to 2008

Source: Port Authority



As Table 2.7 illustrates, more than half of the region's air freight, by weight, is carried by commercial passenger airlines in their baggage holds. Without the passengers to go with those aircraft it is unlikely that SWF will see air cargo volumes comparable to EWR or JFK.

Figure 2.6 displays the history of air cargo movements for the four Port Authority controlled airports from 1995 to 2008, and highlights its stagnant growth in air cargo volumes over this period.[11]

One of the most critical components for an air cargo facility is ground access. EWR and JFK are both well sited in the core of the region and are connected to numerous highways that feed into Manhattan and out to the suburban areas, but they are also hampered by the congestion that plagues the core. As discussed earlier in this chapter, congestion is the most serious at JFK, where the primary truck route, the Van Wyck Expressway, experiences chronic congestion throughout the day.

The problem is not as prevalent at EWR because there are numerous available truck routes that directly connect to the airport. However, Routes 1, 9 and 21 do experience localized congestion as they pass through dense urban centers. Traffic on I-95/NJ Turnpike can also slow due to competing uses with the Port facilities and northeast thru-traffic. I-78 also experiences

8 Rank is based on short tons of goods that pass through the airport.

9 http://www.panynj.gov/air-cargo/

10 (Ibid)

11 Nationally, domestic air cargo has been flat due to the competition of intercity trucking. The growth in international cargo has been constrained due to overall metropolitan roadway congestion and ground access limitations at our airports, which increases the costs of shipping goods to destinations outside the region.

some localized congestion on its auxiliary road that connects it to the airport, but congestion on the Interstate itself is not severe.

There must be sufficient space at the airport to offload and handle cargo because most air cargo is broken down and sorted at facilities that are on or near the airports and then shipped directly to the customer. This differs from the Ports, where cargo is transported first offsite to be broken down, sorted at a distribution center, and then delivered to the customer. JFK has a considerable amount of unused or underused space in its cargo area, the result of airlines abandoning their domestic maintenance facilities, which provides a considerable amount of breathing room.[12] By comparison, EWR is land constrained and aside from one abandoned facility, has no vacancies today and little space to expand.

Landside Access Planning

Landside access is the responsibility of multiple government entities, including the Port Authority, New York and New Jersey Departments of Transportation, the Metropolitan Transportation Authority and New Jersey Transit. Current plans include the following:

- **EWR AirTrain Replacement:** The EWR AirTrain is almost 20 years old and is at its mid-life rehabilitation. The current steel-beam monorail has proven to be unreliable; service is frequently disrupted during severe (and non-severe) weather events. Furthermore, the system capacity is inadequate to serve the anticipated growth at EWR. The Port Authority recognizes that this is a problem and is exploring options to replace the monorail system.

- **PATH Extension to EWR:** The Port Authority is currently undertaking a study to determine the feasibility of extending the PATH, a rapid-transit service that runs from Lower Manhattan to Newark Penn Station, to the terminals at EWR. This extension may or may not be used to replace the existing AirTrain service at EWR.

- **LaGuardia Airport Subway Access:** An aborted study was undertaken by the MTA in the late 1990's to examine alternative alignments for extending the subway (N/W) from Astoria to LGA airport.

- **Lower Manhattan Study:** This study, done under the auspices of the Lower Manhattan Development Corporation was launched in the aftermath of the 9/11 tragedy. It was designed to examine direct airport access from Lower Manhattan to JFK. The results still have not been made public.

Airside Elements and Constraints

Airside issues are divided into two elements – airside facilities that serve aircraft on the ground and the airspace assigned to each airport. Each is discussed separately below.

12 The Port Authority is currently undertaking an air cargo study for JFK and will be developing a plan for how to reuse the abandoned spaces at the airport and strategies to attract cargo related business to the property.

Aircraft Classes

Design Group/Class	Wingspan (ft)	Typical Aircraft
I	< 49'	Various General Aviation Aircraft
II	49 - 79'	Embraer 135/145, RJ, Saab 340, Beech C1900
III	79 - 118'	Canadair RJ-200/700/900, DH8, & Q400, Embraer E170/190, Boeing 737, Airbus 320 and McDonnell Douglas 80/81/88/90
IV	118 - 171'	Boeing 757 & 767 and Airbus A300's & A310
V	171 - 214'	Boeing 777 & 747 and Airbus A330 & A340
VI	214 - 262'	Airbus A380 (only aircraft in class)

Source: Port Authority

TABLE 2.9

Number of Fixed and Remote Gates

Airport	"Fixed" Gates	Remote Gates	Largest Aircraft Class
JFK	123	18	VI
EWR	104	0	V
LGA	72	2	IV

Source: Port Authority

Airside Facility Function and Capacity Issues

Typically 80 to 95[13] percent of an airport's physical footprint is dedicated to the airside, which consisting of runways, taxiways and aprons. The majority of the physical airside components that are located within the three major airports are constructed and maintained by the Port Authority.[14] The design criteria for all of these components vary based on the type of aircraft that they serve. There are six aircraft classes, with each type requiring specific dimensional standards for runways, taxiways and aprons/gates as shown in Table 2.8.

Airside facilities are operated and managed by the airlines and the FAA, with the transition occurring between the apron and taxiways. Airspace is also an airside component, though it extends outside of the physical boundaries of the airport and intermingles with the airspace of surrounding airports.

In the absence of significant changes, each of the major airside components discussed below will be subject to poorer service quality and possible delays as aircraft operations increase. Limited airfield space and the close proximity of our three major airports may restrict the ability to increase the capacity of airside components as traffic grows.

The Gates - Connecting Aircraft to the Landside. Gate or contact stands provide passengers access to aircraft parked on the apron. There are two different types of gates, "fixed" contact stands that are attached to the terminal either directly or by a tunnel/train and remote stands can that can be moved and are normally reached via a shuttle bus.[15] Remote stands are typically used to handle seasonal increases in demand or off schedule flights.

An insufficient number of gates can act as a bottleneck, impeding the number of operations that an airport can handle. Gate design can also be a limiting factor; tight turning radii, narrow alleyways or distances between gates on finger piers can limit the size or number of aircraft able to access the terminal.

Gates are either maintained by individual airlines or by a terminal manager. Aircraft are assigned to specific gates ahead of time. These assignments often change if flights operate early or late. Aircraft that have a long time on the ground may be towed

13 (Ibid. Neufville & Odoni - pg.295)

14 Gates/Contact Stands are considered part of the terminal and therefore are managed and constructed by the airlines.

15 (Ibid. Neufville & Odoni - pgs-352-353)

to a remote apron to make room for another flight. Off-schedule operations increase the complexity of terminal operations since gate assignment changes also change the work assignments of gate agents, baggage handlers, caterers, fuelers, and cabin cleaners.

Table 2.9 summarizes the number and types of gates for each of our airports. JFK has the largest number of fixed and remote gates in the system, and is the only airport that uses transporters to serve its remote gates. JFK has predominantly class IV and V gates, making it capable of serving larger aircraft and is the only airport with class VI multi-storied gates for the Airbus 380. Almost half of EWR's 104 gates are located in Terminal C. Only Terminal B is capable of serving 747's, the largest class V aircraft. LGA has the smallest number of gates. Fifty percent of these gates are located in the Central Terminal Building (CTB). LGA's gates in the CTB are constrained by the narrow alleyways between the finger piers as shown in Figure 2.7, which limit the number and size of aircraft that can be positioned at one time. This also prevents larger aircraft from accessing gates closer to the terminal.

Aprons. Aprons are where aircraft park and are predominately located adjacent to the terminals, provide access to "fixed" contact stands/gates and serve as staging areas for maintenance and baggage operations. Aprons can also be sited on other parts of the airport property where they can be used as holding/storage areas for aircraft during ground delays and cargo operations. Sufficient apron space is essential for aircraft storage, reducing the need for taxiways and runways to take on this role as well. Many of the same gate design issues are applicable to aprons, since apron design must adapt to complement the configuration of contact stands and terminals.

Taxiways. Taxiways connect the aprons to runways and serve as an internal road network for aircraft to move throughout the airport. The configuration of the taxiways can affect the capacity and efficiency of runway operations. Most airports have parallel taxiways that mirror the entire length of a runway, in some cases these taxiways are on both sides of the runway, a typical configuration at many of our region's airports. Conventional exit taxiways connect parallel taxiways with runways, forming a 90-degree angle with the centerline of the connecting runway, and are typically used by departing aircraft. High-speed or acute angle taxiways allow arriving aircraft to exit the runway quickly, clearing the way for the next aircraft. Figure 2.8 depicts this taxiway geometry. Similar to runways, taxiways are constantly being rebuilt to accommodate larger aircraft. JFK has the most extensive airside taxiway network with 34 miles, EWR's second at 18 miles and LGA has 10 miles. At EWR taxiways are being widened to serve the A340-600 and Boeing 777-300 aircraft, similar improvements are also taking place at JFK to serve these aircraft and the A380. The exiting taxiway fillet radii will be widened from 112.5 feet to 175 feet to accommodate the longer wheelbases of these aircraft.[16] Airports are also continuously evaluating whether they need to add new conventional and high-speed taxiways to improve efficiency, handle larger numbers of aircraft and to help reduce delays. At JFK, work is currently underway to extend three taxiways to improve circulation between the central terminal area and the runways.

[16] The wheelbase of an Airbus 380 is 97.8 feet, the Airbus 340-600 is 108.9 feet and the Boeing 777-300 is 100.4 feet, by comparison a Boeing 747-800 has a wheelbase of only 82.3 feet.

LGA Central Terminal Building Narrow Taxi Lanes
Source: Google Earth

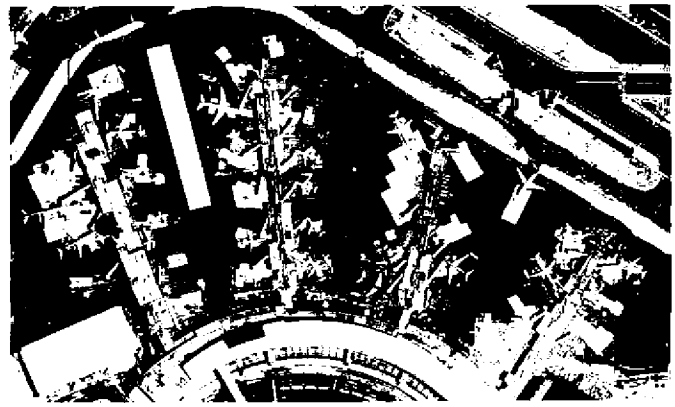
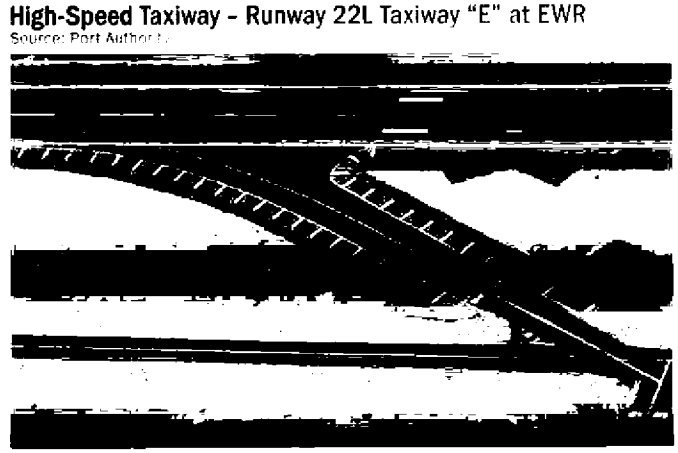


FIGURE 2.8
High-Speed Taxiway - Runway 22L Taxiway "E" at EWR
Source: Port Authority



Runways. To take off and land safely, runways require both sufficient length and width. Where there are two runways that are parallel to one another, as is the case at both JFK and EWR, they also require sufficient space between them. Runways are identified by a two-digit number, which corresponds to one-tenth of the number of degrees the runway is oriented from the magnetic azimuth.[17] For example, runway 22 at EWR translates to an azimuth of approx 220 degrees clockwise from north, or an orientation to the southwest. Since runways point in two directions, this runway is also designated by 180 degrees, or 18 from the first direction, making the runway designation in this case 4-22.

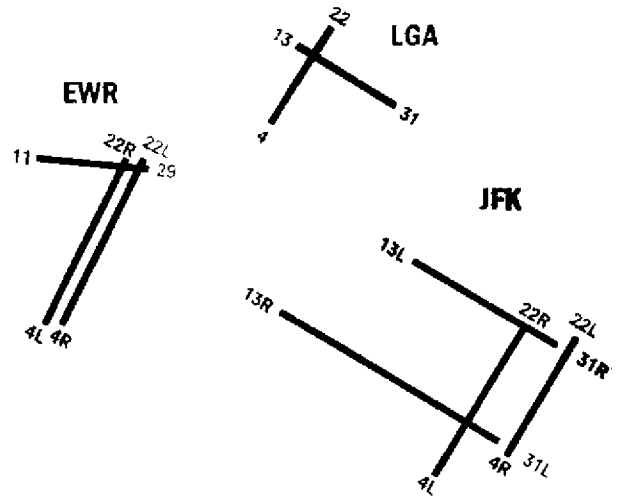
Parallel runways receive an additional designation of left or right when there are two parallels, and (L, R, or C) when there are three. Runways are constructed and operated in different directions to accommodate changes in wind direction and speed. Ideally, aircraft depart into the wind to increase the amount of lift and reduce takeoff distances.

Runway configuration can significantly affect flight operations, intersecting runways are inefficient and parallel runways can only operate independently and simultaneously if they are separated by at least 4,300 feet. Runways intersect at all three major airports in the region. The parallel 4/22 runways at EWR and the parallel 4/22 runways at JFK are less than the required separation for simultaneous parallel operations. Runway length can also be a limiting factor for aircraft operations, with longer range aircraft requiring longer runways. The minimal length for

[17] Ibid. Neufville & Odoni, pg. 411

Runway Layouts (to scale)

Source: Port Authority and Regional Plan Association



Runway Designations and Lengths

Airport	Runway	Length (ft)
JFK	4R - 22L	8,400
	4L - 22R	11,351
	13R - 31L	14,572
	13L - 31R	10,000
EWR	4R - 22L	10,000
	4L - 22R	11,000
	11 - 29	6,800
LGA	4 - 22	7,000
	13 - 31	7,000

Source: Port Authority

commercial operations is usually 7,000 feet, with some larger or longer range aircraft requiring 10,000 feet or more to operate safely[18].

Runways are also required by the FAA to have an additional 1,000 feet of overrun at both ends to protect property and people that are in close proximity to the airport. LGA was constructed before these regulations were enacted 20 years ago. Many airport authorities and the FAA are working to meet a congressionally mandated deadline that requires all airports to have a runway safety area (RSA) by 2015. However, LGA and many older airports do not have the space to meet this requirement and are instead incorporating modern engineered material arresting systems or EMAS technologies[19] to provide a similar level of protection without having to extend their runway safety areas as much. This technology uses densely packed crushable concrete to stop an aircraft in less than 600 feet.

LGA is the only airport without parallel runways, having only two intersecting runways 4/22 and 13/31. These two runways' dimensions, only 150-feet wide and 7,000-feet long, reduce their effectiveness and limit LGA to class IV aircraft (no B-777 or other larger aircraft). EWR has three runways with the two parallel 4/22's that are only 950 feet apart. Both runways are intersected by its third runway 11/29. The 4/22's are 10-11,000 feet and 11/29 is only 6,800 feet, making it more suitable for smaller and lighter aircraft. The limited separation distance between the parallels and intersecting perpendicular runway constrain EWR airfield capacity. JFK has four runways, which consist of two sets of parallels. Runways 4/22 L & R are only separated by 3,000 feet, preventing independent simultaneous parallel operations. These runways are 8,400 feet (4R/22L) and 11, 351 feet (4L/22R) long. The longest runway in the region is the "Bay Runway" or 13R/31L at 14,572 feet in length. Runway 13L/31R is 10,000 feet long; these two parallel runways are separated by the central terminal area, creating a buffer of over 6,000 feet allowing for full independent parallel in a northwest operating direction. However regional airspace constraints prevent independent operations in a southeast operating direction. JFK's runways and taxiways are capable of handling the largest class VI aircraft that are operating today and in the foreseeable future, including the Airbus 380. Figure 2.9 illustrates the runway configurations to scale for LGA, EWR and JFK and Table 2.10 details their lengths.

Existing Plans for Airside Facilities

- **Tracking Aircraft on the Ground (ASDE-X):** The FAA is working with the Airlines at JFK to install ground sensors to detect the movement of aircraft and ancillary vehicles at gates. This technology is called Airport Surface Detection Equipment, model X or ASDE-X. At EWR, Continental Airlines has made a similar investment that currently covers its operating environment at Terminal C and the adjoining taxiways. There are plans to extend this technology to the remaining portions of the airport. ASDE-X is also being installed at LGA airport.

- **Reconstruction of Bay Runway at JFK:** In 2010 the Port Authority reconstructed the Bay Runway 13R/31L. It was widened from 150 to 200ft and rebuilt using concrete. This will reduce maintenance costs over its 30-year projected life, reducing delays and downtime for repairs. The wider runway will allow JFK to better and safely serve aircraft with larger wheelbases like the A380.

- **Runway Safety Area (RSA) at EWR Runway 11:** The Port Authority has plans to extend the runway safety area at EWR on runway 11 and install an EMAS.

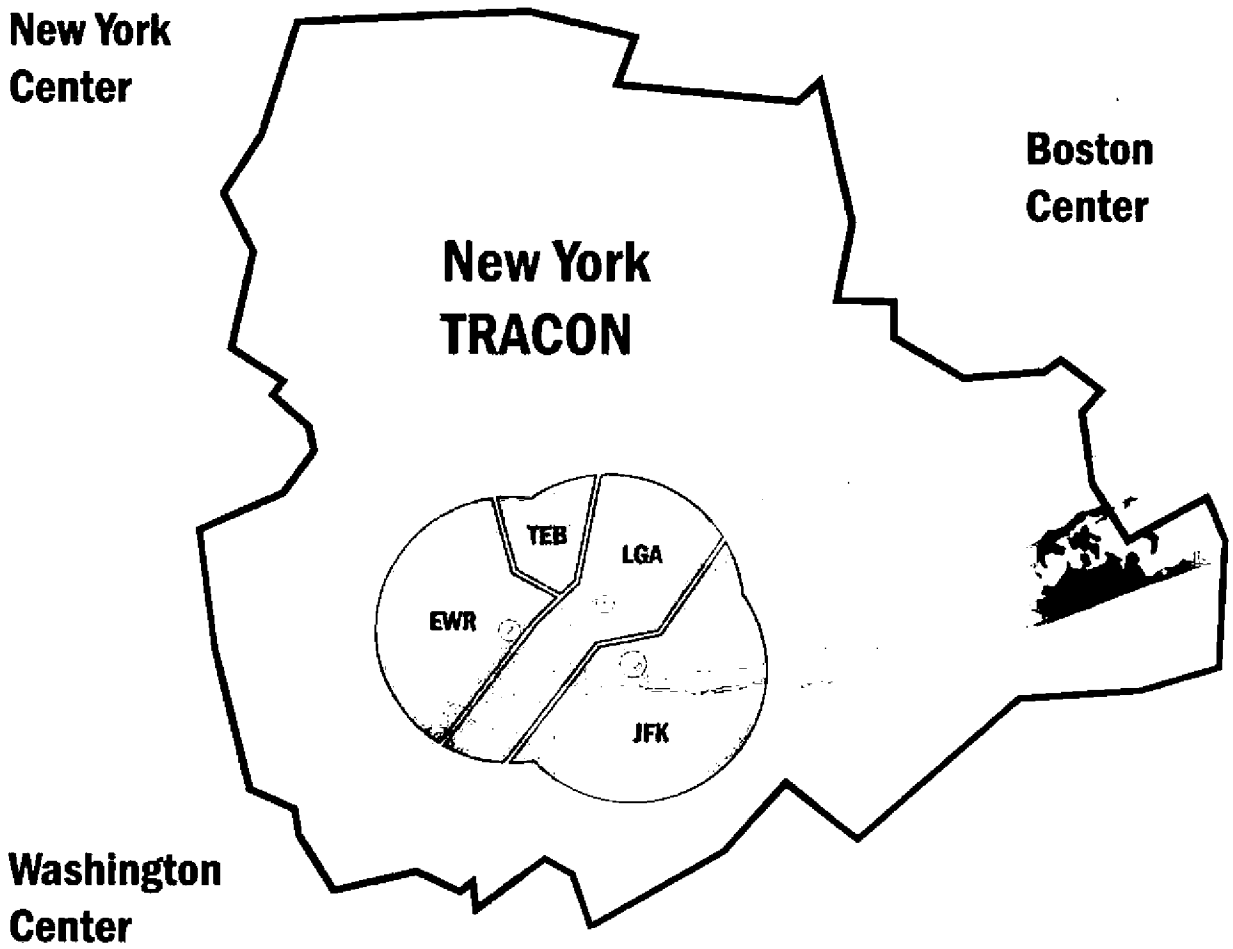
- **Perimeter Intrusion Detection System (PIDS):** The Port Authority continues to aggressively invest in airport security. To secure the airside from intrusion the PA is installing perimeter sensors, Closed Circuit Television (CCTV) and fencing to protect these sensitive areas of the airport.

- **Taxiway Improvements at EWR:** The Port Authority is planning a multi-phase taxiway improvement program at EWR, which will re-align and/or create new taxiways to provide for multiple entrances for aircraft departure operations on Runway 22R. The scope of work will include the installation of concrete pavement, drainage systems, and taxiway lighting systems, signage, and pavement.

18 (Ibid, Neufville & Odoni, pg.337)

19 The Port Authority in conjunction with University of Dayton and the Engineered Arresting Systems Corporation of Logan Township, NJ, developed this technology and has installed it at LGA (2), JFK (2) and EWR (1). (http://www.faa.gov/news/fact_... ...ews_story.cfm?newsId=6279)

The Region's Airspace
Source: FAA and Regional Plan Association



Airspace Function and Capacity Issues

The airspace contains the aerial highways that organize aircraft traffic. There are six[20] classes of airspace; two will be covered here, the "controlled" class A and B airspace. The other four, or uncontrolled airspace in our region will not be covered.[21] The controlled airspace is managed by FAA air traffic controllers; they are responsible for safely routing flights and assigning specific aircraft separation parameters for aircraft based on the airspace class and size of aircraft.

Figure 2.10 displays a simplified overview of the region's airspace. It outlines the New York Terminal Radar Approach Control (NY TRACON) [22] borders and identifies the surrounding three Centers[23]. The NY TRACON is the FAA's primary air traffic control facility for the New York metropolitan area. For the purposes of this overview the NY TRACON should be considered the New York region's airspace, radiating out approximately 50 miles from the Manhattan Central Business District and encompassing the following geographic areas:

- Northern New Jersey
- Southern Connecticut
- All of Westchester, and portions of the Lower Hudson Valley
- New York City and most of geographic Long Island (except for a small section of eastern Suffolk, which is under the control of the NY Center).

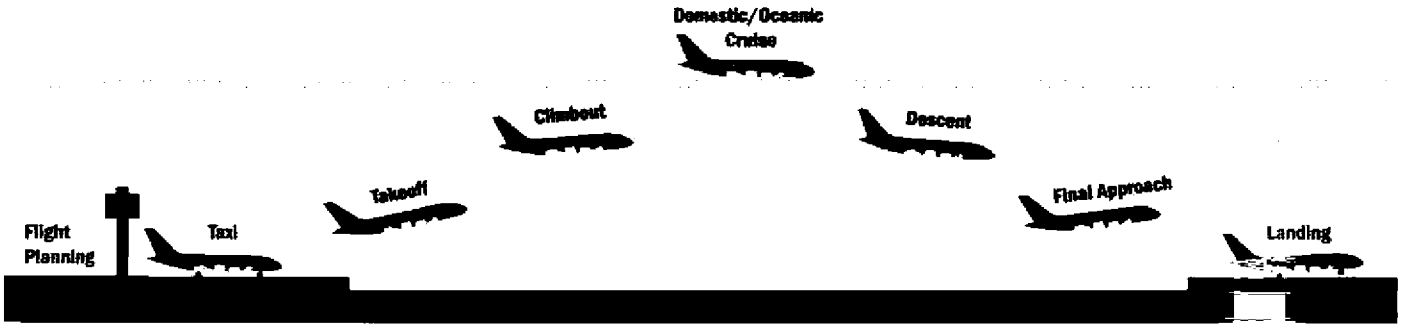
This diagram also clearly illustrates the close proximity of our three major airports plus Teterboro. Ideally, each airport should have five to ten miles of dedicated airspace around it. However, LGA, JFK and EWR each operate with less than half of what is typical elsewhere in the country. This overlapping airspace is a major constraint that inhibits operations at all three airports. Aside from our three major airports, the NY TRACON airspace includes commercial operations at Stewart International Airport, White Plains/Westchester County Airport, and MacArthur Airport, and non-commercial/general aviation operations at over 60 airports in the region.

20 There are five classes of controlled airspace (A, B, C, D & E) and one class designated (G) for uncontrolled traffic.

21 Uncontrolled Class G airspace is not managed by air traffic control, meaning no separation is provided. It's typically designated at a lower elevations and only requires pilots to "see and avoid" other aircraft in their area

22 Pronounced as – tray - con

23 NY Center's airspace is 250% larger than the NYTRACON's, with large portions of the east coast and Bermuda under its control.



Controlling Aircraft in the New York Region's Airspace

As illustrated in Figure 2.11, air traffic control is primarily the responsibility of the FAA, with the airlines controlling a portion of the ground operations from their ramp towers located in the terminals. The FAA operates three different types of facilities that hand off aircraft as they transition through the airspace – the towers, NY TRACON and Centers.

The towers at each airport manage most of the traffic on the ground (taxiways and runways). They also control the airspace up to 3,000 feet and five miles out from the airport, for both arrivals and departures. The NY TRACON is divided into five sectors[24] and is responsible for traffic after handoff from the Tower up to 50 miles out and under 17,000 feet. The three surrounding Centers[25] then assume control of the aircraft once they exit the NY TRACON's airspace and handle en route traffic or over-flights that are passing through the region, operating at an altitude over 17,000 feet in Class A airspace. The NY TRACON also handles over-flights that are below 17,000 feet, which can pass through the airspace of the three major commercial airports.

Both the Centers and NY TRACON are responsible for merging aircraft at the arrival and departure fixes. Each of the major airports has its own dedicated arrival fix for each of the three defined NY TRACON airspace entry-points or gateways – northeast, south, and west. Conversely, departure fixes are shared by all airports in the region, meaning departures are handled as if they were all originating from a single airport. LGA's arrival fixes have slightly lower daily volumes than JFK and EWR, but its volumes tend to remain constant throughout the day unlike the peaks and valleys in demand experienced at the other two airports.

Factors Influencing Operations

Major factors affecting performance of the air traffic control system are the wind, speed, temperature, size of aircraft and visibility conditions.

Flight Rules and Conditions

There are two primary types of operating rules, visual flight rules (VFR), where pilots have the responsibility for avoiding other aircraft (see and avoid) or instrument flight rules (IFR), where air traffic controllers provide aircraft separation services. IFR is really not an indicator of the severity of the operating conditions since most modern commercial aircraft routinely operate under IFR, smaller aircraft are also following this trend as sophisticated avionics systems are becoming standard on all types of aircraft.

The conditions of the operating environment are reported as either Visual Meteorological Conditions (VMC) or Instrument Meteorological Conditions (IMC), which determine what procedures are followed. IMC conditions can dramatically curtail capacity by requiring aircraft to use Instrument Landing Systems (ILS), forcing the FAA to reconfigure airspace to accommodate extended straight-in approaches.

Impacts of Configuration Changes and ILS

Each airport has multiple runway landing and take-off configurations that are characterized by which runways are active and whether they will serve departures, arrivals or in some cases both. Different configurations are triggered based on reports from air traffic controllers and pilots, operational plans, runway closures and changes in the weather. Airports also have optimal configurations to handle specific arrival and departure flows, typically based on the time of day. At each our region's airports there are dozens of configurations; however, all three have several that are used most of the time. JFK has four major configurations, EWR two and LGA five.

When an airport is operating under IMC conditions, pilots use Instrument Landing Systems (ILS) to assist with landing their aircraft. This system uses a radio beam to keep an aircraft on a direct course with the runway when visibility is impaired. To use this technology aircraft must line up with the runway further out from the airport (up to 10 miles) to ensure a safe approach. At JFK an ILS approach to Runway 13L intersects with the flight path of LGA's Runway 4/22, halting all arrivals on 4 or departures on 22. This is not a frequent occurrence (usually about five days a year), but one that has a severe impact on operations. While the LGA/JFK example is the most extreme in the region, IMC impacts occur on a more limited scale between EWR and TEB. There are five categories of ILS approaches – Cat I has the least capability with a 200 foot ceiling and 0.5 miles visibility and Cat III-C has the most, at zero ceiling and visibility.[26]

Separation Standards

Separation standards provide sufficient space between aircraft to maintain an adequate margin of safety when weather conditions preclude pilots from using "see and avoid" rules to stay clear of other aircraft. Separations standards are based on the fidelity

24 Five radar systems or sectors makeup the NYTRACON; EWR, JFK, Westchester, Stewart, and Islip

25 New York Center, Washington Center and Boston Center

26 Ibid, Neufville & Odoni, pgs. 888-890

of the radar available to controllers and the size of the aircraft. Larger, heavier aircraft produce wake vortex behind them as they travel through the air[27]. Because the size of the vortex increases with the size of the aircraft, a smaller aircraft following a larger aircraft requires a greater separation distance. This is analogous to being in a canoe behind a cruise ship. An aircraft's wake vortex can cause a trailing aircraft to lose lift and spiral out of control. Controllers must maintain a five-mile trailing and lateral separation and 1,000 foot altitude separation in en-route (Class A) airspace. As shown in Table 2.11, Controllers can use three-mile separations between like-sized non-heavy aircraft in Class B (TRACON) airspace since radar has a higher update rate (radar display refresh rate), which provides more precise aircraft position information, and aircraft speeds are limited to 250 knots. The sequence of aircraft landing on a runway can have a significant impact on airport capacity since mixing aircraft sizes leads to longer separation distances and a reduction in the number of aircraft that can be served per hour. Ideally, a more homogenous fleet would increase the capacity of an airport.

Arriving aircraft adhere to the below separation distance. However, departing aircraft are predominantly separated by time, as detailed in Table 2.12.

TABLE 2.11

Separation Distances for Arriving Aircraft

		Trailing Aircraft (in nautical miles)*		
		Heavy	Large+B757	Small
Leading Aircraft	Heavy	4	5	6
	B757	4	4	5
	Large	3	3	4
	Small	3	3	3

Source: Airport Systems Planning, Design and Management, pg 380 and FAA

* Heavy, large and small aircraft trailing a small aircraft and heavy and large aircraft trailing a large aircraft can use 2.5 nautical mile. 1 nautical mile equals 6,076 feet. Separations within 5 nautical miles of the runway and if runway occupancy times are demonstrated to be less than 50 seconds

TABLE 2.12

Separation Times for Departing Aircraft

		Trailing Aircraft (in seconds)		
		Heavy	Large+B757	Small
Leading Aircraft	Heavy	90	120	120
	B757	90	90	120
	Large	60	60	60
	Small	45	45	45

Source: Airport Systems Planning, Design and Management, pg 380 and FAA

Aircraft Performance

Modern aircraft have the ability to climb at faster rates and cruise at higher speeds than a generation ago. However, FAA airspace design regulations still use conservative climb rates that do not reflect improvements in aircraft performance, since some older aircraft remain in the fleet.

Our Conflicting Airspace

The airspace of our airports overlap, creating a constraint that limits the number of runways that can be used at one time. Today, the region's airports must stagger or restrict operations to separate arrivals and departures from the surrounding airports airspace. For example, departures on runway 4L at JFK are not possible when aircraft are arriving straight in on runway 31 at LGA. This problem is only exacerbated when weather conditions deteriorate, forcing airports to move to less optimal configurations and to use ILS, requiring traffic to further impede on neighboring airspace.

The three simple diagrams shown in Figure 2.12 illustrate the airspace conflict for the three airports:

LGA is affected by all the conflicts. Whenever, adjustments in the approach or takeoffs are made, they reverberate throughout the entire system. LGA acts as a link between JFK and EWR. Without it both could operate much more independently. For example, a configuration change at JFK forces a change at LGA, then Teterboro (TEB), and finally EWR, potentially limiting operations at all three airports and most definitely adding to the complexity of managing our airspace. Additionally, TEB and LGA must coordinate and share flight paths for approaches in certain configurations (TEB runway 19 and LGA runway 22 arrivals), limiting the capacity of both airports.

On both sides of the Hudson, the pairing of two airports creates another operating challenge that is difficult to overcome. In New Jersey, TEB and EWR are separated by 11 miles and in New York, JFK and LGA are separated by less than 9 miles. JFK's predominate configuration does not typically use more than two of its four runways at one time because of restrictions placed on its airspace by LGA. Theoretically, without this restriction JFK could utilize all four of its runways much more effectively. TEB can severely limit operations at EWR when it needs to adjust to avoid conflicts with LGA. More severely, certain configurations at EWR can virtually shutdown operations at TEB.

Many of the airspace constraints that were discussed can be addressed by adopting new technologies that would modernize the air traffic control system and help to disentangle the airspace conflicts among the region's airports. The modernization of the nation's air traffic control system and its impact on the region's airspace will be detailed in Chapter 5.

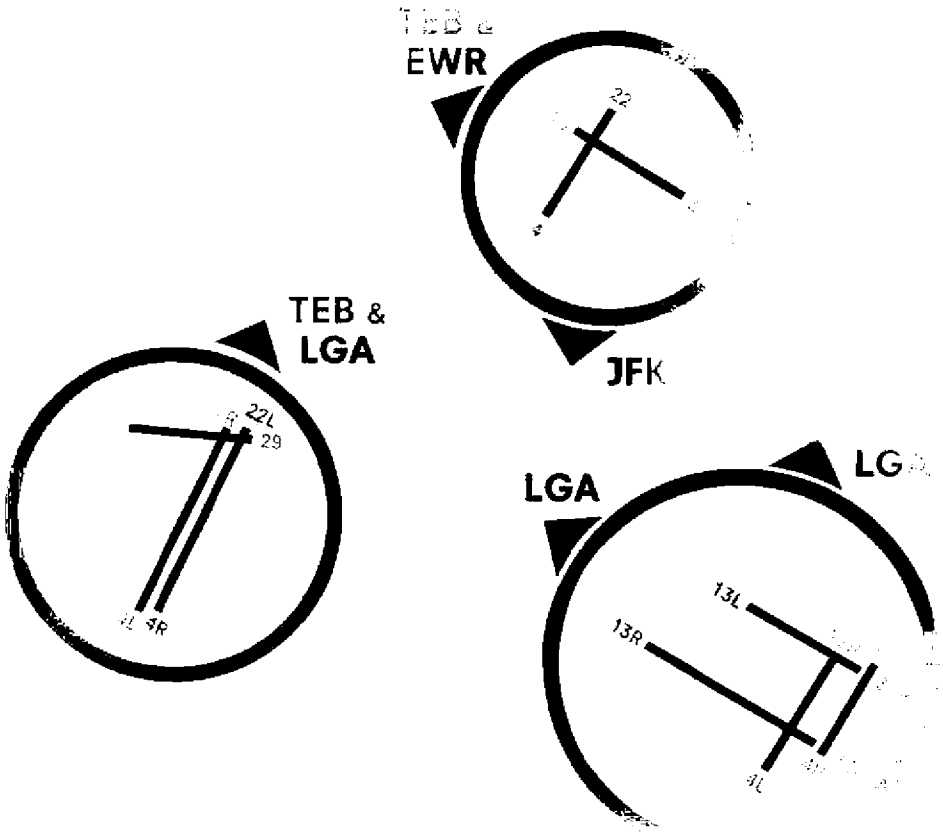
How Airside and Airspace Deficiencies Contribute to Delays

Delays are caused when demand exceeds supply, and are exacerbated by weather, the mix of aircraft size, especially large (or small) aircraft, runway configurations, and on the ground, by insufficient gate capacity.

At its most basic level, delays occur when there is more demand for a service than there is capacity to supply that service. This is true at our airports; when there are more flights scheduled to arrive or depart from an airport than the combined capacity of the airspace and airport can handle, delays inevitably occur. When consecutive hours are oversubscribed, the system loses the opportunity to recover and delays tend to accumulate and lengthen.

On good weather days, the New York airports have sufficient capacity to handle demand during most hours. However, even on good weather days, current flight activity exceeds airport capacity during some hours in the morning, and in the late afternoon and evening. During these periods, there is an imbalance of flights, with more departing flights in the morning and more arriving flights in the evening. This requires air traffic controllers to allocate runways to arriving and departing aircraft to accommodate peak demand conditions, which is not always possible at our three major airports. LGA has the least flexibility since

[27] There are two sources that when combined produce wake vortexes. The most severe is wing-tip turbulence, which consists of tubes of circulating air that trail from the wing tips as they displace air to generate lift. Jet blast from the engines also contributes to the wake vortex, but tend to dissipate at a faster rate.



the airport only has two runways and controllers usually reserve one for arrivals and one for departures. At EWR controllers usually use one of the parallel runways for arrivals and the other for departures. They will use the crossing runway for arrivals or departures depending on demand and wind conditions. JFK's four runways are typically configured as two pairs of parallel runways. Controllers at JFK usually use one pair of the parallel runways, one for arrivals and one for departures. Similar to EWR, JFK controllers will use one of the crossing runways for arrivals or departures to serve peak demand when wind conditions permit. The combination of runway intersections or crossing flight paths usually makes it too complicated to use all four runways at JFK simultaneously.

Most delays are the result of aircraft waiting to use the runways. These delays are most visible to the public since waiting aircraft are usually in line on taxiways near the end of the runway. Delays incurred by arriving aircraft occur away from the airport, either in the air or at the airport of departure.

Other aircraft delays occur because of airspace constraints either at the local level or at more regional level in the Northeast. Sometimes it is the result of too many airplanes planned on the same route, air traffic sector volume, or bad weather, usually thunderstorms blocking the planned route of flight. If air traffic controllers cannot find an alternate route around the constraint, then departing aircraft are held on the taxiways or at the gate until the conditions improve or they space out the aircraft to reduce the volume of traffic.

Delays will also occur if a terminal gate assigned to an arriving aircraft is in use by another aircraft. The airline or terminal manager will attempt to reschedule the aircraft to another gate, but an alternative gate may not always be available. Airlines only have access to gates where they have lease or usage rights. Because not all gates are available to all flights, there are built-in inefficiencies, as aircraft are limited to a smaller subset of gates. The variety of aircraft sizes compounds the problem, restricting the choices of available gates.

Figures 2.13, 2.14, and 2.15 present the recent history of delays for JFK, EWR and LGA, respectively. The annual average delay per operation grew at all three airports from 2004 through 2007. Delays then fell in 2008 and 2009. Although the delay trends are similar for the three airports, the cause of increasing delays is different among them.

In the case of JFK, the increase in delays in the 2004 to 2007 period was largely due to a rapid increase in activity. Figure 2.13 shows that aircraft activity at JFK grew by 40 percent from just under 300,000 annual aircraft movements in 2004 to almost 420,000 in 2007, shown by the dotted line. The result was an increase in delay per aircraft from 15.5 minutes to 27.4 minutes, as represented by the solid line. Subsequently, when activity declined by 5 percent from 2007 through 2009, delays declined by 35 percent. However, the recent decline in delays also reflects changes in airspace and runway operating procedures instituted by the FAA, schedule changes made by the airlines and taxiway and terminal improvements made by the Port Authority. The airspace and runway procedure changes by the FAA enabled air traffic controllers to use three instead of two runways more frequently; this occurred 40 percent of the time in 2009, but only 20 percent of the time in 2007.

The delay and demand relationships at EWR and LGA are quite different from those at JFK. It would seem paradoxical that aircraft activity declined at each airport by about 2 percent from 2004 through 2007 while delays increased by 42 percent at EWR and by 55 percent at LGA. Neither the hourly profile of demand by aircraft or unusual weather conditions can explain this. The changes in delay levels from 2004 through 2007 appear to reflect changes in airspace operating procedures made by the FAA.

These changes in airspace procedures affected two operations. The first produced a slightly greater average separation between successive landing aircraft. The second changed procedures for coordinating operations on converging or intersecting runways. The FAA made both of these changes as a result of extensive multi-year safety reviews of existing operations and reflect an emphasized "safety culture" in air traffic control operations.[28]

These airspace changes affected operations at all three airports. Operations at JFK were adjusted to make use of the third runway more frequently, which mitigated the delay increases that would have otherwise resulted from the airspace procedure changes. But at EWR and LGA, with their runway use already maximized, there were no further actions that could be taken to reduce the impact of the changing procedures, therefore delays increased. Discussions with the FAA have indicated that these airspace procedure changes are permanent, aside from some slight adjustments that might occur, and that the FAA is relying on the NextGen program to reduce delays from current levels.

In response to the higher delays during the summer of 2007, the FAA capped the number of scheduled aircraft operations at JFK at 81 per hour between 6:00 AM and 10:59 PM. Simultaneously, the FAA also capped movements at EWR at 81 per hour to prevent the potential migration of new demand from JFK to EWR. The FAA kept the current cap for LGA at 75 scheduled movements per hour with a limit of up to three general aviation movements per hour. In the final rule for LGA, the FAA indicated that they would cut the hourly limit of scheduled operations to 71 per hour. However, the FAA did not ask airlines to stop using slots. The FAA will take back slots from the airlines if they violate the "use it or lose it" provision or through attrition. The FAA would then permanently retire them, achieving the lower operational rates at LGA over time.

During the past two years (2008 and 2009), delays at all three airports have declined:

- EWR delays decreased by 15 percent while aircraft activity declined by 6 percent
- LGA delays decreased by 25 percent while aircraft activity declined by 9 percent
- JFK delays decreased by 35 percent while aircraft activity declined by 5 percent

EWR and JFK have had similar decreases in the level of aircraft activity. However, JFK has had greater delay reductions because of operational changes, which changed the usage of runways. LGA has had delay reductions commensurate with its reductions in demand. Most of this lost demand is permanent since the FAA has retired LGA slots that airlines returned.

The relationship between air traffic volume and on-time performance is demonstrated in Table 2.13; the on-time percent of aircraft movements at the three airports improved as traffic fell. Over the last three years, on-time performance was worst when aircraft operations increased, with 2007 being the worst performing year at all three airports. The airports in 2008, with higher traffic than 2009, performed more poorly in every instance except for arrivals at EWR.

FIGURE 2.13

JFK Average Delays per Aircraft Operation from 2004-2009

Source: FAA Aviation System Performance Metrics Database http://aspm.faa.gov and RPA analysis

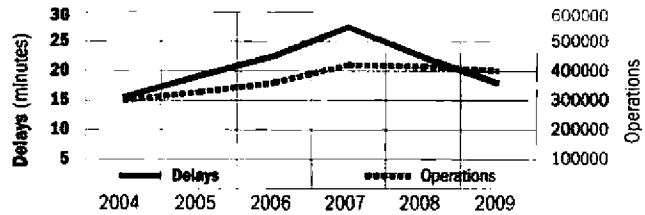


FIGURE 2.14

EWR Average Delays per Aircraft Operation from 2004-2009

Source: FAA Aviation System Performance Metrics Database http://aspm.faa.gov and RPA analysis

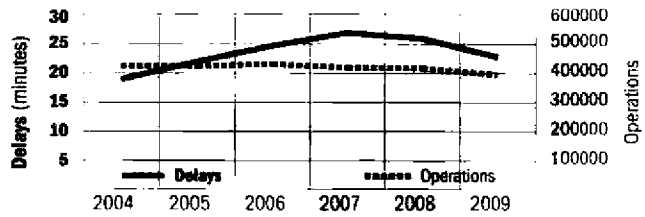


FIGURE 2.15

LGA Average Delays per Aircraft Operation from 2004-2009

Source: FAA Aviation System Performance Metrics Database http://aspm.faa.gov and RPA analysis

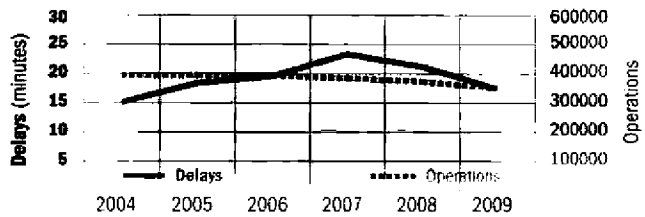


TABLE 2.13

On Time Performance and Passenger Demand: 2007-2009

		Aircraft Operations (thousands)	% Departures On-Time	% Arrivals On-time
JFK	**2007**	444	69.0	67.8
	2008	439	75.6	68.6
	2009	415	77.4	70.45
EWR	**2007**	436	67.8	58.4
	2008	434	69.0	62.3
	2009	412	71.6	60.8
LGA	**2007**	392	71.6	58.5
	2008	379	75.0	62.8
	2009	354	75.8	63.5

Source: Port Authority and FAA – Bureau of Transportation Statistics

28 This 2005 audit is detailed in the FAA's *New York Terminal Radar Approach Control Operational Assessment*, which can be viewed at: http://www.faa.gov/library/reports/ny_tracon/

Initiatives to Reduce Delay - Delay Reduction Task Force and NextGen

While the airspace is the primary responsibility of FAA, the Port Authority and airlines also play important roles. Delays and congestion have spurred recent actions and mobilization for long-term improvements.

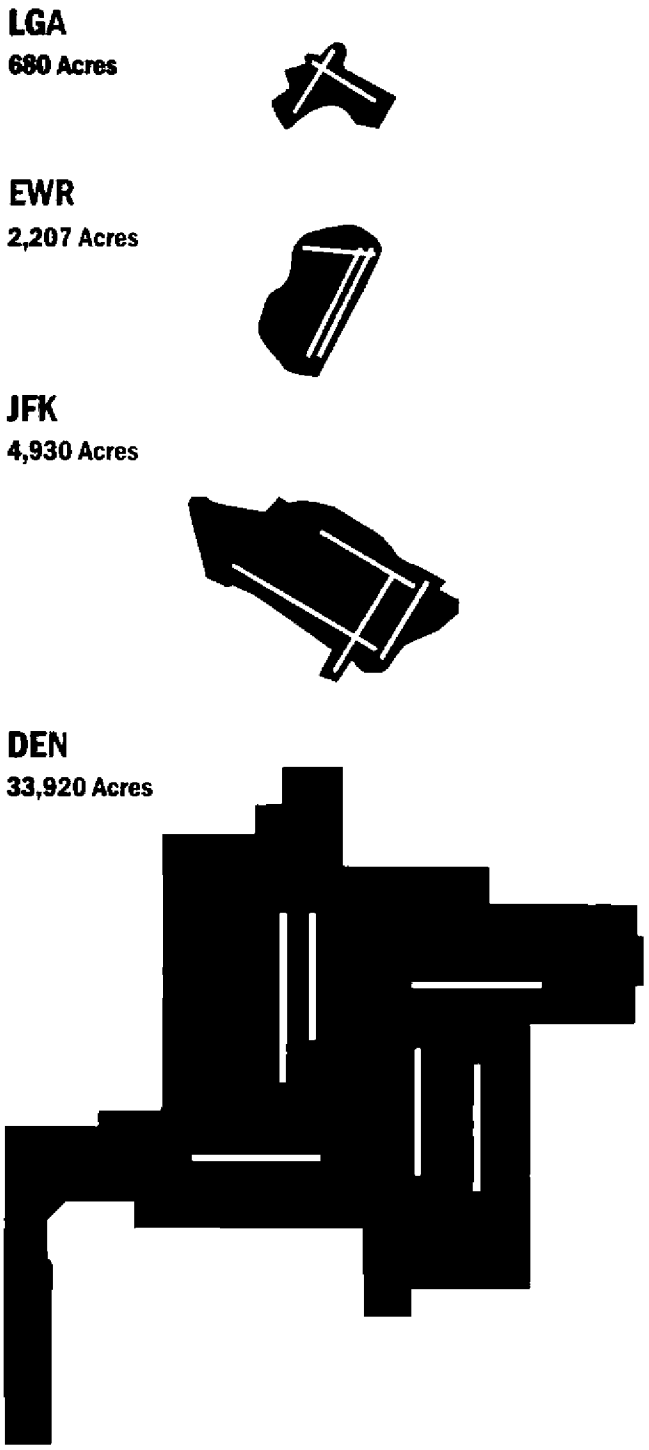
- **Delay Reduction Task Force:** The Port Authority created a task force composed of 28 members from the public and private sectors in 2007 to determine what improvements could be made at all three airports to reduce congestion and delays. The task force recommended 77 actions to manage delays in the short term and provide additional capacity in the long term. For example, they recommended extending a number of JFK's taxiways, as mentioned earlier, and the installation of ground-based sensor networks at all three airports to manage the airfield, which is detailed next. Among the recommendations, 36 have been implemented, 33 adopted into FAA's NextGen implementation plan and 8 were not implemented as of January 2011.

- **NextGen:** The FAA's NextGen airspace modernization program changes the fundamental approach to air navigation, aircraft monitoring, and flight path calculation. Ultimately, it will eliminate the constraints imposed by ground-based air navigation aids such as instrument landing systems - which dictate that all approaches must be straight in to the runway. The higher precision and flexibility provided by NextGen has the potential to remove many of the airspace constraints imposed by the close spacing of the region's airports. Chapter 5 provides more detail about the NextGen program and how it may change air navigation in the region.

Summary of Capacity and Functional Constraints at the Region's Airports

The New York region's three main airports have both airside and landside constraints. The airspace is congested, where a problem at one airport often affects the other two. The roadways are congested, impacting our ability to access the airports and move air cargo. Compared to a modern airport, our airports have very little or no space to expand. As an extreme example at the other end of the spectrum from the region's airports is Denver International Airport (DEN) at 33,920 acres, built in an unpopulated prairie, and over four times the size of our three airports combined (7,817 acres). It currently has three pairs of parallel runways (total of 6), with enough capacity to handle the same number of daily operations that are served by all three of the region's airports combined. Unlike the region's, it is the only commercial airport in the Denver metropolitan area, replacing Stapleton Airport when it opened in 1995.

New York's Airports Compared to Denver International Airport
Source: Regional Plan Association



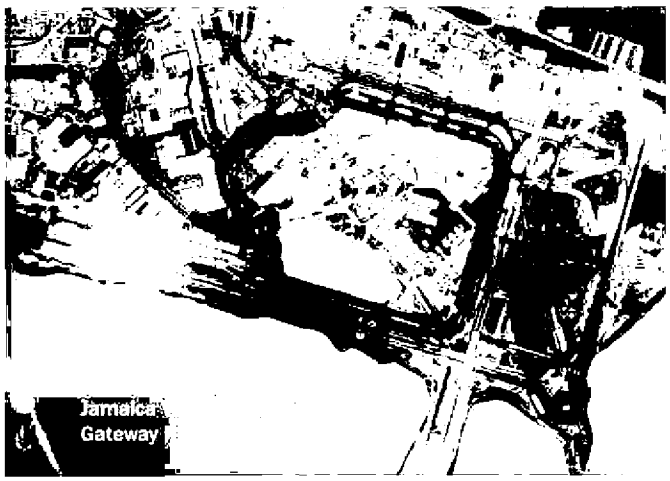
Airside and Landside Constraints by Airport

A summary of the constraints at each of the three major airports discussed in this chapter is presented here. To it are added the findings of the 2007 Regional Air Service Demand Study. This comprehensive study evaluated each airport and determined which components would be deficient by 2030. Other sources of information were observations made by the study team, discussions with Port Authority and FAA officials, and various studies completed by the aforementioned agencies.

Airside Limitations at JFK

1. JFK's proximity to LGA prevents the airport from fully using its surrounding airspace and runway approaches.
2. The runway configuration for JFK limits its capacity. Runway 4L/22R intersects with both 13/31 runways. The separation distance between parallel runways 4/22 L and R is less than the spacing required for independent arrival operations. Phase one of NextGen will initially allow for staggered approaches on these runways and eventually fully independent operations.
3. The taxiways connecting Terminals 1, 2/3, and 4 are narrow.
4. Terminals 2/3 are inefficient and should be replaced. The Port Authority is currently discussing plans to replace or demolish these two terminals.
5. Terminal 6, an outmoded facility, is currently idle and should be replaced. The Port Authority is currently discussing options to demolish this terminal and use its footprint to expand Terminal 5.
6. There are also a number of vertical obstructions around the airport that limit operations.
7. It is surrounded by a densely populated community to the north and west, and Jamaica Bay and Gateway National Recreation Area to the south.

JFK Constraints



Landside Limitations at JFK

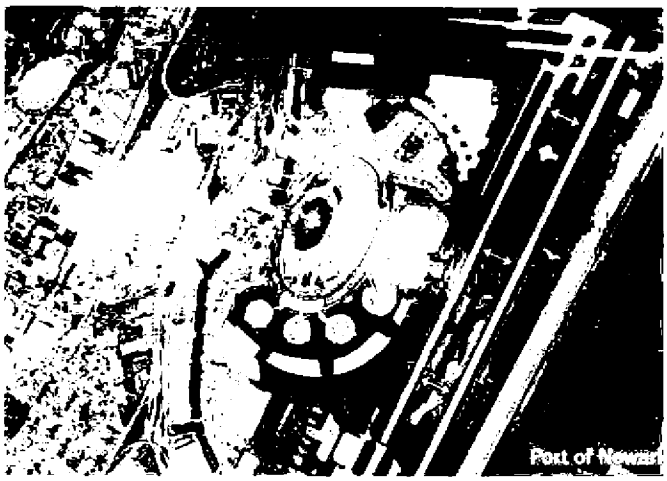
1. Ground access to the airport is problematic, the Van Wyck experiences chronic congestion (Level Of Service = F) on a daily basis and there are limited truck routes for air cargo. The Belt Parkway and Nassau Expressway are less congested; however, the Belt Parkway cannot handle trucks. Additionally, regulations restrict the size of trucks that can access the airport and none of the access routes to JFK allows 53 foot trucks.
2. Options to expand highway capacity are very expensive and would have severe community impacts.
3. Public transit requires a multi-seat ride in most cases and travel times can be excessive if connecting from the New York City subway system.
4. The airport has much underutilized land that could be used for additional cargo facilities, but it is uncertain that demand would grow there, given the congested highway access. The Port Authority is currently undertaking a study to determine the best use of this idle property at JFK.

Airside Limitations at EWR

1. Capacity is constrained by the configuration of its airfield's runways. The airport is not allowed to operate its two parallel runways independently because they are only separated by 950 feet. Phase 1 of NextGen would allow staggered parallel (3/5 of a mile) approaches on these two runways.
2. The intersection of both parallels by runway 11/29 only further complicates operations at the airport.
3. Vertical obstructions at the adjacent Ports of Newark and Elizabeth can limit operations under certain conditions, especially on Runway 11/29.
4. Taxiing to and from 4R/22L requires crossing Runway 4L/22R.
5. EWR's airspace can be impacted by TEB, but mostly it is TEB that is constrained by EWR.

EWR Constraints

Source: Regional Plan Association



LGA Constraints

Source: Regional Plan Association

Landside Limitations at EWR

1. There is limited space for expansion of cargo facilities.
2. Terminals A and B have inadequate security checkpoints and holding rooms. The Port Authority is currently performing extensive renovations on Terminal B to address many of these concerns and planning is underway to replace Terminal A with an entirely new facility.
3. The AirTrain is inadequate, slow and lacks capacity for growth. It is near the end of its useful life and will need to be replaced.
4. Highway congestion while not excessive now, threatens to hold down air passenger growth.
5. NJ TRANSIT train schedule to Newark Liberty rail station, connecting to AirTrain often has gaps that exceed 20 minutes, and occasionally as much as 40 minutes. Amtrak service frequency is so limited as to be almost useless. Its cost from Manhattan of $40 one-way further guarantees its limited use for local access to the airport.

Airside Limitations at LGA

1. LGA has little room for expansion. The surrounding dense urban development in College Point, the adjacent Grand Central Parkway and the Riker's Island Prison Complex, located just offshore, all contribute to limiting the future growth of this airport.
2. LGA's airspace routinely conflicts with JFK and TEB, with ILS procedures at JFK, virtually shutting down runway 4/22 and forcing LGA to operate with just one runway.
3. Narrow alleyways between piers at the Central Terminal reduce gate capacity and airport efficiency.
4. Intersecting and short runways limits the airport's capacity, flexibility, and the destinations to which it can operate.
5. Vertical obstructions along Grand Central Parkway and in Flushing can conflict with Runway 4 and limit the weights of aircraft departing on Runway 13.
6. Space is limited for queuing aircraft awaiting departure.

Landside Limitations at LGA

1. The Central Terminal Building is obsolete; its finger piers are too closely spaced, limiting the size of aircraft that can access the gates at one time. The Port Authority is currently planning the replacement of the CTB with a modern facility that will address these limitations.
2. Overall its terminals are crowded and lack many of the modern amenities that air travelers have come to expect at an airport. The replacement of the CTB will reduce this crowding and greatly improve passenger amenities.
3. There is inadequate security checkpoint and holdroom capacity at the CTB and Air Marine terminals. Holdroom capacity at the CTB will be addressed when the terminal is replaced.
4. LGA does not have a robust transit connection to the airport, only buses operating in mixed traffic.
5. It experiences congestion on the Grand Central Parkway and in the bottlenecks within its twisting maze of internal roadways. The internal roadway network is shoe-horned in into a small space and consequently is very constrained.
6. Internal public transit connections rely on slow buses, which are often stuck in traffic.
7. Curb space and parking is limited.

Moving Beyond Existing Constraints

As demonstrated by the recent investments and ongoing plans cited earlier, the Port Authority, FAA and airlines are all well aware of what is at stake if improvements are not made to the region's airports. Over the past ten years the Port Authority, FAA and airlines have invested billions of dollars to improve and maintain the three major airports, Table 2.14 shows the annual agency capital expenditures for each airport for years 2000 to 2010 and Table 2.15 displays the investments made by the private sector. The agency contributed over 60 percent of the capital funding during this period, with the private sector investing almost $4 billion at the airports on AirTrain and new terminal development. The Port Authority is responsible for managing and partially funding these capital investments. The agency also solicits grants and Passenger Facility Charge (PFC) funds

from the FAA and recaptures part of the capital costs from the airlines through landing fees. Approximately 56 percent of these funds supported state of good repair (SOGR) or infrastructural renewal, which includes upgrades to the airports so they conform to modern guidelines (runway safety areas and security). The other 44 percent were used to increase airport capacity and efficiency (JFK AirTrain, terminal C at EWR, terminal 5 at JFK and the reconstruction of the Bay runway).

Capital investments include maintaining the 285 miles[29] of roadways, taxiways and runways, 425 buildings totaling more than 21,000,000 square feet and 50,000 parking spaces at all five airports. Over the last ten years 19 miles of internal roadways, 18 miles of runways, 43 miles of taxiways and 61 acres of aprons were repaved or reconstructed (a total capital investment of $836 million), the AirTrain at EWR was rebuilt, and three new terminals and the AirTrain were constructed at JFK. The Port Authority has also invested in developing new technologies like Engineered Material Arresting System (EMAS), which was used to improve the runway safety areas (RSA) at several of its airports where space was insufficient to physically extend the runways an additional 1,000ft.

The agency is required by the FAA to develop a five-year capital improvement plan and has developed two multi-year plans during the past decade, a three-year plan 2006-2008 and ten-year plan 2007-2016, and is currently in the process of drafting a 2011-2020 ten-year capital plan. The Port Authority is financially self-sustaining and must raise the moneys necessary to operate its facilities and provide services to the public through tolls, fares, rentals and other user charges. The funds needed for capital improvements, construction and acquisition of facilities are raised on the basis of the Port Authority's own credit rating.

The improvements currently underway provide a baseline for the range of longer-term actions to expand capacity that this report will consider.

Airport Investments – Port Authority Capital Expenditures by Facility (current dollars, in millions)

Year	JFK	EWR	LGA	TEB	SWF	PFC	All Facilities	
2000	124	180	57	6	-	-	367	
2001	117	452	40	14	[redacted]		623	
2002	125	349	65	12	-	-	551	
2003	116	191	59	9	[redacted]		375	
2004	80	102	72	26	-	-	280	
2005	114	50	59	47	0.2	[redacted]	437	
2006	295	55	38	34	0.1	135	557	
2007	378	165	93	23	1	[redacted]	660	
2008	259	203	136	24	9	-	631	
2009	306	156	148	28	20	[redacted]	658	*
2010	269	107	104	25	16	-	521	**
Totals	$2,183	$2,010	$871	$248	$46	$302	$5,660	

Source: Port Authority – Notes: * $100M from 2009 Capital Expenditures are from Queens swap; ** The 2010 numbers are Budgeted dollars & *** $1.9B in AirTrain increases total investment to $7.258B

TABLE 2.15

Airport Investments – Private Sector Capital Expenditures by Facility

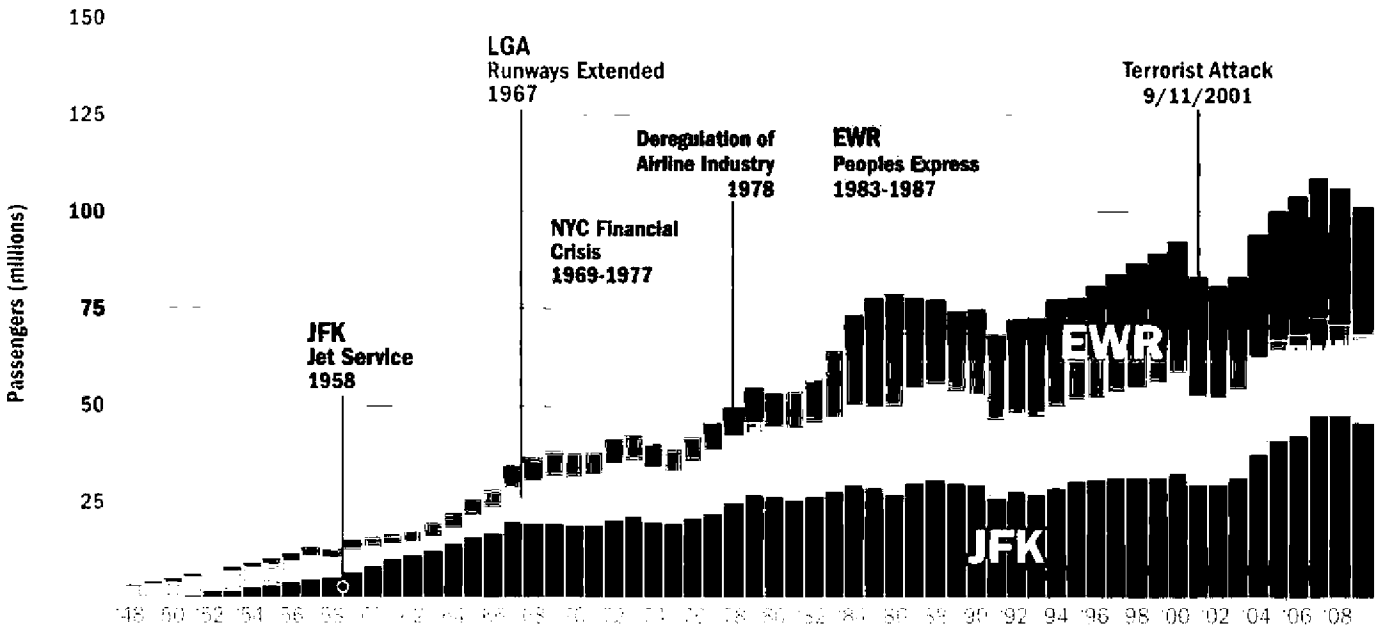
(current dollars, in millions)

Year	JFK	EWR	LGA	TEB	All Facilities
2000	500	234	15	11	760
2001	529	120	32	36	717
2002	253	32	56	3	344
2003	100	18	3	28	149
2004	109	17	4	5	135
2005	579	26	5	2	612
2006	134	17	17	27	195
2007	116	33	13	8	170
2008	138	69	13	3	223
2009	46	100	37	1	184
2010	67	13	43	0.1	123
Totals	$2,571	$679	$238	$124	$3,612

Source: Port Authority

29 189 miles of roadway, 71 miles of taxiways and 25 miles of runways

Air Travel Demand at New York Airports: 1948 to 2009



How Much Growth and When Can We Expect It?

Projecting air travel is a risky business, and the further the time horizon, the riskier it is. Projections require an interpretation of the past, an evaluation of how relationships among different trends are likely to evolve, and an application of these to future conditions. In the late 1960s, following a long period of double-digit growth of air travel, the projections for air travel were robust, assuming that the earlier growth rates would continue. They did not, as actual annual averages were less than two and a half percent increase over the following forty years. Consequently, these projections substantially overestimated air travel demand. While the models at the time did attempt to account for economic growth, they assumed that economic growth would be more sustained than what actually occurred.

Today, the models used are more sophisticated. They incorporate economic factors, a reading of the airline business, and the impacts of airport improvements. They also examine the geographic distribution of the origination and destination points in the metropolitan region more carefully, accounting for projected changes in demographic conditions around the region.

Once air passenger projections are made, they can be used to calculate passenger aircraft activities at the three airports by applying load factors per aircraft, adding the contributions of cargo and general aviation operations and distributing projected annual aircraft operations to daily aircraft operations. These estimates of future activities can then be converted to peak hour movements, as they will be in the next chapter to evaluate the adequacy of the airports runway and airspace system to accommodate future growth.

How Many Air Passengers Will There Be?

In this section, various methods of projecting air passenger traffic are described and the results they produce are compared. The purpose is to make credible estimates of air passenger demand **if there were no capacity constraints at the three major airports – JFK, EWR, and LGA.** By examining methods used to project air travel an understanding can be gained as to why air passenger traffic grows and by doing so, converge on reasonable estimates of future growth rates.

Port Authority Projections

The most nuanced approach to projecting air traffic is the set of models established by the Port Authority. They use a three stage econometric model that is driven by both national and international growth, airline prices and knowledge of air carrier plans and other factors. In the first stage, econometric models calibrated on data since 1984 are used to project domestic and international air travel separately. The domestic model is calibrated on U.S gross national product, airline prices, and is corrected to account for the impacts of past fuel shortages and the terrorist act of 2001. The international model uses the U.S. gross national product and the European Union gross domestic product, exchange rates, and airline prices.

In the second stage, the model adjusts to account for income elasticities, the advent of low cost carriers, and underlying fears of terrorism.[1] In the final stage, the impact of expansion at each airport is accounted for, as are prospective air carrier plans and knowledge about new airline entrants.

This most recent update of the Port Authority projections[2] was completed in May 2010. It includes three separate scenarios – optimistic, moderate and pessimistic – to represent a range of future economic conditions. The economic assumptions include a U.S. economic contraction of 2.8 percent in 2009 and a recovery of 2 percent in 2010. Beyond 2011, the U.S. economy is expected to grow at a trend rate of 3 percent. The projections assume that the world economy will contract by 2.6 percent in 2009, recover and grow faster than the U.S. economy, with about 0.8 percent annual average growth higher than the U.S. rate after 2011.

The Port Authority has assumed that, unlike previous recessions, the current recession has involved an evaporation of wealth on a worldwide scale that will take longer to recovery and the result will be a slower bounce back in air travel demand.

The Port Authority's 2009 projections are done on an annual basis to 2019. The estimated annual passenger volumes for that year are 138.8 million, 130.5 million and 114.8 million for the optimistic, moderate, and pessimistic projections, respectively. These projections correspond to annual growth rates from 2010 to 2019 of 3.16 percent, 2.53 percent and 1.22 percent. The optimistic scenario assumes a less risky world situation, a strong dollar and lower oil prices, relative to the moderate and pessimistic scenarios.

Beyond 2019, the Port Authority does not rely on its models because it is much more difficult to estimate the independent variables on which the models are based. The Port Authority assumes growth is closely tied to regional population growth. Consequently, the annual rates of growth drop substantially, to 0.7, 0.7 and 0.5 percent for the pessimistic, moderate and optimistic projections. The Port Authority's 2010 to 2040 projections are shown in Figure 3.1. By 2030, the passenger estimates would be about 150 million, 141 million

1 See Long Range Forecast and Key Assumptions 2010 – 2019; November 2009; Port Authority of New York and New Jersey for this discussion.

2 Port Authority of New York and New Jersey – Aviation Department, Industry Forecasting, May 2010

and 121 million for the optimistic, moderate, and pessimistic scenarios, which translates to annual rates from 2009 to 2030 of 1.86, 1.56, and 0.84 percent.

Because projecting air passenger traffic is such an inexact science it is useful to examine other methods and then compare them to the Port Authority's results to gain greater confidence, and perhaps adjust them based on what is learned from other methods.

Trend Extrapolation Methods

The most straightforward methods involve extrapolation of past demand trends. While these approaches do not attempt to anticipate changes in the economy or other factors that could affect travel, trend methods have the advantage of simplicity and can be a benchmark against which more complex methods can be evaluated.

Figure 3.2 uses a weighted moving average[3] for each year's air passenger travel demand to smooth out much of the annual variations. The chart accomplishes this, displaying a smooth relationship with two exceptions: the Peoples' Express "bump" in the 1980s and the 9/11 drop largely induced by the terrorist attacks. A straight line fits these data very well with a coefficient of best fit of 0.813. Projecting this line of "best fit" to 2030 yields an estimate of about 126 million air passengers, which is close to but above the Port Authority's pessimistic scenario.

Top-Down Trend Method

A slightly more refined method is a *top-down* method based on separate trends in domestic and international traffic projected, shown in Figure 3.3. Projections of these trends yield an estimate for 2030 of about 127 million passengers, also between the pessimistic and moderate projections by the Port Authority.

Note that the fit for domestic air travel is much more volatile and is growing at a slower rate than international travel. This last point is made even clearer in Figure 3.3, which shows the long-term trend and projection of the share of domestic travel at the three New York airports combined. The domestic share has dropped from around 73 percent in the early 1990s to the mid-60s in 2000s, and could fall to the low 60s in the next 20 years.

Personal Income Based Trends

Another set of methods explicitly models the close relationship between personal incomes and air travel – over time higher incomes produces more air trips. This isolates the single best predictor of air passenger demand. However, it only accounts for the growth in travel generated by residents of the region, and not travel generated by non-residents (tourists and business travelers).

Introducing this concept was done in a number of ways. First, the annual regional personal income[4] was compared to annual air travel. Second, the personal income per capita was compared to air travel per capita. The plots cover the period from 1969 to 2006. Each was fitted with linear and logarithmic lines of "best fit." The logarithmic curves fit better in both cases. Th. two plots, the equations and the r-squares indicating the qualit of fit are shown in Figures 3.5 and 3.6. The concave shape of the curves indicates a rate of increase of air passengers declining with rising incomes.

To use these relationships for projecting air travel requ projections of income as well. Such projections have been d for the 31-county tri-state region in five-year estimates fron to 2035.[5] Applying these adjusted personal income projections to the two equations in Figures 3.5 and 3.6 yields estimates of 129.5 million and 148 million air passengers, respectively. The former sits squarely between the Port Authority's pessimistic and erate projections and the latter just below their optimistic

Regional Air Service Demand Study (RASDS) Method

The RASDS projections were performed by Parsons, Brinckerhoff, working with Landrum and Brown in cooperation with th Port Authority.[6] They were published in May 2007. The data for the model relied on both trends and cross-sectional data from 2005 to define the characteristics of air travelers as these relate to the airport(s) they use, unlike the Port Authority projections described earlier, which resulted from a top-down method that projected total traffic for the three airports and then allocated it to each one. This method is based on building up the estimates from air trips generated by counties to each of nine airports in the region, including the three major Port Authority airports. The projections were based on population, employment and hotel rooms (for-non-resident trips only), and on a growing propensity to travel by air over time. This method resulted in an estimate of 149 million air passengers for the three major airports in 2025, higher than the Port Authority's optimistic projections, which would not reach that level until 2030.

Federal Aviation Administration's TAF Projectio

The FAA recently projected air travel for each of the three major airports in annual increments to 2030[7]. The FAA uses a two-step national econometric model and then allocates national demand back to local airports. In the first step, this model considers population, per capita income, and airline fares. The FAA then adjusts their local projections based on more current information from airport sponsors. In the second step, the FAA adjusts short-term projections to reflect known plans by airlines to change air service levels at local airports. The FAA projections average over 3 percent annual growth rate from 2010 to 2020 and just below 3 percent annually in the 2020s. Overall, the annual growth rat

3 The moving average used here weighs the current year with a weight of three, the previous and next year with a weight of two and two years earlier and later with a weight of one.

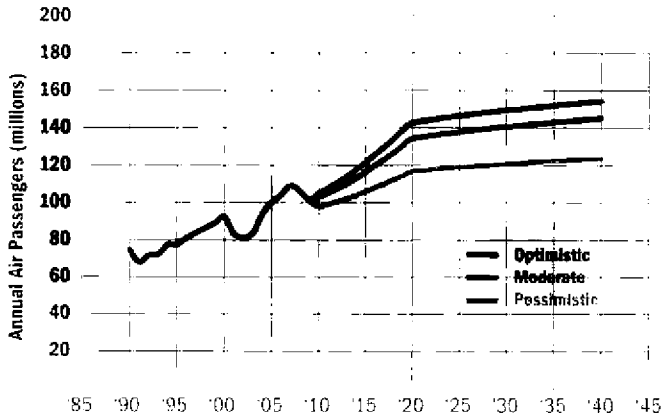
4 Source: Bureau of Economic Analysis estimates for the New York metropolitan area. This area approximates the 31-county tri-state area as defined by Regional Plan Association. The BEA area generates about 3 percent more income than the RPA area as estimated by RPA

5 These estimates have been done by Urbanomics for the New York Metropolitan Transportation Council. Use of these estimates requires three adjustments. First, the 31-county personal income estimates must be adjusted to conform to the slight larger (by 3 percent BEA area that was used to develop the relationships in Figures 3.8 and 3.9. Second, the personal income estimates, provided in current dollars, must be adjusted to constant dollars. This is done by assuming an annual consumer price index of 2.6 percent, which approximated the median value of the index over the last 15 years. Third, these personal income projections were developed prior to the recent deep recession. Urbanomics suggested that the 2008 personal income estimates for 2010 be lagged by two years, projections for 2015 be lagged by three years and the 2035 projections be set at 1 per lower than the original projections for personal income.

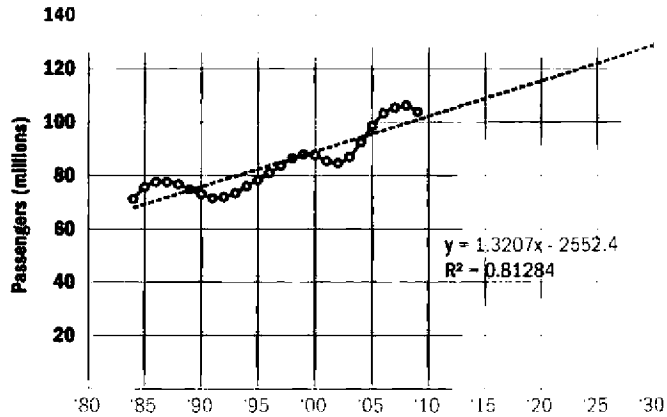
6 Regional Air Service Demand Study - The Port Authority of New York and New - Task C: Forecast of Origin and Destination – May 2007

7 FAA TAF citation here

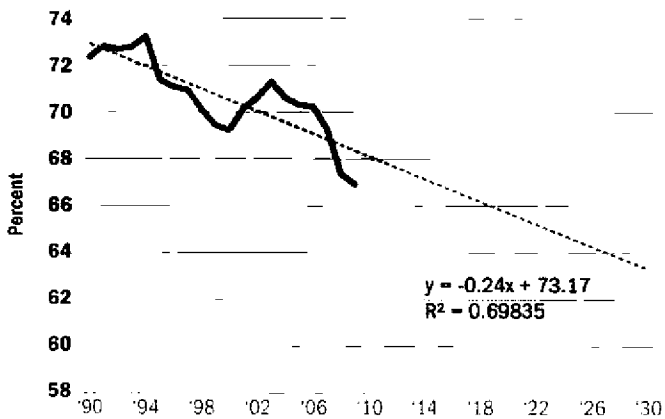
Port Authority Passenger Projections to 2040
Source: Port Authority of New York and New Jersey



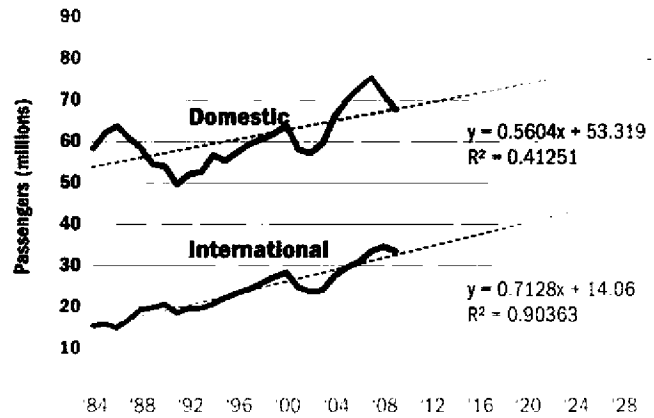
Air Passengers at Three Major Airports Weighed Moving Average
Source: Port Authority - 2008 Air Traffic Report and Regional Plan Association



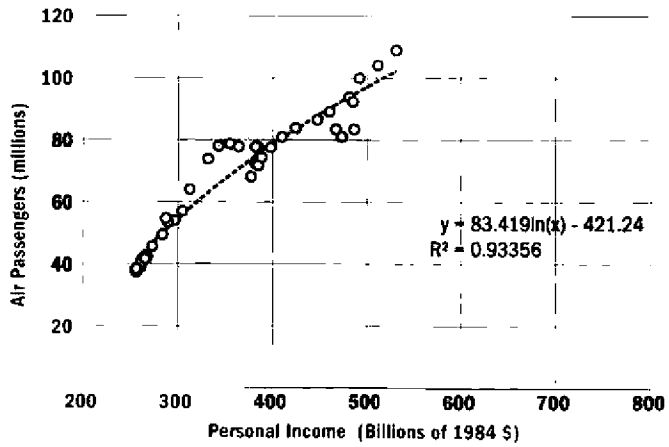
Domestic Passengers as Percent of All Passengers at Three Major Airports
Source: Port Authority – 2008 Air Traffic Report and Regional Plan Association



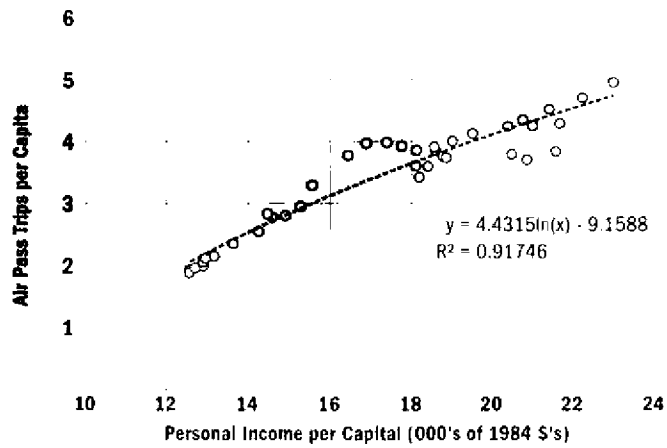
Domestic and International Air Passengers Three Major New York Airports 1984 to 2008 (millions)
Source: Port Authority - 2008 Air Traffic Report and Regional Plan Association



Regional Personal Income vs Annual Air Passengers New York Region 1969 to 2007 With Logrithmitic Relationship
Source: Regional Plan Association



Personal Income per Capita versus Air Passenger Trips per Capita New York Region 1969 to 2007
Source: Regional Plan Association



[illegible] tion to 186 million, well above the rates of the Port Authority's optimistic projection of 150 million.

Comparing the Methods

Clearly, projecting air traffic shares is very risky; much depends on the growth of the economy and on how much flying will continue to grow on a per capita basis. In the short-term, the business decisions by airlines will also play a part, especially regarding the relative growth at individual airports. And such decisions become even less certain over longer time horizons.

Yet, it is possible to arrive at some reasonable conclusions by arraying and comparing the methods discussed here. This is done in Table 3.1. Shown is the annual rate of increase for each method over the 2009 to 2030 period, with the exception of RASDS, which was projected from 2005. Also, shown is the absolute increase from 2009 to 2030. It is readily apparent that the FAA projection is by far the highest, showing an increase of over 80 million passengers in 21 years. However, as shown in Figure 3.7, there has never been an increase in air passengers of such magnitude in any 21-year period. The greatest 21-year gain ever was 55 million between 1964 and 1985. In recent years, the 21-year gain never exceeded 30 million; and has been falling to 25 million or less rather consistently. It is difficult to envision that there will be 80 million more air passengers in the next 21 years at the three New York airports. Therefore, the FAA projections are not considered any further here.

At the high end of the remaining projections sits RASDS, at 2.02 percent annually. The RASDS projection was developed before the recent deep recession, so it is not too surprising that it ranks even above the Port Authority's optimistic projection. The optimistic projection by the Port Authority of 1.87 percent increase annually, and the highest projection using income per capita increase at 1.81 percent annually are very similar in outcome by 2030. The major difference is that the Port Authority's projection arrives there with higher growth in the first ten years – as evident in Figure 3.1 – while the income method arrives there more evenly over the 2009 to 2030 period. These two methods would add 48 million and 46 million more air passengers, respectively, with a 21-year increase of over 40 million, approaching absolute increases not experienced since the 1980s, as show in Figure 3.7. They are near the high end of a 21-year growth range, making them quite plausible for an optimistic or high scenario.

Comparisons of Projections (in Millions of Air Passengers)

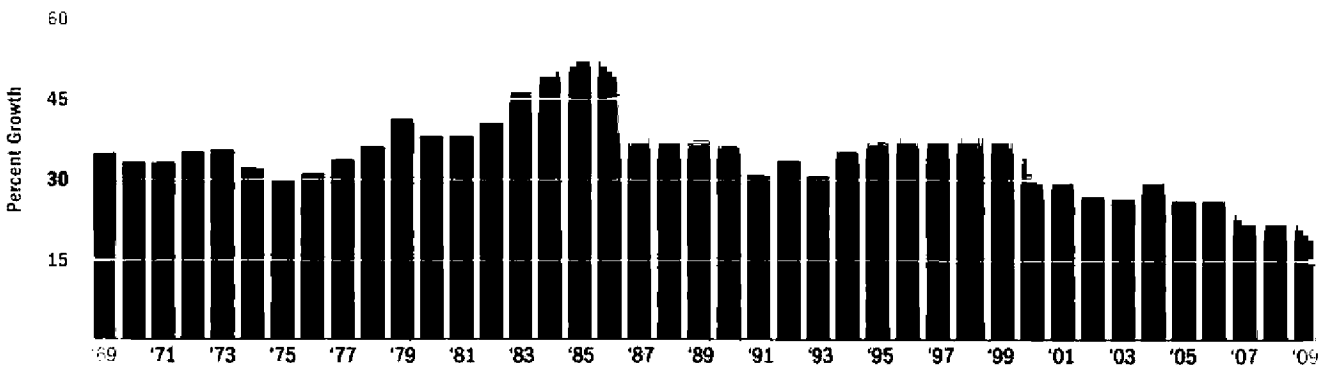
Source	Description	Air Passengers Projected for 2030 (mil)	Annual Growth Rate 2009 to 2030 (%)	Added [illegible] gers from 2[illegible] to 2030 ([illegible]
PANYNJ	Econometric - Optimistic	149.6	1.86	4[illegible]
PANYNJ	Econometric - Moderate	140.8	1.57	3[illegible]
PANYNJ	Econometric - Pessimistic	121.2	0.85	19[illegible]
RPA	Trend from Moving Average	125.9	1.03	24[illegible]
RPA	Top Down Trend	126.9	1.07	25[illegible]
RPA	Personal Income - Log	129.5	1.17	28[illegible]
RPA	Income per capita vs trips per capita - Log	147.9	1.81	46[illegible]
RASD	Econometric - Built up by Airport	149.1	2.02*	4[illegible]
FAA	National Econometric and Shares to New York	182.2	2.93	80[illegible]

At the low end of the spectrum sits the Port Authority's pessimistic scenario, with a 0.85 percent annual growth rate, adding only 19.7 million passengers in 21 years. It is considerably lower than RPA's two trend-based projections and the lower of its two personal income-based equations. These add from about 24 to 28 million passengers in the 21-year period, with growth rates of 1.03 to 1.17. No 21-year period has added fewer than 24 million passengers over 21 years, making a projection that adds about 25 million annually, quite plausible for a pessimistic or low scenario.

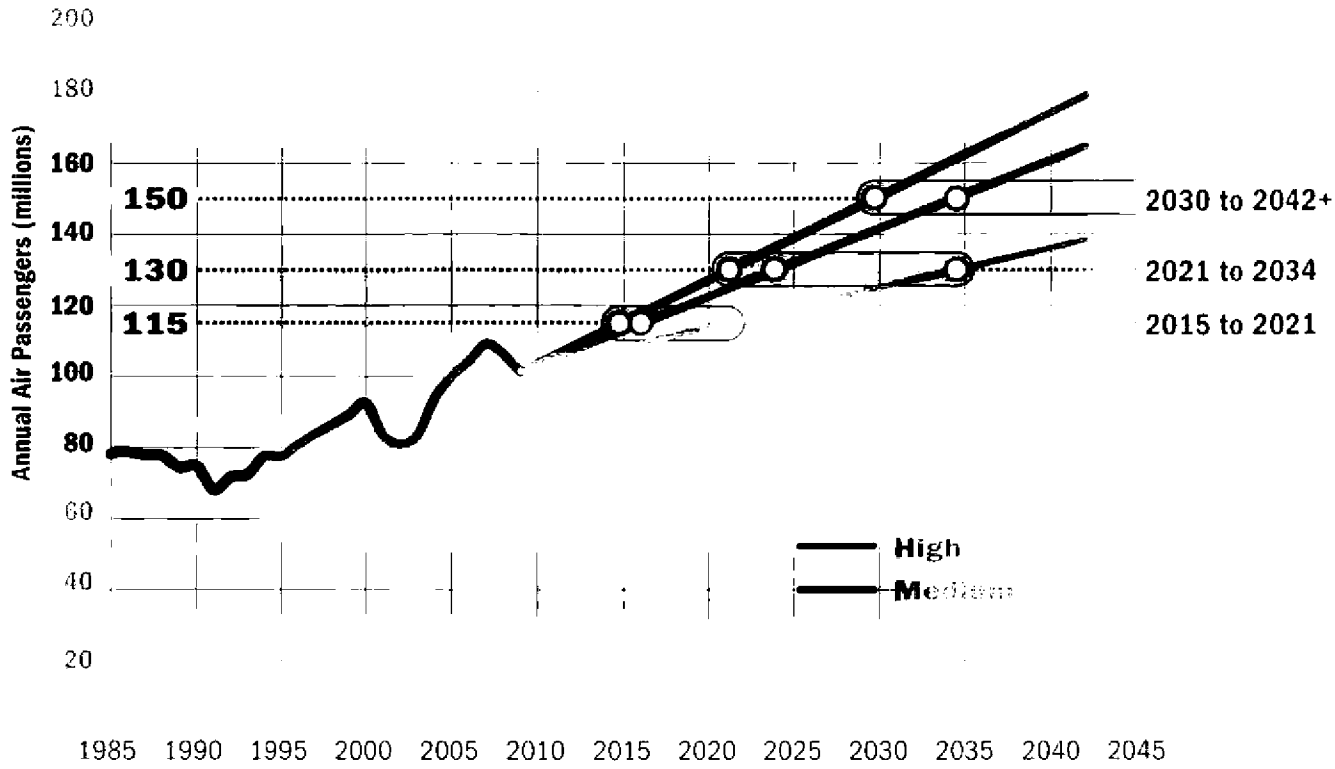
The only remaining projection to evaluate is the Port Authority's moderate one, at 1.53 percent, which falls closer to its optimistic projections than to its pessimistic one.

It would appear that the Port Authority's projections, at least to 2030 are reasonable at the high and moderate end and may be a bit low at the pessimistic end. Setting the high-end annual projection at 1.9 percent annually, the middle scenario at 1.6 percent and the lower end at 1.0 percent would seem to be reasonable in light of the forgoing discussion. However, rather than the discontinuous curves to reach the 2030 values as the Port Authority has done, it is desirable to smooth the curves. Accordingly, this can be done by assuming the 2030 values are reached by equal absolute increments, which translates to declining annual rates of growth. The annual increments are approximately 2.3 million, 1.9 million and 1.1 million for the three projections, respectively.

Passenger Growth in the Previous 21-Year Period 1969 to 2009



Unconstrained Air Passengers Projections for Three Growth Scenarios at the Three Major Airports
Source: Regional Plan Association



Year Projected Passenger Levels are Reached

Projected Passengers (millions)	Year Projected Demand Reached		
	Low	Medium	High
115	2021	2016	2015
130	2034	2024	2021
150	after 2042	2034	2030

Source: Regional Plan Association

The annual rates start at 2.31 percent, 1.89 percent, 1.11 percent and then drop to 1.33, 1.18 and 0.81 percent by 2042. The results are shown in Figure 3.8.

All three scenarios assume a rebound in air traffic to 2007 levels to varying degrees. In the high scenario, there is a moderate rebound, but it still takes about three years to recover the air passengers lost in the 2007 to 2009 period. The rebound continues at a robust rate, adding almost 50 million air passengers in the next 21 years, or about 2.35 million air passengers per year as commerce, particularly as international travel, continues to shrink the globe. This puts the absolute growth for the 21-year period near the historic high end, as shown in Figure 3.7. In the medium scenario, it takes about four years to reach the pre-recession passenger volumes of 2007, and the growth resumes at the pre-recession rates, and adds about 40 million air passengers in 21 years. In the low scenario, it takes about seven years to climb back to the 2007 levels, as demand is dampened by a combination of slow economic recovery, advanced communication innovations and the nuisance associated with security. About 23 million air passengers are added in the 21 years, near the historic low as shown in Figure 3.7.

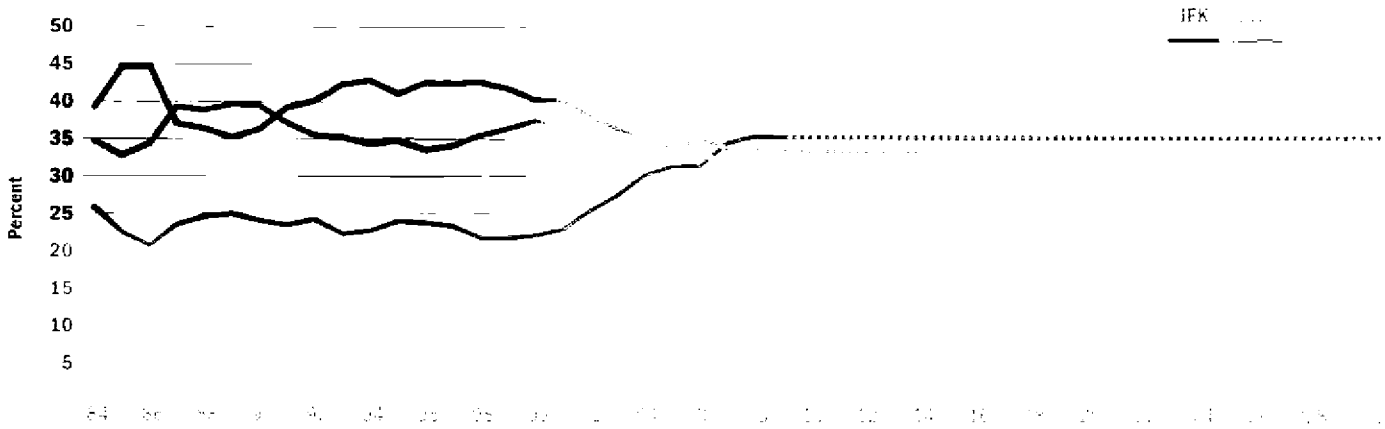
How Will These Projections Be Used?

This study focuses on the consequences of growing air travel and the extent that various actions can accommodate that growing demand. The uncertainties suggest that rather than estimating the demand at a particular date, it is preferable to establish a range of time when a particular demand level will likely materialize. As demand projections change, and they surely will, the target date for needed new capacity will shift. However, unless there is a radical departure from historic trends, it is more a question of when, rather than if, new capacity will be needed.

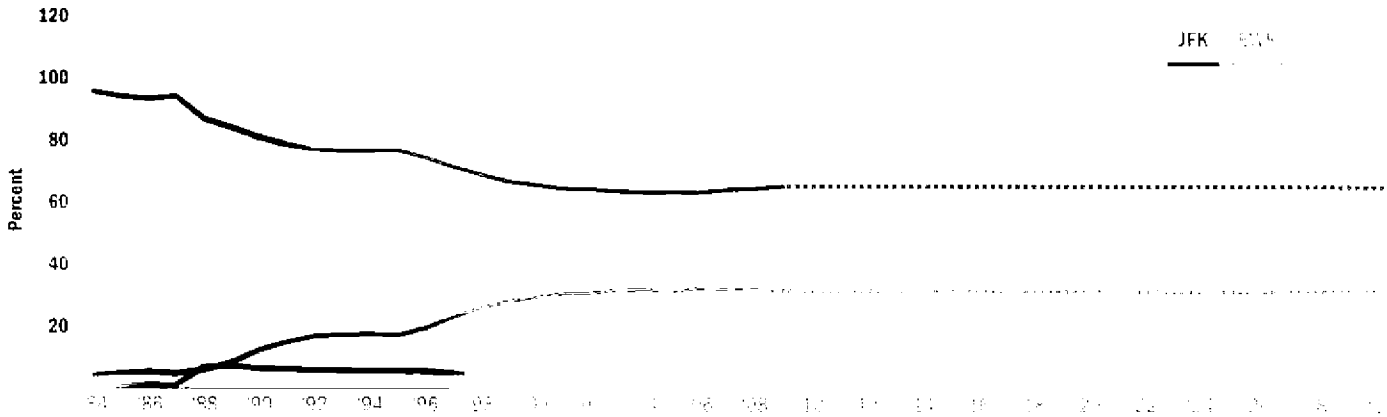
Accordingly, in this study the unconstrained air travel demand is set at three levels, 115 million, 130 million and 150 million annual air passengers (MAP), and the years that each would reach these levels for the high, medium and low growth rates is determined. This is shown in Table 3.2 and indicated in Figure 3.8 with the red horizontal two-way arrows.

The table suggests that the unconstrained 115 MAP will occur between 2015 and 2021, the 130 MAP level will occur in the 2021 to 2034 period, and the 150 MAP level could occur as earlier as 2030, and certainly not long after 2042. Of course, the uncertainties associated with air passenger demand forecasting require constant monitoring, for not only the actual growth of air travel but also because of the economic factors that the Port Authority is continually tracking and the personal income data reported by the Bureau of Economic Analysis. Additionally, the modeling methods that are discussed in this report deserve continued updating.

Share of Domestic Air Passengers by Airport 1984 to 2009 and Projections to 2030
Source: Port Authority of New York and New Jersey and Regional Plan Association



Share of International Passenger Demand by Airport 1984 to 2009 and Projections to 2030
Source: Port Authority of New York and New Jersey and Regional Plan Association



Projecting Aircraft Operations

To hone in on estimates of future operations at the three airports, which will be needed to estimate the performance of the three major airports in the future, a number of steps are applied to the air passenger projections described above.

These steps discussed below are:

- split the projected demand by domestic and international travel and assign it to each of the three airports;
- convert the annual passenger volumes at each airport to annual passenger aircraft movements;
- determine the daily aircraft movements; and
- add the number of projected movements for air cargo and general aviation aircraft.

Allocation of Future Traffic by Airport

Earlier, Figure 3.4 showed that the domestic share of all passenger traffic has been declining steadily from about 73 percent in 1990 to the high 60s percent today. The equation in this figure was used to project the domestic – international split.

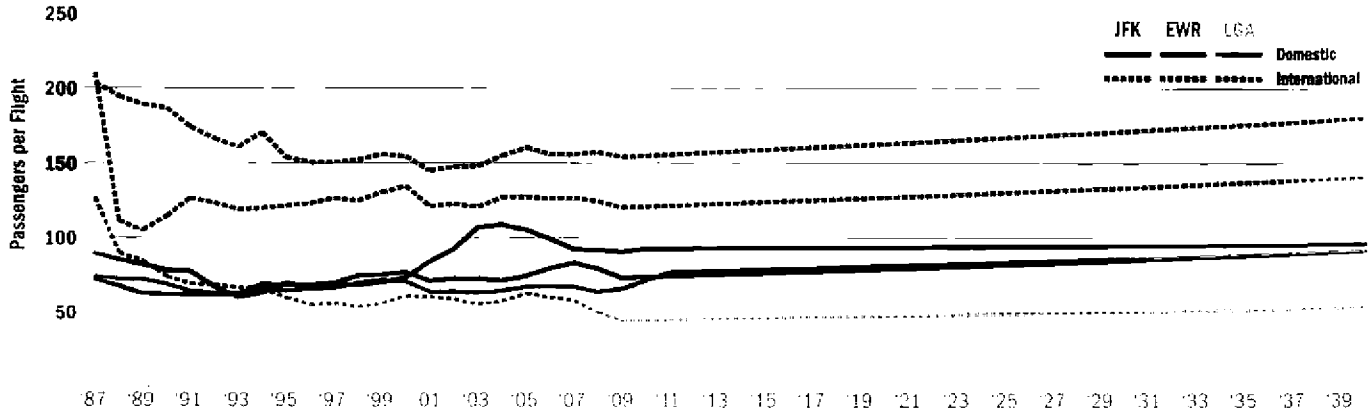
Next, the domestic and international passengers each must be allocated to the three major airports. Figures 3.9 and 3.10 display the historic trends for these allocations. In the case of domestic traffic, the historical traffic shares fluctuated when new low-fare carriers introduced new service in a large-scale manner. Peoples Express started at Newark in the mid-1980s and JetBlue started at JFK in 1999. Thus, the trends shown in Figure 3.4 are less meaningful since major events upset the trends.

Over time, this imbalance in the availability of low-fare service between the airports should abate, as other low-fare carriers start service at LGA or EWR. At LGA, Southwest Airlines has started service and Airtran has maintained its service levels by obtaining slots from Continental Airlines, despite losing some of its slots to Southwest Airlines. In the short-term, FAA slot limits make it more difficult to start new airline service at EWR.

As shown in Figure 3.10, for international traffic the split among the three airports has been much more stable, coming in at about a 65 / 32 / 3 split for JFK / EWR / LGA. There is no reason to consider changing this for the projected traffic.

The domestic / international splits and the airport allocations for both domestic and international traffic can then be used to stratify the total traffic into the six categories of domestic or international at each of the three airports, to be then converted into annual aircraft movements for the projection years.

Airline Passengers per Flight Three New York Airports Domestic and International 1987 to 2009 and Projected to 2040
Source: Port Authority of New York and New Jersey and Regional Plan Association



Passenger Movements

By far the largest share of aircraft movements at the three airports is for scheduled airline passenger service, the remaining consisting largely of general aviation and all-cargo aircraft movements. Thus, the next step is to convert passenger volumes to aircraft movements. Figure 3.11 shows the trends in passengers per movement for the three major airports separately for domestic and international flights. Historically, the passengers per movement generally correlated to the size of aircraft. However, recent trends reflect carriers flying smaller aircraft, but filling more of the seats. This trend has about run its course as the percentage of seats occupied on current airline services fluctuates between 75 and 80 percent at EWR and JFK, close to a practical maximum. The percentage of seats occupied at LGA is lower, fluctuating between 65 and 70 percent. Given industry trends, this percentage at LGA should increase over time to match the levels of JFK and EWR. After this adjustment occurs at LGA, changes in passengers per aircraft will again correlate to the size of aircraft.

The size of aircraft for international service at JFK is larger than at EWR. This reflects the larger proportion of international service at EWR that is oriented towards the Caribbean, Central and South America compared to JFK's greater orientation to Europe, the Middle East and Asia. The size of international aircraft at LGA is very similar to domestic service since most of the international service from LGA is short-haul service to eastern Canada. The rapid increase in the size of domestic aircraft at JFK reflects the growth of JetBlue compared to the other domestic carriers. The more recent decline at JFK reflects the competitive response by Delta Air Lines and the introduction of the smaller Embraer 195 aircraft by JetBlue.

Increasing fuel prices will likely result in airlines discontinuing the use of the smallest regional jet aircraft and replacing them with larger ones. Larger aircraft generally have lower fuel costs per seat than smaller aircraft. Since the U.S. Department of Energy's long-range forecasts are for the real price of fuel to increase approximately two percent annually, there will be further pressure toward larger aircraft size. The larger regional jet aircraft will likely have both first class and coach seats, thus reducing the overall effect of increasing the aircraft size, but average aircraft passenger should increase as the airline leases for smaller regional jet aircraft expire.

As shown in Figure 3.11, the largest increases in aircraft sizes should occur at LGA, since LGA has the largest proportion of the small (30-35 seat) regional jet aircraft. EWR will increase at a slower rate, while JFK will increase at the lowest rate since it has the smallest proportion of the small regional jet aircraft. The proportion of small regional jet aircraft should decline rapidly after Delta Air Lines consolidates its domestic hub operations at LGA. Over the long-term, the size of aircraft used for domestic air service at each of the three airports should be fairly similar.

The size of aircraft used for international service is expected to grow more rapidly than for domestic aircraft. New wide-body aircraft tend to be slightly larger than the older aircraft they replace. In addition, the relatively low frequency of service on international routes makes it more economical to accommodate increasing passenger volumes through use of larger aircraft, such as the super jumbo A380, rather than adding additional flights. The rates of growth in aircraft size at EWR and JFK are expected to be similar.

Once the annual passenger aircraft movements are estimated, they are factored to a daily volume based on recent ratios of annual-to-daily passengers in the peak month (August) for each airport for domestic and international traffic separately. To these airline passenger movements are added the projected cargo and general aviation movements. General aviation movements have remained essentially flat for the last few years and it is assumed that this will continue for future years. Cargo aircraft movements are projected to grow slowly, averaging about one percent per year at JFK and slightly less at EWR.

Table 3.3 displays the results of this conversion process. The percent increases are all based on 2007 data, the year of the highest volume of passengers at the three airports to date, 109.1 million. The table indicates that the passenger volume growth will be substantially higher than the aircraft movements, the result of higher passenger-per-aircraft movements and relatively flat growth in air cargo and general aviation movements. For example, for the 150 million-passenger level, projected to occur after 2029, passenger growth would be 37.5 percent, while total daily aircraft movements would increase by 18.8 percent. At JFK the growth would be higher – 42.5 percent more passengers and a total daily aircraft movement growth of 29.4 percent. EWR passenger growth would be at 32.2 percent and daily aircraft movements would grow by 14.6 percent; LGA's passenger volumes would grow by 36.6 percent, but the growth of daily aircraft movements would be much lower, adding only 12.2 percent.

Summary of Aircraft Movements Projections – Three Passenger Demand Levels

	Demand Level	Base	115 MAP	130 MAP	150 MAP	115 MAP	130 MAP	150 MAP
	Range of Years	2007	2015 to 2021	2021 to 2034	2030 to 2042	2015 to 2021	2021 to 2034	2030 to 204[illegible]
Annual Passengers (millions)	JFK	47.6	50.7	58.1	67.8	7%	22%	43[illegible]
	EWR	36.3	37.1	41.6	48.0	2%	15%	32[illegible]
	LGA	25.0	27.1	30.3	34.2	9%	21%	37[illegible]
	Total	109.1	115.0	130.0	150.0	5%	19%	37[illegible]
Annual Passenger Aircraft Movements (000's)	JFK	423	441	493	560	4%	17%	32[illegible]
	EWR	394	426	456	499	8%	16%	27[illegible]
	LGA	377	388	418	444	3%	11%	18[illegible]
	Total	1,194	1,254	1,367	1,503	5%	15%	26[illegible]
Daily Passenger Aircraft Movements	JFK	1,268	1,292	1,448	1,644	2%	14%	30[illegible]
	EWR	1,302	1,274	1,363	1,493	-2%	5%	15[illegible]
	LGA	1,210	1,186	1,280	1,359	-2%	6%	12[illegible]
	Total	3,780	3,753	4,091	4,496	-1%	8%	19[illegible]
Daily Cargo and General Aviation Movements	JFK	32	34	36	38	6%	13%	19%
	EWR	66	70	74	74	6%	12%	12%
	LGA	12	12	12	12	0%	0%	0%
	Total	110	116	122	124	5%	11%	13%
Total Daily Aircraft Movements	JFK	1,300	1,326	1,484	1,682	2%	14%	29%
	EWR	1,368	1,344	1,437	1,567	-2%	5%	15%
	LGA	1,222	1,198	1,292	1,371	-2%	6%	12%
	Total	3,890	3,869	4,213	4,620	-1%	8%	19%

Of course, in the earlier years with lower passenger volumes, the growth would be less. At the 115 million-passenger level, projected to occur in the 2015 to 2021 period, aircraft operations would grow only by 2 percent at JFK, and would decline by 1.7 percent at EWR and 2 percent at LGA. However, with the 130 MAP level, which is projected to be reached between 2021 and 2034, JFK would see a 14.1 percent growth in operations, with EWR growing by 5.1 percent while LGA increasing by 5.7 percent.

The variation in aircraft operation growth rates by airport is a result of a series of factors. For example, JFK aircraft operations tend to grow fastest because it has a larger share of international passengers, which makes up a growing share of the total market. LGA's operations tend to grow slowest because it is assumed that its passenger load per movement will grow fastest, reducing the relative increase in aircraft movements.

The estimated hourly movements for each passenger scenario will be used to evaluate the various possible actions for reducing delay and expanding capacity.

In Chapter 4, these will be matched against the assumed hourly capacities at the three airports to estimate both the delays and the passengers that would be unable to fly if no steps are taken to expand capacity or constrain demand to lower levels.

Photo: Regional Plan Association

Runway Lineup at JFK

Photo: ATIS547 (Flickr)

The Nexus of Demand and Supply

Prospective Actions and How to Evaluate Them

In this chapter, the prospective unconstrained demand for aircraft movements at the three airports is compared to the ability of the airports to meet that demand. The focus will be on runway demand and capacity, measured by the peak-hour aircraft departures and arrivals that can be accommodated. While there are other elements of the airport system that could exceed their capacities, such as terminals, gates, ground access, and parking, it is the runway and airspace (airside) capacities that are likely to be the most difficult and expensive to expand. Moreover, much of the delay travelers experience is associated with the ability of the airspace to process aircraft movements. Respondents to RPA's poll[1] expressed the most concern about delays experienced while on the aircraft, rather than delays in the terminal, such as ticketing, baggage processing or problems associated with getting to the airport.

As the desire to travel by air in the region extends beyond the current ability of the three airports and the surrounding airspace system to absorb it, aircraft would queue up on the ground and in the air to greater and greater levels. Of course, if allowed to continue, at some point delays at the New York airports would become so great that the ripple effect on other airports and on national airspace would cause a breakdown in the national aviation system. As discussed in Chapter 2, the FAA, when faced with this situation in 2008, put a cap on the number of peak flights allowed to use JFK and EWR, rather than allow delays at the region's airports to cause delays nationwide. A cap on hourly operations has been in effect at LGA since 1969. Left in place, the consequence of permanent caps at all three New York airports would be a limit on the number of passengers that could travel to, from and through the New York region and would consequently severely damage the future economy of the region.

As will be shown later in this chapter, the airspace / runway capacities of our three airports are estimated to be about 110 million passengers per year, approximately the level reached in 2007 of 109 million. Therefore, it can be expected, based on the projections discussed earlier this report, that the combined capacities of the three major airports will be exceeded within the next few years, with the prospect of resumption of caps on growth, once the delays climb beyond the historical highs of 2007.

To avoid this, either capacity could be expanded to accommodate the growth, or demand for using the airports could be reduced, or some combination of the two would occur. This chapter establishes the targets for increasing capacity at the three airports. The actions discussed in this report are intended to do one of three things: a) provide the needed capacity, c) shift demand to lessen the required capacity, or c) manage the demand to lessen the capacity needed. It is against these targets that possible actions outlined still later in this chapter can be judged.

Planning only for the current level of delays leaves the region at a competitive disadvantage, given the low delay rankings of the New York airports. Therefore, this analysis goes a step further by postulating higher standards, i.e. a lower level of acceptable delay closer to the norms experienced at most major airports in the nation. The actions to address current airport capacity limitations will also be judged against these higher standards. Rather than institutionalizing a low level of service that permanently locks the region into the worst airport delays in the nation, these higher standards would establish a level of service that would allow the region to thrive.

Delays

This report examines the performance resulting from actions that change either demand or capacity, and the metrics chosen to measure that performance must respond to changes in both. These include measures that calculate the impact on delays and the ability to accommodate the growing number of passengers. Calculation of each of these measures requires a comparison of the demand and capacity defined as aircraft operations per hour.

Chapter 1 presented a discussion of delays from a passenger's perspective and the effect of these delays on the regional economy and Chapter 2 detailed the causes of delay. This chapter analyzes aircraft delays, as measured by the FAA. The FAA evaluates air traffic system performance in part using aircraft delays. In addition, the FAA uses aircraft delay levels in defining airport and airspace capacity. These evaluations do not focus on passenger experience since this is an indirect impact from the aircraft delays. Chapters 1 and 2 showed that the delay that the passenger experiences is considerably larger than the delay incurred by the aircraft.

To calculate aircraft delay, a queuing model was used to determine total daily aircraft delays caused by runway capacity constraints for each the three New York airports. The model compares the number of aircraft projected to use the airport with the airport's runway capacity to handle the volume, stratified into five-minute increments throughout the day.

Aircraft Operations Demand

Existing unconstrained demand is based on the hourly profile of activity at JFK and EWR from 2007 data prior to the FAA's imposition of the slot rule at these two airports. Therefore, in this chapter demand is projected from an unconstrained situa-

1 The poll of the region's residents on airport issues is summarized in the Appendix to this report.

tion. LGA demand is projected to account for the longstanding slot rule at that airport. Data about scheduled aircraft activity is derived from the Official Airline Guide (OAG) for a summer day in 2007, the year when passenger demand was the highest.[2] From this base case in 2007, the hourly unconstrained demand is used to derive the profiles for each of the three airports for each of the three projected air passenger levels discussed in the previous chapter.

Figures 4.1 through 4.3 show the existing and future unconstrained demand profiles by hour for each airport. These volumes represent the activities that would occur at the three airports if there was the capacity to accommodate them. At JFK, the unconstrained peak-hour aircraft activity in 2007 is projected to grow from approximately 100 aircraft per hour to 130 per hour when the 150-million air passenger (MAP) demand level is reached. The morning peak is predominantly departures while the early afternoon peak is predominantly arrivals. After 6pm, the peak has more departures than arrivals.

At EWR, the unconstrained (2007) peak-hour aircraft activity is projected to grow from a peak of 89 aircraft per hour to 115 per hour at the 150 MAP level. Similar to JFK, the morning peak is predominantly departures, while the early afternoon peak has more arrivals than departures. Demand in the evening hours is evenly split between arrivals and departures.

Unlike JFK and EWR, the hourly unconstrained future demand at LGA is constant throughout the entire day from 7am until 9pm, hovering in the mid-80 aircraft per hour. The early morning period has more departures than arrivals, while the evening hours have more arrivals than departures. During the bulk of the day, demand is evenly split between arrivals and departures.

Capacity and Throughput

As discussed earlier, among the most important factors that determine runway capacity are runway design, aircraft speeds, separation between successive aircraft, air traffic control procedures, weather conditions, and airspace availability.

Airport runway capacity is also a function of the capacity of the particular combination of runways that are being used at any given time. An individual runway may have reduced capacity if air traffic control procedures require coordination of its aircraft activity with activity on parallel or intersecting runways. The availability of airspace and the allocation of aircraft activity among various runways will also influence capacity. Air traffic controllers may alter the allocation of demand between runways depending upon the percentages of arriving and departing aircraft in any given hour.

Rather than define a maximum hourly capacity for the runway system at each airport, this analysis uses the average annual hourly runway throughput actually achieved at each of the airports during the period of 2004 through 2009. This annual average reflects both runway operations achieved in both ideal conditions of good weather and airspace availability, and during less ideal conditions of poorer weather or airspace availability.

The runway throughput rates used here and shown in Table 4.1 for each of the three major airports, reflect average peak period runway utilization rates observed in FAA data on hourly runway utilization rates and delays collected in 2004 through 2009 at each airport. These data are available from the FAA's Aviation System Performance Measurement (ASPM) database.

[2] August 23, 2007

JFK Airport Daily Profile of Future Activity
Source: OAG and Regional Plan Association

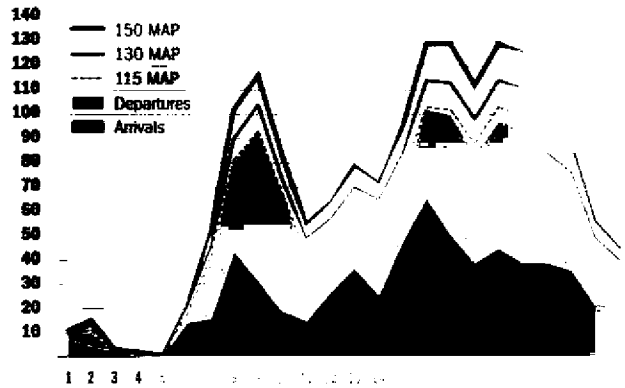


FIGURE 4.2
EWR Airport Daily Profile of Future Activity
Source: OAG and Regional Plan Association

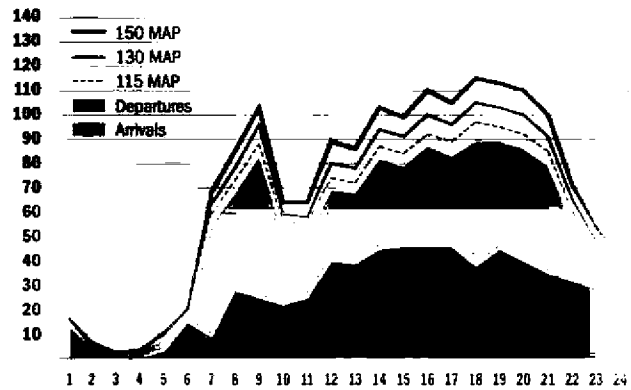
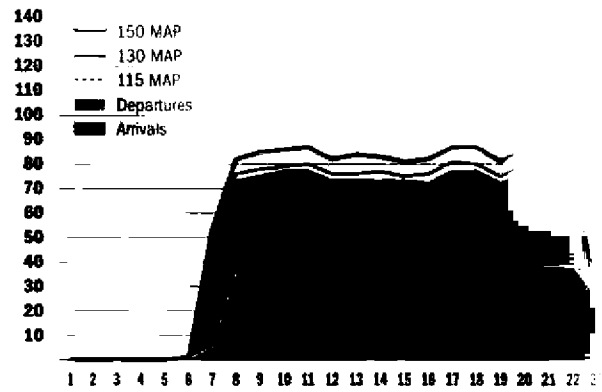


FIGURE 4.3
LGA Airport Daily Profile of Future Activity
Source: OAG and Regional Plan Association



Delay and runway utilization levels observed in 2009 were used to calibrate the model by correlating observed delays against calculated capacity, since 2009 data reflects the most current operations at the airports. Detailed information about observed runway utilizations and delay; as well as modeling of existing and forecast demand against existing capacity is shown in Appendix B.

The capacity of airport taxiways and gates also affect the level of capacity for aircraft operations. As discussed earlier, taxiways provide the connection between runways and gates. In addition, they accommodate delayed aircraft waiting for space on a

departure runway. As delays increase, the taxiway system's ability to accommodate the flow of aircraft between runways and gates will become increasingly impaired. Aircraft require a certain minimum parking time at the gate for unloading and loading passengers, to handle cargo and to refuel. If runway capacity and use increases, then expansion of taxiways, gates and other facilities may be required as well. However, because none of these other factors will matter if there is insufficient runway and airspace capacity, the evaluation model starts with an analysis of runway capacity and its impact on airspace.

The Model

The queuing model compares hourly aircraft activity and calculates airport runway throughput rates. It mimics air traffic control decisions by evaluating short-term demand and altering the airport arrival or departure capacity to accommodate a higher percentage of arrivals or departures. The model provides outputs on the number of aircraft queued for the arrival and departure runways, percent of aircraft waiting specific intervals of time and total runway queue delays. Delay is the difference between the planned and actual time it takes an aircraft to perform an arrival or departure. The resulting aircraft delay is a measure of system operational performance that indicates the efficiency with which a given level of runway throughput is achieved. This model and its output are used to estimate future aircraft delays associated with the many demand and capacity scenarios that are described later in this report.

Base Case Delays

Table 4.2 shows the average annual delay per aircraft for the base cases for the three projected passenger levels for the three major airports. The delay levels shown reflect a *theoretical* unconstrained condition, where delays would grow unabated if there were no demand management or passenger diversion programs to limit flight or passenger activity. By 2015-2021 (corresponding to an air passenger demand level of 115 MAP), delays would grow from the 2007 conditions at all three airports, JFK adding five minutes, EWR 11 minutes and LGA five minutes. By then, delays at both JFK and EWR would exceed 30 minutes per aircraft while delays at LGA would exceed 20 minutes, with the three-airport system average delay increasing from 22 minutes to 31 minutes. By 2021-2034 (130 MAP), delays at all three airports would be almost an hour and by 2030-2042 or beyond (150 MAP), average delays would reach more then 90 minutes at each airport.

Delays of this magnitude would never occur. Instead, the use of the airports would be limited, aircraft traffic would be lost, trips would not be taken (at least to and from the three airports), and the regional economy would suffer. Intervention would occur long before these delay levels were reached. Without intervention, departure delays would balloon at the airport's taxiways or gates and physical space would limit how many departing aircraft could wait at the airport. Arrival delays would occur either in the airspace or at the airport where a flight originated. Airborne delays would create extra workload for air traffic controllers while physical space would limit the number of aircraft that could wait at an originating airport. In short, the situation would become untenable.

Current Airfield Average Annual Hourly Runway Throughput by Airport

	Capacity	Balanced Flow	Arrival Push	Departure Push	Daily Average
JFK	**Arrival**	39	51	35	40
	Departure	42	30	46	41
	Total	**81**	**81**	**81**	**81**
EWR	**Arrival**	39	50	36	40
	Departure	40	29	44	40
	Total	**79**	**79**	**80**	**79**
LGA	**Arrival**	35	43	30	35
	Departure	34	26	39	34
	Total	**69**	**69**	**69**	**69**

Source: Regional Plan Association
Note: The runway utilization rates shown in this table are an average in all weather conditions during peak operational hours.

TABLE 4.2

Base Case (Unconstrained) Delay by Airport and Passenger Levels

		Average annual minutes per aircraft movement			
Demand	**Range of Years**	**JFK**	**EWR**	**LGA**	**System**
109 MAP	2007	25	21	19	22
115 MAP	2015 - 2021	32	32	24	31
130 MAP	2021 - 2034	55	60	53	56
150 MAP	2030 - 2042+	96	102	103	99

Source: Regional Plan Association

The FAA policy guidance drives this process; it states that when preparing benefit-cost analyses for airport improvement projects, the average annual delays above 20 minutes per aircraft should not be considered since they are unlikely to occur in actual operations. Further, the FAA imposed slot restrictions at JFK and EWR when average delays at JFK exceeded 22 minutes per aircraft. The slot limits effectively established the maximum number of daily (and annual) flights that can occur at each airport. All three major airports have had FAA imposed slot limits, with LGA limits in force for over 40 years. Over time, these caps will also increasingly limit demand, resulting in a loss of passengers that would not be served at the three airports.

Delays and Level of Service

The above estimates of congestion and delay conditions under the current maximum operating capacity of the airports are clearly not realistic. Even at current levels, few airports in the world have the amount of aircraft delay incurred at the New York airports. In Europe, most airports have their operations controlled at a level of capacity appropriate for operating in poor weather conditions.

Among major airports in the United States, delays at the three airports rank at the bottom as shown quite dramatically in Figure 4.4. Not only do the three New York airports rank highest in delays, but the differences are stark. All three exceed the 20-minute level, but the next worst is barely 17 minutes, and almost all of the remaining 34 airports experience delays of 12 minutes or less.

This raises the issue of what is tolerable, i.e. what is acceptable and what is not, and what standard should be applied to judge the adequacy of future conditions? By imposing the caps on demand when delays reached 22 minutes, the FAA made the judgment that delays higher than 22 minutes per aircraft created an unmanageable air traffic flow and were unacceptable. The

FAA actions to impose the caps on hourly aircraft operations confirm its previous policy guidance about the unacceptability of average aircraft delays in excess of twenty minutes.

This analysis uses the FAA hourly cap as the upper limit on the number of aircraft per hour that can use the three major airports. JFK and EWR have some ability to increase their daily volume of aircraft operations during off-peak hours when not all slots are used. However, LGA has no ability to expand its daily operations since the peak period lasts throughout the day. The FAA has actually cut the number of hourly slots at LGA, but is not forcing airlines to immediately reduce service. Rather, the FAA will retire slots that airlines stop using and expects to eventually reach the lower slot level through attrition. Thus, actual operations at LGA for many hours range from two to four operations per hour above the stated cap. This analysis uses the actual operations levels observed in 2009 instead of the stated cap.

Figure 4.4 also establishes that current delay levels at the New York airports are well above the norms for busy airports across the country. Thus, the current delay conditions at the three airports place the New York region at a competitive disadvantage. Consequently, the analysis uses an average delay of ten minutes per aircraft as a quality of service standard that matches the norms at other major airports. It is this standard that the New York region should aspire to. However, the analysis acknowledges the difficulty of meeting such a high standard, and therefore examines the implications of a 15-minute and 20-minute delay levels.

Table 4.3 shows the level of hourly capacity required at each airport to reduce the delay levels shown in Table 4.2 to meet the current default standard of 20 minutes, a 15-minute standard and a 10-minute standard. For example, if the objective at JFK was to achieve a standard of 10-minutes, then runway capacity by the 2030-plus period would have to handle 119 aircraft operations per hour, compared to the current slot limit of 81 per hour. Similarly, EWR would need a capacity of 107 operations per hour to achieve a 10-minute delay standard. Overall, the current three-airport system provides capacity of 236 aircraft movements per hour. In 2030, the three major airports will need to accommodate 292 aircraft movements per hour to meet a 20-minute delay standard, 301 aircraft movements per hour to meet a 15-minute delay standard or 311 aircraft movements per hour to meet a 10-minute delay standard .

Table 4.3 also shows the runway capacity needed in addition to the current slot limit at each airport. For example, JFK at the 150 MAP level would require a capacity of 38 more movements per hour to meet the 10-minute delay standard. By as soon as 2030, the three major airports would need to accommodate an additional 59 aircraft movements per hour to meet a 20-minute delay standard, 68 more aircraft movements per hour to meet a 15-minute delay standard or 78 additional aircraft movements per hour to meet a 10-minute delay standard.

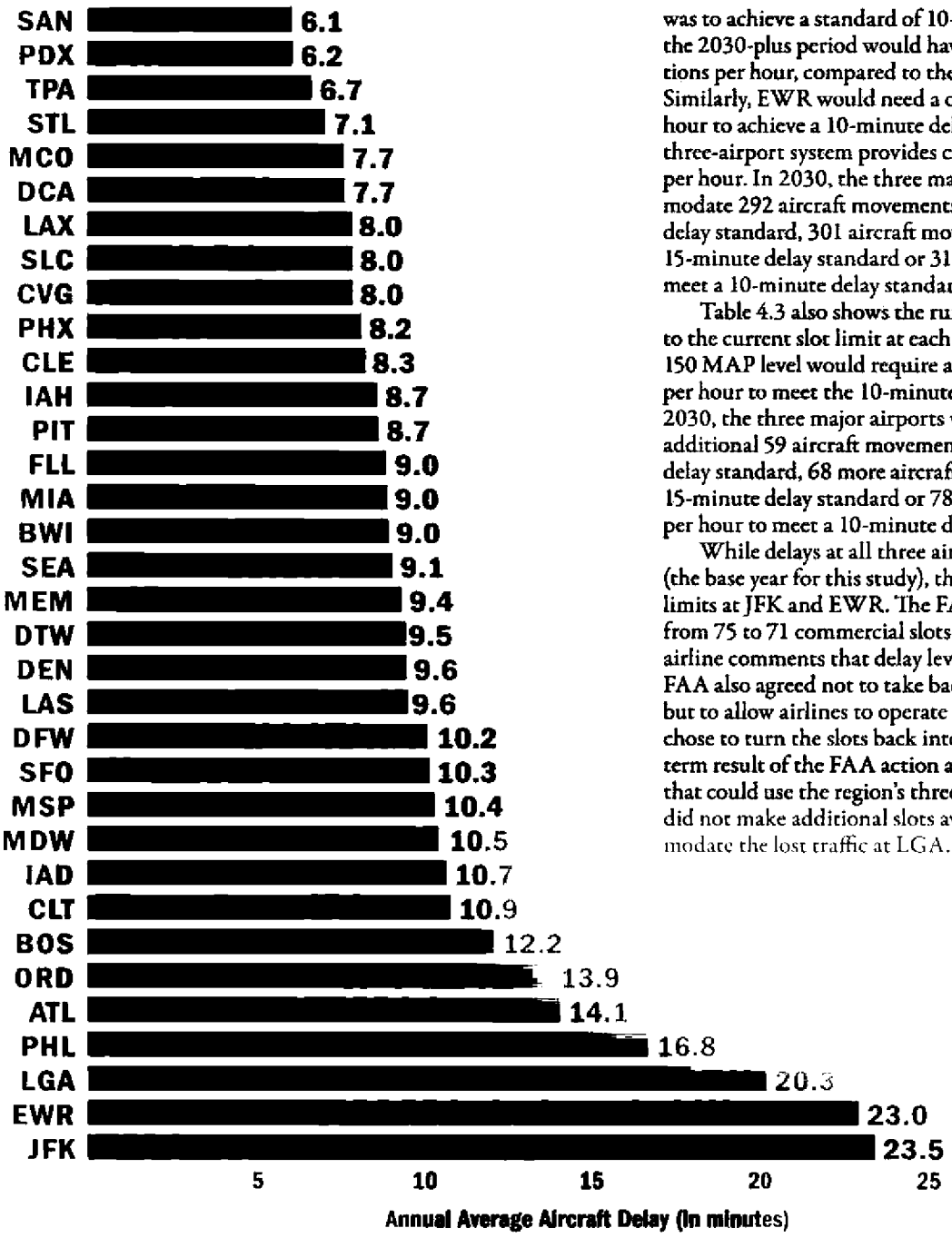
While delays at all three airports have declined since 2007 (the base year for this study), the FAA has retained existing slot limits at JFK and EWR. The FAA has lowered the slot limit from 75 to 71 commercial slots per hour at LGA in response to airline comments that delay levels at LGA were too high. The FAA also agreed not to take back the "extra" slots immediately, but to allow airlines to operate them unless they voluntarily chose to turn the slots back into the FAA. The potential long term result of the FAA action at LGA will lower aircraft volume that could use the region's three major airports, since the FAA did not make additional slots available at JFK or EWR to accommodate the lost traffic at LGA.

FIGURE 4.4

Average Delay at 37 Major Airports in 2007

Source: FAA Aviation Performance Metrics

Note: Delay is measured as time deviation from the flight plan.



Total and Additional Hourly Runway Capacity Required to Achieve 10, 15 and 20 Minute Average Annual Aircraft Delays

			Total Capacity Needed			Additional Capacity Needed		
		Existing Slots	10-minute delay	15-minute delay	20-minute delay	10- minute delay	15-minute delay	20-minute delay
JFK	**115 MAP** (2015-2021)	81	94	91	88	13	10	7
	130 MAP (2021-2034)	81	105	102	98	24	21	17
	150 MAP (2030-2042+)	81	119	115	111	38	34	30
EWR	**115 MAP** (2015-2021)	81	91	88	85	10	7	4
	130 MAP (2021-2034)	81	99	95	92	18	14	11
	150 MAP (2030-2042+)	81	107	103	100	26	22	19
LGA	**115 MAP** (2015-2021)	74	73	71	69	2		
	130 MAP (2021-2034)	74	78	76	75	7	5	4
	150 MAP (2030-2042+)	74	85	83	81	14	12	10
System	**115 MAP** (2015-2021)	236	258	250	242	25	17	11
	130 MAP (2021-2034)	236	282	273	265	49	40	32
	150 MAP (2030-2042+)	236	311	301	292	78	68	59

Source: Regional Plan Association

Current slot control regulations allow airlines to retain control of a slot so long as they operate the slot 80 percent of the time. Some airlines with a large portfolio of slots have taken advantage of the regulation and have dropped the number of flights they operate, yet maintaining enough flights to retain their slot rights. The number of flights operated has also declined at JFK and EWR. This has not lead to significant delay reductions since air traffic control procedures have evolved to include new air traffic safety initiatives, which include changes in operations on converging runways. The result is slightly longer distances between successive arriving aircraft.

Figure 4.4 shows that the delays at the three New York region's airports average more than double the delays at most other major airports in the nation. The stark contrast will grow even starker, since the next highest-ranking airports (PHL, ATL, and ORD) have undertaken on-going airfield improvements to lower their delays in the near future. Thus, the New York region's airports' poor delay performance will be even more conspicuous. Businesses that require air transportation take into consideration the quality of air service when deciding where to locate or expand. While the New York region has a diversity of destinations available, the reliability of its air service will almost certainly be degraded if the current situation remains. As described in Chapter 1, these delays increase operating costs for local businesses, which may make other locations more attractive.

Loss of Passengers and the Resulting Economic Loss to the Region

Limiting aircraft activity ultimately will limit passenger volumes at each of the airports. Traffic has begun to grow again as the economy recovers. As demand grows, airlines would normally add flights or use larger aircraft to accommodate the additional passengers. The current caps on demand prevent airlines from adding flights (which would increase delays). While the airlines have some ability to use larger aircraft, scarce capital and long aircraft life spans largely prevent them from changing their fleets quickly. This "cap-constrained" environment would eventually cause fares to rise and prevent some passengers from using air transportation in the New York/New Jersey market, and in many cases, result in trips not being made at all, affecting the local economy.

This analysis assumes that airlines could operate new flights in off-peak hours when slots were still available, but also acknowledges that some new flights might not occur because they would only be viable during controlled-slot hours. This is especially true for new airlines currently not operating in New York. These "startups" would require some flights during limited-slot time periods to establish a reasonable pattern of arrivals and departures for the New York market. Long-distance (mostly international) markets may also have limited ability to operate during off-peak hours since slot limitations and curfews may preclude arriving or departing times at the destination market. A more detailed analysis of maximizing the spread of operations to off-peak hours is presented in Chapter 9, which describes demand management strategies.

Table 4.4 shows that at the 115 MAP demand level (some time between 2015 and 2021), the three airports would fall short by 2.5 million passengers of being able to accommodate the projected demand. At the 130 MAP level the capacity shortfall would reach 9.2 million passengers, and at the 150 MAP level, this figure would grow to 20.9 million passengers per year. In each case, about half of this unmet capacity would occur at JFK.

Table 4.4 also shows the number of passengers that would be served at each juncture. For example, when demand reaches 150 MAP, and with 20.9 million not served, those served would total 129.1 million. The fact that more passengers would be served

Unmet Demand at Current Slot Levels (millions of passengers)

	Unmet Demand				Demand Met
	JFK	EWR	LGA	System	System
115 MAP (2015-2021)	1.2	0.7	0.6	2.5	112.5
130 MAP (2021-2034)	4.4	2.4	2.4	9.2	120.8
150 MAP (2030-2042+)	10.9	5.5	4.5	20.9	129.1

Source: Regional Plan Association

Unmet Demand with 10, 15 and 20 Minute Delay Standards (millions of passengers)

Delay		Unmet Demand				Demand Met
		JFK	EWR	LGA	System	System
10 Minutes	**115 MAP** (2015-2021)	8.3	4.8	2.0	15.1	99.9
	130 MAP (2021-2034)	14.0	7.3	4.3	25.5	104.5
	150 MAP (2030-2042+)	21.5	11.1	6.5	39.0	111.0
15 Minutes	**115 MAP** (2015-2021)	4.1	3.0	1.1	8.3	106.7
	130 MAP (2021-2034)	9.3	5.3	3.2	17.7	112.3
	150 MAP (2030-2042+)	16.6	8.8	5.3	30.7	119.3
20 Minutes	**115 MAP** (2015-2021)	2.5	1.1	0.6	4.2	110.8
	130 MAP (2021-2034)	6.3	3.2	2.4	11.9	118.1
	150 MAP (2030-2042+)	11.5	5.8	4.5	21.8	128.3

Source: Regional Plan Association

as the unconstrained demand rises is a consequence of a higher average number of passengers per aircraft and more off-peak flights, even as the supply side remains static.

With the 10-minute delay standard, the capacity shortfall would naturally grow, as more of the capacity would be used to keep the aircraft delays down. As shown in Table 4.5, there would be 39 million annual passengers not served when the demand reaches 150 MAP. Lower levels of demand would have a lower unmet demand. At each level about half of the unmet demand occurs at JFK.

To accommodate the unmet demand some combination of added airport capacity and alternative means of travel are needed, either at other airports or by other modes. The stratification by the three airports shown in Table 4.5 is somewhat flexible; to the extent that if one airport cannot accommodate the excess demand, or have its passengers shifted to other airports or modes, the shortfall might be covered, at least in part, at one of the other two airports.

The demand that is met with the 10-minute standard is hardly higher than the current demand of 101.5 MAP. This indicates the to achieve this standard, largely achieved at other major airports in the nation, that any demand beyond current levels would have to be service by expanding current capacity or by shift air travelers away from the three airports.

The loss of passengers and the resulting economic loss are calculated here for each level of unconstrained passenger growth. Using the economic impact estimates per passengers served at the three airports, as discussed in Chapter 1, updated to 2009, the Port Authority has calculated that the airport system provides nearly 415,000 jobs, which contribute $16.8 billion in wages to the regional economy and generate over $48.6 billion in sales while accommodating 101.5 million annual passengers.[3] This converts to an impact of $521 in sales per passenger, $190 in wages per passenger and about 4,100 jobs created for each million passengers. These factors are used to estimate the potential economic losses from passengers that would not be served as reported in Table 4.4. The results are presented in Table 4.6 for each of the projected demand levels, for each of the three airports. By the150 MAP level, the losses would amount to 86,000 jobs lost, $11 billion in sales not made and $4 billion in wages not earned annually.

These losses would accumulate over the years. Table 4.7 displays the economic impact for each of the three passenger projections using these values for each passenger trip not taken if the capacity were not available. The upper half of the table shows the losses for the year only, and the lower half shows cumulative losses. The losses would begin relatively modestly. By 2015, the region could lose between $0.8 and $1.7 billion in wages and between $2.3 and $4.5 billion in sales. By 2020, the accumulated losses, would reach $2.6 billion in wages and $7.2 in sales for the lowest rate of passenger growth, to $7.6 billion in wages and $19.8 billion in sales for the highest. As traffic potential grows and is not accommodated, the losses mount and by 2035 they would reach between $21 billion and $60 billion in lost wages and between $58 billion to $165 billion in lost sales. By that year, the region would have about 46,004 fewer jobs with the low forecast and about 114,855 fewer jobs with the high forecast.

This analysis assumes that each "lost" passenger generates a value equivalent to the average for that airport. It is possible that the marginal value of passengers that would choose not to fly because of higher costs would be less than average, but that is beyond the scope of what can be estimated here. In addition, to the extent that these passengers are accommodated by using another airport in the region, or by intercity rail travel, the economic loss would be diminished. Accordingly, when evaluating the alternative actions that could be taken to address the airport congestion problem, the economic loss from passengers not traveling by air at the three airports will be adjusted to account for passengers served in other ways.

There is also the economic loss associated with passenger delays that were described in Chapter 1. For those that can be accommodated, there will be growing losses associated with delay, which would grow slightly, reaching about $1.8 billion at the 150-million passenger level. This is based on the assumption that the total delay cannot rise to more than 20 minutes per person on average or else the FAA would cap operations to whatever level was necessary to ensure that delays would not exceed 20 minutes. Similarly, the cost of delays to the airlines cannot grow much with the delay capped at 20 minutes, which is estimated at $1.4 billion per year.

The analysis in this chapter establishes the base condition against which the many actions to either add capacity or shift demand will be evaluated. It also establishes the metrics that will be used to carry out that evaluation, i.e. – passengers not served and the resulting economic loss, and the runway capacity shortfalls. These actions include supply-based actions that increase capacity or demand-based actions that shift demand from the three airports or adjust demand by time of day or by airport.

[3] The Port Authority of New York and New Jersey, The Economic Impact of the Aviation Industry on the New York–New Jersey Metropolitan Region, October 2005. Update 2009 by Port Authority and adjusted for inflation to 2009

Economic Impact of Loss of Passengers – Three Passengers Projections

	JFK			EWR			LGA			System		
		Annual Lost Pass. Millions	Econ. Value $Billions/Jobs		Annual Lost Pass. Millions	Econ. Value $Billions/Jobs		Annual Lost Pass. Millions	Econ. Value $Billions/Jobs		Annual Lost Pass. Millions	Econ. Value $Billions/Jobs
Wages per Passenger	$205			$167			$192			$190		
115 MAP (2015-2021)		1.2	$0.2		0.7	$0.1		0.6	$0.1		2.5	$0.5
130 MAP (2021-2034)		4.4	$0.9		2.4	$0.4		2.4	$0.5		9.2	$1.8
150 MAP (2030-2042+)		10.9	$2.2		5.5	$0.9		4.5	$0.9		20.9	$4.0
Sales per **Passenger**	$561			$461			$527			$521		
115 MAP (2015-2021)		1.2	$0.7		0.7	$0.3		0.6	$0.3		2.5	$1.3
130 MAP (2021-2034)		4.4	$2.5		2.4	$1.1		2.4	$1.3		9.2	$4.9
150 MAP (2030-2042+)		10.9	$6.1		5.5	$2.5		4.5	$2.4		20.9	$11.0
Jobs per **Million Pass.**	4,377			3,573			4,249			4,091		
115 MAP (2015-2021)		1.2	5,172		0.7	2,645		0.6	2,439		2.5	10,256
130 MAP (2021-2034)		4.4	19,442		2.4	8,420		2.4	10,370		9.2	38,233
150 MAP (2030-2042+)		10.9	47,885		5.5	19,484		4.5	19,097		20.9	86,466

Cumulative Economic Losses to 2035 for Three Growth Scenarios

	Wages Lost in Year Shown ($Billions)			Sales Lost in Year Shown ($Billions)			Accumulating Wages Lost ($Billions)			Accumulating Sales Lost ($Billions)			Jobs Lost by Year Shown Total Jobs		
	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
2015	$0.2	$0.4	$0.5	$0.7	$1.1	$1.3	$0.8	$1.4	$1.7	$2.3	$3.9	$4.5	5,167	8,857	10,331
2020	$0.6	$1.1	$1.5	$1.6	$3.0	$4.2	$2.6	$5.4	$7.2	$7.2	$14.8	$19.8	12,786	23,967	33,412
2025	$0.9	$2.0	$2.7	$2.4	$5.4	$7.5	$6.1	$13.5	$18.5	$16.7	$36.9	$50.8	19,350	42,894	59,208
2030	$1.4	$3.1	$4.0	$3.9	$8.4	$10.9	$12.1	$26.7	$36.1	$33.3	$73.3	$98.9	30,627	66,720	86,454
2035	$2.1	$4.2	$5.3	$5.8	$11.5	$14.5	$21.0	$45.7	$60.1	$57.7	$125.2	$164.8	46,004	91,100	114,855

Source: Regional Plan Association

Flight Information Display System at JFK Airport

Raleigh-Durham, NC	1109	9:48p	On Time
Rochester, NY	32	1:20p	Now 5:50p
Rochester, NY	38	7:36p	Cancelled
Rochester, NY	30	10:35p	On Time
Sacramento, CA	171	7:08p	Cancelled
San Diego, CA	185	4:30p	Cancelled
San Francisco, CA	647	6:55p	Now 7:40p
San Jose, CA	173	5:57p	On Time
San Juan, PR	709	3:30p	Now 5:15p
San Juan, PR	715	8:56p	On Time
San Juan, PR	717	11:59p	On Time
Santiago, DO	837	10:05p	On Time
Santiago, DO	839	11:59p	On Time
Santo Domingo, DO	827	9:00p	Now 9:45p
Santo Domingo, DO	819	12:55a	On Time
Syracuse, NY	22	10:45	
Tampa, FL			

What Can We Do?

Actions to Meet Demand and Lower Delay

1. NextGen I. The FAA's NextGen program will transform air traffic control from current ground-based technologies such as radar and radio beacons to satellite-based technologies such as GPS and digital communications. This transformation will allow aircraft to fly closer together because air traffic controllers will have better information on their location. It can also establish more reliable methods to communicate route information. NextGen I will likely expand capacity and permit realignment of departure and arrival airspace patterns. This action will produce capacity increases for each airport. This first phase of NextGen features actions that the FAA is currently committed to implementing in the next ten years. The result of this analysis established a modified base case against which the other actions discussed below are tested. This is discussed in Chapter 5.

2. **NextGen II.** Numerous elements of NextGen are not yet committed to by the FAA, since the research supporting them is still underway or they would require additional capability from aircraft not yet agreed to by all airlines. These NextGen elements should further improve capacity, but their implementation remains uncertain. These include 4-D trajectories that will combine earlier independent components to adjust flight schedules dynamically and allow aircraft to send their locations directly and to provide status to surrounding aircraft by broadcasting "peer-to-peer." These are also discussed in Chapter 5.

3. **Shift to Outlying Airports.** To examine this possibility, the candidate airports in the tri-state region and beyond were examined for their potential to free up capacity at the three major airports. Initially, sixty-seven airports, both with and without existing commercial service, were considered. The screening criteria included existing runway length, proximity to market, impact on airspace and on surrounding communities, highway access, and market duplication with existing services. For those airports that met the screening criteria, an estimate was made of the potential to shift passengers and the consequent reduction in aircraft operations at the major airports. This analysis is presented in Chapter 6.

4. **Establish a new airport.** This analysis determines if there is an accessible, available and adequate site for a new airport. It is discussed in the Chapter 7.

5. Air-to-**Rail Passenger Shifts.** Air passenger travel demand may be shifted to rail to free up capacity at the existing airports. The share of projected air passengers that could shift to rail under a number of rail service scenarios was examined to estimate the impact at the three major airports. This analysis is presented in Chapter 8.

6. **Transportation Demand Management Measures.** Managing demand at the three airports by banning or limiting selected peak flights directly, or through pricing differentials, or the use of auctions and lotteries are considered in Chapter 9. Also discussed is the passive "action" of peak spreading, which could occur under a slot-controlled environment as airlines use available capacity in the off peak hours. The barriers and weaknesses of these policies, including any legal ramifications, are also assessed and an estimate is made of the impact on aircraft movements at the three major airports.

7. **Expansion and/or Reconfiguration of the Three Existing Airports.** For each airport a number of potential reconfiguration options were screened to determine if they were worthy of serious consideration for their ability to increase the capacity of aircraft operations. The screens included airspace feasibility, capacity benefits, community impacts, environmental impacts, construction feasibility, timing and phasing feasibility, and cost. Twenty expansion combinations were considered, which in most cases included an option for each airport, for each of the four airspace categories developed during the earlier screening process. This analysis is presented in Chapter10.

8. **Ground Access.** Ground access becomes an issue in this study in many forms. First, if ground capacity is insufficient to bring people to an expanded airport, then the expansion may be compromised. Second, poor access can reduce the likelihood of passengers choosing a particular airport. Conversely, if access is improved there could be a shift among airports. The potential for this shift is particularly important if there is excess capacity at one airport and insufficient at another; improved access could result in a shift to the underused one from the airport that is oversubscribed. Third, for outlying airports, improved access could expand the area from which the airport could draw riders. Potential access improvements are discussed in Chapter 11.

In the concluding chapter of this report each of these actions and their combinations are compared using the evaluation metrics discussed above, including their ability to accommodate or shift air passengers beyond the capacity of the three existing airports.

The NextGen Air Traffic Control System

Modernization and Its Impacts on the Region's Airports

The United States has been working for the past several years on the complex task of modernizing its air traffic control system (ATC), an initiative simply known as NextGen. Over the next 20 years the Federal Aviation Administration (FAA) will incrementally upgrade the existing air traffic control systems that have functional components and designs dating back to the 1960's. Critical to the success of NextGen, and just as important as the FAA's technological contribution, will be investments by aircraft operators to upgrade their avionic systems, acceptance by the "human element" which includes pilots and air traffic controllers, the development of new flight procedures and the regulatory changes that must be made to permit the FAA to take full advantage of the technological improvements it will be implementing.

The New York region's airspace is the busiest and most complex in the nation, as detailed in Chapter 2. The average aircraft delay at the region's three major airports is over 20 minutes, twice the national average. NextGen will provide the tools that will help to alleviate this congestion and reduce delays by shrinking or eliminating the overlapping airspace over the three major airports and by increasing runway capacity through improved airfield management.

The FAA is also in the process of redesigning the region's airspace, which will eliminate many traffic choke points, but will not increase capacity at the airports. The FAA anticipates completing the airspace redesign project by the end of 2012.

NextGen is an all encompassing term for a suite of technological solutions that will locate an aircraft's position, provide navigational services, and allow for collaborative decision making between airlines and air traffic controllers through the sharing of data in real time. It is both an assembly of new technologies and a combination of existing and proven technologies that are being leveraged in new ways. NextGen replaces many existing voice-based, analog systems with digital data communications, using many of the technologies that we have come to take for granted in our everyday lives. For example, it relies heavily on the Global Positioning System or GPS, a technology increasingly available today, which can more precisely determine the position of aircraft. NextGen will also transmit all of this data digitally over secure wireless and fiber-based networks, similar to the public networks that are relied on for access to the World Wide Web.

The core components of the existing traffic control system are communications, navigation, traffic management, surveillance (location of aircraft) and air traffic control. Some of the major components of NextGen and their benefits are described below.

From Analog to Digital: An Aviation Network

Today, air traffic controllers ("controllers") transmit flight data and instructions using analog voice communications. However, much of this information is already in an electronic format and it would be more efficient if it was possible to transmit these digital instructions directly to the aircraft instead of using verbal communications. A central component of NextGen includes the installation of high-speed data networks, ground-based communications stations and satellites to allow most of this information to be uploaded directly to the aircraft's avionics. This improves efficiency and eliminates verbal data transmission errors. It requires investments by both the FAA and by the aircraft operators to equip their aircraft to receive these data transmissions; some airlines have made this investment and already have this capability between their aircraft and private flight operation centers.

Replacing Radar

The existing systems for locating aircraft use a technology that matured during WWII called "radio detection and ranging" or more familiarly, RADAR. It uses electromagnetic waves to determine the position of aircraft. Radar is expensive to maintain because of its moving parts (rotating dish), becomes less accurate as the distance between the radar station and aircraft increases and is limited to covering the airspace over land and the ocean near the coast. NextGen replaces radar with a technology called Automated Dependent Surveillance – Broadcast or ADS-B. It uses GPS and wireless data communications to locate an aircraft's precise position and then transmit this information to the ATC network (using satellites or ground stations) and other nearby aircraft. ADS-B is more accurate, it provides additional information about the "health" of the aircraft in real time to controllers, and covers areas that radar cannot. It would also be much less expensive to maintain than radar. This new precision should permit the FAA to rethink aircraft separation standards, potentially allowing more aircraft to operate in the same amount of airspace.

Precision Navigation – Bye, Bye Beacons

Aircraft rely on radio beacons known as VORs[1] today for en-route navigation. The placement and limited broadcast range of these beacons often result in inefficient or "zigzag"

[1] VOR stands for VHF Omnidirectional Ranging, sometimes referred to as a NAVAID, a ground-based beacon that transmits a signal (Morse code) that aircraft use to locate their positions.

NextGen Core Components
Source: Regional Plan Association

	Today	NextGen	Tomorrow	Benefit
Navigation	Fly from Beacon-to-Beacon	RNAV/RNP	Direct Routes Using Satellites	Use Less Fuel Arrive Sooner
Communications	Voice	Data Comm	Digital Data	More Information With No Errors
Air Traffic Monitoring	Find Aircraft With Radar	ADS-B	Precise Positions Transmitted by Aircraft	"See" Every Plane Less Error
Air Traffic Control	Step-by-Step Voice Commands	SWIM	Complete Flight Path via Data Message	Higher Capacity

flight paths, forcing aircraft to take circuitous routes to their destinations. NextGen would eliminate these beacons by using GPS, creating more direct routing, which in turn would reduce travel times and fuel consumption, thereby lowering costs and emissions. Further improvements to GPS-based navigation will increase flight path precision and make flying in inclement weather safer.

These three examples are a sampling of the dozens of technologies that fall under the umbrella of NextGen. Taken together these technologies will:

- Increase the capacity of the airspace system by making it possible for the FAA to reduce separation standards;
- Increase safety by greatly improving the situational awareness of pilots and air traffic controllers through the transmission of the real-time aircraft locations, status of the aircraft and weather;
- Allow collaboration by the FAA, airlines and airport operators using modern data networks and greatly improving their ability to respond to day-to-day management of the NAS and to a crisis;
- Reduce travel time;
- Save fuel;
- Reduce emissions;
- Increase reliability and predictability of flight schedules; and
- Increase the capacity of airfields, particularly in poor weather conditions.

The impact of nationwide NextGen system has been estimated by the FAA in its *2010 NextGen Implementation Plan*. They have concluded that it would reduce flight delays by 21 percent, save more than 1.4 billion gallons of fuel and cut carbon emissions by 14 million tons by the time the first phase of NextGen is expected to be in place, projected to be in 2018.[2]

The implementation of NextGen is not only a critical step towards increasing the capacity of the airport system, but also to improving interoperability with air traffic control (ATC) systems throughout the world. The European Union's version of NextGen is planned for deployment over the six years starting in 2014. The FAA and EU are working to coordinate technology standards through the International Civil Aviation Organization (ICAO) to ensure interoperability. The full implementation of NextGen is scheduled for 2025, but recent developments[3] within the aviation industry and FAA might result in a more accelerated implementation of the core NextGen technologies to match the EU schedule.

The FAA is now accelerating the implementation of NextGen, incorporating industry feedback reflected in the March 2010 plan publication. Over the past year progress has not only been made on FAA directives and procedures, but also with "on the ground" installation and testing of NextGen components.

The FAA's published mid-term implementation is referred to here as NextGen I and is assumed to be in place by 2018. This chapter details the components of NextGen I and quantifies their impacts on capacity and delay reduction. The chapter then goes on to discuss NextGen II, the FAA's full-term implementation of NextGen, discussing what improvements might materialize and their impact on airport capacity and operations. The chapter concludes with a discussion of implementation challenges and recommends several actions to advance both NextGen I and II.

NextGen

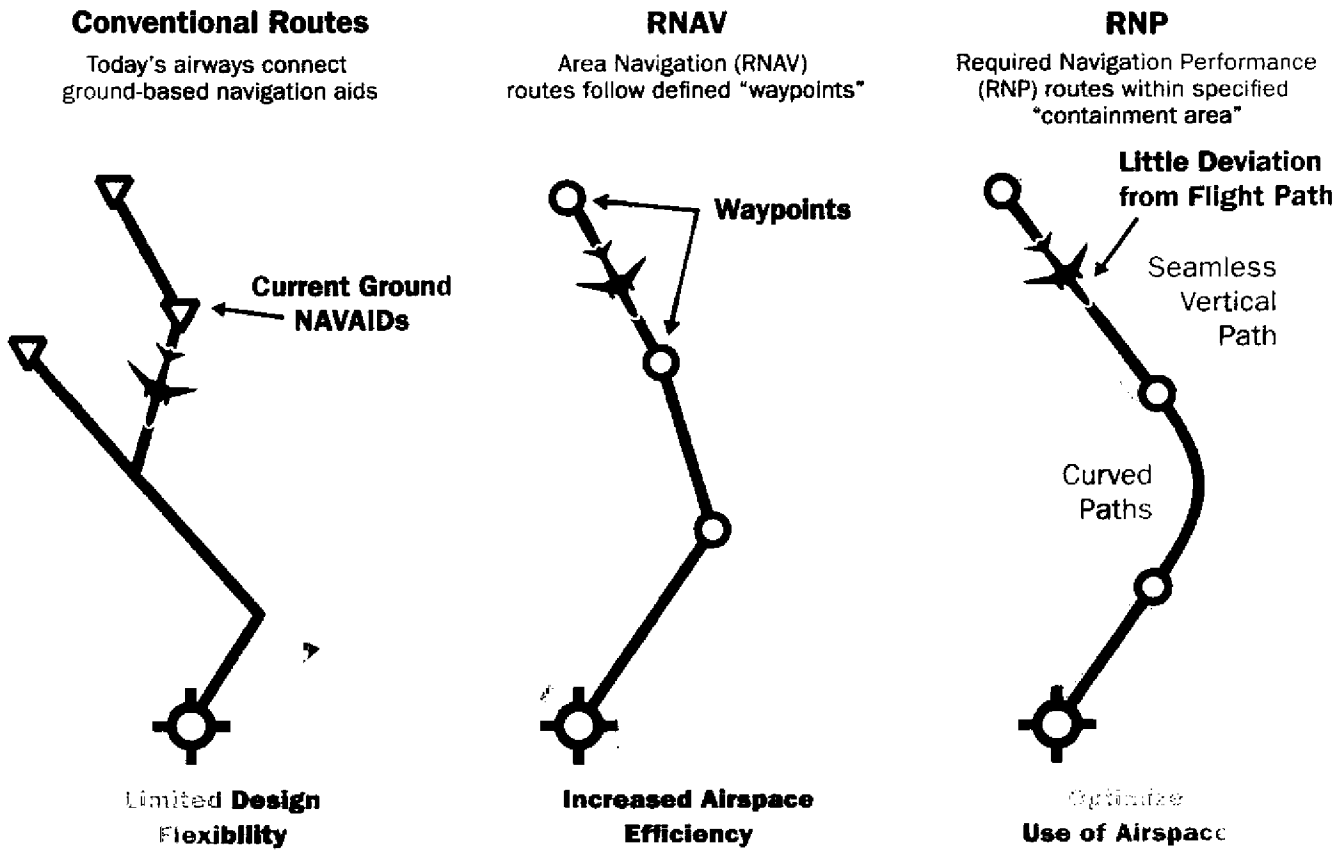
NextGen I is projected to cost the federal government $14.5 billion dollars and require the private sector aircraft operators to invest billions of dollars to upgrade their avionics systems. It will introduce the foundational technologies to transform the existing air traffic control system from analog to digital. NextGen I will change how controllers communicate with, monitor and control aircraft, and how aircraft navigate. Figure 5.1 is a simpli-

2 Federal Aviation Administration, NextGen Implementation Plan, 2010 - http://www.faa.gov/about/initiatives/nextgen/media/NGIP_3-2010.pdf

3 Industry input was solicited during a consensus-building effort organized by the RTCA, Inc., an aviation not-for-profit corporation that develops consensus-based recommendations, at the request of the FAA during the fall of 2009. The working group was representative of the aviation industry and included airlines, airport operators, government and researchers. Its mission was to determine a mid-implementation framework that all parties could agree with and would publicly support. The working group focused on how to accelerate the implementation schedule and leverage existing technologies so that benefits could be realized early. The FAA agreed with many of the RTCA outcomes and revised its mid-term implementation plan in March 2010.

4 The FAA estimates $13.7 billion in capital investments, and $0.8 billion in research and development.

The Evolving Precision of Navigation Systems
Source: Federal Aviation Administration



fied illustration of how the four core components of the ATC system – navigation, communications, air traffic monitoring (surveillance, aircraft position), and air traffic control – would evolve under NextGen I.

It describes how these components operate today, the associated NextGen technologies for each, how the operation of the airspace will change and the benefits of NextGen I.

The benefits of NextGen I are clear – aircraft would use less fuel, the airspace would operate even more safely than it does today and more precise aircraft monitoring would reduce delays and increase capacity. The following sections will further discuss each of the four components and their corresponding NextGen I technologies, providing additional technical and implementation details for each.

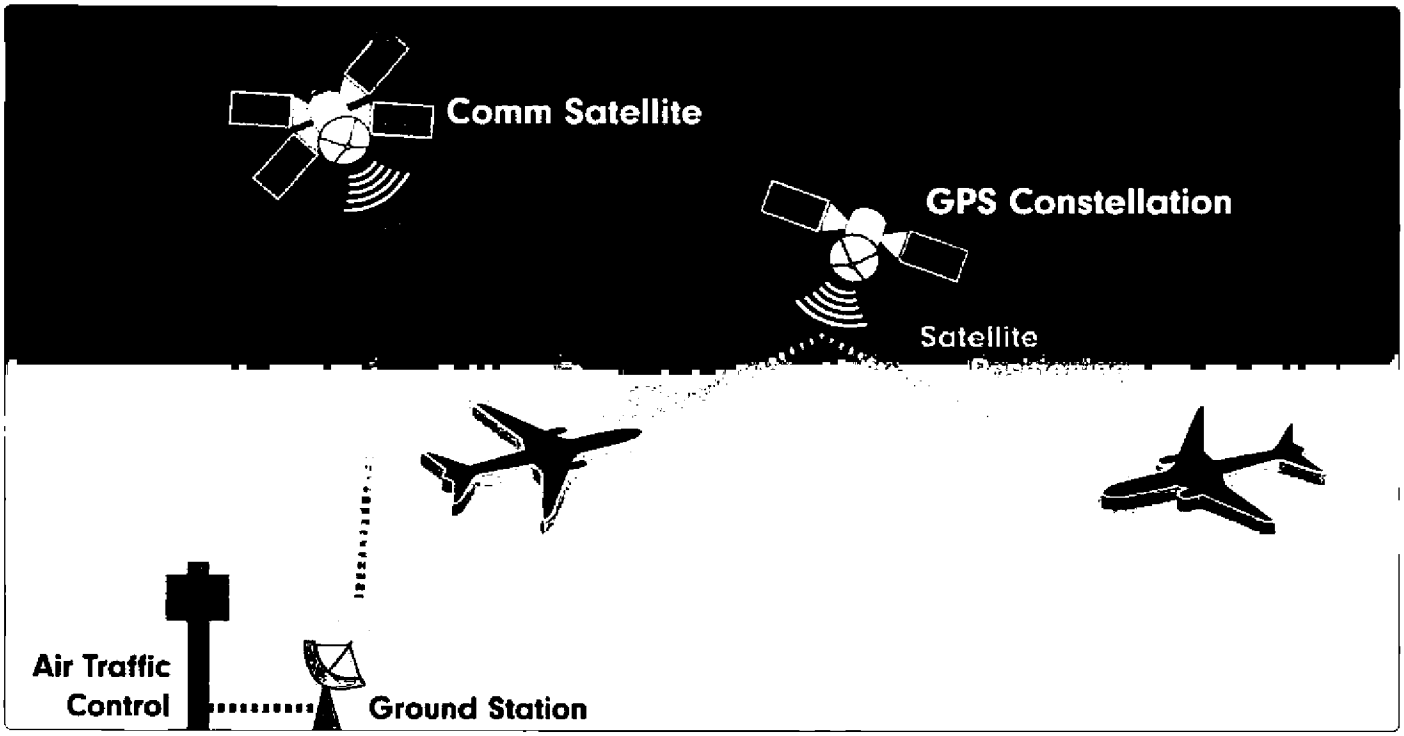
Precision Navigation

NextGen I would incrementally replace conventional navigation systems with Area Navigation (RNAV) and Required Navigation Performance (RNP) precision-based navigation technologies and procedures. RNAV uses multiple data inputs simultaneously such as GPS to define exact locations and direct flight paths to the flight's destination, rather than using beacons (VORs) that require changes in direction along the way. RNP takes this a step further by introducing the capability to monitor and correct flight-path deviations within a predefined tolerance, accounting for movement forward and back, laterally, horizontally, and vertically as illustrated in Figure 5.2. With NextGen, the safety buffer or envelope in all three dimensions can be reduced by the FAA because the exact location of an aircraft is more predictable. This makes it possible to set the separation of aircraft more narrowly, leading to higher capacity in the airspace. These tolerances are quantified; an RNP value of 1.0 is less precise than 0.3. The airlines have agreed to equip their entire aircraft fleets to achieve RNP 0.3 by 2018, meaning that an aircraft's navigation system will be able to report its position accurately within an envelope with a radius of three-tenths of a nautical mile. Thus, NextGen I would allow aircraft to operate in a narrower window, allowing closely spaced parallel operations on runways separated by at least 3,700 feet[5] compared to today's requirement of 4,300 feet. The system would also allow aircraft to make real-time adjustments to the flight plan en-route based on changes to the flight schedule, weather conditions or unforeseen airspace/airport delays. RNAV and RNP are both avionics upgrades, requiring a direct investment by the airlines. To take advantage of this technology the FAA must also establish new high-altitude "en-route" and terminal area RNAV and RNP procedures.

Ground Based Augmentation Systems (GBAS) is a NextGen component that would allow aircraft to use curved approaches and line up closer in to the runway during all weather conditions, removing the additional approach spacing required today during inclement weather conditions. In the New York region, GBAS would help to eliminate conflicts in the airspace around the three major airports and enable them to operate more inde-

5 FAA regulations require a minimal track separations of the twice the required approach RNP precision, in this case 2x0.3 nautical miles (nm) or 0.6nm. The required separation was calculated by multiplying the RNP value by the number of feet in a nautical mile (6,076ft) or 0.6 * 6,076 = 3,700ft (rounded).

ADS-B in Operation
Source: Regional Plan Association



pendently, with a higher throughput during bad weather events. GBAS is being installed at EWR and will likely be rolled-out at the other two airports soon.

The FAA will continue to develop RNAV/RNP approaches, departures, and routes, as part of the current regional airspace redesign project (estimated to be completed in 2012), and to take advantage of the new capabilities introduced by NextGen. However, there is no guarantee that these procedures will be developed and approved in time to allow aircraft operators to take advantage of NextGen I ground-side and avionics improvements. The current approval process is slow and inefficient; ways to streamline this process without sacrificing safety should be explored.

Data Communications

The shift to digital communications is critical if the air traffic control system is to be modernized. Today, controllers share most information using analog voice communications, much of which could easily be transmitted as text messages digitally to the aircraft. The FAA is in the process of developing the specifications for a communications system,[6] which will serve as the backbone for NextGen. This new aviation network will be similar to the high-speed networks that are relied on today, using fiber optic cabling to transmit large amounts of data in nanoseconds. The major difference is that this network will be completely secure, physically separated from the commercial networks that host the World Wide Web.

Aircraft will transmit/receive data to/from ground-stations that will be linked with fiber over land and with space-based satellites over the ocean to communicate to the secure high-speed aviation network.

Eventually this network would be used to directly link with the aircraft's onboard computers, allowing controllers to monitor the status of the aircraft, send messages and instructions and enable many of the other NextGen technologies that will rely on bi-directional communication between onboard systems and ground-based services. One of the significant benefits of this technology is the ability to rapidly transmit revised clearances (reroutes) during severe weather events. The FAA anticipates the start of nationwide deployment of this communication system by 2014 at most Towers and TRACONs/Centers starting in 2018. In the New York region the implementation timeline is extended because of the complexity of ATC, with Tower services coming online in 2016-17, and New York TRACON and (en-route) Center sometime after 2020. While this component of NextGen does not translate directly into capacity increases at the New York airports it does serve as a prerequisite for components that should lead to greater capacity.

Air Traffic Monitoring

The NextGen-based air traffic monitoring system (ADS-B) uses GPS and digital communications to replace conventional radar as the means of locating the position of aircraft. This system, depicted in Figure 5.3 allows pilots to "virtually see" aircraft that are in their general vicinity, continuously reporting their positions and status to air control centers and surrounding aircraft and providing updates much more frequently than is done today. With more precise knowledge of the location of aircraft, a reduction of en route aircraft separation standards from the current five miles would be possible, increasing capacity in the system.[7]

6 This system is known as the Aeronautical Telecommunications Network (ATN) and Future Air Navigation System (FANS-1/A+) defined further in the glossary.

7 There are two variants of ADS-B, IN and OUT. ADS-B-IN refers to the "peer-to-peer" data exchange that would take place between airborne aircraft within a specified coverage area. Aircraft would report its position to the new ATC system using ADS-B-OUT. ADS-B-OUT is already in place today in some parts of the NAS, both ADS-B-IN and OUT.

Estimated Savings from NextGen I Improvements for New York Region

Facility	Description	Technology	Delay Savings (minutes per flight)	2008 Procedure Usage	Net Savings (minutes per flight)
JFK	4L/4R Simultaneous Approaches w/31L Departures	RNP 0.3	2.5	17%	0.4
	22L/22R Simul. Approaches w/LGA 13 Whitestone Climb	RNP 1.0	2.6	44%	1.1
	13L RNAV Approaches w/LGA Maspeth Climb	RNP 1.0	1.6	19%	0.3
	31L Departures w/LGA Maspeth Climb	RNP 1.0	3.1	44%	1.4
	31L/R Departures w/LGA Stadium Visual Approaches	RNP 0.3	3.0	20%	0.6
	13L RNAV Approaches w/LGA 22 ILS Approaches	RNP 0.3	166.9	1%	1.8
LGA	31 RNAV Approaches w/JFK 31L/R Approaches	Sequencing Tools	3.6	27%	1.0
	31 RNAV Approaches w/JFK 22L/R Approaches	Sequencing Tools	3.6	27%	1.0
	RNAV (all)	RNP 1.0	1.1	52%	0.6
	RNAV 31 Approaches	Sequencing Tools	4.0	20%	0.8
EWR	29 Departures/TEB 6 RNAV	RNP 1.0	0.2	36%	0.1
	29 Departures/TEB 6 RNAV/EWR 4 Departures	RNP 1.0	1.2	36%	0.4
	GBAS 29	RNP 0.3		36%	
	Diagonally Separated Approaches	RNP+ADS-B	1.0	98%	0.5
	Allow compression of separations within 5 NM of Runway Threshold	Sequencing Tools	3.0*	62%	1.9
	Coordinated Converging Approaches on Runway 11	Sequencing Tools	5.0*	36%	1.8
Each*	TBFM (+/- 10 Seconds)	RNP+ADS-B	2.5*	99%	2.5

* TBFM delay savings is applied to each airport
Source: Regional Plan Association; Delay savings from 1998 Port Authority Airspace Study. * indicates delay savings estimated by RPA

The FAA has begun to install ADS-B on a demonstration basis, first at Louisville's International Airport (SDF) and most recently at the Philadelphia International Airport (PHL) and the surrounding airspace. Currently, only the UPS fleet is equipped for ADS-B. However, US Airways is in the process of upgrading its fleet for ADS-B operations at PHL. The FAA has plans to install eight ADS-B ground stations in the New York region in 2010[8], with roll-out of the broadcast services (real-time traffic and weather information to the cockpit) expected to have been done by year end and the ability to control live traffic by late 2011. The agency has set a deadline of 2013 for national coverage of ADS-B.

Airport Surface Detection Equipment or ASDE-X is a complementary technology. It lets controllers track the movement of aircraft on the ground as they are taxiing in and out of the gates. It uses ground-based sensors placed throughout the airfield to detect the signal from an aircraft's transponder and generates a real-time map that indicates the aircraft's precise location on airfield. Airside ancillary vehicles can be tagged so that their location is displayed as well[9]. This service is now operational at all three major airports in the region. When ADS-B is fully operational, it will improve the precision of ASDE-X and will allow pilots to view a similar display in their cockpits.

Air Traffic Control

Air traffic controllers would rely on the digital network consisting of a suite of applications to allow them to access flight plans, current weather conditions/forecasts and other operational information, and then to share that information with the airlines and pilots in flight. This system, the System Wide Information Management (SWIM) would act as the common interface for all of these services, operating in the background to provide customized data to aviation system users, and is a critical component of NextGen I. It would create common standards to share information for flight planning and air traffic management. The SWIM core services will include the capability to adjust flight plans in real time to account for current weather conditions or other airport/airspace related delays. Time-based metering of aircraft would build on this system to synchronize an aircraft's flight plan with real-time conditions in flight and on the ground, adjusting the aircraft's speed and route based on these conditions or other unforeseen delays.

Unlike most of the other NextGen core components, SWIM is not a geographically specific improvement. However, availability of the SWIM will be contingent on the implementation of DataCom or ADS-B. The first phase of SWIM will make various programs "SWIM compliant" and create a registry for SWIM services; implementation is already underway and will be completed by 2015. Phase two of SWIM, which involves establishing the architecture and interfaces for SWIM messaging, commences in 2012 and should be finished by 2016.

Impact on Capacity and Delay Reduction in New York Region

In the past, the FAA has attempted to quantify the impact of NextGen on the capacity of the national airspace system, concluding that it would increase capacity by 20 to 34 percent for the first phase. However, none of these projections realistically attempted to estimate the *local* delay reduction or capacity impact of NextGen in the New York region. That analysis is done here.

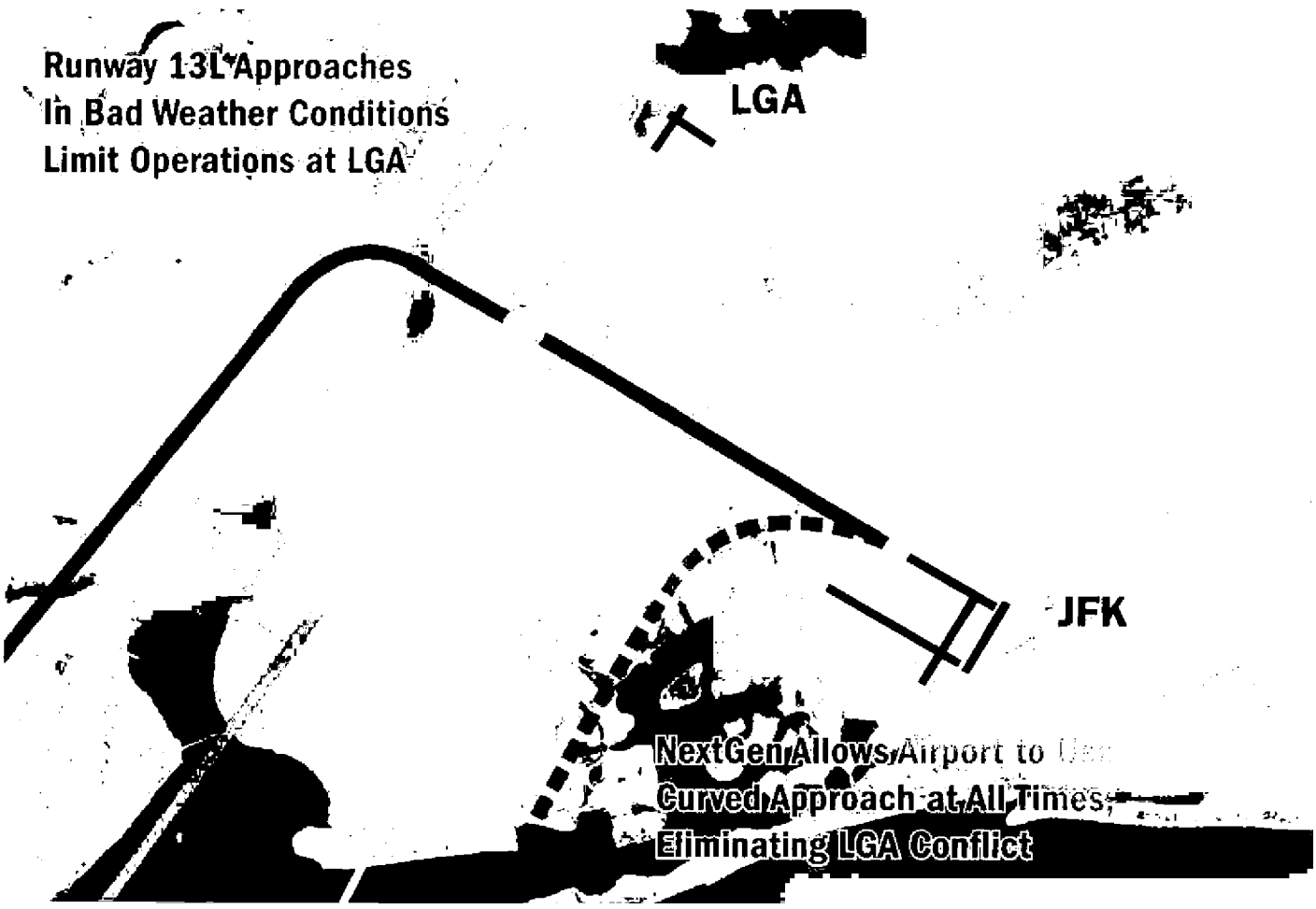
Every core NextGen component would contribute in some way to improving efficiency of New York's airspace. As a starting point, RPA used a 1998 report completed by the Port Authority (with the cooperation of the FAA) that examined over two dozen possible RNP/RNAV procedures for JFK, EWR & LGA, quantifying the level of precision required (from RNP 1 to 0.1) and the resulting delay savings. Table 5.1 lists the RNAV/RNP procedures for each airport that would be implemented during the first phase of NextGen (from RNP 1 to 0.3 or greater). Most of these navigation improvements are targeted at LGA and JFK, and would reduce the airspace conflicts that exist between those

should be available by 2020.

8 The FAA completed site selection for the terminal areas at LaGuardia, JFK, and Newark Airports in March 2010, these sites are subject to change pending further coverage analysis.

9 Standard ASDE-X does not currently cover the non-aircraft movement area and there is no requirement to equip ground-based airside vehicles with transponders.

Curved Approaches in Poor Weather Conditions with NextGen I
Source: Regional Plan Association



two airports today, as illustrated in Figure 5.4. However, in the near-term, EWR will benefit from a FAA rule change that may ultimately allow ½ mile staggered parallel operations on runways separated by less than 2,500 feet (centerline-to-centerline). EWR runways are separated by 950 feet. A variation of this procedure using 1.5 mile staggered approaches should have gone into effect by now or early 2011.

One of the more dramatic impacts of NextGen is shown in Figure 5.4, which depicts the "before-and-after" approaches to JFK under poor weather conditions. Currently, the curved approach to JFK, shown with a solid blue line, conflicts with the approach to LGA, which reduces the landing capacity of each airport. After NextGen, the JFK approach shown with a dashed blue line would avoid the LGA conflict.

This NextGen capacity impact analysis assumes that data communications and SWIM would enable time-based metering of all flights by 2018. Furthermore, ADS-B would reduce the separation standards for final approaches to the airport, a factor in the "Time Based Flow Management" (TBFM) calculation. In combination, these two improvements will result in an almost 2.5 minute savings per-peak hour at each of the three airports.

Table 5.1 details how much savings each action would produce and the proportion of the time it would save depending on how the runways are used. The last column estimates the total savings attributed to each action. The next step in the analysis was to summarize the delays savings by airport and then to convert delay in minutes to operations per hour. The conversion

TABLE 5.2 –
NextGen I Summary of Delay Savings/Capacity Increase

Facility	Delay Savings	Additional Aircraft per Hour	Annual Aircraft Operations	Air per H
JFK	10.1	11	56,300	
EWR	6.6	3	15,100	
LGA	10.2	7	30,500	
Average or Total	9.0	21	101,900	

Source: Regional Plan Association
Note: LGA new aircraft per hour do not in

of delay savings to hourly capacity changes was completed using the delay-per-aircraft curves shown in Appendix B. These curves were computed using the queuing models used to define existing airport delays under future conditions in Chapter 4, which are also described in Appendix B.

Table 5.2 displays the additional operations per hour, annual operations and revised capacity[10] for each airport, assuming NextGen I is implemented by 2018. This table assumes that delays will remain at current levels and that the entire potential delay reduction benefit gets converted to additional capacity. JFK benefits the most from NextGen I, with over 56,000 additional operations annually and a new hourly capacity of 92 operations per hour, up from 81 per hour. LGA gains seven

10 The existing USDOT mandated hourly flight cap plus new hourly capacity.

Hourly Capacity Provided by NextGen I and Remaining Shortfalls of Capacity at 10, 15 and 20-Minute Average Annual Delay Per Aircraft

Aircraft Movements in Peak Hour		Existing Slots	Total Capacity Needed			Capacity Provided with Next-Gen I			Additional Capacity Needed		
			10-minute delay	15-minute delay	Existing delay	10-minute delay	15-minute delay	Existing delay	10-minute delay	15-minute delay	Existing delay
JFK	115 MAP (2015-2021)	81	94	91	88	81	84	92	13	7	-
	130 MAP (2021-2034)	81	105	102	98	81	84	92	24	18	6
	150 MAP (2030-2042+)	81	119	115	111	81	84	92	38	31	19
EWR	115 MAP (2015-2021)	81	91	88	85	81	81	84	10	7	1
	130 MAP (2021-2034)	81	99	95	92	81	81	84	18	14	8
	150 MAP (2030-2042+)	81	107	103	100	81	81	84	26	22	16
LGA	115 MAP (2015-2021)	74	73	71	69	74	79	81	-	-	-
	130 MAP (2021-2034	74	78	76	75	74	79	81	4	-	-
	150 MAP (2030-2042+)	74	85	83	81	74	79	81	11	4	-
System	115 MAP (2015-2021)	236	258	250	242	236	244	257	23	14	1
	130 MAP (2021-2034	236	282	273	265	236	244	257	46	32	14
	150 MAP (2030-2042+)	236	311	301	292	236	244	257	75	57	35

Note 1: LGA has a slot limit of 71 scheduled aircraft per hour, plus 3 GA. However, the FAA has not strictly enforced it. Currently, LGA averages 74 scheduled aircraft per hour

operations per hour and EWR adds capacity for three additional operations per hour. Overall, the cumulative impact of NextGen I is substantial, producing an additional 21 operations per hour at the three airports combined. These estimates are conservative and do not include the potential capacity benefits of GBAS and additional precision navigation procedures that might be developed between now and 2018.

How Does NextGen Phase I Impact the Projected Shortfall?

In Chapter 4 the number of hourly operations needed, if the airports were to serve 115, 130 and 150 million annual passengers, was calculated. Table 5.3 shows this unmet need. Based on the recent actions of the FAA, airlines and other industry stakeholders, RPA is assuming that NextGen I will be implemented by 2018. Table 5.3 also shows the operations per hour needed if NextGen I was in place. As discussed in earlier chapters, hourly operations are currently capped at 81, 81 and 74 operations per hour[11] at JFK, EWR and LGA, respectively.

Table 5.3 shows that at current delays NextGen I would provide for almost all the needed hourly capacity when passenger volumes reach 115 million annual passengers. Both this level of demand and the completion of NextGen I are projected to be reached between 2015 and 2021. However, at 130 MAP there would still be a shortfall of 14 flights per hour, and at 150 MAP, a shortfall of 35 flights per hour. At the 10-minute delay standard, the 115 MAP would fall short by 23 flights per hour, even with NextGen I in place. These shortfalls will be lower when combining NextGen with other actions discussed in this report. The combined effects, which will lower the shortfalls, are provided in Chapter 12.

These shortfalls must be examined for each of the three airports separately, since the shift of demand among airports cannot be assumed. Only LGA would require no additional actions under NextGen I for 115MAP, and at the 130 MAP level at current levels of delays, and provide delay reduction to the 15 minute level. The two other airports would continue to need significantly more capacity for either delay reduction or capacity increases under all three passenger volume scenarios.

NextGen Phase II

NextGen II includes an unspecified number of air traffic control (ATC) system improvements that would continue the implementation and build off the foundational technologies introduced during the first phase, after 2018. Many of the NextGen technologies in this phase are unproven or still in the developmental stage. NextGen II will likely be less of a revolutionary change in the ATC system and more of a refinement of the core NextGen technologies that will already be implemented. Increasing the precision of aircraft navigation and management are the two areas where most of the advancements should occur. Required Navigation Performance (RNP) could increase in precision from 0.3 to 0.1, allowing closely spaced parallel operations (CSPO) on runways separated by a distance of 1,300 feet or more (Figure 5.5). Average separation between aircraft could drop even further by improving time-based flow management (TBFM) systems. In the longer term, the FAA could reduce separation standards based upon the performance of TBFM in predicting aircraft locations[12].

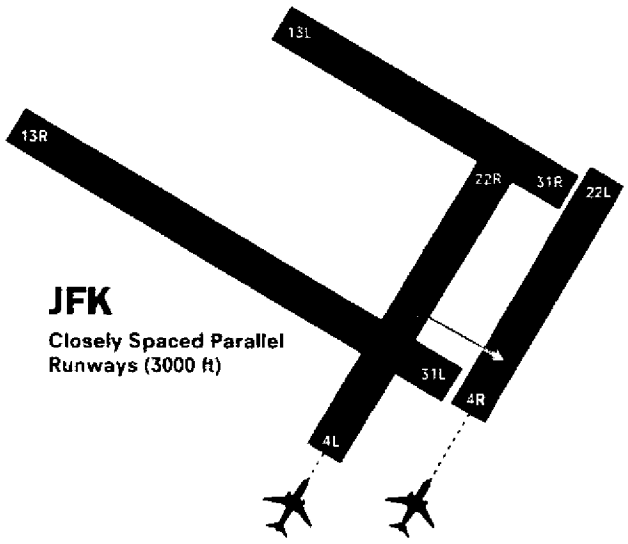
Impact on Capacity and Delay Reduction in the New York Region

Estimates are presented here of the potential impact of NextGen II on the New York region's airspace, and as before the capacity increase and delay savings for each option are calculated. Because the improvements projected for this second phase are less well-developed and proven than those in the initial phase, the estimates of their impacts are less precise than for NextGen I. TBFM throughput was increased by reducing separation distances, distances for staggered parallel approaches at EWR

11 The cap is enforced from 6am to 11pm, the period when the overwhelming majority of commercial operations take place. While the LGA cap is at 71 scheduled flights per hour, the FAA has not required the airlines to return slots in excess of that value. The overnight period is typically a window used for cargo operations.

12 Separation distance will also be influenced by the effects of wake vortex, these safety concerns would supersede the capabilities of future navigation systems unless new aeronautical advancements are made to reduce the wake an aircraft produces, or technology to measure real-time wake improves.

Closely Spaced Parallel Runway Operations at JFK with NextGen II



NextGen II Improvements for New York Region

Facility	Description	Technology	Delay Savings (minutes per ops)	2008 Procedure Usage	Sav (minu per
JFK	JFK 13L/13R RNAV Approaches	RNP 0.1	36.5	1%	[illegible]
	JFK 13L RNAV Approaches w/LGA 4 ILS Approaches	RNP 0.1	2.6	1%	[illegible]
LGA	LGA RNAV (all) Approaches	RNP 0.1	5.2	10%	[illegible]
	LGA 13 RNAV/EWR 22/ TEB6	RNP 0.1	4.9	1%	[illegible]
EWR	EWR River Downwind	RNP 0.1	2.1	57%	[illegible]
EACH*	TBFM	RNP & ADS-B	5.0	99%	[illegible]

NextGen II Summary of Delay Savings/Capacity Increase

Facility	Delay Savings	Additional Aircraft per Hour	Annual Aircraft Operations	Aircr per H
JFK	12.1	9	45,900	[illegible]
EWR	11.6	5	24,800	[illegible]
LGA	12.7	4	17,400	[illegible]
Avg. or Total	12.[illegible]	[illegible]	[illegible]	[illegible]

Source: Regional Plan Associa[illegible]

were reduced, and RNAV/RNP procedures were included for all three airports that require RNP .1 or greater precision. Table 5.4, details the outcome of this analysis.

Most of the delay savings or capacity increase is realized through reducing average aircraft separations based on the assumption of improved system efficiencies, resulting in TBFM delay savings of five minutes per airport. RNP procedures at JFK requiring a greater level of precision contribute the next largest benefit, with EWR and LGA rounding out the list, respectively.

Table 5.5 details the impact of NextGen II on the region's airport system; overall this phase generates an additional 18 operations per hour or almost an eight percent increase in airspace capacity over NextGen I. This capacity increase occurs if current delay levels are maintained and all of the delay reduction benefits of NextGen II get converted to additional capacity.

How Does NextGen II Impact the Projected Shortfall?

Similar to the NextGen I, the calculated increase in operations per hour for both NextGen I and II were applied to RPA's unmet needs projections for 115 MAP, 130 MAP and 150 MAP. The improvements for NextGen II were applied starting at 130 MAP level because they will not be implemented until sometime after 2018, which is after the shortfall for 115 MAP (2015-2021) is projected to occur. However, it is likely that most of the benefit of NextGen II will not be realized until 150 MAP.

As shown in Table 5.6, on a system-wide basis, NextGen II falls short by only 3 hourly operations at the 130 MAP level, but 21 short at the 150 MAP level. If the 10-minute standard is used, the shortages are predictably much higher. When viewed airport by airport, LGA achieves most of its capacity needs at 130 MAP or beyond, but JFK and EWR fall short at the 130 MAP and 150 MAP demand levels, with the gap between capacity and demand growing as passenger volumes grow and the standard for delay is tightened. Sixty-seven more aircraft per hour are required above and beyond NextGen II impact to achieve a 10-minute standard. Of this amount, 34 aircraft per hour would be required at JFK, 26 more at EWR, and [illegible] more at LGA.

Moving Forward

It is clear, as summarized in Table 5.7, that both phases of NextGen could result in significant capacity increases at our region's three airports, but only if existing delay levels remain. In this scenario Next Gen I will increase capacity by seven percent and NextGen II by almost eight percent. In the long term, LGA could come closest to meeting its needs with NextGen, with the capacity-versus-demand gap mostly closed. JFK and EWR will benefit considerably, but significant other actions will be needed to close their gaps

Applying the 10-minute delay standard for the 150 MAP level, JFK, EWR and LGA would still need an additional 34, 26 and seven operations per peak-hour, respectively, even after NextGen I and II were both implemented. If the "world class" standard is relaxed to 15-minutes then the unmet need is less at 23, 20 and one, further indicating that NextGen alone cannot solve the capacity deficit by 150 MAP.

However, if the FAA chooses to use the NextGen program to reduce delay, the capacity gap will only further widen and the region will need to rely far more heavily on other solutions to provide additional capacity to serve future demand. Furthermore, without the capacity afforded by NextGen I, passengers at the 115 and 130 MAP levels would likely be lost. The capacity gap over the next ten to 15 years is where the benefits NextGen would likely be felt the most, which is why it is essential that FAA implements the program in a timely manner.

Hourly Capacity Provided by NextGen I & II and Remaining Shortfalls of Capacity at 10, 15 and 20-Minute Average Annual Delay Per Aircraft

Aircraft Movements in Peak Hour		Existing Slots	Total Capacity Needed: 10-minute delay	Total Capacity Needed: 15-minute delay	Total Capacity Needed: Existing delay	Capacity Provided with Next-Gen I: 10-minute delay	Capacity Provided with Next-Gen I: 15-minute delay	Capacity Provided with Next-Gen I: Existing delay	Additional Capacity Needed: 10-minute delay	Additional Capacity Needed: 15-minute delay	Additional Capacity Needed: Existing delay
JFK	115 MAP (2015-2021)	81	94	91	88	85	92	101	9	-	-
	130 MAP (2021-2034)	81	105	102	98	85	92	101	20	10	-
	150 MAP (2030-2042+)	81	119	115	111	85	92	101	34	23	10
EWR	115 MAP (2015-2021)	81	91	88	85	81	83	89	10	5	-
	130 MAP (2021-2034)	81	99	95	92	81	83	89	18	12	3
	150 MAP (2030-2042+)	81	107	103	100	81	83	89	26	20	11
LGA	115 MAP (2015-2021)	74	73	71	69	78	82	85	-	-	-
	130 MAP (2021-2034	74	78	76	75	78	82	85	-	-	-
	150 MAP (2030-2042+)	74	85	83	81	78	82	85	7	1	-
System	115 MAP (2015-2021)	236	258	250	242	244	257	275	19	5	-
	130 MAP (2021-2034	236	282	273	265	244	257	275	38	22	3
	150 MAP (2030-2042+)	236	311	301	292	244	257	275	67	44	21

Note 1: LGA has a slot limit of 71 scheduled aircraft per hour, plus 3 GA. However, the FAA has not strictly enforced it. Currently, LGA averages 74 scheduled aircraft per hour

Summary of Hourly Capacity & Unmet Needs for NextGen I & II

Facility	Current Slot Limit	NextGen I with existing delays: Added Ops/Hour	NextGen I with existing delays: New Ops/Hour	NextGen I - 150MAP: 10-min	NextGen I - 150MAP: 15-min	NextGen II with existing delays: Added Ops/Hour	NextGen II with existing delays: New Ops/Hour	NextGen I & II - 150MAP: 10-min	NextGen I & II - 150MAP: 15-min
JFK	81	11	92	38	31	9	101	34	23
EWR	81	3	84	26	22	5	89	26	20
LGA	74	7	78	11	4	4	85	7	1
Total	236	21	254	75	57	18	275	67	44

Source: Regional Plan Association

The first challenge for NextGen implementation will be for the FAA to stay on schedule with its rollout of the core ground-based NextGen I services (ADS-B, SWIM and Data Communications). To encourage the airlines to equip their aircraft with NextGen technologies may require some incentives. Congress is currently debating legislation that would provide a subsidy for airlines to install ADS-B upgrades and set a deadline of 2014 for this equipage. Many of the commercial carriers are already equipped to operate in this environment; it's mostly the smaller regional carriers that are not. For the last several years Boeing has included many of these upgrades in its newer aircraft, understanding that increasing the capacity of the airspace would most likely correlate to an increased demand for new aircraft. The FAA and the European Union will also need to coordinate equipage of international carriers to ensure that the New York region's gateway airports realize the full benefits of the ATC modernization.

Various different groups that represent the "human element" will need to "buy in" to NextGen I if it is to be implemented by 2018. NextGen I will result in substantial changes to the job description of an air traffic controller and will also change how pilots interact with the NAS. It is hoped that the early demonstrations in Philadelphia and other locations will provide some insights into some of these challenges and help the FAA to develop a roadmap for the eventual transition of the entire NAS to NextGen.

The greatest challenge in implementing NextGen II will be convincing the industry, especially the airlines, that further investment in the ATC system is warranted. It will be essential that they be partners in this initiative since many of the NextGen II improvements will be achieved only through installation of the latest hardware and software upgrades to their fleet's avionics packages. This will require direct capital investments by all aircraft operators, along with the additional employee training costs that go with it. The successful implementation of the first phase of NextGen, where the espoused benefits have actually materialized as promised, would go a long way towards convincing the industry to move forward with this next phase.

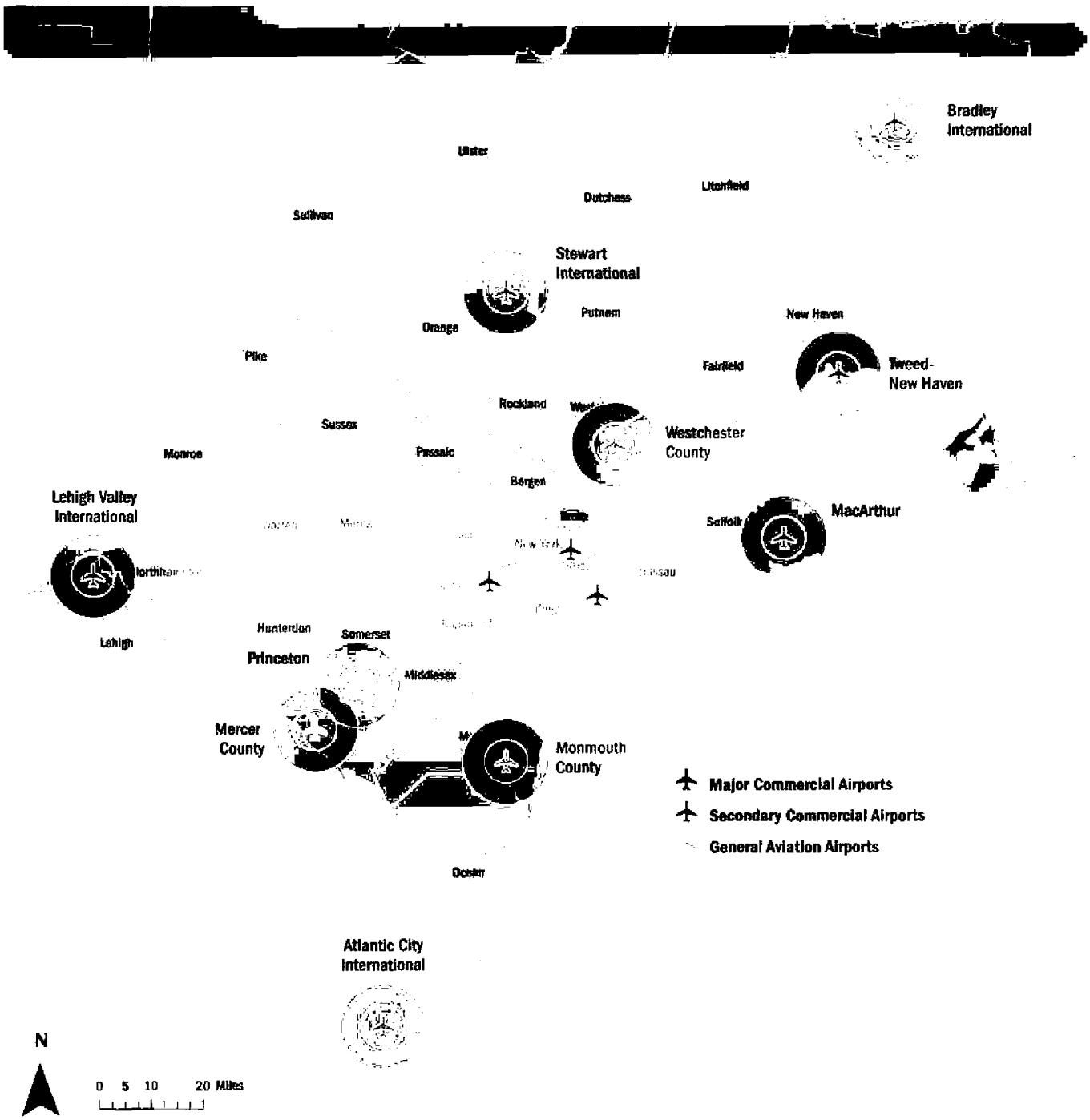
The FAA and industry have taken bold steps over the last year to advance NextGen, but more will be needed.

- The Congress must pass legislation to fund NextGen I and require equipage by the airlines. The Senate has already done so but action by the House is still required.
- The future role of air traffic controllers under NextGen must be determined by the FAA in a transparent fashion and in partnership with the labor unions. The demonstration projects that are underway present an opportunity to jumpstart this process.
- The FAA should develop a long-term implementation framework, building off the NAS architecture that JPDO has created, for NextGen II. This analysis of NextGen indicates that the mid-term implementation of NextGen includes all of the core services, with the next phased focused on refining these core system.

With a clear mid-term implementation plan and real demonstrations underway, the conversion to NextGen has begun in earnest. It is imperative that this momentum be maintained, the 2018 deadline for mid-term implementation met and progress made towards "fleshing out" a full-term implementation plan for NextGen II.

Airports for Third-Level Screening

Source: Regional Plan Association



The Outlying Airports

Can They Relieve the Region's Three Major Airports?

Table 6.1

Existing Smaller Commercial Passenger Regional Airports

Airport Statistics	Stewart SWF)	Westchester County (HPN)	Islip (ISP)	Tweed-New Haven (HVN)	Atlantic City (ACY)	Lehigh Valley (ABE)	Bradley (BDL)
County, State	Orange, NY	Westchester, NY	Islip, NY	New Haven, CT	Atlantic, NJ	Lehigh, PA	Hartford, CT
Driving from Manhattan (in miles)	66	35	50	80	125	91	126
Land Area (in acres)	2,139	702	1,311	394	5,000	2,629	2,616
Longest Runway (in feet)	11,818	6,548	7,006	5,600	10,000	7,600	9,502
2009 Annual Passengers	390,065	1,917,422	1,008,000	Less than 30,000	1,126,919	748,482	5,334,322
2009 All Annual Operations	44,597	150,102	11,334	46,675	90,967	108,479	108,868
Capacity (Annual Ops.)	189,000-227,000	234,000-249,000	Over 200,000	Over 200,000	224,000-273,000	216,000-244,000	Over 200,000

Sources: Regional Plan Association, ACI-NA 2009 traffic reports, USDOT-BTS Schedule T100 (ISP) & FAA Regional Air Service Demand Study, 2007

This chapter investigates the prospects for outlying airports in the region to free up capacity at the three major airports. The airports examined are both those with current scheduled passenger airline service and those without. Airports without scheduled passenger service are screened to determine if their physical attributes, with improvements, would be likely to support future service. Candidate airports are then tested to see how much of an impact they could have in shifting some of the air passenger traffic from the three major airports, and by doing so, freeing up capacity to accommodate the projected traffic growth.

These outlying airports could contribute to congestion relief at major commercial hubs, drawing passengers from the core of the metropolitan area and intercepting local demand within the airport's natural catchment area. Passengers residing or visiting the core of the metropolitan area could shift to outlying airports, attracted by lower cost services and less congestion and delay than airports in the core. These airports also could intercept some locally-based passengers who would normally have traveled to the major commercial airports, but are attracted to traveling via their local airport instead.

While the focus in this chapter is the ability of these airports to relieve traffic and free up capacity at the major airports, they also serve their local communities.

Airports with Air Passenger Service Today

The analysis included the seven smaller regional airports with commercial passenger service today and another 59 general aviation airports that are within the catchment areas of the three major airports. Table 6.1 shows the most pertinent data for the seven airports with scheduled passenger service today. They range from the close-in Westchester County (HPN) airport just 35 miles from Manhattan to Atlantic City International (ACY) and Hartford's Bradley International Airport (BDL), each more than 120 miles away from the region's core. New Haven's Tweed (NHV) airport is the smallest in size (half the size of LGA), while Allentown, Pennsylvania's Lehigh Valley Airport (ABE) and Bradley are the largest in land area, to ACY, which is still larger than JFK. Tweed's runway is short (5,600 feet), less than what is required for larger commercial jet service, and ACY, Stewart International (SWF) and BDL have runways that are 9,500 feet or more in length. Tweed serves only 30,000 air passengers annually, Westchester County serves about 2 million, and Bradley handles 5.3 million, down from 7 million in 2007. ABE, ACY and Long Island MacArthur (ISP) serve about one million passengers annually, while SWF serves only about 400,000, down from 900,000 in 2007. Each of the seven could handle upwards of 200,000 aircraft operations annually, some appreciably more.

Westchester County Airport is limited by a curfew and caps on the number of hourly operations and there may be local community opposition that would inhibit greater use of the airport.

Among these seven regional airports, Stewart has been most widely discussed as a reliever airport. The Port Authority acquired it in 2007 by taking over a 99-year lease to operate the airport for the State of New York. The agency is developing plans to redevelop Stewart that may amount to an investment of $500 million dollars over the next ten to fifteen years.

All seven of these regional airports, by virtue of their size, current use or proximity to the region's core are worthy of consideration for their potential to attract passengers from the major airports. In addition, 59 general aviation airports were screened to see if they might function in a similar fashion.

Evaluation of the Region's General Aviation Airports

The full list of the 59 General Aviation (GA) facilities being considered is found in Appendix C. None of these airports currently offer regularly scheduled commercial service and, are in most cases, considerably smaller than the seven larger regional

airports. However, these GA facilities serve an essential function, which is to relieve larger airports of small aircraft traffic and provide service for the recreational aviator, business traveler and some limited passenger charter flights.

The First-Level Screening

The general aviation airports were subjected to a three-tier screening process. In the first screen, only airports that were located in the catchment area of the three major airports were included for consideration. This catchment area was defined as a 55-county area (plus four counties in Connecticut) that includes the area that generates virtually all of the local air passenger trips using the three major airports.[1] Airports were also screened out if they conflicted with the airspace of the three major airports.

Using these two criteria, all four GA facilities in Connecticut, five in the Hudson Valley, and eight in New Jersey were eliminated. They are listed in Table 6.2. The 42 airports that survived the first-level screening are east of Allentown airport (ABE), north of McGuire AFB, south of Stewart (SWF) and west of Westchester (HPN).

The Second-Level Screening

After completing the first-level screening the remaining airports in New Jersey/Lower Hudson Valley and Long Island were assessed separately[2]. Thirty-one GA airports were evaluated in New Jersey/Lower Hudson Valley and eleven on Long Island.

The second-level screening evaluated and ranked the remaining airports by five criteria; site criteria, airspace capacity, roadway access, and rail access. The "site" criterion consists of several sub-criteria. Each site was evaluated to determine if a) there was sufficient space for an 11,000-foot runway for long distance flights or at the very least a 7,000-foot runway[3], and b) space for runway safety areas, taxiways, terminals, access roads, parking and other ancillary support structures. These site criteria were further influenced by a number of other factors.

- The potential expansion of the site must not require the acquisition of more than a dozen parcels.
- The site should be relatively flat with no water features.
- There must be limited residential development around the periphery of the airport.
- Any expansion of the facility to accommodate commercial traffic must not impede major roadways and expressways.

Proximity to major roadways is also critical to the success of the airport, and while a poor score would not automatically remove an airport from consideration, good highway access is necessary in the locations in question. Rail access to the region's core was also considered, and while it is not essential, it could be helpful in expanding the airports reach, particularly if connected to the core of the region.

1 The catchment area was defined using the 2007 Regional Air Service Demand Study completed by Parsons Brinckerhoff and Landrum & Brown for the Port Authority.

2 Only three New York State GA airports in Orange County (Warwick, Randall and Orange County) and one Pennsylvanian GA facility (Braden Airpark) made it past the initial screening.

3 7,000-foot runways will accommodate almost all short-medium range flights (RJ's up to 757, 767's) and over 10,500-foot runways will accommodate many longer range flights (747, A380)

Airports Eliminated in First-Level Screening

Airport Name	Airport Code	County	State
Danbury Municipal Airport	DXR	Fairfield	CT
Igor Sikorsky Memorial	[redacted]	[redacted]	[redacted]
Meriden Markham Municipal Airport	MMK	New Haven	CT
Waterbury-Oxford Airport	OXC	New Haven	[redacted]
Dutchess County	POU	Dutchess	NY
Sky Acres Airport [redacted]	44N	Dutchess	[redacted]
Stormville	N69	Dutchess	NY
Sullivan County Int'l Airport	MSV	Sullivan	NY
Wurtsboro-Sullivan County Airport	N82	Sullivan	NY
Hammonton Municipal Airport	N81	Atlantic	NJ
Flying W. Airport	N14	Burlington	NJ
Pemberton Airport [redacted]	3NJ1	Burlington	NJ
South Jersey Regional Airport	VAY	Burlington	NJ
Red Lion Airport [redacted]	N73	Burlington	NJ
Eagles Nest Airport	31E	Ocean	NJ
Robert J. Miller Air Park [redacted]	MJX	Ocean	NJ
Allentown Queen City Municipal	XLL	Lehigh	PA

Source - Regional Plan Association

TABLE 6.3

Second-Level Screening Criteria

Evaluation Criteria	Score 1	0	-1
Site Criteria	Potential for 11,000-foot long runway	Potential for 7,000-foot long runway	Limited ability to expand to a minimum 7,000-foot long runway
Airspace Capacity	No Impact - No commercial service airports within 20 nautical miles	Possible Impact -1 commercial service airport within 20 nautical miles	Severe Impact - More than 1 commercial service airport within 20 nautical miles
Roadway Access	Within 6 miles of major highway	Within 6 to 11 miles of major highway	More than 11 miles from any major highway
Rail Access	Within 5 miles of known passenger rail	Within 5 miles of some type of rail	More than 5 miles from any rail line

Source: Regional Plan Association

Table 6.3 provides the screening thresholds for these criteria, assigning a scale of -1, to + 1 to them. In the evaluation that follows the airspace capacity and site criteria were given the greatest weight; any airport receiving a score of -1 for either of these two was eliminated from consideration.

The results of the second-level screening are displayed in Table 6.4. Twenty-two of the 31 airports were dropped, mostly because they have insufficient land to construct a 7,000-foot runway, the desired minimum for commercial passenger service. The nine remaining airports did not contain any fatal flaws, scoring a "0" or +1 for all four criteria. Only New Jersey's Monmouth County Executive Airport scored +1 across the board, and only Princeton Airport scored +1 for three of the four criteria. Monmouth County was the most accessible and readily expandable airport of all of the existing GA facilities in NJ. Trenton Mercer, a former commercial facility, also scored well and did not have any airspace or accessibility issues that were prevalent at the other seven airports.

Table 6.5 shows the results of the evaluation of the eleven airports on Long Island in the same manner. Only two GA airports passed the second-level screening, Francis S Gabreski and Calverton Executive. Both facilities are in close proximity, less than ten miles apart from each other and were former military facilities that have since been converted to serve general aviation aircraft. The Long Island Railroad runs parallel along the property lines of both airports, with the Ronkonkoma Branch (Calverton) to the north and the Montauk Branch (Gabreski) to

New Jersey/Lower Hudson Valley GA Evaluation Matrix

Airport Name	Code	Scoring: Site	Scoring: Airspace	Scoring: Roadway	Scoring: Rail	Total Score
Monmouth Executive Airport	BLM	1	1	1	1	4
Princeton Airport	39N	0	1	1	1	3
Randall Airport	06N	0	0	1	1	2
Lakehurst NAES/ Maxfield Field	NEL	1	1	0	0	2
Trenton-Mercer	TTN	0	1	1	0	2
Lincoln Park Airport	N07	0	0	1	1	2
Old Bridge Airport	3N6	1	1	0	0	2
McGuire Air Force Base	WRI	1	[redacted]	0	[redacted]	[redacted]
Morristown Municipal Airport	MMU	0	0	1	0	1
Somerset Airport	SMQ	[redacted]	[redacted]	1	1	[redacted]
Central Jersey Regional (formerly known as Kupper)	47N	-1	1	1	1	2
Solberg Hunterdon Airport	N51	-1	0	1	1	1
Linden Airport	LDJ	-1	0	1	1	1
Orange County Airport	MGJ	-1	0	1	0	0
Teterboro	TEB	-1	-1	1	1	0
Essex County	CDW	-1	-1	1	1	0
Alexandria Airport	N85	-1	0	1	0	0
Aeroflex-Andover	12N	[redacted]	1	1	-1	0
Trinca Airport	13N	-1	1	1	-1	0
Trenton-Robbinsville	N87	[redacted]	1	1	-1	0
Sky Manor Airport	N40	-1	1	0	0	0
Redwing Airport	2N6	0	1	0	-1	0
Warwick Municipal Airport	N72	-1	0	0	0	-1
Lakewood	N12	-1	[redacted]	-1	0	[redacted]
Sussex	FWN	-1	1	-1	0	-1
Newton	3N5	-1	1	0	-1	-1
Hackettstown Airport	N05	-1	1	0	-1	-1
Blairstown	1N7	-1	0	0	-1	-2
Greenwood Lake Airport	4N1	-1	1	-1	-1	-2
Braden Airpark	N43	[redacted]	0	0	-1	-2
Marlboro (closed in 2002)	2N8	-1	1	-1	-1	-2

Source: Regional Plan Association

Long Island GA Evaluation Matrix

Airport Name	Code	Scoring: Site	Scoring: Airspace	Scoring: Roadway	Scoring: Rail	Total Score
Francis S. Gabreski	FOK	1	1	1	1	4
Calverton Executive	3C8	0	0	1	1	2
East Hampton	HTO	1	1	-1	1	2
Lufker	49N	-1	0	1	1	1
Spadaro	1N2	-1	0	1	1	1
Brookhaven	HWV	-1	0	1	1	1
Bayport Aerodrome	23N	-1	0	1	1	1
Republic	FRG	0	-1	1	1	1
Mattituck	21N	-1	1	-1	1	0
Montauk	MTP	[redacted]	[redacted]	[redacted]	-1	-2
Elizabeth Field	0B8	-1	1	-1	-1	-2

Source: Regional Plan Association

the south. Gabreski – owned and operated by Suffolk County – is the more active of the two airports and still serves as the home of Air National Guard (106th Rescue Wing). It achieved an across-the-board +1 score while Calverton scored high in only two categories.

Third-Level Screening: Selected Airports for Further Analysis

Monmouth County Executive, Trenton-Mercer and Princeton airports in New Jersey are the only GA facilities that are recommended for further analysis. While Gabreski on Long Island ranked high, its close proximity to MacArthur Airport (ISP) – less than 25 miles away – duplicating its catchment area, eliminated it from further consideration. Its greater isolation from the core than ISP would preclude it as an attraction to air travelers at the three airports, with the "intervening opportunity" of ISP capturing any possible shift of passengers.

Figure 6.1 maps the ten airports – the three selected GA sites and seven existing smaller commercial facilities – that will be evaluated in the next phase of the analysis, which will estimate how much of an impact these airports are likely to have on freeing up capacity at the three major airports.

Freeing up Capacity

The ability of each of the candidate airports that remain after the screening process to attract travelers who now use the three major airports depends on two fundamental factors:

1. How much air service, measured by the number of destinations and frequency of service, could each candidate airport provide in the future to encourage those now traveling via the three major airports to shift?
2. How easy will it be to reach these airports relative to the three major airports?

The Model for Accessibility

To answer these questions the current patterns of choices made by the travelers in the region were examined by using the data collected in 2005 data as part of the Regional Air Service Demand Study (RASDS) effort, published by the FAA in 2007. This survey compiled data on air travelers in each of the 55 counties centered on New York City who traveled to or from ten airports in this greater region.[4] These data were used to construct an airport share model that accounted for the two factors – relative amount of air service and the relative ease of travel. The model is based on the premise that the choice people make among alternative destinations is proportional to the relative attraction at each destination, measured by the relative magnitude of passengers boarding aircraft at each airport[5], and inversely proportional to the relative travel time to each destination (airport).

The formulation can be expressed in the following equation:

4 These airports included all those that had air carrier service in 2005, including JFK, EWR, and LGA, as well as Atlantic City International (ACY), MacArthur – Long Island (ISP), Westchester County (HPN), Lehigh Valley (ABE), Stewart International Airport (SWF) and Trenton Mercer (TTN)

5 The number of passengers boarding at each airport tends to be proportional to the number of seats flown and therefore proportional to the range of services available to attract passengers.

$$\% \text{ to airport } 1 = \frac{P1/(\text{tt co to airport})^e}{\Sigma P_1/(\text{tt co to airport})^e + P_2/(\text{tt between co and airport})^e + P_3(\text{tt between co and airport})^e + \ldots}$$

Where

P_1 = the number of passengers boarding at airport 1;
tt = travel time between each airport and each county;

and

e = the exponent to be calibrated

This formulation is known as the gravity model since it follows the same principal as Newton's law of universal gravitation which states that every massive particle in the universe attracts every other massive particle with a force, which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. In this case, the mass corresponds to the volume of air service and the distance corresponds to travel time. This formulation has been used widely and successfully in travel demand modeling, adjusting the exponent to match empirical data, rather than the physical law that sets the exponent to equal 2.0.

To calibrate this model, the share of each of the 55 counties' air trips traveling to each airport was calculated using the RASDS data. For each county the highway travel times were estimated from the estimated air travel centroid of each county to each of the ten airports.[6] The ability to draw passengers to each airport was based on the number of total passengers that used the airport in 2005, the year RASDS survey was taken. The number of passengers served at each airport in 2005 was used as a surrogate for the attractive power of the airport, proportional to the number of seats available for travelers to choose from to represent the range of destinations and frequency of choices.

The central task in calibrating the models is to determine the value of the exponent for the travel times that best fits the data. The larger the exponent, the less willing an air traveler is to travel longer distances to an airport when a shorter ground trip is available, all else being equal. Of course, not everything is always equal; the choice of which airport to use depends on the range of flights available, both in the number of destinations and the frequency of service to those destinations. It also could depend on the relative fare levels for individual flights, which could not be taken into account here.

Because the choices for using each airport in the region for domestic and international trips differ – there were few international flights from other than the three major airports in 2005 – two separate models were calibrated, domestic and international.

The domestic model produced an exponent of 2.8 and the international model produced an exponent of 1.8. The lower exponent for international travel indicates a greater willingness to travel farther to reach a far away airport for these trips. A more detailed discussion of the calibration process is presented in Appendix C.

Application of Accessibility Model

The accessibility model was applied to determine the proportion of the projected unconstrained volume of passengers that would shift to each of the outlying airports, if these airports had ports would increase the ability of the regional airport system to accommodate more air passengers, and thus reduce the economic impact of the passengers lost to the region.

To perform the airport shift analysis for each outlying airport, it was necessary to first postulate a level of air passenger service at the outlying airport, and then to determine if that level of passengers was likely to be reached by a combination of natural growth over the current passenger levels, shifts from the major airports and any added passengers. For future years, the distribution of trips generated in each county was adjusted to account for differential population and job growth using the methodology developed in the RASDS study. For the projected years, it was also necessary to make assumptions about the future travel times to the major airports. To account of the greater difficulty of reaching the three major airports they were each given a time penalty of ten minutes when testing the shift to the outlying airports.

Additional (additive factors) passenger growth at the outlying airports might come:

- From areas beyond the 55-county region that might send passengers from other airports outside the region, e.g. Albany, Philadelphia, Hartford.
- From passengers that would not have made the trip at all i.e. inducement to make the trip to an outlying airport if special services were offered that were not available at the three major airports, such as low cost trips or package deals to tourist locations, in and out of the region;
- From added connecting passengers that could materialize if the choice of destinations at the outlying airport grew.
- From the introduction of international service at airports that currently do not offer it.

The analysis requires that the estimated future air-passenger level be built-up from the sum of a) the existing passengers, b) the shift from the three major airports, and c) the additive factors – passengers from outside the region, induced travel, connecting passengers, and international passengers. If the resulting air passenger levels are not consistent with the initial assumption, the process can be iterated until the two estimates converge. The process is explained through an example in Appendix C. The detailed results for each airport for each year is also shown in the Appendix, with the contributions from diversions and of the additive factors delineated separately.

Table 6.6 shows the summary results of the passenger shifts when the model is applied to all of the outlying airports. A number of features of this table require some explanation.

Westchester County Airport (HPN) was subject to a separate analysis because its volume is capped at 2.24 million passengers, a result of limitations placed on it by agreement with the surrounding communities in Purchase, NY, and Greenwich, CT. In 2009, 1.93 million passengers used the airport, and if it were unconstrained, the airports volume would grow well beyond that. Instead, the cap means that, rather than act as a possible reliever to the three major airports, it is more likely to send additional passengers to them. It is projected that the overflow at HPN would reach 72,000, 458,000 and 844,000 passengers a year at the time when the three major airports reached the combined unconstrained demand of 115 MAP, 130 MAP, and 150 MAP. The accessibility model was used to estimate how it would affect other airports in the region. It estimated that by the time the 150 MAP was reached, JFK would receive about

[6] The travel times were computed as the average of off-peak and peak times, from Google's wayfinding program.

245,000 added passengers per year, LGA 382,000 and EWR 183,000. About 35,000 would shift to SWF, assuming the 3.3 million passenger level at SWF by the time the other airports have an unconstrained demand level of 150 MAP. The offsetting overflow *to* the three major airports therefore must be subtracted from the shifts *from* the major airports to the outlying ones, as is done in Table 6.6.

Table 6.6 sums up the net shift from the three major airports to all the outlying airports. However, not all of these airports are likely to be in a position to receive added passengers. The three in central New Jersey – Monmouth, Mercer, and Princeton – do not have air carrier service today. Only Monmouth appears to attract sizable volumes. Therefore, Mercer and Princeton are removed from consideration as reliever airports. New Haven – Tweed Airport, while attracting sizable numbers of passengers from the majors, does not have the ability to provide the necessary level of service given its runway length constraints and the surrounding residential land uses that prevent expansion. This suggests that it not be counted on to shift passengers from the three major airports. It too was removed from consideration. The "Revised Total" excludes Mercer, Princeton and New Haven airports.

Not all of the passengers in the revised total are likely to shift to the outlying airports. These shifts may not occur for a number of reasons.

- The airlines may not drop flights, but rather choose to use a smaller aircraft, thereby not freeing up runway capacity.
- The flights that the airlines might choose to drop could be during off-peak hours, thereby not freeing up capacity at the three major airports when it was most needed.
- The outlying airports (and the airlines that serve them) are more likely to start with service to larger markets, where they can gain a toehold in capturing the regional total air traffic. The estimated shifts would therefore not be felt across the board, especially for the smaller markets at the three airports.

To illustrate this last point consider two examples. In the first, using the 7.98 percent shift shown in Table 6.6 that might occur at EWR at the 150 MAP level, suppose there is a relatively small market which operates with three 80-seat aircraft, typically with an 80 percent load factor, which calculates to 192 passengers. If 7.98 percent shift to an outlying airport – or 15 fewer passengers, 17 out of the remaining 177 passengers would not be served if the airline dropped to only two flights with only 160 seats. The airline might over time look to use an aircraft that had fewer seats rather than dropping a flight and losing customers.

In contrast, consider the example of a market with ten flights with the same 80 seats each and the same 80 percent load factor. The 640 passengers would drop by 7.98 percent, or 51 passengers, to 589 people. In this case, either eight or nine flights could handle that load, averaging 74 or 65 passengers, respectively. It should be expected that the impact of outlying airports on aircraft operations at the three major airports would be less than the across-the-board percentages estimated here. These impacts should be considered the maximum possible estimates if the airlines dropped flights in the peak in proportion to the loss of passengers, rather than most likely ones. Table 6.7 shows the maximum peak hour capacity freed up if all these potential flights were eliminated. Since the Monmouth County airport is more uncertain, without scheduled passenger air service today, the estimates are shown with and with that airport. With just SWF and ISP, the capacity freed up at each of the airports would be only about one flight per hour at 115 MAP, growing to two at 150 MAP. Not surprisingly, the addition of Monmouth County airport would have the greatest impact at EWR, with six flights per peak hour freed up there compared to fewer than three per hour at JFK and LGA at the 150 MAP level.

Since the airlines operate in a free market environment, they may react by not reducing their flights in the peak to this extent, or even at all. Therefore, the effect on peak-period aircraft operations could be quite small without regulatory intervention. The most likely result is that there will be a mix of reductions in the number of flights and downsizing of aircraft.

These shifts might be increased if transportation access to the outlying airports were to be improved. In the chapter on ground access (11), we consider the prospects for improved access to SWF and ISP to shift air passenger traffic from the major airports.

Table 6.6

Annual Passengers Attracted from the Major Airports to the Outlying Airport at Three Projected Unconstrained Demand Levels (000's)

	Airport	JFK	EWR	LGA	Total
115 MAP	**SWF**	121	228	166	515
	ISP	286	84	275	645
	Monmouth	180	1,018	195	1,393
	NHV	127	102	172	363
	Mercer	26	195	28	249
	BDL	16	18	21	56
	Princeton	13	93	14	120
	ABE	15	52	17	84
	ACY	11	39	12	62
	HPN	-20	-17	-33	-70
	TOTAL	775	1,812	867	3,417
	Revised Total	609	1,422	653	2,685
	Revised Total % of Domestic Traffic	2.34	5.69	2.51	3.49
130 MAP	**SWF**	177	322	241	741
	ISP	487	140	468	1,096
	Monmouth	220	1,217	239	1,676
	NHV	149	118	202	468
	Mercer	39	280	42	360
	BDL	30	33	38	101
	Princeton	16	115	18	151
	ABE	20	70	24	114
	ACY	15	54	16	85
	HPN	-133	-94	-219	-447
	TOTAL	1,020	2,255	1,069	4,345
	Revised Total	816	1,742	807	3,366
	Revised Total % of Domestic Traffic	2.78	6.33	2.75	3.91
150 MAP	**SWF**	301	564	384	1,248
	ISP	638	190	578	1,407
	Monmouth	278	1,606	284	2,168
	NHV	182	152	231	565
	Mercer	53	399	55	507
	BDL	58	88	75	195
	Princeton	20	148	21	189
	ABE	28	105	32	165
	ACY	19	72	20	111
	HPN	-245	-183	-382	-824
	TOTAL	1,332	3,141	1,298	5,731
	Revised Total	1,077	2,442	991	4,470
	Revised Total % of Domestic Traffic	3.31	7.98	3.05	4.68

Source: Regional Plan Association

Capacity in Peak Hour Freed Up by Shift to Outlying Airports

Without Monmouth	JFK	EWR	LGA	System
115 MAP (2015-2021)	1.2	1.1	1.1	3.4
130 MAP (2021-2034)	1.6	1.3	1.5	4.4
150 MAP (2030-2042+)	2.2	2.0	1.8	6.0
With Monmouth	**JFK**	**EWR**	**LGA**	**System**
115 MAP (2015-2021)	1.7	3.7	1.6	7.0
130 MAP (2021-2034)	2.2	4.4	2.1	8.7
150 MAP (2030-2042+)	2.9	5.8	2.5	11.3

Source: Regional Plan Association

The shifts in the domestic air passengers using the three major airports assume that the impact on aircraft operations would be felt proportionally across all times of day. Flight reductions might occur in the less popular off-peak periods as passenger levels fall at three major airports. Should this be the case, with less impact in the peak, these shifts could be overstated.

The estimated shifts were only calculated for domestic trips. Currently, the airports tested have little or no international traffic. Moreover, the nature of international trips at these outlying airports is likely to be more specifically attuned to special marketing and arrangements – whether shopping excursions at SWF or future casino packages at ISP should Long Island become the site of casino development. These packages could have the impact of lowering fares at these outlying airports, making them more attractive not only to induced new travel, but to those now using the three major airports. If this were to happen, it could further drive up the air passenger volumes at these airports. These situations may not lend themselves to analysis using a model calibrated for the more usual variety of air travel.

Conditions at Outlying Airports
That Could Provide Relief

This section discusses the characteristics of three outlying airports that could free up capacity at the major airports. The features that could inhibit this potential are discussed. However, none of these three airports is seen as a "fourth" airport in the sense that it can attract the levels of use achieved at the major airports.

Stewart International Airport (SWF)

This airport is located in the municipalities of New Windsor and Newburgh in Orange County, NY. Average travel time from mid-Manhattan by motor vehicle is 93 minutes[7]. It has a footprint of 2,139 acres, about the same size as EWR. The airport has one runway (9/27) of 11,817 feet and a second one (16/34) of less than 7,000 feet. Stewart is owned by the State of New York and leased to the Port Authority for 99 years.

Currently, three airlines serve seven destinations with 25 daily departures. In 2009 the airport handled 390,000 passengers down from a high of 914,000 in 2007, a result of the economic downturn and subsequent abandonment of a number of lower cost carriers.

[7] As indicated earlier, times are based on Google's wayfinding program, averaging peak and off peak times.

SWF has several deficiencies: one runway that is less than 7,000 feet, an inefficient terminal, airfield obstructions (the two hills) that reduce the efficiency of operations, and an insufficient taxiway system to support a large number of commercial operations. These deficiencies should not stand in the way of handling the volume of passengers that can be expected of it in the next 20 years or so. The Port Authority is investing $150 million dollars between 2011 and 2020 to address some of these shortfalls, with much of this spending marked for airside improvements (new taxiways, rehabilitation of runways, etc.). In addition, the agency is formulating a redevelopment plan that will advance airport improvements required to meet increases in passenger demand currently estimated to be $350 million dollars. The capital plan will include improvements to the existing terminal and the eventual replacement of the facility.

Interest in expanding the use of the airport has been strong in the Hudson Valley, particularly in the business community. However, this interest is tempered by the concerns of many residents, who would like to see it as a local resource and not as an alternative for travelers throughout the greater region.

The airport is also constrained by its hilly topography and the protected land surrounding it, which makes expansion beyond the two million passenger very complex and subject to extensive environmental reviews. This would likely be a protracted process requiring extensive mitigation actions, further adding to the cost of the project.

There has also been a great deal of interest in making SWF more accessible by transit from Manhattan to encourage greater use of the airport. A joint study by the Port Authority and the Metropolitan Transportation Authority is underway. It has posited five alternatives, including direct rail access, a busway / rail combination and a bus shuttle to the existing Metro North Hudson line at Beacon. This effort will be detailed in Chapter 11, which will discuss ground access issues.

MacArthur Airport (ISP)

MacArthur Airport (ISP) is located 72 minutes from Manhattan in the Town of Islip in Suffolk County. The airport has a 1,310-acre footprint, two-thirds the size of EWR, and about double the size of LGA. ISP has four runways; the longest is barely 7,000 feet.

Currently, two airlines operate out of ISP with almost 30 departures a day to nine domestic destinations. In 2009 the passenger volumes totaled 1.9 million.

Existing runways are too short for larger commercial aircraft; only one out of its four runways is capable of serving commercial traffic. The size of the site and its shape make extension difficult, which would likely require acquiring surrounding parcels, possibly both residential and commercial. Local municipal ownership of the airport and community concerns might also limit expansion opportunities.

Noise, increased air traffic, and property takings would likely make substantial expansion problematic.

Since the Long Island Rail Road is only 1 ½ miles away, there are possible transit access opportunities. They will also be discussed in greater detail in Chapter 11.

Even after weighing the local political hurdles, further study of MacArthur to serve as a major reliever for JFK and LGA is still recommended. The study would need to determine whether relocating the terminal, creating a direct connection to the LIRR and expansion of select runways are feasible and what the associated costs would be.

Monmouth County Executive Airport (BLM)

This airport straddles the towns of Belmar and Farmingdale in Monmouth, County, NJ, 81 minutes driving time from Manhattan. Its 850 acres, slightly bigger than LGA, supports three runways, the longest at 7,300 feet.

This privately operated airport serves the general aviation community with 57,000 operations per year (2007). Currently there is no commercial passenger traffic at Monmouth and its landside and airside facilities are designed to accommodate only general aviation traffic, a shortcoming which would have to be addressed, if it is to serve as a reliever airport. Considerable infrastructure investments will be needed to upgrade the physical plant to accommodate larger commercial aircraft (weight and dimensions) and the greater number of air passengers (larger terminal, baggage handling and gates).

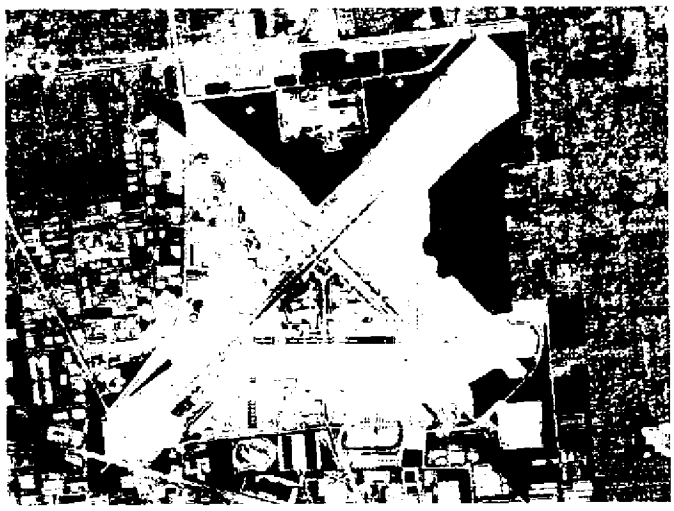
Complicating the development of BLM is the likely resistance by local and county government to increased air traffic, which is a common community reaction to airport expansion or conversion of a facility from GA to commercial passenger operations.

Summary

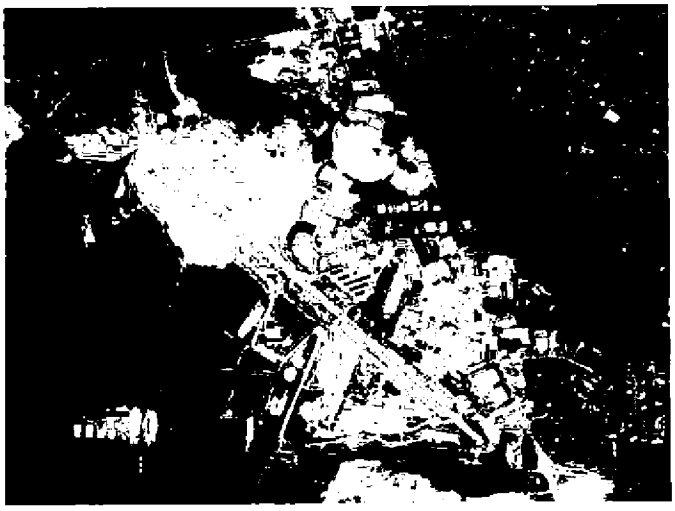
Three of the outlying airports – Stewart, MacArthur and Monmouth County airports -- can open up some capacity at the three major airports, but the findings here suggest that they will be a complementary, not primary actions to address the capacity needs at the three airports. Rather, each can offer expanded service in its sector of the region, expanding flying opportunities, mostly for residents within easy reach. Monmouth County airport would require significant investment to initiate air carrier service now absent. This step should be considered if other actions to relieve EWR leave that airport short of serving its projected need.

Stewart International Airport

MacArthur Airport (ISP)

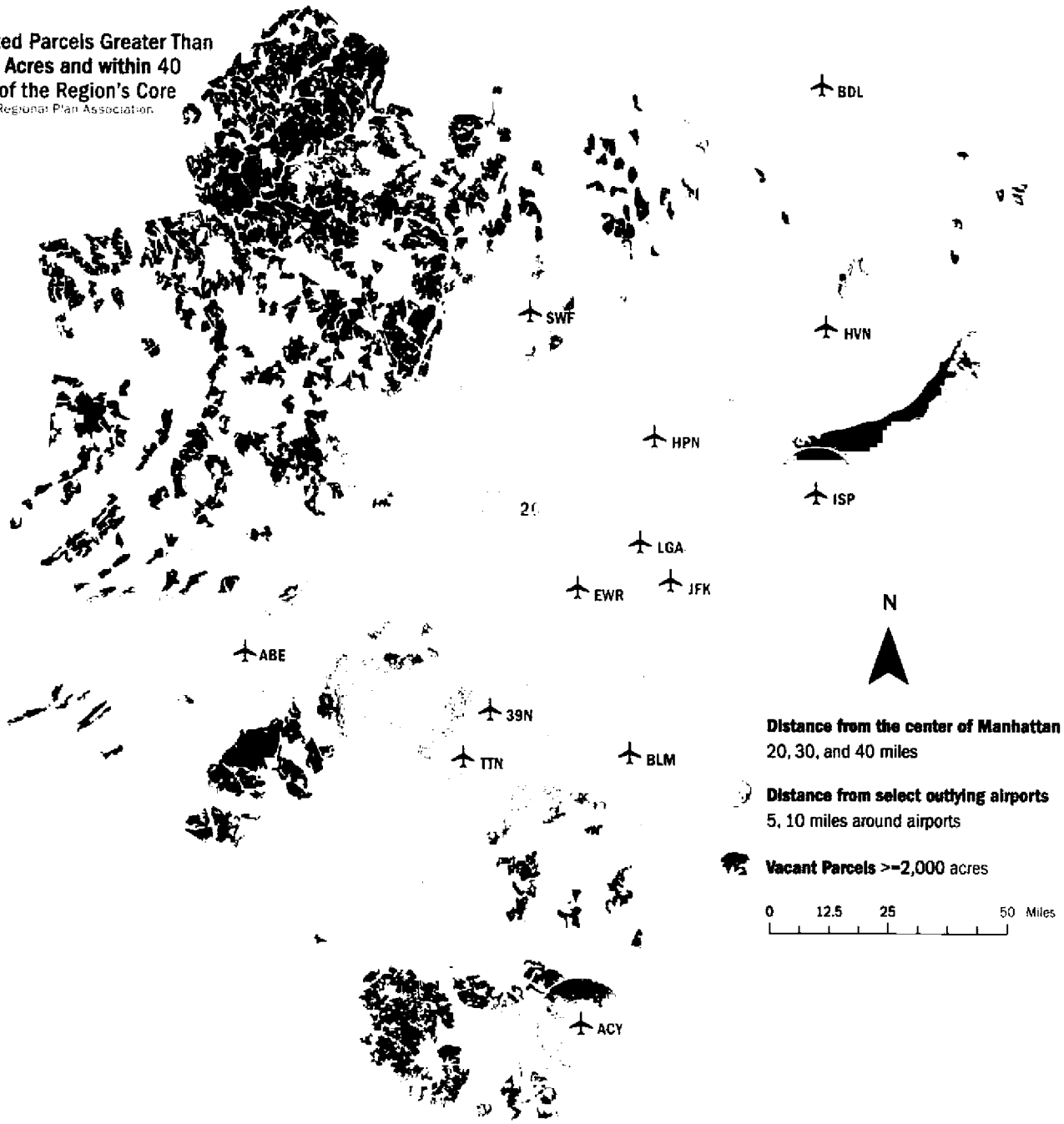


Monmouth County Executive Airport (BLM)



Selected Parcels Greater Than 2,000 Acres and within 40 Miles of the Region's Core

Source: Regional Plan Association



Can a New Major Airport Be Built?

For over the past sixty years, there has been discussion about finding a site for a major airport in the tri-state region that could provide a comparable amount of service as the existing three major Port Authority airports. The argument supporting the development of a new airport has always been that at some point the existing airports will run out of capacity and that a "fourth" airport was inevitable. This chapter briefly reviews that history and then scours the region to determine if there remains a site or sites that could meet that long sought objective.

In the 1950s the Port Authority proposed the "Great Swamp" in Morris County as the preferred location for a new major airport. The area is only 26 miles from the region's core. Strong community and environmental opposition to these plans eventually forced the Port Authority to abandon the development of a new airport on this site, and the area is now protected as parkland. Regional Plan Association (RPA) had opposed turning the site into an airport, arguing that many actions could be taken to forestall the need well into the future.[1] Other sites were discussed by the Port Authority from time to time, but no action was ever taken.

In the early 1970s, the State of New York acquired Stewart Air Force Base in Orange County. New York State made the case that Stewart was the answer to the fourth airport search. RPA issued a follow-up report to the first, making many of the same arguments of the earlier report.[2] The severe financial crisis in New York then intervened, dampening airport passenger growth substantially. Rising fuel prices and the first oil embargo in 1973 also affected the aviation industry. Interest in Stewart as a major airport faded.

The City of New York briefly considered the concept of an offshore airfield south of Long Island, but that too came to naught.

During the long period from the 1970s into the 1990s, many changes took place in the aviation industry and at the airports that forestalled the need for a fourth airport. These included:

- slower than projected growth in air travel;
- the pricing out of most general aviation aircraft at the major airports, with much of it shifting to Teterboro, opening up capacity for air passengers;
- the advent of the Metroliner,[3] and later Acela, in the Northeast Corridor that made reaching Washington, D.C., and Boston by intercity rail more practical, drawing many air passengers; and
- larger aircraft that served the growth in air passengers with fewer aircraft movements.

Now, with air passenger volumes more than double their 1970s levels, and with these other remedies threatening to run their course[4], a look for a new site or the expansion of an existing site like Stewart, must be considered. Toward that end, in 2007, the Port Authority acquired an operating lease at Stewart, and has begun to invest in it.

This chapter explores three different approaches in a search for a possible major airport:

- Locate a "greenfield" site to construct a new airport;
- Expansion of an outlying airport; or the
- Construction of an airport island offshore on reclaimed land.

The Greenfield Analysis: Building a New Airport

RPA completed a land use analysis to indentify undeveloped and unprotected parcels in the 31-county RPA-designated tri-state region that might be suitable for the development of a new major airport. Land coverage data was collected and analyzed using geographical information systems (GIS). Aerial imagery was used to indentify basic land use topologies – urban, agricultural, vacant land and parks. Several steps were then taken to further refine the dataset; details of this process are covered in Appendix D. Protected land data (state and federal reserves) was then overlaid with the coverage data to filter out all parcels protected land.

The land area required for a major new airport is significant. Other major airports in the nation vary from 3,500 acres to ten times that – Denver International at 34,000 acres. A major airport would require at least 2,000 acres (the size of Newark Liberty) and ideally about 2,500 acres (approximating a rectangle of 14,000 by 6,500 feet) to accommodate two 11,000-foot runways.

Figure 7.1 displays the unprotected undeveloped parcels in the region that are at least 2,000 acres of contiguous land. Many of these sites, especially the larger ones, are located at a considerable distance from the core of the region, where the vast majority of today's air travelers start or end their trip.

1 The Region's Airports -- Regional Plan News #89 – Regional Plan Association - July 1969

2 The Region's Airports Revisited – The Regional Plan News #93 – Regional Plan Association - October 1973

3 The Metroliner began service on January 16, 1968 - http://www.fra.dot.gov/rpd/passenger/643.shtml

4 Another reversal occurred during the 1990's when larger aircraft were swapped out for smaller regional jets.

As shown in Table 7.1, most of the major airports in the nation are on average 15 miles "as the crow flies" and 20 miles driving distance from their corresponding central business districts (CBD). The furthest airport is Dulles International, which is 27 miles from downtown Washington D.C., with a travel time of 30 to 45 minutes. There are international examples of airports that are between 30 to 40 miles from their CBDs, but in these cases high-speed transit connections (mostly rail) have been developed to offset the increased distances, resulting in travel times within 30 to 50 minutes[5].

Based on these comparable examples, distance from the CBD was introduced as the final criterion, eliminating sites over 40 miles "as a crow flies" from the core. Figure 7.1 displays the potential development sites that are over 2,000 acres and within 30 to 40 miles of the core.

There were two clusters of undeveloped land within these bands, one in Orange County in New York and the other in Hunterdon, Somerset and Morris Counties in New Jersey. The New York cluster had three large undeveloped parcels, and in New Jersey there were two, all over 2,000 acres in size. For each parcel detailed maps were generated, overlaying roadways, water features, land coverage data, topographic and other data that might indicate potential obstructions to the development of an airport. Aerial photography was also referenced to verify accuracy of the land coverage data. A template of the proposed airport footprint was then overlaid to determine whether the shape of the parcel was adequate to accommodate the new airport. Additionally, orientation of the airport footprint was critical to accommodate the constraints of the New York region's airspace, which requires either 4/22s or 8/26s runway orientations, i.e. 40 and 220 degrees or 80 and 260 degrees from north.

This essentially dictated a site of 16,000 feet running north to south and 6,500 feet east to west. Each parcel was examined for obstructions and the ability to accommodate the aforementioned dimensions, the analysis of each site in New York and New Jersey follows.

In New York State, two out of the three parcels (2,279 acres and 2,149 acres) were eliminated because of their proximity to Stewart International Airport; both are within 10 miles of the airport, which is the ideal minimum airspace separation distance required between commercial airports. Both parcels also do not have sufficient space to accommodate dimensions of the new airport and require the taking of almost a hundred residences. The third parcel (4,751 acres), bordered by Warwick, Greenwood Lake and Sterling Forest has steep grades that make it ill suited for airport development. Additionally, the valleys in this parcel contain residential developments that would also need to be removed. None of the sites in New York State are candidates for airport development.

In New Jersey, the Somerset County parcel (2,232 acres) extends into the municipalities of Bernardsville and Gladstone. It does not have enough space to accommodate a major airport. The second parcel straddling Morris, Hunterdon and Somerset Counties and over 10,000 acres, is oddly shaped with some sections unable to support even a 9,000 feet runway. To fit the necessary dimensions would involve considerable taking of private property, both residential and commercial, and intrusion into protected lands (the Highlands) that border the parcel. The takings required and other environmental and regulatory hurdles would make the development of an airport here impractical.

5 Transportation Research Board, ACRP – Report 4, Ground Access to Major Airports by Public Transportation, 2008.

Expanding an Outlying Airport

Another approach to developing a new major airport would be to expand one of the 66 existing aviation facilities[6] located in the region. Building off the Chapter 6 and earlier Greenfield analyses, outlying airports of over 2,000 acres were selected as possible candidates for expansion. Table 7.2 identifies the four outlying airports in the region that met this criterion for expansion – Atlantic City International, Calverton Executive, Stewart International and Lehigh Valley International.

Three out of four of the airports are existing commercial aviation facilities. Calverton Executive is the only general aviation (GA) facility; it was a Naval Aviation test facility and currently has little air traffic. Atlantic City and Lehigh Valley are at a substantial distance from the region's core, where the majority of air travel originates. Both of these airports currently serve the fringe areas of the region and other air markets (Philadelphia). Chapter 6 discussed the ability of these airports to shift travel from the existing major airports, and found them limiting, largely because of their distance from the core. The chapter detailed the Port Authority's operating role and plans to invest in Stewart International Airport. Expansion of this airport is complicated by its rugged topography, which makes any plans to add runway capacity very expensive. This, along with its considerable distance from the core and community opposition to major airport expansion, makes Stewart an unlikely candidate for expansion of this magnitude. This does not prevent Stewart from being a major regional airport to serve the Hudson Valley and special services that may materialize, as discussed in Chapter 6.

The last of these four outlying airports, Calverton Executive, would require a large investment since it is currently a general aviation facility that would need to be converted to serve the needs of commercial air traffic. However, the site does have a considerable amount of available land for redevelopment. Calverton is almost 3,000 acres, with most of the surrounding land use characterized as agricultural, recreational and residential sprawl. Additionally, the airport sits only 2,000 feet (at its closest point, the edge of runway 32) from Long Island Railroad's Ronkonkoma branch. Currently, the travel time to Riverhead (the station closest to the airport) from Midtown Manhattan is on average 2 hours, which is excessive. A high-speed rail alternative would need to be developed to bring this travel time closer to 30-40 minutes.

Calverton and its neighbor, MacArthur Airport, an existing commercial passenger facility, are less than 20 miles apart, meaning that their airspace would overlap, resulting in a reduction in airport capacity. NextGen might alleviate some of these conflicts, but it's unlikely to mitigate them all.

While Calverton's size and proximity to transit are advantages, its distance from the CDB and MacArthur Airport make it a less than ideal site for expansion. In 1967 Governor Nelson Rockefeller endorsed making Calverton the "fourth" airport, as an alternative to the "Great Swamp" site in Morris County, NJ. This proposal was rejected by the Port Authority because of airspace conflicts and the distance of the airport from Manhattan.

Out of the four outlying airports examined in this analysis only Calverton came close to meeting the requirements for expansion. The three other airports are either too far away from the region's core or have physical site and community constraints that would limit their ability to expand to accommodate tens of millions of passengers annually.

6 Seven commercial passenger and 59 general aviation

Select National Airport Comparatives

Airport	Acreage	Distance from the Central Business District (in miles) "As the Bird Flies"	Shortest Driving	Average Travel Time (in minutes) Free Flow	In Traffic	Rail Access & Travel Time to CBD (in minutes) Served?	Travel Time
Atlanta Hartsfield	3,750	8	11	18	–	Yes	30
San Francisco	5,270	11	13	19	25	Yes	52
Chicago O'Hare	7,000	14	20	30	40	Yes	75
Los Angeles	3,500	14	19	22	45	No	--
Dallas-Fort Worth	18,076	16	23	27	60	No	--
Denver	34,000	17	24	34	–	No	--
Dulles	12,000	22	27	31	45	No	--
Averages:	11,942	15	20	26	43		52

Source: Regional Plan Association and Various Airport Operators

TABLE 7.2

Selected Outlying Airports for Expansion

Airport Name	Airport Code	County, State	Land Area (Acres)	Max Rwy Length (Feet)	Driving Distance from CBD (miles)	Commercial Airports within 10 miles
Atlantic City International Airport	ACY	Atlantic, NJ	5,000	10,000	125	No
Calverton Executive	3C8	Suffolk (L.I.), NY	2,921	10,001	70	Yes
Stewart International Airport	SWF	Orange, NY	2,100	11,818	66	No
Lehigh Valley International Airport	ABE	Lehigh, PA	2,629	7,600	91	No

Source: Regional Plan Association and Various Airport Operators

Constructing an Airport Island

The concept of an airport island has been studied for decades in the New York region. In 1969 RPA raised the possibility of constructing an airport island in two locations – the lower bay adjacent to Staten Island or the open ocean four miles off the coast of Long Beach. The report noted several benefits of airport islands over inland sites, which have been "fleshed-out" further during the course of this study:

- Elimination or reduction of community noise impacts caused by aircraft departures and landings, possibly allowing for 24/7 operations;
- Remote location of airport, away from populated areas, creates a safer operating environment;
- Lack of obstructions allows for more flexibility in flight paths; and
- The almost limitless ability to expand the site by reclaiming additional land.

However, the two sites selected in 1969 had several drawbacks and would entail significant investments beyond the construction of the island itself. Each site would require the construction of an extensive new high-speed rail tunnel and/or surface roadway to connect the airport island to the mainland (New York City and/or New Jersey). It's questionable whether it would be practical to provide roadway access or construct a rail tunnel because the significant distances that would need to be spanned, roughly four to eight miles from the mainland,[7] and the nature of the open ocean, which would likely preclude the operation of automobile traffic on a causeway under certain weather conditions. Both sites would also require the closing of one or more of the existing major airports because of airspace conflicts. The lower bay site would impact EWR and LGA and the Atlantic site would extensively curtail operations at JFK. Aside from the higher costs of constructing these islands, the costs of abandoning the existing airports and the billions of dollars of capital invested over the past decades must also be taken into consideration.

Since 1969, the idea of an airport island has gone from a concept to reality, not in the New York region or the Untied States, but in several countries in Asia. As shown in Table 7.3, Japan, Hong Kong and South Korea have all constructed major international airports by reclaiming land. Hong Kong and South Korea filled in the water channel between two existing islands, a larger scale version of what Robert Moses did at Randalls and Wards islands in the 1930's, to create sites for their new airports. Hong Kong International airport occupies the entire landmass and can be dubbed an airport island, while Incheon International Airport in South Korea only occupies the space between the two existing populated islands. Kansai airport in Japan is entirely fill, which has resulted in a less than stable island that is still settling at rate of 2.8 inches a year. All three of these projects were extremely expensive, $20 billion U.S. dollars or more, and required new high-speed transit connections to their respective metropolitan areas.

The scarcity of land, encroachment of residential development and topographic constraints made expanding existing airports or finding a suitable site for a new airport in these countries extremely difficult, which in turn forced them to make these expensive investments. As shown in the prior analyses to locate a greenfield site for a new airport and expand outlying airports, the New York region also faces similar constraints. However, regulatory requirements, environmental impacts and higher construction costs would make developing an airport island in our region even more difficult today than in the past. While the feasibility of such a facility is questionable, popular interest in an airport island still has not waned. In 2009 the New York Times Magazine invited Grimshaw Architects, a New York based architectural firm to develop a sketch concept for an airport island for its issue devoted to *"American's Future Investment in Infrastructure."*[8] Grimshaw's concept places the island in the lower bay off the coast of Staten Island, one of the two sites indentified in RPA's earlier study. Figure 7.2 is a rendering of the

7 As a comparative, the Verrazano Narrows Bridge spans almost one mile and the Tappan Zee Bridge is three miles, which includes its approaches and main span.

8 http://www.nytimes.com/2009/06/14/magazine/14searchgrimshawside.html?ref=magazine

Examples of Airport Islands

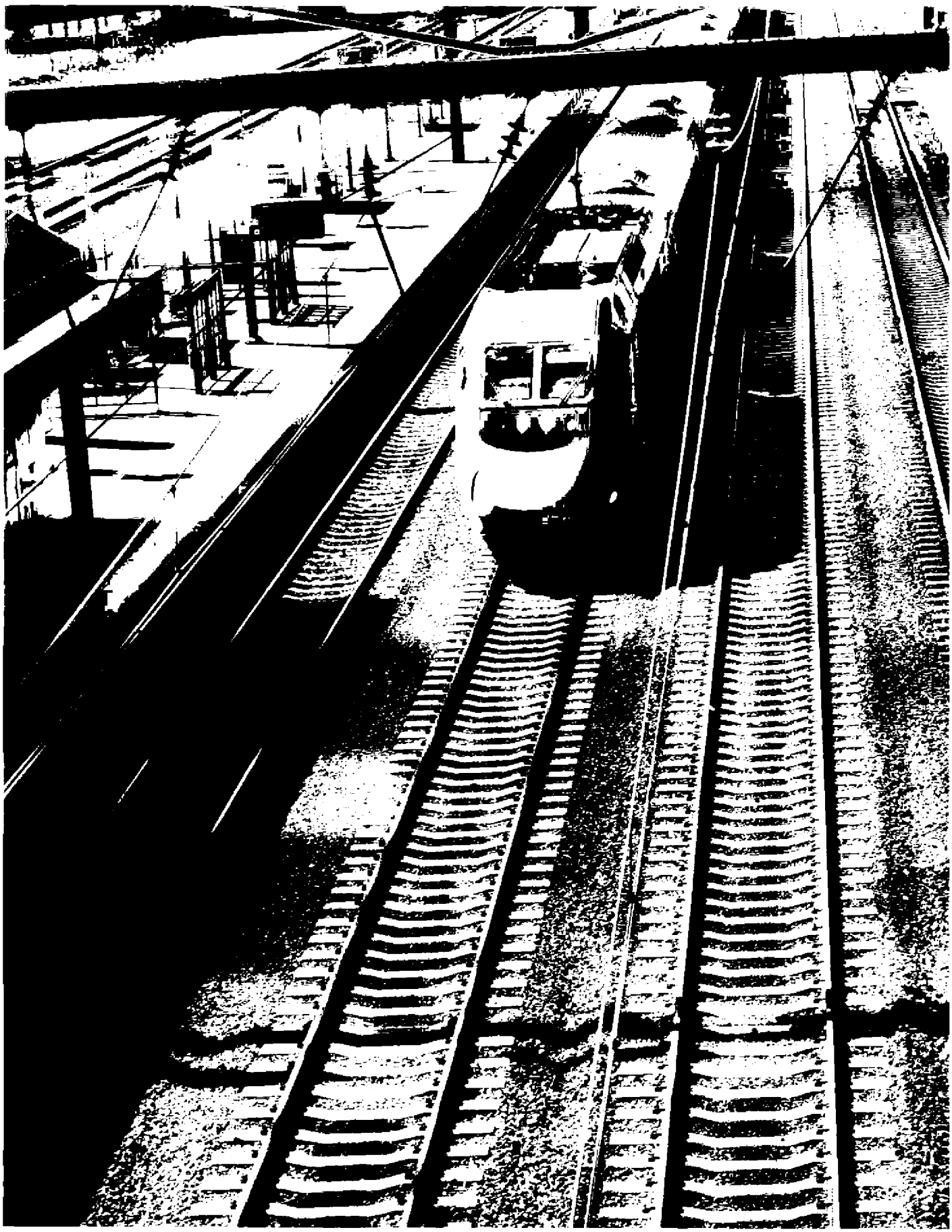
Airport Name	City/Country	Acreage	Cost (billions)	Runways (planned)	Type
Hong Kong (Chek Lap Kok)	Hong Kong, China	3,083	20	2	Landfill between two existing islands
Kansai Airport	Osaka, Japan	2,606	+20	2	An artificial island, airport is sinking 2.8 inches annually
Incheon International Airport	Seoul, South Korea	12,000	—	3 (4)	Landfill between two existing islands

Source: Regional Plan Association and Various Airport Operators

concept, which is designed around a single terminal and envisions a high-speed rail connection to Hudson Yards in midtown Manhattan.

An airport island is the only viable way to develop a fourth major international airport within close proximity to the region's core, as our analysis confirmed that there are no suitable greenfield sites or outlying airports that can serve this role within 40 miles of the CBD. Yet, the exorbitant costs (in the tens of billions of dollars), including the abandonment of one or more of the existing airports, regulatory hurdles and excessive environmental impacts would make an investment of this nature extremely difficult to justify. Expansion of one or more of the existing airports would cost considerably less, would likely provide sufficient capacity and be less controversial, even though potential noise impacts would likely result in greater community ire than an island alternative.

Concept of Airport Island for the New York Region
Source: Concept Developed for the New York Times Magazine by Grimshaw Architects, 2009



The Intercity Rail Alternative to Air Travel

In this chapter the impact that intercity rail service could have on addressing the capacity shortfalls at the three major airports is explored. As with the shift of passengers to outlying airports discussed in Chapter 6, intercity rail service could do two important things. First, it could provide an option that expands the overall transportation capacity of the intercity transportation system, which would be beneficial to the region's economy. Second, it would free up airport capacity for air passengers for whom intercity rail is not a viable choice.

The prospects for greater use of rail for intercity travel have grown brighter with the creation of the federal High Speed and Intercity Passenger Rail (HSIPR) program, a sign that the federal government has a much greater interest nationally in new and upgraded intercity rail travel. The Obama administration made $8 billion available nationally for "high" speed rail travel in the American Recovery and Reinvestment Act and the Administration and Congress have made an additional $2.5 billion in FY10 available through a competitive grant process. However, the Northeast Corridor (NEC) was largely overlooked in this first round of intercity rail grants.

Potential Benefits of High Speed Rail

The potential impact on the three major airports is only one of several benefits that could be achieved through improvements in intercity rail service. While these other considerations are not the subject of this study, they are important for understanding the viability of rail improvements as part of a comprehensive, intermodal strategy for improving intercity mobility.

The primary rationale for improving rail speed and reliability is to improve connectivity between city centers. In many cases, fast, reliable rail service could provide considerable time savings and greater convenience and comfort than air, auto or bus service for a substantial proportion of intercity travelers. Regardless of its impact on air travel or other modes, improvements in rail service would yield time savings, increased productivity and greater economic growth. Particularly in a dense corridor such as the Northeast, rail provides a means of avoiding congested highways and air space, an advantage that will become even more pronounced as population growth increases congestion levels. With other regions in Europe and Asia, and potentially in the United States, investing heavily in high speed rail, similar investments in the Northeast are likely to be an important factor in maintaining the Northeast's economic competitiveness.

More than other modes of intercity travel, rail also encourages metropolitan settlement patterns associated with high productivity and energy efficiency. Because it largely connects city centers and provides an alternative to auto travel, rail service promotes downtown development, connecting transit service and greater urban density. These attributes are a major reason that the Northeast and similar regions have high GDP and low energy use per capita. Combined with other urban development strategies, intercity rail improvements can also facilitate urban revitalization in underperforming cities.

Analysis of Potential Passenger Mode Shifts

The Northeast Corridor, the most highly used rail line in the nation, is centered on New York. Amtrak provides rail service between New York and major cities in the corridor, including Boston, Providence, New Haven, Stamford, Newark, Trenton, Philadelphia, Wilmington, Baltimore and Washington, DC. Amtrak also has services to Albany and other upstate New York points, to Hartford, to Vermont and Montreal, to Harrisburg and Pittsburgh, and to Richmond, Raleigh and Norfolk in Virginia. Currently, some of these destinations attract significant numbers of travelers who might otherwise travel by air. Today, about half of the combined markets between New York and the five Northeast Corridor (NEC) cities – Boston, Providence, Philadelphia, Baltimore, and Washington, DC, – choose rail.

In this chapter, the impact of improvements in intercity rail serving the New York markets is examined to see how it affects travel by air at the three major New York airports. The number of air passengers who would likely shift to rail is estimated. Using this estimate, the number of peak hour flights that might be obviated is determined. The absence of these flights would free up capacity at the three airports for the other flights to accommodate the expected growth in air travel.

To accomplish these tasks a statistical model was calibrated to estimate the number of air passengers who might shift to rail if faster and more frequent rail service was made available. This model is based on data of current rail and air use between New York and all cities within 500 miles and that have existing rail service to New York. Both the rail and air data sets are station-to-station (or airport-to-airport), and do not provide information of the specific origin or destination within the metropolitan areas for each end of the trip. More refined trip data would have made it possible to create a more nuanced demand model. However, these data either do not exist or are not available from the carriers. Reliable intercity automobile travel data is unavailable. If it were, the interplay among the three modes and their shares would have been of great interest. The lack of auto data has long been a handicap to intercity travel modelers, and its continued absence prevents credible estimates from

Share of Departing Flights With and Without Rail Service - Three Major Airports - 2008

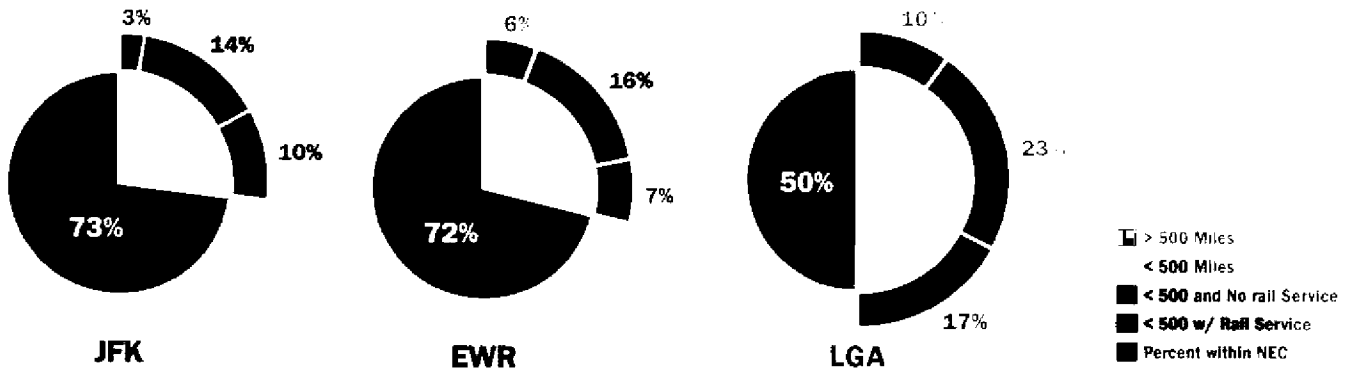


TABLE 8.1

Departing Flights by Distance from Major New York Airports

	# of Cities	JFK	EWR	LGA	Total
TOTAL	226	641	610	543	1,794
Beyond 500 Miles	195	487	439	272	1,178
Within 500 Miles	31	174	171	271	616
With Rail Service	21	153	135	219	507
With NEC Rail Service	5	58	37	92	188
With Other Rail Service	16	94	98	127	[illegible]
Without Rail Service	10	21	36	52	109

Source: Port Authority

TABLE [illegible]

Daily Departing Air and Rail Passengers - 2008

	# of Cities	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	226	145,200	13,200	158,400	91.7	[illegible]
Beyond 500 Miles	195	119,400	2,400	121,800	[illegible]	2.0
Within 500 Miles	31	25,800	10,800	36,600	70.5	29.5
With Rail Service	21	22,400	10,800	33,200	67.5	32.5
With NEC Rail Service	5	8,400	9,200	17,600	47.7	52.3
With Other Rail Service	16	14,000	1,600	15,600	89.7	10.3
Without Rail Service	[illegible]	3,400	[illegible]	[illegible]	[illegible]	[illegible]

Source: Amtrak and Port Authority

being made of how well speedier rail service can attract auto travelers.[1] For the purposes here, the air versus rail model was adequate to estimate the shift from air to rail.

As shown in Table 8.1, in 2008 there were nearly 1,800 commercial passenger aircraft departures[2] each day from the three major New York metropolitan airports (610 EWR, 641 JFK, and 543 LGA). About one in three of these flights were to the 31 airports within 500 miles of New York. Of these 31 destinations, ten did not have rail service, making them non-candidates for a shift to rail. The 21 destinations with rail service totaled about 500 daily departures. However, only five of these destinations – Boston, Providence, Philadelphia, Baltimore and Washington, D.C. – with 188 daily departing flights have rail service in the Northeast Corridor, where higher travel speeds make them the strongest candidates for a shift to rail.

These data are depicted graphically in percentage terms by airport in Figure 8.1, which shows that only ten percent, seven percent, and 17 percent of the flights from JFK, EWR and LGA, respectively are departing to destinations with NEC rail service. Another 14 percent, 16 percent, and 23 percent are destined for places with other rail service.

Table 8.2 indicates that almost 160,000 people left the New York region by either air or rail on an average day in 2008. Of these, 145,200 flew and 13,200 used intercity rail. Of the air travelers, 119,400 were destined for places that were too distant – 500 miles or more – to make intercity rail a realistic option, leaving 25,800 travelers as possible candidates to switch from air to rail. However, of these, 3,400 were destined for places with no rail service, dropping the eligible total to 22,400 travelers to 21 destinations. For the destinations with a rail option and within 500 miles, 33 percent chose to travel by rail, but this share masks the fact that the rail share climbs to over 50 percent for the five destinations with Northeast Corridor service, yet is barely 10 percent for the 16 destinations with non-NEC service is the rail option.

The Modal Shift Model

To estimate the potential impact on aircraft movements from a shift of the eligible air passengers at the three major airports a two-step process was required. In the first step, a model was developed to estimate the number of passengers who would shift from air to rail. The second step, discussed in the next section of this chapter, converted the number of passengers shifted to peak hour aircraft departures that would be affected at each airport. The shift model was calibrated using data from 17 of the 21 cities within 500 miles of New York City. Four of the otherwise eligible cities were dropped from the analysis.

Lebanon/Hanover, NH, and Charlottesville, VA, were dropped because they have small markets (25 and 33 daily one-way air passengers respectively), making their modal shares a small and unreliable statistical sample.[3] Toronto and Montreal, two large Canadian cities, with a combined daily average of [illegible]6 flight departures and 3,000 one-way air passengers, were also excluded from the calibration since the long wait times at the rail border crossings significantly extended the trip times and distorted the model's estimates. However, these two markets were later used in the application of the model when estimating

1 The importance of better data for auto trips is due to auto travel's overwhelming share in the Northeast– 89 percent of travel is by auto, with the rest split evenly between air and rail (USDOT, BTS(2006).

2 The data analysis is initiated using only departure flights and will later be doubled to reflect traffic in both directions.

3 [illegible]

TABLE 8.2

Current Rail and Air Passenger Data Inputs

Destination	Average One-Way Daily Rail Passengers: Rail	Average One-Way Daily Rail Passengers: Air	Total One Way Market	Air Distance from NYC (in Miles)	Rail Trips as Percent of Rail and Air Trips, %
Albany	941	310	1,251	141	75
Baltimore	1,136	462	1,598	181	[illegible]
Boston	1,934	3,709	5,643	189	34
Buffalo	69	1,715	1,783	292	[illegible]
Burlington	8	915	923	265	1
Cleveland	8	1,106	1,113	414	[illegible]
Greensboro / HP	19	409	427	454	4
Hartford	105	244	349	110	30
Norfolk, N.N	44	665	709	290	6
Philadelphia	2,468	351	2,819	89	88
Pittsburgh	36	1,357	1,393	331	3
Providence	408	413	821	152	[illegible]
Raleigh	41	1,581	1,622	424	3
Richmond	70	829	899	287	[illegible]
Rochester	57	935	992	257	6
Syracuse	81	793	874	201	[illegible]
Washington	3,207	3,455	6,662	217	48

Source: Amtrak and FAA

passenger shifts. The 17 remaining markets have 19,200 air passenger departures and 10,600 rail passenger departures, with the combined rail share at 36 percent.

The modal shift equation[4] was developed to estimate the share of air and rail travel that can be expected based on changes in relative trip times and operating frequencies of the two modes. The data for the model are shown in Table 8.3. The primary inputs for the model were passenger volume and operating travel times and frequencies for air and rail.

The complexity of the air and rail fare options available to the traveler made it impractical to include relative fares in the model. The imprecision of the origin or destination of the trip, indicated earlier, made it necessary to use the travel times on either the train or the plane, rather than the "door-to-door" travel times.

The data used was obtained from a variety of sources:

- Average number of daily flights was obtained from Official Airline Guide (OAG): August Average Nonstop Daily Scheduled Passenger Departures 2008.
- Rail passenger volume by city pair was obtained from Amtrak based on the FY08 Ridership by Station Pair data set. Data was reported as annual passengers and were divided by 730 (365 days x two directions) to estimate average one-way daily volume.[5]
- Rail frequency and travel times were obtained from Amtrak schedules.
- Average air time was obtained from flightstats.com a site run by Conducive Technology Corp., a provider of worldwide flight on-time performance information to the global travel and transportation industries.

FIGURE 8.2

Rail Share as Function of Time Ratios

Source: Regional Plan Association

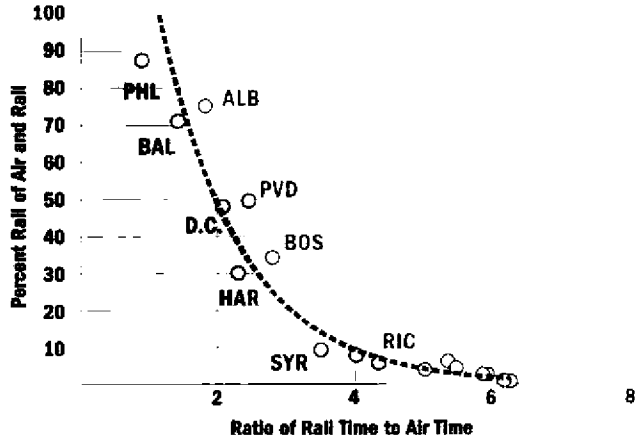
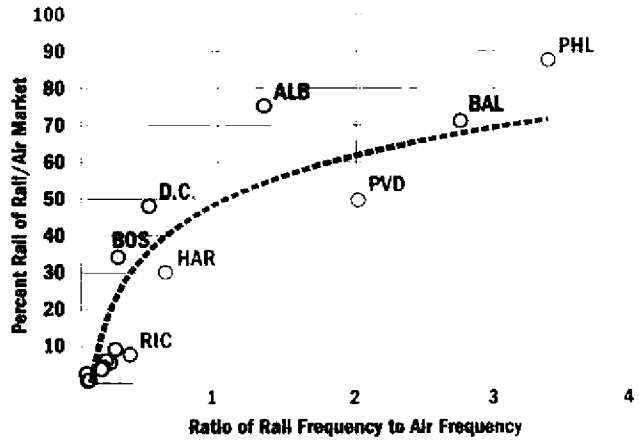


FIGURE 8.3

Rail Share as Function of Frequency Ratios

Source: Regional Plan Association



- Average daily passenger volume and origin and destination information for flights was obtained through the T-100 segment market data from the Federal Aviation Administration's trans-stats data set.

Figure 8.2 displays the relationship between rail market share and the ratio of rail time to air time for city pairs within 500 miles of New York City and with direct air and rail service. For example, a city pair with a rail travel time of two hours and a flight time of one hour would have a rail/air time ratio of two. From Figure 8.2 it is apparent that there is a strong and non-linear relationship between rail market share and this time ratio. As the ratio of rail/air time ratio decreases (and since air travel time varies little to destinations within 500 miles, the reduction in the ratio is primarily due to a reduction in rail time) the rail market share increases at an accelerated rate, displaying an exponential rather than a linear relationship. This relationship manifests itself in a number of ways; the rail market share increases only slightly as time ratios halve from six to three, but when the time ratio moves below three, rail becomes increasingly competitive with air. When ratios move below two, rail begins to dominate the market. Most of the remaining air passengers in such markets tend to be those connecting to flights from New York, where the rail option would require a trip between Penn

4 This model relies on an exponential relationship between rail time and ridership and a logarithmic relationship between frequency and ridership. An S-shaped logistic function would have also fit the data well and could have been used to estimate ridership.

5 For each city pair, rail volumes for center city and suburban locations within a metropolitan region were aggregated to get a more accurate comparison with the area from which air passenger are drawn. Stations in the New York metro area included New York Penn Station, Metropark, Stamford, Newark, New Rochelle, and Yonkers.

Station and one of the three airports, making this option unattractive today. These connecting passengers will be the subject of further discussion later in this chapter.

The ratio between rail frequency and air frequency has a relationship similar to travel times, except here as rail to air frequency increases rail market share increases (Figure 8.3). As with the travel time ratios, gains in rail frequency have the greatest effect at low ratios (i.e. when rail frequencies are low and air frequencies are high). The effect of frequency on rail share diminishes sharply as this ratio increases to over two. Increases in frequencies beyond this have little effect on market share. This implies that there must be a minimum threshold of rail frequency present in a market for rail to have significant market share. This minimum threshold is achieved when rail trips approach half the frequency of air trips (rail/air ratio of 0.5). Of course, the logic here is somewhat circular; the lower frequency may be the result of low ridership rather than the cause.

Although both the time and frequency variables have an effect on rail market share, the connection to time is stronger than to frequency. When these variables are combined into a multivariate equation accounting for both (as described below), changes in time affect market share much more than changes in frequency.

This equation with both the time and frequency independent variables is:

$$A = b1 + b2 * \ln(b3*X) + b4*\exp(b5*Y)$$

Where

A = rail market share;
b1 = - 0.0188;
b2 = 0.0228;
b3 = 1.9539;
b4 = 1.4558;
b5 = -0.5214;
X = rail/air frequency;
Y = rail/air time

This multivariable nonlinear regression model yields an R-squared value of 0.938, suggesting that the two variables "explain" 93.8 percent of the variation in rail market share. This value is superior to the R-squared values obtained with either linear or other nonlinear models tested.

To assess the reasonableness of the model, current times and frequencies were used to estimate current rail market share. Estimates ranged from a 19 percent under estimation of rail share (Albany) to a 12 percent over estimation (Hartford) with 11 of the 19 pairs within +/- 5 percent of actual ridership. These results offer a high level of comfort for the use of this model.

Application of the Modal Shift Equation

To estimate the shift of air passengers to rail, the two independent variables – rail/air time and frequency ratios – were varied to reflect a series of rail service improvements. Three new rail travel times were applied to test three scenarios (Table 8.4). In the first, dubbed Master Plan, the 2030 trip time goals from Amtrak's Northeast Corridor Master Plan were used for the five Northeast Corridor destinations. These improvements include the replacement of antiquated bridges and tunnels, as well as replacing the existing catenary on the southern half of the corridor with constant tension catenary that would allow maximum speeds of 150mph. For the markets outside the Northeast Corridor, trip times were estimated separately. For the four destinations in New York State, the trip time goals came from the NY State rail plan.[6] For the other ten destinations, improvements in trip times were estimated by assuming commensurate incremental improvements. These trip time reductions are achievable through incremental improvements to the Northeast Corridor and its feeder routes (e.g. New York to Washington, D.C., 2 hrs 15 min).

The second scenario, Enhanced Master Plan, is based on a more aggressive, but undefined set of improvements, which would undoubtedly involve some track straightening. This scenario would bring trip times down an additional 8-20 percent (e.g. New York to Washington, D.C., 2 hrs). These trip times approach the maximum intercity trip times possible to destinations on the NEC without a new alignment and right-of-way. Trip times to destinations off the corridor, while likely faster than today, are not assumed to increase as much without aggressive improvements in existing rights-of-way, but even still they would not approach the speeds on the Corridor. At present, there is no adopted program to implement these proposed improvements

The third and final scenario, California-style high speed rail (HSR), is based on trip time assumptions achievable through rail service that operates primarily on its own right-of-way, similar to the system currently being planned in California.[7] Average speeds for destinations on the Northeast Corridor are assumed to reach between 130-140 mph on the southern end and 110-120 on the northern end. These speeds are achievable with existing technology. However, they would require significant new rights-of-way with new rolling stock.

Trip Times for Modal Share Testing (minutes)

		Current	Master Plan	Enhanced Master Plan	California Style HSR
NEC	Baltimore	129	110	100	85
	Boston	207	180	160	120
	Philadelphia	67	54	48	40
	Providence	172	150	134	100
	Washington	166	135	120	100
	New York State				
	Albany	140	120	110	100
	Buffalo	450	386	321	240
	Rochester	390	334	279	210
	Syracuse	315	270	225	165
Other	Burlington	554	524	494	300
	Cleveland	687	623	558	360
	Greensboro	600	480	435	340
	Hartford	161	130	100	55
	Norfolk	480	384	350	240
	Pittsburgh	555	522	465	275
	Raleigh	621	385	350	280
	Richmond	361	265	240	180
	Canada				
	Montreal	650	600	540	255
	Toronto	742	680	620	400

Source: Regional Plan Association

6 New York State Rail Plan – New York State Department of Transportation – February 2009

7 http://www.cahighspeedrail.ca.gov/images/chsr/20090403111715_LOS_Assumptions.pdf

Average speeds to destinations off the corridor under this scenario range from 70 to 110 mph and would require substantially more capital investment than trip times achievable through the Enhanced Master Plan. This final scenario would bring trip times down an additional 9-50 percent (e.g. New York to Washington, D.C., 1hr 40 min).

Estimates of Air Passenger Shifts to Rail

For each of the three rail improvement scenarios, the mode share equation was used to estimate the new rail market shares and the number of passengers who would shift from air to rail with today's traffic volumes and patterns. The percent modal shift obtained from the model was applied to the total rail plus air volumes to determine the new air and rail market volumes. The changes in frequency of rail and air service were adjusted to account for the gain (or loss) of passengers in each mode and an adjusted estimate of the shift in passengers was recalculated based on this new rail/air frequency ratio.

To calculate the total number of passengers estimated to shift from air travel, each of the three major airports was considered separately. As indicated earlier, since intercity rail service connections to the three airports are so poor today, it is unlikely that with today's ground access options many connecting air passengers would use intercity rail to connect to another flight.

Consequently, connecting passengers were not included in the pool of passengers who might shift to rail. As shown in Table 8.5, the share of connecting passengers for the 20 markets is currently quite high. Travelers who fly to and from New York from these relatively close locations, tend to be those who are flying because they are connecting at the New York airports to go (or come from) other places. Most travelers who begin or end their trip in New York to and from these 20 destinations (including Washington-Dulles, which is counted separately from Washington-National airport) are more likely to drive or use intercity rail (if it is available) for their entire trip.

The highest connecting passenger shares tend to be from places nearby and from places with better rail service today such as Philadelphia or Providence. This suggests that the places with the greatest potential for a shift to rail have already occurred.

Passengers who are estimated to shift for the 20 markets* at the three levels of rail improvements are shown in Table 8.6.

- The NEC Master Plan scenario results in passenger shift of six percent -- 1,200 of 22,000 -- for all markets combined. These improvements would have most of their impact on destinations on the NEC, with 58 percent of the shift. These markets already enjoy relatively good rail service, but the improvements in travel time by rail continue to attract more rail riders as rail becomes increasingly competitive with air travel. For places not in the corridor, even with the reduction under this scenario rail travel times are still too long to attract most air travelers.
- The Enhanced Master Plan scenario is estimated to shift about nine percent or about 2,100 trips from air to rail, with 56 percent of these from the NEC cities. The pattern of the shifts is the same as for the Master Plan scenario.

Percent of Passengers Connecting to Other Flights

	JFK	EWR	LGA		JFK	EWR	LGA
Albany	90	93	57	**Pittsburgh**	39	38	16
Baltimore	86	91	50	**Providence**	92	87	65
Boston	67	60	22	**Raleigh**	38	22	10
Buffalo	27	55	23	**Richmond**	41	44	13
Burlington	68	71	50	**Rochester**	38	58	18
Cleveland	58	55	16	**Syracuse**	63	75	41
Greensboro / HP	N/A	25	9	**Washington(IAD)**	60	74	73
Hartford	97	94	N/A	**Washington (DCA)**	65	62	22
Norfolk, N.N	55	63	28	**Montreal**	30	28	8
Philadelphia	94	89	90	**Toronto**	30	28	8

Source: Federal Aviation Administration

TABLE 8.6

Daily One-Way Passengers in 2008 Shifting to Rail - Three Rail Scenarios

			Shifted Passengers		
		Current Air Passengers	**Master Plan**	**Enhanced Master Plan**	**California Style HSR**
NEC	**Baltimore**	462	34	54	88
	Boston	3,709	217	409	887
	Philadelphia	351	32	32	32
	Providence	413	10	18	37
	Washington (IAD)	1,345	105	164	253
	Washington (DCA)	2,110	315	492	752
	New York State				
	Albany	310	8	13	18
	Buffalo	1,715	61	147	313
	Rochester	935	39	93	188
	Syracuse	793	30	65	130
Other	**Burlington**	915	4	8	63
	Cleveland	1,106	14	32	143
	Greensboro	409	23	36	75
	Hartford	244	3	6	12
	Norfolk	665	31	44	110
	Pittsburgh	1,357	11	41	244
	Raleigh	1,581	190	242	377
	Richmond	829	94	129	236
	Canada				
	Montreal	890	6	19	210
	Toronto	2,160	9	29	203
	Total	22,298	1,237	2,074	4,372
	Share of all Corridor Air Passengers		6%	9%	20%

Source: Regional Plan Association

- The California Style plan scenario would cause a significantly higher shift of about 20 percent (4,400 trips), with sizable volumes of travelers from Boston and Washington. Because of the relatively greater travel time improvements, Raleigh and Richmond capture disproportionately higher rider shares.[9]

* The operator was applied to the [illegible] which were passed to [illegible] the [illegible] destinations.

[illegible] high speed [illegible] to the [illegible] style plan, Amtrak: A Vision for High-Speed Rail in the Northeast Corridor - Septemb[illegible] 2010

Projected Capacity Freed Up and Added Passengers Served at the Three Airports

A multi-step process was used to estimate how the shift of air passengers to intercity rail would affect the number of flights in the peak times at the airports for future years. The first step used the percentage of passengers shifting from each market as reported in Table 8.5 and applied it to the number of daily flights. Next, the number of affected flights was distributed by hour and the average number of affected peak hour movements was determined. Then, these were expanded to account for two-way traffic, factored to annual estimates and then factored from the domestic passenger traffic levels in 2008 to the 115 MAP, 130 MAP and 150 MAP domestic passenger projections by airport. These results are reported in Table 8.7.

Two factors suggest that these estimates are high. First, the estimates assume that the percentage shift in air passengers will result in a proportional shift in aircraft movements. Second, the rail improvements might not occur as quickly as implied.

JFK and EWR serve as major hubs for travel to long distance domestic and international markets. The airlines rely on shorter flights to feed these routes. Rather than eliminating flights or reduce the frequency of service that could create longer connections, airlines may instead shift to smaller aircraft and keep the same number of flights.

With fewer passengers in a particular market, the airlines will have the option of either eliminating flights or lowering the seating capacity of the aircraft they fly. Further, the size of the flights or individual markets may not make it practical for the airlines to reduce the number of flights. Their reluctance to drop flights may also stem from their interest in retaining peak hour slots where the capacity is capped by the FAA.

For example, if a market has 240 passengers on three flights with 100 seats each – 300 seats in one direction – and rail attracts 10 percent of the market or 30 passengers, this would leave 210 air passengers. If the airline were to reduce the number of flights from three to two and continue to use the same sized aircraft, then they would be unable to serve the 210 passengers. Thus, it is more likely in this case, that they would retain the same number of flights, and over time adjust their fleet mix to use smaller aircraft to serve the 210 people on three flights. The airlines are likely to have yet another reason to retain the flights, given the high shares of connecting passengers who would be inconvenienced by longer connecting times if there were fewer flights.

If the market was four times as large – 12 flights with 960 passengers and the same percent shift of 10 percent to rail – dropping one or even two of those flights would be much more likely, keeping the load factor in a reasonable range near 80 percent. This suggests that the destinations with large markets, such as Boston or DCA, are the more likely candidates for fewer flights where the airlines can accommodate the loss of air passengers to rail more easily. Given this uncertainty, these values are likely to be the maximum possible values, suggesting that these are maximum values for capacity freed up, rather than probable impacts.

The speed of implementation of the rail improvements is likely to make the shifts in traffic occur later than suggested in Table 8.7. However, the likelihood of reaching these rail improvements at a time when the air passenger levels have materialized is the more critical question. As currently planned, these rail improvements will not be in place anytime soon.

Peak Hour Capacity Freed Up Based on Shift of Air Passengers to Intercity Rail for Three Rail Improvement Scenarios – Three Major Airports at 115 MAP, 130 MAP and 150 MAP

		JFK	EWR	LGA	System
Amtrak NEC Plan	**115 MAP** (2015 - 2021)	0.8	0.7	3.2	4.7
	130 MAP (2021 - 2034)	0.9	0.7	3.6	5.2
	150 MAP (2030 - 2042+)	1.0	0.8	4.0	5.8
Enhanced	**115 MAP** (2015 - 2021)	1.4	1.1	5.1	7.6
	130 MAP (2021 - 2034)	1.5	1.2	5.7	8.4
	150 MAP (2030 - 2042+)	1.7	1.4	6.4	9.5
High Speed	**115 MAP** (2015 - 2021)	2.8	2.6	9.8	15.3
	130 MAP (2021 - 2034)	3.1	2.8	10.9	16.9
	150 MAP (2030 - 2042+)	3.5	3.2	12.3	19.0

Source: Regional Plan Association

TABLE 8.8

Air Passengers Shifting to Rail for Three Rail Improvement Scenarios – Three Major Airports at 115 MAP, 130 MAP and 150 MAP

		JFK	EWR	LGA	System
Amtrak NEC Plan	**115 MAP** (2015 - 2021)	0.3	0.2	0.6	1.0
	130 MAP (2021 - 2034)	0.3	0.2	0.6	1.1
	150 MAP (2030 - 2042+)	0.3	0.2	0.7	1.3
Enhanced	**115 MAP** (2015 - 2021)	0.5	0.3	0.9	1.7
	130 MAP (2021 - 2034)	0.5	0.3	1.0	1.9
	150 MAP (2030 - 2042+)	0.6	0.3	1.2	2.1
High Speed	**115 MAP** (2015 - 2021)	1.0	0.7	1.9	3.5
	130 MAP (2021 - 2034)	1.1	0.7	2.1	3.9
	150 MAP (2030 - 2042+)	1.2	0.8	2.4	4.4

Source: Regional Plan Association

The Amtrak NEC 2030 Master Plan – the lowest level of rail improvement is projected for 2030, well past the time when the 115 MAP would be reached (between 2015 and 2021) and near the end of the range of the 130 MAP projection of 2021 to 2034. However, the new federal interest in intercity travel suggests that this pace could be accelerated. Accordingly, in this analysis the assumption is made that the Amtrak NEC Master Plan will be in place by 2021 (nine years earlier) and the Enhanced Master plan by the early 2030s. This means that the impacts of the Amtrak NEC Master Plan would occur by the time the 130 MAP level is reached, and the impacts of the Enhanced Plan would occur when the 150 MAP level is reached. At the 115 MAP level, projected for the next four to ten years, none of the rail improvements is assumed since the Amtrak NEC Master Plan would still be a few years away by the time the 115 MAP level is reached. The other improvements are likely to occur later; high-speed rail in the Northeast by time the 150 MAP level might be reached, in the 2030 to 2042 period, is problematic.

With these timing assumptions, rail improvements would replace less than one flight per hour at JFK and EWR at the 130 MAP level when the Amtrak NEC plan is accomplished, and between three and four flights per hour at LGA. The Enhanced Plan, in place after 2030 and at the time 150 MAP is projected, would see a drop of between one and two flights per hour at JFK and EWR and almost six flights per hour at LGA. This could grow to over three flights per hour at JFK and EWR and 12 flights per hour at LGA. The much higher LGA effect occurs because LGA has a much larger percentage of traffic to and from nearby destinations and a much smaller share of its passengers connect to other flights – a group of flyers much less susceptible to a shift to rail.

The added number of passengers that could be served in the region if these shifts occur are calculated by expanding the daily one-way air-to-rail shift for 2008 into annual passengers in future years for each of the rail improvement scenarios. These results are reported in Table 8.8.

For the Amtrak NEC Plan, it can be expected that a little more than one million air passengers would shift, mostly from LGA. As rail improves further, this shift could expand to more than two million air passengers and eventually to over four million air passengers if high-speed rail were in place by the 2030s – the time when 150 MAP air passengers are projected to use the three airports, if there was capacity to handle them.

To the extent that the flights that are eliminated and replaced by fewer flights with more capacity, the number of air passengers served by freeing up capacity could be considerably greater. The flights to nearby destinations affected by intercity rail typically have far fewer seats than the average flight using each airport.

What Could Increase the Impact of Intercity Rail on Air Travel?

Connecting Passengers

The estimates of air-to-rail shifts would be significantly higher if the connecting passengers, as shown earlier in Table 8.5,[10] were more susceptible to a shift to rail. However, the current rail system does not connect well with the three airports. This means that rail trip time improvements to markets such as Philadelphia and Albany would have very little effect on air demand, since most of the air passengers to and from New York from these places are connecting to other flights at a New York airport. For example, the percentage of passengers from Albany to or from New York with an ultimate origin or destination other than New York is 93 percent at EWR, 90 percent at JFK, and 57 percent at LGA. Thus, of the 310 daily air passengers between Albany and the three New York area airports, 270 are estimated to continue to fly regardless of rail improvements leaving only 13 percent of the total market as the pool of potential passengers who could use rail. Philadelphia is another striking example with connecting passengers accounting for 89 percent at EWR, 94 percent at JFK, and 90 percent at LGA. In total, of the 20 daily flights to and from Albany and the 28 to and from Philadelphia, a maximum of one flight per day in each direction could be eliminated regardless of change in rail trip time, in the absence of improved rail connections between the Northeast Corridor, Penn Station and the airports.

Connecting passengers are much more reluctant to shift to rail for a variety of reasons. Their destination within New York is the airport, not the center city, removing the primary competitive advantage of rail. Further, the ability to check luggage from the origin airport through to the final destination increases the convenience of taking a short-haul flight rather than carry luggage on the train to the connecting flight. Finally, the single itinerary with connecting flights makes travel planning simpler than buying separate rail and air tickets. For these reasons, the first iteration of the model excluded connecting passengers. However, creating better connections between the rail infrastructure, particularly the mainline Northeast Corridor, and the region's airports could allow at least some of these connecting passengers to shift to rail. Today, intercity rail serving the region is not configured to serve any of the three airports well, with the exception of Amtrak passengers from the south who could use the NEC station by EWR. To reach either EWR or JFK most intercity passengers would have to disembark at either Penn Station in New York or Newark-Penn Station and then use local transportation -- NJ TRANSIT, LIRR, the NYC subway or taxis to reach one of the three airports, seriously discouraging them from using intercity rail. However, what would happen if intercity rail served the airports more directly?

One way of finding this out suggested in a University of Pennsylvania high-speed rail proposal,[11] posited a direct Northeast Corridor service to Jamaica.[12] Air passengers would use AirTrain to complete their trip from Jamaica to JFK. This direct high-speed service to Jamaica was estimated to attract 430,000 connecting passengers annually by the time the region's unconstrained air passenger demand reached 150 MAP. By comparison, as indicated in Table 8.8 there are an estimated 1.1 million non-connecting (originating or destined in the region) passengers who would be attracted to rail by that time. The shift of the connecting passengers could free up 2.8 flights per peak hour at JFK if the airlines responded by dropping flights. If these flights were replaced by larger aircraft, the overall impact on passengers served would be greater than the 430,000 people who would shift to rail.[13] The direct service to Jamaica would more than double the air trips shifting to rail if the connection were in place.

These estimates for connecting passengers should be viewed as the upper limit of the potential shift to rail and would require not only faster trip times, but also significantly higher frequency and logistical integration with the airports.

Extending the rail service from JFK into Penn Station would create a direct connection from the terminals to the Northeast Corridor, and would improve the rail access to that airport significantly. If this and similar projects around the region aimed at improving air/rail connections move forward during the next several decades, some connecting passengers would shift. The issue of creating more direct rail service to New York airports is discussed further in Chapter 11.

If Everyone within 500 Miles Now Flying Shifted to Rail

To measure a possible high-end diversion, a hypothetical situation was tested: what would be the impact on airport traffic if every air passenger to and from places within 500 miles was *forced* to use intercity rail? If all the markets within 500 miles away made the shift to rail by the time the 150 MAP level was reached, then the peak capacity that could open up would grow to 4.9, 4.5 and 13.7 movements, or 23 flights an hour for the three airports combined. This is about 20 percent higher than the freed up capacity shown in Table 8.7 for high speed rail by the 150 MAP level (3.5, 3.2, 12.3, totaling 19), most of which came from the cities in the NEC and from Albany.

10 European Commission: Air and Rail Competition and Complementarity- August 2006

11 Making High-Speed Rail Work in the Northeast Mega Region - University of Pennsylvania. School of Design - Department of City and Regional Planning - Spring 2010

12 It is assumed that this would occur only if the proposed high-speed rail alternative suggested by the University of Pennsylvania came to pass, whereby a new right-of-way were created through Long Island that could avoid the capacity limitations that now prevent direct airport services from Penn Station to either Jamaica or JFK. The Amtrak proposal would not operate through Long Island.

13 This subject is covered more thoroughly in the section of Chapter 9 dealing with short distance flight bans.

Airport Security Delays

Another possibility for higher shifts from air to rail could occur if the air travel choice became less desirable because of delays associated with security checks. Terrorist actions have resulted in the tightening of security measures at flight check-ins, requiring passengers to arrive to the airport earlier to ensure that have enough time to pass through security and make their flight. This could have two effects on air travel. The broader impact could be on the public's willingness to fly and should that prove to be the case, affect the overall projections of air travel demand. To date, there is little evidence that this is occurring.

The second impact could be that longer check-in times might results in a shift of travelers to rail or bus (and to driving). The modal share model was used to estimate the potential impact of a 15-minute penalty for an air trip to account for the uncertainty of future security procedures. The impacts from the longer air times would decrease the number of hourly aircraft movements in the peak by only four, with most of that likely to come at LGA. When the air passenger volumes reach 150 MAP, the number could amount to eight to ten flights per peak hour at the three airports combined. With the introduction of higher speed rail services, the impact of longer airport security times would be somewhat lower, since the gains from rail speeds would account for changes to a greater degree than the air travel time increases resulting from security measures. Put another way the higher rail speeds will account for most of the shift, and the air travel time penalty would pale by comparison.

What Prevents These Estimates from Being **Higher?**

Numerous factors prevent intercity rail from accomplishing even more than estimated here.

1. The markets that are within existing or potential competitive rail travel times are a small number compared to the number of markets that the three airports serve today.
2. For those markets within distances susceptible to a shift to rail, much of the shift has already occurred.
3. Much of the current air travel that is nominally susceptible to a shift consists of connecting passengers, for whom the use of rail today is not practical.
4. Substantial increases in rail speeds will not materialize for some time.
5. These maximum impacts depend on the airlines voluntarily responding by eliminating flights rather than using smaller aircraft.

Lessons from Elsewhere

In Europe and Japan the train service is faster and more frequent than in the United States and the use of rail for short-haul travel much more prevalent. This has been a result of government policies about land use and transportation investment decisions. The stated goal of the European countries is to limit the growth of air travel. This has led to a continued commitment to their intercity rail systems. Investments have gone into creating a network of high-speed trains and robust regional and local transit systems to handle the intercity travel demand. The result of these policies has been a travel experience on rail that is superior in comfort and convenience to alternate travel modes.

To illustrate the difference between Europe and the Northeast, Figure 8.4 shows the Northeast time ratio vs. rail share data and resulting curve and the comparable information for European city pairs. The latter shows higher rail shares for comparable travel time differences, suggesting other reasons than time for this disparity. These include higher frequency of service, more compact land use patterns that put riders trip ends closer to transit and intercity rail hubs, high air fares, better rail on-time performance, a robust local and regional transit system, and greater transit riding habits. To explore this further it is instructive to look at individual performance in a few select European city pairs to examine some issues faced in these markets and identify reasons why performance in some of these markets deviates from the European trend line.

On-time performance and reliability for most rail systems in Europe far exceed the current performance of Amtrak, contributing to the higher ridership share at any given rail time. Two European city pairs that underperform when compared to the overall European experience are London-Manchester and London-Edinburgh, which are both plagued by reliability issues. Only about 70 percent of the trains on the London-Manchester route arrive within 15 minutes of the scheduled arrival time. In contrast, the Spanish city pairs such as Madrid-Seville and Barcelona-Madrid (not included on the chart because high speed service introduced in February 2008 is too new to get an accurate air/rail share in a mature market) outperform the European trend due in part to their high punctuality and reliability. Spain is second in the world only to the Japanese Shinkansen with 98.5 percent of its trains arriving within three minutes of scheduled time. RENFE, the national rail carrier, offers a punctuality promise, and will refund the entire cost of the ticket if a train is more than five minutes late, provided it was responsible for the delay.[14]

The Frankfurt-Cologne market is another European market pair with lessons for rail service in the Northeast. High-speed service opened in 2002 with average trip time of 75 minutes. Lufthansa has continued to offer flights between the two cities, despite the short travel time and through baggage handling for connecting air/rail passengers. Although the point-to-point rail market (non-connecting passengers) now approaches 100 percent, flights have only been reduced from six flights per day to four flights per day and much of the air capacity reduction that occurred in this market was achieved by switching to smaller aircraft. There are several reasons why the improved rail times and integrated airport linkages did not result in capturing a greater share of interlined passengers. First, the city centers of Frankfurt and Cologne account for a relatively small share of the origins of airport users, 22 percent and 35 percent, respectively. Second, and perhaps more importantly, the Lufthansa booking system does not show air/rail options. Therefore, passengers looking for an international flight from Cologne may not be offered a Lufthansa option if air service were discontinued.[15]

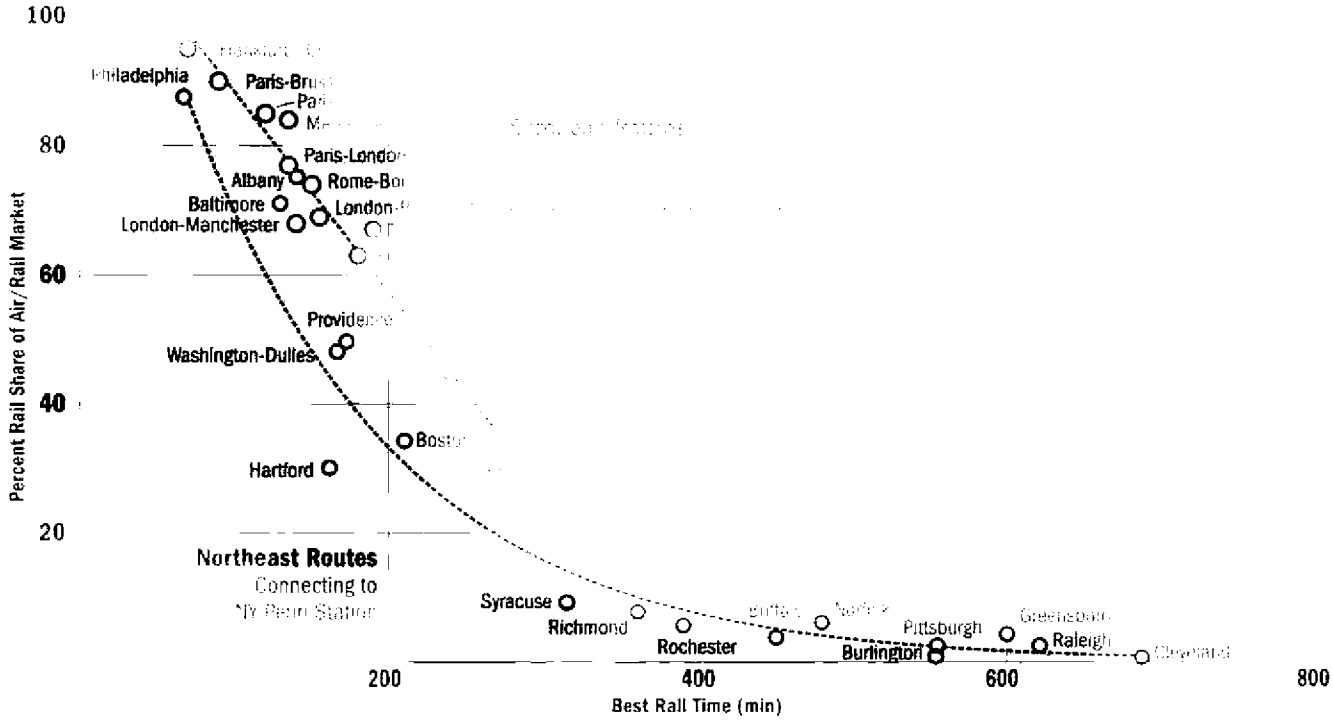
Airport constraints have also contributed to rail market share in Europe. For the most part, it's left to the market to determine how slots are allocated between short and long- haul flights. However, where slots have been limited, low cost carriers have had a more difficult time serving markets, and higher rail

14 *Air and Rail Competition and* Complementarities. *Legs 2006 Prepared for European Commission DG Energy and Transportation*

15 ibid

Ridership Higher in Europe at Any Given Rail Time

Source: Regional Plan Association and Steer Davies Gleave



Maximum Peak Hour Impacts (Departures and Arrivals) - European and Domestic Equations at 150 MAP

	JFK	EWR	LGA	System
Domestic Curve	3.5	3.2	12.3	19.0
European Curve	5.8	4.4	16.4	26.5

Source: Regional Plan Association

shares have been observed than the trend line would indicate. This is the case in the Paris–Marseille market where Air France owns a majority of the slots at Paris-Orly, preventing low cost carriers from serving this route. Similar constraints occur for some Madrid routes.

What If We Were More Like Europe?

The "European" equation in Figure 8.4 shows that if travel in the Northeast were more like Europe, more people would travel by rail and fewer by air. To determine how much difference this would have at the airports, if the European equation applied:

$$y = -0.0031x + 1.193$$

where:

y = Rail Share of Rail Air Market
x = Best Rail Time

Table 8.9 shows the results using this relationship at such time when there is a demand for 150 million air passengers at the three airports. At the high-speed California style level, the impact would increase from 19 peak hour flights opened up at the three airports combined to 26.5 flights.

For intercity rail service in the Northeast to achieve market shares similar to Europe, several factors need to change in addition to improving rail trip time. First, reliability is essential. On-time arrival rates approaching 100 percent will ensure much higher ridership at any given rail trip time. Next, physical integration with trains and air terminals is essential, but is not enough to attract interlined passengers. Ticket and booking integration as well as logistics integration (i.e. baggage handling) is necessary to attract intercity connecting passengers. Even with these improvements rail should continue to focus on city center locations. While serving the airports is important, the share of interlined passengers originating or destined to Manhattan

is relatively low, making city center connections that focus on point-to-point travelers the primary rail market for the foreseeable future.

Summary and Conclusions

The jury is still out on how effective intercity rail can be in attracting substantial number of passengers from using the three New York airports, thereby freeing up peak hour capacity at the three airports. The size of the impacts will depend to a great degree on the extent of investments in rail improvements, but also on the reactions to reduced demand by the airlines. The rail speed improvements currently planned by Amtrak are likely to have a very limited impact at all three airports. Even with an Enhanced Master Plan, capacity freed up at JFK and EWR would barely rise above two movements in the peak hour. And the current two-seat rail access from Penn Station to JFK and the limited stops by Amtrak at EWR limit the use of rail by connecting to other flights through those two airports.

LGA has a higher potential because it has a higher percentage of short-haul flights and a greater share of non-connecting passengers. With an Enhanced Amtrak Master Plan, the freed-up capacity would amount to about six movements in the peak hour out of a total demand in the 70s today and projected to the high 80s by the 2030s. With high-speed service, the capacity freed up at LGA could amount to ten movements in the peak hour. And these relatively modest aircraft capacity impacts would be achieved only if the airlines responded to the loss of passengers to rail by reducing the number of flights rather than by reducing the size of their aircraft.

In addition to improving the physical links, features that exist in many European cities would simplify these connections. For example, a single itinerary for rail and air and the ability to check-in for flights and check baggage at downtown train stations would undoubtedly increase these connecting volumes.

Following a European model, peak hour impacts could be significantly higher. However, this would require not only high-speed service and excellent rail connections to the New York airports, but a host of changes in attitude, a greater reliance on transit locally, a behavioral shift among Americans and the consolidation of flights by the airlines. Under these ideal circumstances, capacity freed up could amount to 16 flights in the peak hour at LGA, six of at JFK and at least four at EWR.

These increased impacts would require changes in government policies and development patterns in the Northeast over the next several decades. It would require an expanded network of regional rail and improved local transit to support the higher speed intercity rail network. To extend beyond these estimates it would require improved rail access to the region's airports and city center check-in to attract the large number of connecting passengers that access the New York airports for final destinations around the world. It would require major investments in the rail infrastructure, not only to reduce rail trip times to these destinations to make them competitive with air, but also to expand the capacity to ensure the operating frequency required to meet the new demand. In addition, it would require government policies that are committed to making the necessary investments in the rail infrastructure to guarantee that these policies do not limit the mobility in the region. With these changes, the intercity rail network and the airport networks could act symbiotically, combining the best features of each for the traveler.

The shift of air passengers to rail is only one of the environmental, economic, and social benefits of having a high quality passenger rail service and only one of many reasons that justify major investments in our rail network. The opening of these slots to higher value long distance routes, without limiting the region's mobility, could be a contributing factor in justifying such investments.

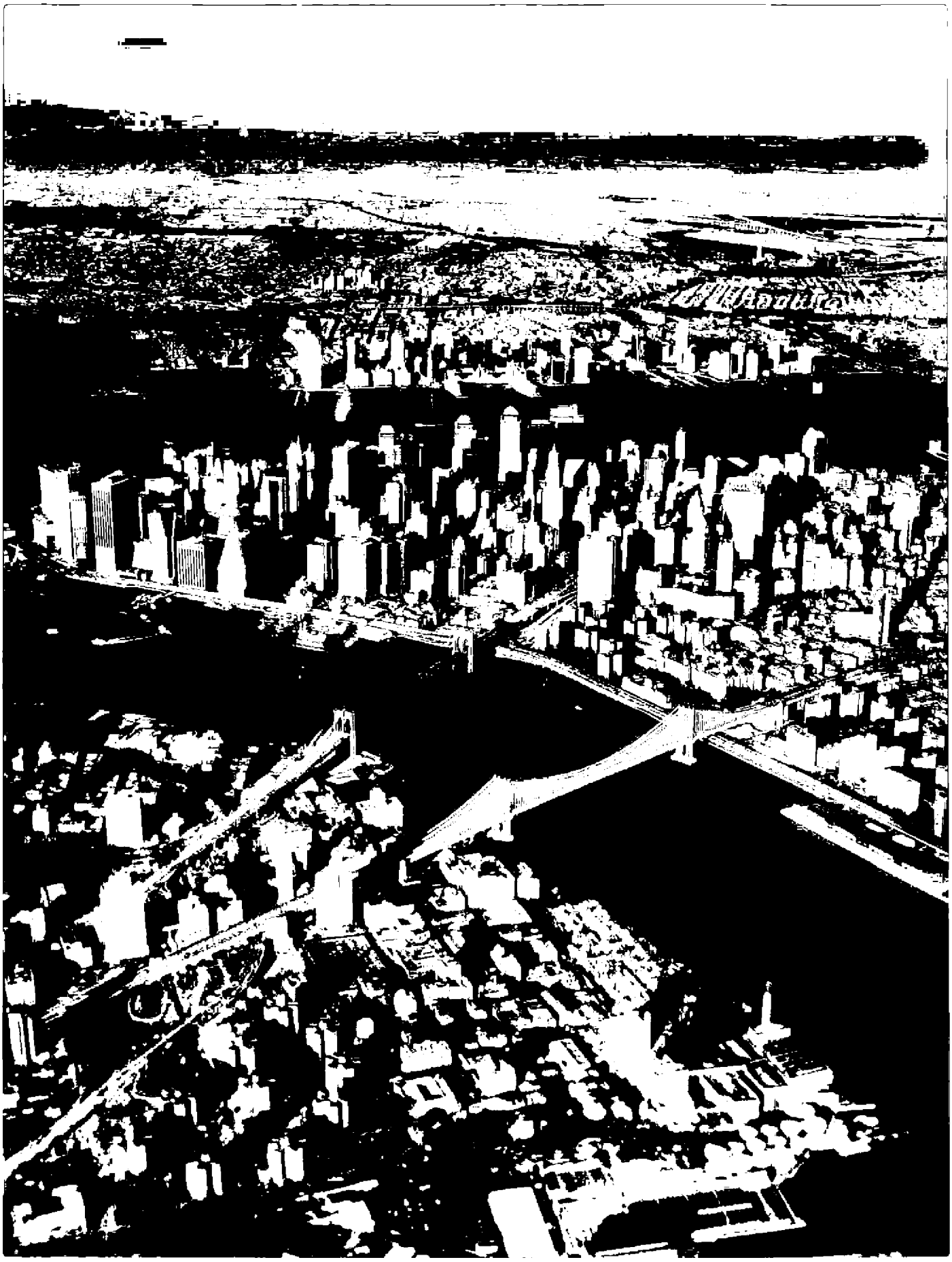


Photo: Mazen Mahdi/Agence France-Presse/Getty Images

Managing Demand

This chapter reviews the steps that might be taken to manage demand at the airports. The intent is to find ways to increase the number of passengers that the three airports can serve in their current configuration. Management actions can expand airport use in only two ways – increase current peak capacity by flying larger aircraft or increase the number of aircraft that use off-peak capacity.

These actions may be applicable in one or two of the three major airports in the region, but not the other(s). These airports tend to serve different functions, and in some cases, different markets. LGA serves largely short-haul markets with a limited number of international flights; JFK is the premier international airport in the region; it has about an equal number of domestic and international passengers. EWR offers a mix of domestic and international flights.

Management techniques fall into two distinct categories. The first category refers to the slot-controlled environment, where peak period capacity is scarce. The second category of management techniques applies when more capacity has been provided through either technological advances or airport reconfiguration or expansion, and the goal is to allocate the additional capacity more effectively. The ultimate objective may be the same in both circumstances, but appropriateness of individual actions may differ since any gains in passenger capacity could come at the expense of the air passenger and the airlines.

Demand management measures are distinct from the other actions discussed in this report. The other actions offer a potentially superior travel alternative – outlying airports or intercity rail – or offer more service or reduce delays (NextGen). In contrast, demand management measures may limit choices in an effort to increase throughput. This limitation could come in the form of reduced destinations served, a decrease in the frequency to particular destinations, or by higher fares that would reduce travel demand. Second, demand management measures by their nature are policy interventions imposed on an industry that was deregulated in the last three decades, and demand management measures would indicate a reversal (or at least a pause) of that approach. The carriers are likely to resist such policy changes.

Theoretically, there are many methods to encourage a shift of operations to off-peak times. These methods are intended to accomplish the same thing – allocate a precious resource more efficiently. The size and nature of the incentives would have to change as demand grows and peak hours take up a larger portion of the day.

The actions under consideration fall under three categories. The first is a more passive action and is most relevant in the current slot-controlled environment. Airlines can schedule additional flights in the off-peak hours where some capacity still exists, if they find no capacity at times they would ordinarily prefer to fly. They would tend to choose times as close to the peak as possible. This action will initially absorb some of the growth, but as the troughs in the diurnal schedule fill up, the time for recovery from peak period congestion would be sacrificed, leading to more delay. A challenge is finding an available slot to operate the reverse trip.

In Chapter 4 (Figures 4.1, and 4.2, and 4.3), the diurnal distribution of flights at the major airports were graphed, indicating the hours in which there is still capacity to schedule more flights. The times when there is less use than capacity are quite limited, particularly at LGA. Only the hours before 7am and after 9pm have any room for additional flights. At JFK and EWR there is a little more leeway, with early morning time before 7am at JFK and 8am at EWR, midday "troughs" at both airports – 9am to 1pm at JFK and 9am to 3pm at EWR, and in the evening after 8pm at JFK and 9pm at EWR. However, these "troughs" allow for valuable schedule recovery due to weather and other capacity interruptions[1]. Therefore, filling in the troughs of the schedule with additional operations could increase delays.

An additional issue that arises is the need to store some arriving aircraft for a longer period before they turn around and depart. This will be true for flights from Europe to JFK and EWR. Adding domestic and Central American markets in the off-peak period creates an additional need for long-term aircraft parking. Growing markets in the rest of the world (South America, Asia, Middle East, and Africa) will create an additional long-term aircraft parking need, regardless of when those flights occur.

Service in the shoulder can also create problems for hub operations, most notably for Delta Airlines at JFK and Continental Airlines at EWR. As flight arrival and departure times are extended over longer periods, the time between connecting flights increases, making the connections less attractive.

Airlines compete in the market place on a few key variables: mainly fare, frequency, and service components (like frequent flier programs, first and business class cabins, etc.). However, it has been empirically shown that airlines can increase their market share by increasing their frequency rather than altering the other service variables[2]. Beyond a simple addition of frequency, airlines can increase their competitiveness by adding targeted frequency, most notably by scheduling flights at times very close to those of their competitors[3].

1 Churchill A. M., "Determining the Number of Slots to Submit to a Market Mechanism at a Single Airport." Masters of Science Thesis, Faculty of the Graduate School of the University of Maryland, College Park. Digital Repository at the University of Maryland, https://drum.umd.edu/dspace/handle/1903/6964, 2007.

2 Wei, W. and Hansen, M., "Impact of aircraft size and seat availability on airlines' demand and market share in duopoly markets." Transportation Research Part E, 41(3), pp. 315–327, 2005.

3 Borenstein, S., Netz J., "Why do all the flights leave at 8 am?: Competition and departure-time differentiation in airline markets." International Journal of Industrial Organization, 17(5), pp. 611-640, 1999.

However, if there is no capacity in the peak period when airlines might chose to schedule flights, the consideration of adding flights in the off-peak times becomes the only recourse. The practice of following the competition, whereby one carrier schedules an operation at a particular time, and the other carriers follow, is not possible during the peak period in a slot-controlled environment[4].

In this passive, or voluntary, strategy additional slots will be available in the peak period only if a carrier decides to move peak period flights to non-peak periods. This is unlikely. Rather, in the absence of enough peak capacity, loading the off-peak with additional flights is the only recourse. As demand grows, airlines will have only the choice of using the off-peak until those hours reach slot limits as well.

Off-Peak Flight Additions

An airline's ability to use off-peak hours for additional fights depends on the length of flight, the timing of its other flights to the same destination and the ability of the destination to support an additional flight, and the willingness of the traveling public to fly at that time. In general, more passengers are willing to consider flying at a different time for a longer flight than for a shorter flight. This willingness to accept different arrival and departure times is limited to normal waking hours. In addition, nighttime curfews at foreign airports also limit times when aircraft can arrive and depart from New York. Thus, most European flights must depart New York no earlier than the late afternoon to avoid arriving at the European airport before it opens. Similarly, few flights leave New York for Europe after midnight, since many passengers are unwilling to either stay up that late or to arrive in the midday. Over time, as peak hours fill up, adjacent off-peak hours will also become full, thus extending the peak activity period at the airport.

A detailed flight-by-flight analysis was performed to see how many additional flights could be located in off-peak hours. It assumed that new times for the added flights would be no more than one hour from the peak hours, subject to following constraints.[5]

To estimate how much of the new demand could be located in the off-peak, the projected number of unconstrained hourly movements for the three demand levels – 115 MAP, 130 MAP, and 150 MAP – were compared to the slot limits of 81, 81 and 74 per hour at JFK, EWR, and LGA, respectively. The unconstrained flights that exceeded these levels were then assigned to other hours adjacent to the peak to the extent there is room to reschedule them, using the footnoted rules. This analysis of future conditions assumes that peak hours will continue to spread across the day, but this spread will be limited by the finite number of reasonable and legal departure and arrival times for flights to various world areas.

As Table 9.1 shows, at 115 MAP only 55 flights of the 80 "overflow" flights could reasonably be added to the off-peak. As the unconstrained demand moves to the 130 MAP level, the number of flights in excess of the peak climbs, but the ability of the off-peak to absorb them is severely curtailed. Of the 285 flights that are "seeking" an off-peak home, only 31 can be accommodated. By the time demand reaches the 150 MAP level, none of the 601 flights can be accommodated in the off-peak hours.

4 Ibid

5 See Assumptions for Shifting Flights to Off-Peak

Assumptions for Shifting Flights to Off-Peak

- Flight arrivals from the Eastern and Central Time Zones of the United States currently occur between 7am and 11pm, with most flights occurring before 10pm. Peak spreading will extend flight arrival times until 11pm for the Eastern Time Zone and midnight for the Central Time Zone
- Flight departures to the Eastern and Central Time Zones of the United States currently occur between 6:00am and 11pm. Peak spreading will extend flight departure times from 5:30am, but will not extend the evening peak past its current time.
- Flight arrivals from the Mountain and Pacific Time Zones of the United States currently occur between 3pm and midnight, with another peak time between 5am and 8am. Peak spreading will result in arrivals occurring between 2pm and 1am and between 5am and 9am.
- Flight departures to the Mountain and Pacific Time Zones of the United States currently occur between 6am and 9pm. Peak spreading will result in departures occurring between 6am and 10pm.
- Most flight arrivals from Europe occur between noon and 9pm (U.K. 11pm). Peak spreading will result in arrivals occurring between 10am and 11pm.
- Most departures to Europe occur between 4pm (U.K. 6pm) and 11pm. Peak spreading will result in departures occurring between 4pm and midnight. A departure peak can also occur between 8am and 9am.
- Central America tends to have arrivals and departures throughout the 24-hour period.
- The rest of the world has arrivals between 5am and 10pm and departures between 10am and 2am.

The passengers served are calculated using the average number of passengers served for domestic flights, the number of flights per day added in the off peak (from Table 9.1), and an annual factor to convert daily passengers to annual ones. The results are in detailed in Table 9.2, showing that these added flights can accommodate about 1.6 million passengers in the short term, and another 960,000 by the time 130 MAP is reached. The table does not show the 150 MAP level since by that time there would be no room for the added flights if the current slot-constrained environment were still in effect.

Adding flights were there is off-peak capacity is a passive strategy with diminishing returns. However, it does come with costs. Aircraft will inevitably be on the ground longer, requiring more storage, requiring more apron area for storage will have a negative impact on airlines' operating costs as they must keep aircraft on the ground for longer periods.

Hub operations can also suffer. Over time, as peak hours fill up, off-peak hours will also become saturated, extending the peak activity period at the airport, with more nighttime flights, which are likely to generate more noise complaints from neighboring communities. Finally, as the troughs or valleys fill up, the ability of airports to recover from the delays of morning peak periods will erode.

TABLE 9.1

The Impacts of Adding Flights in the Off-Peak

	Flights per Day			
115 MAP	**JFK**	**EWR**	**LGA**	**Avg/Total**
Unconstrained Demand	1,326	1,344	1,198	3,868
Accommodated with Slot Rules	1,296	1,319	1,173	3,788
Looking for Off-peak Capacity	30	25	25	80
Found Off-peak capacity	15	19	21	55
Not Accommodated	15	6	4	25
% Not Accommodated	50	24	16	31.25
130 MAP	**JFK**	**EWR**	**LGA**	**Avg/Total**
Unconstrained Demand	1,484	1,437	1,292	4,213
Accommodated with Slot Rules	1,373	1,360	1,195	3,928
Looking for Off-peak Capacity	111	77	97	285
Found Off-peak capacity	11	13	7	31
Not Accommodated	100	64	90	254
% Not Accommodated	90	83	93	89
150 MAP	**JFK**	**EWR**	**LGA**	**Avg/Total**
Unconstrained Demand	1,682	1,567	1,371	4,620
Accommodated with Slot Rules	1,417	1,398	1,204	4,019
Looking for Off-peak Capacity	265	169	167	601
Found Off-peak capacity	0	0	0	0
Not Accommodated	265	169	167	601
% Not Accommodated	100	100	100	100

Source: Regional Plan Association

TABLE 9.2

Passengers Served by Added Flights

115 MAP	**JFK**	**EWR**	**LGA**	**Total**
Added Flights per Day	15	19	21	55
Passengers per Flight	115.1	87.1	70	88.2
Added Daily Passengers	1,727	1,655	1,470	4,851
Annual factor	340.92	334.4	326.86	334.4
Added Annual Passengers	588,598	553,399	480,484	1,622,481
130 MAP	**JFK**	**EWR**	**LGA**	**Total**
Added Flights per Day	11	7	13	31
Passengers per Flight	117.8	91.3	72.4	92.8
Added Daily Passengers	1,296	639	941	2,876
Annual factor	340.92	334.4	326.86	334.9
Added Annual Passengers	441,764	213,715	307,641	963,120

Source: Regional Plan Association

Regulatory or Legislative Interventions

This section discusses actions that require active policy changes, either through pricing of the scarce space or by limiting or barring categories of aircraft movements from operating during peak times. Theoretically, these steps could be taken under the current slot rules environment or after slots are increased or eliminated. Some of these actions would limit the frequency to a market that has demonstrated adequate service, but the airlines would still choose when to operate those flights. However, in either case regulatory changes and possibly legislative changes would be necessary first.

These demand management actions examined here are illustrative, rather than prescriptive, in order to understand their value in the context of the other actions discussed in this report.

Pricing actions can accomplish similar objectives. A scarce resource, by an economist's definition, is underpriced. Therefore, raising the price of peak-hour capacity deserves examination. Limiting flights directly or through pricing would require changes in the regulatory environment, and may first require a legislative action.

Many questions should be answered about each of these potential measures before they can be seriously entertained.

- Will it have the effect that is desired, i.e. to serve more passengers either from shift to larger aircraft and /or greater use of the off-peak "trough" periods?
- Will it reduce passenger flight options, resulting in losses in both time and money and greater inconvenience?
- Will it result in higher fares?
- Will it reduce service frequency or even eliminate service between some cities and the region?
- Will it reduce or eliminate flights that depend on connecting passengers for flights to some major world cities, thereby damaging the region's role as a world city?
- Will the resultant mix of aircraft actually decrease throughput at an airport because of aircraft spacing requirements?
- Will it reduce service frequency to some destinations, and if so which ones?
- Will it prevent entry of new carriers to the market?
- Will it be disruptive of airline schedules, affecting their networks, aircraft positioning and possible loss of markets?
- Will it raise revenues and for whom, and can those revenues be used to make improvements at the airports?
- Are there legal barriers and can (or should they) be overcome by legislation?

All regulatory actions could also be rendered less effective or even unworkable because some international flights may be protected by bi-lateral treaties that guarantee foreign carriers access to the New York market. Reluctance to disadvantage U.S. based carriers vis a vis foreign companies that are exempt from a pricing policy may reduce interest in pricing actions. Other challenges include economic development interests both in the New York region and in those destinations connected to the region by air. It is possible that certain destinations are marginally profitable to the airlines, yet air service provides a large economic benefit to that destination. These operations may be shifted to the off-peak or may simply be shed, resulting in less pressure on the airport and little change in profitability to the air carrier, yet a large loss to a region that loses the service. We note these challenges as areas that should be explored before designing regulations to maximize efficiency at the region's airport system.

Pricing

Pricing policies are designed to increase the price of operations in the peak period compared with the off-peak, and reflect the higher value of peak service. Policies related to pricing peak operations are generally meant to segregate the essential travel to the peak period (i.e., the value of the service can justify the increase in cost) and non-essential travel nonessential to the off peak (i.e., the value of the service is not enough to justify peak travel). Just as some road differential pricing policies are advertised as a "shopper's special" break in tolls in the mid-day, pricing policies related to airport operations are meant to shift operations with a lower value to the off-peak.

Pricing policies include peak-period pricing in multiple forms, including peak-period slot allocation, higher landing fees during the peak, airline surcharges for peak travel, slot auctions,

and slot lotteries. Peak-period slot allocation is a non-pricing measure that would require renegotiation of all slots. Higher peak period landing fees or surcharges could be levied on an air carrier or imposed directly on a passenger through a passenger peak-period fee. Auctioning off peak period slots is an additional method to attempt to shed operations from the peak and shift travel and flights to the off-peak. In the case of auctions, the price is not preset and the auction may drive up prices to an extreme. This could also drive up the fare price at those times. An alternative to an auction is a lottery, where the luck of the draw decides which airline gets the available peak capacity. The following sections delve into these policies in more detail.

All of these measures would require the renegotiation of flight fee agreements between the airlines and the Port Authority. This would only occur if both parties have an incentive to do so. There are many reasons why an airline operates a particular flight at a particular time, such that the value of that flight is a complex function not well understood outside an airline. As described in Hansen et al. (2001), increases or decreases in aircraft size are not incremental across the aircraft serving an airport, but rather are pronounced in certain markets. Therefore, we would expect markets with high flight frequencies and a diversity of aircraft types to be candidates for upgauging rather than markets with very low frequencies. Another uncertainty relates to new entrants. They seek to be competitive by acquiring peak-period slots; peak-period pricing (especially peak-period slot allocation and auctions) can either provide a route for new entrants or can completely preclude new entrants that may lack the resources to invest in peak-period slots.

Airlines could minimize their operating costs by using aircraft with larger capacities than those operated today - for example, by operating a 350 seat aircraft (in the wide-body range) on a 500-mile route where typically a narrow body aircraft (about 150 seats) are now used.[6] This suggests that airlines may be looking for much more than cost minimization when scheduling routes, frequencies and aircraft types. Airlines are looking for a competitive advantage, to complete their route network, and other benefits not directly related to the fare that can be charged or the operating costs incurred. Airlines also have business arrangements that influence their schedule and their routes[7]. In addition, they must consider the real estate they lease at the airports, and whether the mix of aircraft can be accommodated on their gates.

Airlines may not be swayed by pricing because many use their networks, some more diverse than others, to cross-subsidize non-profitable markets with other profitable routes. For example, consider the well-known "Southwest Effect." In 2008, US Airways dominated the market at LGA until Southwest Airlines entered it in 2009. Fare statistics collected by the U.S. Department of Transportation in the second quarters of 2008, 2009, and 2010 for LGA-BWI flights, show that one-way fares were between $110 and $270 in 2008. By 2010 when Southwest Airlines had entered the market, US Airways fares were down to a range of $75 to $165 and Southwest fares were between $75 and $135, which is a 32 percent to 50 percent reduction in fares over just a two-year period.[8]

The rapid action of an airline to respond to competition shows that profitability on a segment is not the only factor. The fact that such a practice is typical means that airlines are not concerned with making a profit on every flight, but rather making enough profit on a subset of their flights to be profitable network-wide. Airlines may fight an additional charge intended to get them to change this practice; however, their lack of concern over profitability on every segment points to the possibility that the intended result, upgauging, may not occur. Pricing strategies may not draw the intended response.

Auctioning off the slots created from new capacity during peak times is another method of shifting some travel and flights to the off-peak, and thus making room for new activity. This action could drive up the price for flights at those times. An alternative to an auction is a lottery, where the luck of the draw decides who gets the available peak capacity. An option to ensure that new entrants and limited incumbents have a greater chance to growth operations at the airport is a weighted lottery. Another alternative is a set-aside for new entrants; the other carriers would compete for the balance through a lottery. This however, requires a rather large pool of new slots.

While these pricing actions open the choice of destinations and service frequencies to market forces, they may not be politically acceptable to economic development interests at both ends of the flight. For example, there is strong interest in maintaining services between many small communities, including those in upstate New York and the New York metropolitan region.

Differential Peak-Hour Pricing

Using market forces to encourage greater off-peak use of the airports can theoretically occur in a number of ways: higher peak period landing fees or surcharges, hybrid weight-based and fixed landing fees in the peak, or passenger surcharges for peak period travel.

If airlines are charged a premium to fly in peak hours, they would likely respond in a combination of three ways:

a. Absorb some or all of the higher costs in their entire network, so as not to damage their peak period market.

b. Shift to larger aircraft in the peak to spread the added expense over more passengers, minimizing or eliminating the added cost to the individual passenger. This would have the positive effect of making the peak period more efficient through "upgauging." However, there may be a loss of smaller markets and connecting flights, as was the case with the banned flights analysis presented earlier in this chapter, as some passengers are priced out of the market. Only in large markets might the airlines be able to drop a peak flight, substituting another destination (or origin).

c. Pass along the costs to their passengers in the form of higher fares, which would encourage some passengers to shift to flights in the off-peak, meeting the desired objective. This would be felt most by the passenger, who would have to pay more or fly at a less desirable time. This would only work if the boost in fares was accompanied by the establishment of the off-peak service. The airline would have to decide if the added flight is in its interest. Therefore, there is no guarantee that the flight in the off-peak would materialize.

Hybrid Landing Fees

In 1988, the Massachusetts Port Authority (Massport) implemented higher landing fees for small aircraft at BOS as part of the Program for Airfield Capacity Efficiency (PACE). The

6 Ryerson, M. S., "Optimal Intercity Transportation Services with Heterogeneous Demand and Variable Fuel Price." Ph.D. Thesis, University of California, Berkeley, Berkeley, CA., 2010.

7 McGinnis, C., "SWISS Flower-Power Arrives at SFO." San Francisco Chronicle, International Travel News, http://www.sfgate.com/cgi-bin/blogs/cmcginnis/detail?entry_id=64896, June 2, 2010.

8 A fuller analysis requires statistical models; these summary statistics suggests certain patterns that warrant more analysis of this issue.

program changed the landing fee formula from weight-based to a hybrid-fixed and variable structure. Implementation of the program led to a significant drop in small regional aircraft, an effect confirmed empirically by Ryerson and Hansen (2009). As small aircraft were charged more and larger aircraft charged less under this fee structure, the Department of Transportation found that this scheme discriminated against an aeronautical user group and therefore was in violation of the grant assurances. This form of charging is tentatively allowed in the 2008 Amendment to the Airport Rates and Charges[9].

Imposing a hybrid landing fee structure is complex and challenging to implement. It raises many policy issues. As discussed in Hansen et al. (2001), small flights are often used to connect small communities to the broader aviation network or to complete the hub-and-spoke network of a carrier. These smaller communities often have low market densities. Ryerson and Hansen (2010) found that in small markets, small aircraft can provide minimum cost service (airline operating cost plus passenger costs, including schedule delay). Thus, pricing out small aircraft becomes difficult to accomplish.

These complex issues notwithstanding, small aircraft do take up the same slot as a larger aircraft yet diminish the overall throughput count of an airport. Hansen et al. (2001) notes that in the study period of the early 2000s, 30 percent of the operations at Los Angeles International Airport carried only 5 percent of the passengers; Coogan et al. (2009) shows that a similar phenomenon exists at San Francisco International Airport. At LGA, 44 percent of the departing flights, those with 50 seats or less, carried only 21 percent of the seating capacity.

Passing the Cost to the Passenger

A second approach would be to impose a charge directly to the passenger for peak travel (or less in the off-peak) with what amounts to a variable head tax. This is currently not legal. This has the effect of accomplishing "c" above without "a" or "b". With this approach, it is more certain that the airlines will follow a course that tends toward more off-peak use, since passengers will have a direct incentive to fly off-peak to avoid the peak period fee. However, as previously discussed airlines have their own unique reasons for valuing flights at different rates, and engage in cross-subsidization. The airlines could absorb the additional cost themselves by reducing fares in the peak period and increasing fares on other routes or in other markets outside of the New York region, effectively mitigating the peak-period passenger fee effect.

Peak-hour pricing concepts attempt to create direct incentives, such as differential landing fees, or indirect incentives, such as a peak hour per passenger tax, for airlines to change their scheduling practices to include more off-peak flights. These approaches could have serious impacts on the airlines' networks. Perturbing the operation at one airport in a network can have negative effects on the entire network, involving positioning of aircraft, connecting flights and ensuring sufficiently robust service over the day. In addition, it is difficult to set the correct price in advance or to predict the magnitude of the effects of shifting passengers and flights from the peak to the off-peak. Theoretically, one could set a desired outcome and experiment with pricing through trial-and-error until that outcome was reached.[10] This iterative approach could be disruptive to the airline industry with little certainty that the desired outcome would ever be reached. From a practical perspective, this would lead to a chaotic and untenable situation since the terminal facilities – gates, hold room, ticket counters, baggage equipment – are owned or leased by individual airlines. The reallocation of the operations through pricing would be unworkable.

Auctions

Rather than applying surcharges to landing fees or directly to the passenger for traveling in the peak (or discounts in the off-peak) another approach would have the airlines bid through an auction process for the right to use added slots during peak hours. An auction would have the carriers bid on slots, such that the value of peak period service is captured. This encourages airlines to operate air services that they value most highly during peak hours when slot costs are higher versus other less profitable air service. Auctions could be held for only the new slots made available from capacity increases resulting from either NextGen improvements or airport expansion. The auction timeframe has the effect of maximizing the value derived from peak period service, but not necessarily the number of passengers served in a particular peak period.

In the implementation of an auction, a market price of a peak slot would be established. In contrast to a peak period surcharge or an increase in the landing fee, the airline proactively decides to bid a certain amount for a given slot; indicating that the slot is valuable to its operation. This market price does not translate into higher passenger throughput – it simply means that an airline values serving a particular market at that particular time. The "winning" airline would use that slot in a way that maximizes its value; this could be from a long-haul domestic or international flight; it could be to combine flights and upgauge; or it could provide service to a small market on a small aircraft that creates larger benefit to the airline. In this way, auctions are an excellent way to capture the value of a slot but do not directly translate to the goal of increased passenger throughput (said another way, auctions make sure all peak hour slots are being used such that they are deriving the maximum value but not necessarily maximum passenger flow).

Auctions will assist in establishing the cost of a slot, and in determining how that cost varies over the peak periods. Auctions, and the secondary market they enable, have the unique potential to allow for new entrants because slots are simply assigned to the carrier willing to bid the highest; however, auctions could also limit the entry of airlines that lack the resources to participate successfully in the auction. Collecting the slots for auction and then reallocating them would also require a reorganization of slots and a major paradigm shift related to slot ownership and long-term gate leases. Currently the federal government allows airlines to trade slots, and accounting rules allow airlines to amortize slots; for this reason, reallocation of something the airlines in effect "own" could damage airline operations, affecting the way they match their operations and their slots with their gate infrastructure. However, even if the FAA and the airlines reached agreement, the airport operator may be unable to provide the terminal and gate infrastructure to accommodate the added service.

Another challenge of the current slot situation is the lack of transparency, creating inefficiencies in the secondary market. While the identity of slot ownership is known, the actual use is exceedingly more difficult to establish, making negotiation

9 Coogan, M., RSG, Hansen, M., Kiernan, L., Last, J., Marchi, R., et al, "Innovative Approaches to Addressing Aviation Capacity in Coastal Mega-Regions." Airport Cooperative Research Program, 2009.

10 There has been work on setting the price differential for peak flights and the potential shifts that would result. See *Congestion Pricing for the New York Airports: Reducing Delay & Promoting Growth and Competition* - Robert W. Poole, Jr. and Benjamin Dachis - The Reason Foundation, December 2007. However, this effort was necessarily theoretical with results based on simulation or game playing by airline executives.

for slots for new entrants more problematic. The "use it or lose it" provision favors large slot holders over small ones, as the 80 percent usage rate is based on a carrier's entire pool of slots. The secondary market, while a means to trade, lease or sell slots, could also be more effective as a vehicle for new entrants, thereby limiting incumbents from holding on to their slots. Currently slot owners can simply refuse to negotiate with competitors and can effectively limit their use of the airport. One solution is that the "buy-sell" or lease transactions be conducted "blind" rather than have full transparency regarding which carrier is the buyer or trading partner. This makes it possible to add operations, and potentially fly larger aircraft, either way adding capacity. Finally, airlines may be reluctant to purchase slots because they could lobby for exemption or work for a "free" way to secure a slot.[11]

There are many challenges related to auctions, some specific and others identical to those explored in the differential pricing strategy. Some auction-specific concerns relate to infrastructure and policy. The proceeds from auctions could be set aside for airport runway capacity and aircraft delay reduction improvements, however there are limitations to using airline charges for using infrastructure. In addition, a landing/departure operation pair necessitates the use of additional airport facilities such as gates and baggage facilities. As discussed in Coogan et al. (2009), designing auctions with the match between air- and landside operations is a challenging task. Furthermore, airline's property rights over slots are not well defined: an incumbent airline that loses capacity in the auction would have unamortized investments in airport infrastructure that it would have to write-off and this uncertainty about the future would limit airline investment in the airport. In addition, the winning bidder may have an aircraft that cannot be accommodated at the airport at the winning time.

For this reason, only auctions for new capacity created by NextGen or physical airport improvements are considered here. This approach eliminates the defect of incumbent airlines losing capacity while retaining some of the benefits of optimizing the utilization of peak-hour capacity. As noted earlier, it does not explicitly maximize throughput; if that is a goal, the auction could specify a restriction on aircraft size.

Auctions are effective in establishing an airline's value of peak period service. They are not, however, effective in capturing the total benefit of an operation. Because all carriers do not have an equal ability to participate in an auction, it is possible that service from which passengers or a community derive great benefit could be eliminated because the airline is unable to extract that value in the form of fare. If this is the case, the allocation of capacity among the airlines resulting from an auction could actually reduce competition. This is increasingly possible with the reduction in the number of airlines due to recent mergers. To the extent that competition reduces prices for air service, the region may see higher priced, less competitive air service because of the auctions.

Lottery

Competition, while possibly driving down frequencies, reinforces the benefit of competitively priced air service in the region. To remedy the challenges related to competition in auctions, certain slots could be allocated by a lottery. There is a precedent for slot lotteries in the New York airport system: In 2000, the Federal Aviation Administration had a lottery for some exemptions previously granted at LaGuardia, which led to high delays in 2000.[12]

The lottery could be organized in different ways depending on the goal. One version could be a tiered lottery for slots created by new capacity, where new-entrant and small market share carriers have either an exclusive or a preferred status in the lottery to obtain a portion of the new slots. Particularly pertaining to small market share carriers, this lottery is not for maximum throughput but rather for competition and connectivity, which are additional system goals. After the interests of these two carrier groups have been met, the lottery could be opened up to all carriers. The advantage of a lottery is that it eliminates a financial barrier to establishing a presence in the New York market. In addition, a tiered lottery would increase carrier competition. The disadvantage of the lottery approach is that it does not establish a market price for peak-hour capacity. Unlike auctions, it does make it possible for cash-strapped airlines to participate.

Approaches that mix auctions and lotteries could also be used. In this manner, some of the new capacity becomes available via lottery for new-entrant or small market share carriers, while another portion of the new capacity is available to all carriers through auction. This type of approach potentially addresses both concerns for better utilization of limited capacity while creating opportunities for new entrant and small market share carriers. The ability to use both approaches depends upon having sufficient new capacity available from NextGen and physical airport improvements to satisfy both needs.

Of the pricing approaches, the auctions and lotteries of incremental capacity seem to have sufficient merit to pursue. The results are mostly known in advance, funds are raised for airport improvements, and the existing airlines will not be faced with significant disruption of their networks that have been carefully built up over many years. However, despite these positive features, it is not clear how much of an impact an incremental auction could have on adding passenger capacity at the airport either through more seats per aircraft in the peak, or more off-peak flights serving more passengers. If the increase were five percent, given the range of growth rates assumed in this report, the incremental auction would extend the benefits of new capacity for two to four years of growth.

Limitations or Bans

The proposed policies examined here that directly limit flights include:

- ban general aviation flights during peak periods;
- ban all-cargo flights during peak periods;
- cap frequencies in individual markets during the peak period;
- ban short distanced air carrier flights during peak periods; and
- ban flights with low seating capacity during peak periods.

11 Coogan, M., RSG; Hansen, M.; Karlaftis, T.; Lee, D.; Mackie, R.; et al. "Innovative Approaches to Addressing Aviation Capacity in Coastal Mega Regions." Airport Cooperative Research Program, 2009.

12 Hansen, M.; Zhang, Y. "Operational Consequences of Alternative Airport Demand Management Policies: The Case of LaGuardia Airport." Transportation Research Record 1915, pp. 95-104, 2005.

Scheduled and Non-Scheduled All Cargo Flights by Hour by Airport

	Current		115 MAP		130 MAP		150 MAP	
Hour Ending	**JFK**	**EWR**	**JFK**	**EWR**	**JFK**	**EWR**	**JFK**	**EWR**
1	1	4	1	4	1	5	1	5
2	0	2	0	2	0	2	0	2
3	0	2	0	2	0	2	0	2
4	0	3	0	3	0	3	0	3
5	1	6	1	7	1	8	1	8
6	3	5	4	6	4	7	4	7
7	3	3	3	3	4	3	4	3
8	2	3	2	3	2	3	2	3
9	1	5	1	5	1	6	1	6
10	2	3	2	3	2	3	2	3
11	0	1	0	1	0	1	0	1
12	0	1	0	1	0	1	0	1
13	0	0	0	0	0	0	0	0
14	0	1	0	1	0	1	0	1
15	0	0	0	0	0	0	0	0
16	0	2	0	2	0	2	0	2
17	0	1	0	1	0	1	0	1
18	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1
21	0	1	0	1	0	1	0	1
22	1	0	1	0	1	0	1	0
23	3	2	4	2	5	2	5	2
24	2	8	2	10	2	10	2	10
TOTAL	22	56	24	60	26	64	26	64
Total in Peak Hours	7	8	8	8	9	8	8	8
Average in Peak Hours	0.78	1.00	0.89	1.00	1.00	1.00	1.00	1.00

Source: FAA ASPM data for current demand and RPA forecasts for future conditions

Capping Flights by Market

	Number of Arriving Flights in Peak Period			Reductions if Capped at One per Hour			Reductions if Capped at One per 90 Minutes		
	EWR	**JFK**	**LGA**	**EWR**	**JFK**	**LGA**	**EWR**	**JFK**	**LGA**
# Peak Hrs	8	9	14						
Market									
PHL			12						3
BOS		11	35		2	21		5	26
DCA		6	28			14			19
IAD		6							
BUF		7						1	
RDU		6	22			8			13
CLT	7	7	19			5	2	1	10
YYZ	6						1		
CMH			15			1			6
CVG	6						1		
DTW			15			1			6
MCO	6	8					1	2	
ORD		7	25			11		1	16
ATL	11		19	3		5	6		10
TPA		6							
FLL		6							
LAS		7						1	
LAX		18			9			12	
SFO		15			6			9	
LHR		11			2			5	
TOTAL	36	121	178	3	19	66	11	37	106
Reductions per Hour - Two Directions				0.8	4.2	9.4	2.8	8.2	15.1

Source: OAG and Regional Plan Association

General Aviation Bans

General aviation movements at each of the three major airports have dropped steadily since the mid-90s, with 54 percent fewer flights in 2009 than there were in 1996. On the typical July 2009 day (chosen to be consistent with the earlier analysis in Chapter 4), only 32 flights occurred at the three airports combined.[13] Most general aviation flights have been priced out of the three airports over the years, with much of the shift to Teterboro, which on an average day in 2009 handled about 380 general aviation flights, twelve times the number at the three major airports combined. Among the 32 remaining flights, there are no more than two at any hour at any one airport, with an average in the peak hours of about one flight per hour. Because it can be expected that this trend will continue, the ban of general aviation movements would likely free up less than one slot in the peak hour at each of the three airports in subsequent years, making the total ban of general aviation flights of limited value.

All-Cargo Flight Bans

Although much of the cargo is carried in the bellies of air passenger aircraft, there are some all-cargo flights, mostly operating overnight. In Table 9.3, the diurnal pattern of these flights is shown for JFK and EWR (there are no all-cargo flights at LGA). The projected number of flights by hour is also displayed. The majority of all cargo flights occurs in off peak hours, mostly in the overnight periods from 10pm to 7am. At EWR there are a large number of arrivals in the morning hours. Fedex and UPS rely on these flights for morning delivery in New York and banning them would be fatal to their operations and damage the economy of the region. At both airports, the average all-cargo movements during peak hours are projected never to exceed one per hour. If such flights were banned it would not open more than that number of slots in the peak hour. Moreover, their elimination would do little to free up capacity during peak times.

Cap Frequencies in Individual Markets in the Peak Period

The most straightforward method to limit peak-period passenger air carrier activity is to reduce the number of peak period flights to individual markets where frequencies are high. Rather than an outright ban of certain types of flights over a long peak period, this option would merely thin out service, retaining the options for the traveler. Table 9.4 illustrates the number of flights that would no longer occur over 8, 9, and 14-hour peaks at EWR, JFK and LGA, respectively for two frequency thresholds. One would limit the number of flights to one per hour in each direction during the peak period, and the other would limit flights one every 90 minutes. The impacts are far greater at LGA than at the other two airports because of very high service frequencies to Boston, Washington, Raleigh/Durham, and Chicago, and because of the multiple carriers in those markets. At LGA, the reductions could amount to more than 10 flights per hour with a one-per-hour cap, and over 15 per hour with a one per 90-minute cap. JFK reductions would be about four per hour for the hourly cap and more than eight per hour with the 90-minute cap. EWR reductions would be relatively insignificant, three per hour with the 90-minute cap and under one-per-hour with the hourly cap.

By applying the one-per-hour standard for LGA, the service to and from Boston, Washington National, Raleigh/Durham and Atlanta would be significantly reduced. Among these four, Boston and Washington National would seem to be the most

[13] FAA Aviation System Performance Metrics (ASPM) database

arriving every 23 minutes on average during the 14-hour peak; Washington National every 30 minutes. These two cities have an intercity rail option as well. Any changes of this type would require an agreement among the competing airlines, which would be difficult to fashion. These flights are currently quite profitable. Nor is it clear what would trigger the government intervention to implement this approach.

The Atlanta and Raleigh/Durham markets are even less suited for this treatment. Atlanta flights range from 120 to 190 seats today, and thinning the number of flights would require much larger aircraft. The Raleigh/Durham flights mostly employ aircraft of 50 seats or less, making consolidation a more serious consideration.

If the one-hour standard were applied to only the Boston and Washington National markets, five slots per hour in the 14-hour peak could be opened up. In neither of the these markets is the aircraft size excessively large, and the load factors are low, under 50 percent in both cases, so reducing the number of flights would make them more efficient, and it can be done with aircraft within the fleet size commonly used domestically. The impact of reducing competition would undoubtedly drive up fares, if one or both of the two airlines now providing the shuttle service to these two markets were to curtail service significantly.

At JFK, the major high frequency markets are Los Angeles and San Francisco. Applying the one per hour standard in these highly competitive markets would open up almost four slots per hour. However, the application of this standard to these long distance flights is less practical. For the LAX market, to serve the same number of passengers, the aircraft size would have to be doubled; for SFO the aircraft size would have to be 2 ½ times larger than it is today. While this might be possible over time, it would require a major rethinking of the affected airlines' fleet plans. As for EWR, Table 9.4 suggests, there is little to be gained by establishing a one-hour cap there.

The concept of thinning high frequency flights is in conflict with the desire of new entrants in highly desirable markets that could bring fares down. Whatever the potential value of thinning flights, this action would have be weighed against the impact on fare levels and the creation of more, not less competition.

The foregoing discussion suggests that there is some potential at LGA to open up capacity by capping flight frequency. Currently, there is no legal authority by the federal government or the Port Authority to establish such caps. A system to establish frequency of service caps would require a legal change – a *re-regulation* of the market – establishing a method of allocation of service among the airlines. A system of this type could certainly force airlines to increase aircraft size over time. This measure could reduce competition among airlines and result in higher fares. It would also offer less choice for the traveling public, particularly the business community that values the convenience of high frequencies in markets like Boston and Washington. For competitive reasons the airlines are likely to resist this action, but as a low cost measure to free up capacity, it cannot be ignored.

Ban of Short Distance Flights

A reduction or ban on short-distance air carrier flights is one possible way of gaining capacity at the three airports on the premise that these short flights are less necessary since other modes may be substituted for flying. For the three airports the peak hours for arriving and departing flights was isolated, and the flights of 250 miles or less identified. The results are shown in Table 9.5.

Short Distance Flight Ban Analysis

JFK	Arrivals	Arrivals	Departures	Departures
Peak Hours	5am - 7am	1pm - 8pm	7am - 10am	4pm - [illegible]
# Short Flights	0	29	16	
# Total Flights	35	276	124	
% Short	0	10.5	12.9	
Short Flights per Hour	0	4.1	5.3	3.3
Markets	0	9	8	6
EWR	**Arrivals**	**Departures**	**Departures**	
Peak Hours	1pm - 10pm	6am - 10am	3pm - 9pm	
# Short Flights	40	19	21	
# Total Flights	320	267	215	
% Short	12.5	7.1	9.8	
Short Flights per Hour	4.4	4.8	3.5	
Markets	15	13	[illegible]	
LGA	**Arrivals**	**Departures**		
Peak Hours	7am - 9pm	7am - 9pm		
# Short Flights	128	121		
# Total Flights	521	499		
% Short	24.6	24.2		
Short Flights per Hour	9.1	8.6		
Markets	13	13		

Source: OAG and Regional Plan Association

TABLE 9.6

Passengers Affected by Short Distance Flight Ban – 2009

	JFK		EWR		LGA	
	Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
Total Passengers	1,737	2,159	1,869	1,966	8,108	7,629
Non-connecting	585	728	[illegible]	598	[illegible]	5,195
Connecting	1,152	1,431	1,301	1,368	2,586	2,434
[illegible]		66.3		69.6		31.9

Source: OAG and Regional Plan Association

At JFK there is an early morning arrival peak, mostly with long distance flights that would not be subject to a short flight ban. The other peak arrival period extends from 1pm to 8pm during which time there are 29 short distance flights, or about four per hour arriving from nine markets. Departures peak in the 7am to 10am period in the morning and in the late afternoon to evening period; a ban in the morning would result in over five fewer flights per hour, and a ban in the evening would reduce departing flights by more than three per hour. The overlap in arrival and departure peaks fall between 4pm and 8pm; a ban of short flights would lower flight movements by more than eight per hour.

At EWR, there is one nine-hour peak arrival period, between 1pm and 10pm. The departures peak twice, in the morning and after 3pm in the afternoon. These peak periods would have from about four to five fewer flights per hour if a short flight ban had been put in effect. For the overlap period from 3pm to 9pm about eight fewer flights per hour would operate.

At LGA, the idea of banning peak period short-distance flights has broad implications since the peak period extends over the entire day from 7am to 9pm. LGA is primary a short distance market, limited by the 1,500 mile perimeter rule and by runway lengths. An outright ban on short-distance flights would affect about ¼ of all daily flights. The ban of short-distance flights during peak times translates to removal of flights at just about all the times people wish to travel. Moreover, as has been shown in earlier chapters, the need for added capacity at LGA is likely to be less severe than at the other two airports, suggesting that

a ban on flights at LGA is likely to be an overreaction to the problem. Nevertheless, for completeness sake, the LGA impacts are included here.

The impact on passengers of the elimination of these flights would depend on the nature of their trips and the ground options available to them. Just how disruptive it would be depends, in large measure, on whether they are traveling to the region, or are using the three airports to connect to another flight. The data for arriving passengers stratified for connecting and non-connecting passengers are shown in Table 9.6.

At JFK and EWR there are close to 4,000 arriving and departing passengers at each airport who would be directly affected by the short flight ban. At LGA the number swells to almost 16,000. There are significant ramifications to these passengers if they were no longer able to fly in the peak. If they are connecting, banning the first (or last link) coulddisrupt their entire trip. If their banned flight is being used only to travel to or from the region, they may have other choices that might be less disruptive.

Passenger Choices.

Passengers whose flights are banned have a number of choices, at least theoretically. They can fly at a time when flights are not banned, or they can use intercity rail or buses, or drive, or not make the trip at all, or, if they are connecting at a New York airport, connect through another city. The feasibility of these options differs for connecting and non-connecting passengers.

For JFK and EWR passengers, if flights were not available at the time they initially chose, their first thought might be to find another time to fly. Flying was their initial modal choice, probably for the combined consideration of relative time, cost, and convenience among the possible modes, and these factors are relevant. However, the window of flying options has now been narrowed.

At JFK and EWR combined, there are about 2,500 non-connecting passengers on flights that might be banned in the peak period. They would have to choose an earlier arriving flight, effectively losing the day to premature travel, or requiring them to arrive late in the evening. Either option would disrupt their schedules. For the business traveler these choices are likely to have the greatest impact, resulting in a loss of productive time at one end of their trip, i.e. having less than a full day available, or leaving the night before and suffering an added expense. For the personal travelers the loss of preferred travel time would have an impact as well, although their schedules are likely to more flexible. Still, they would suffer some time and convenience losses.

For a connecting passenger, the loss of the connecting flight can have a severe impact. In some cases, the passenger may be unable to make a connection to another flight by flying in the off-peak, but in many cases, especially where the connecting flight is infrequent, or for travel over the Atlantic, this will not be an option at all.

The prospect of flying at a different time is a non-starter at LGA, since the ban would be in place throughout the entire day; passengers would be left with the unrealistic choice of either landing or taking off at LGA before 7am or after 9pm.

Another option could be to switch to intercity rail. For those who have this option now, but chose to fly, rail obviously represented an inferior alternative, especially if they number among the nearly two-thirds of the travelers who are not traveling to Manhattan. Of course, as was discussed in the previous chapter, the eventual improvement in rail travel times could make rail a more attractive option. The absence of flights at preferred times could drive still more people to rail. This can be a realistic, if not preferred option for some of the 13,000 non-connecting passengers on short distance flights. Most of them are traveling from places with acceptable rail service either on the Northeast Corridor or to/from Albany. Of these, about 2,500 are flying into or out of JFK or EWR. About three in four of these, or about 1,700 have rail service today of less than three hours. For LGA, 93 percent of the affected passengers have a reasonable rail option. These observations should be tempered by the fact that all intercity rail service begins or ends at Penn Station, and most passengers are not traveling to or from Manhattan. Yet, it can be expected that in the absence of a timely air option a sizable shift to rail could take place.

For the 10,300 connecting passengers however, the rail option is less realistic, since intercity rail leaves them at Penn Station and they still must make their way to the airport for their connecting flight. For those traveling to or from points south – Philadelphia, Baltimore, Washington – and connecting at EWR, this option is a possibility since they can use Amtrak to reach EWR. Of the 2,700 EWR connecting passengers in the peak hours, about 800 are from these markets. However, as discussed elsewhere, the current Amtrak schedule has very limited stops at the EWR station on the Northeast Corridor, with little prospect that this will change in the near future.

In recent years, new bus services between major cities with attractive amenities have become a realistic option for many travelers. This service is now available from cites that carry 88 percent of the non-connecting JFK and EWR passengers impacted by a short flight ban. The LGA share is still higher, 94 percent. Like intercity rail, intercity bus could be a realistic option for those non-connecting air passengers who would be negatively affected by a peak flight ban. The bus option becomes less attractive alternative to flying for the driving distances of more than four hours, such as Boston or Washington, and for those travelers for whom price is not as great a consideration. Similar to intercity rail, the bus services begin and end in Manhattan and will be a less attractive option for those without a Manhattan origin or destination. Still, for those passengers who will be lured by lower fares and willingness to chance the unreliability of the highway system, and who are less time-sensitive, this could be a practical option. For connecting passengers, this option is a poor choice, since the passengers must make their way to or from Manhattan to make their airport connection.

The option to drive for trips to or from New York is available to most air passengers traveling within 250 miles, particularly for those at the shortest distances, such as Philadelphia, Scranton, Hartford, or Albany. However, only about 200 of the non-connecting air passengers to JFK and EWR are coming from these locations since these flights are largely made of connecting passengers; those going only as far as New York are less likely to be flying such short distances now. From longer distances, the non-connecting passengers are likely to find driving a less attractive choice because of time disadvantages.

For connecting passengers, the drive option is unattractive, adding the stress of catching a flight while negotiating the uncertainties of the region's congested highway network, adding to the inconvenience and expense of flying at time that is not preferred.

A non-connecting passenger may decide that the trip is not worth taking if it cannot be taken at a convenient hour, and the other travel choices are unattractive or unavailable. This possibility may become more real over time as the repeat flyers conclude that traveling to another place for business or pleasure is preferable. For business travelers, the choice may be to conduct more business electronically.

Choices for Passengers Faced with Short Distanced Flight Bans

	Non-connecting Passengers	Connecting Passengers
Total in Peak	13,196	10,272
JFK	1,313	2,583
EWR	1,166	2,669
LGA	10,717	5,020
Change travel time	Loss of productivity inconvenient	May make connection impossible; loss of time; inconvenient
Intercity Rail	Possible for many, especially if trip end is in Manhattan	Unrealistic for most except if connecting at EWR from south; limited Amtrak schedule though.
Intercity Bus	Possible for those prepared for highway delay and for trips to Manhattan; poor choice for business travelers	Poor option: leaves passengers in Manhattan
Drive	Realistic option only for trips with driving time of under three hours.	Possible for driving time of under three hours; unreliable high-way travel makes a poor choice.
Connect elsewhere	NA	Poor choices may lead to rerouting via another airport
Not make trip	Poor choices above may lead to trip not made	Might consider if only way to reach destination is through NY airport.

Source: Regional Plan Association

For connecting passengers, the option to make their connections at airports outside the region may exist, but in many cases may involve less convenient connecting choices.

A summary of the choices that short-distance passengers face with from a theoretical peak flight ban is shown in Table 9.7.

Effect on Markets Curtailed or Abandoned.

Because the wide span of the day that would be affected by a ban of flights ,the impact of a total ban on short distance flights on the markets that lose service in the peak is likely to be severe. In many cases, the off-peak that remains may not be enough to retain a viable service in the market over the course of the day. In Table 9.8 the implications of an-across-the-board ban on short-distance flights in peak hours are suggested for service in the 16 affected markets for the three airports. For nine of the 16 markets the loss of peak period service over such a wide part of the day would have airlines seriously considering dropping the market entirely. For the four markets with the most air service today, the size of the air market would likely result in the retention of air service to the three airports, but not without poorer time of day choices and highly inconvenient connections. Albany, Baltimore and Providence could lose air service to one or more of the three airports.

While these impacts would be severe, causing loss of service in many markets and inconvenience to today's air passengers, a more nuanced version of limiting the demand in a slot-controlled environment could be considered with considerably fewer negative ramifications. This approach would consider whether there are rail and auto options available and the importance of retaining service in markets with high shares of connecting passengers. It would also consider how many flights could be sacrificed and still offer a reasonable frequency for those connecting flights. In Table 9.9, the connecting passenger percentages and the number of two-way peak flights are shown for these 16 markets.

Of these 16 markets, Boston and Washington National are large markets, and despite the relatively high quality of rail, the four-hour-plus drive times, and high connecting shares, they do not warrant further thinning out of service beyond what has been estimated for the frequency caps discussed earlier. Scranton and Hartford are two markets that could be dropped because their driving times to New York are relatively short. Harrisburg can access the Philadephia airport by auto. Passengers destined to New York would have the choice of flying from Philadelphia to one of the New York airports if they were connecting to other destinations, or use Amtrak from Philadelphia to New York, if they were destined for the region. All other markets are either too far to be a reasonable drive, have high connecting shares, have poor rail service as a substitute, or service would not be frequent enough to warrant thinning out some of it.[14] For Nantucket and Martha's Vineyard, their island isolation argues against dropping their flights.

The foregoing suggests that reductions in short distance peak flights would at most affect two flights a day at JFK and ten flights a day at EWR or about one per hour at EWR (those shown in the bold boxes), hardly worthy as an effective action to gain significant capacity.

Ban of Small-Sized Aircraft Flights

The premise for a ban on flights of smaller aircraft with fewer seats is that these aircraft use scarce airspace and runway capacity less effectively than would larger aircraft. By removing them, more passengers could be served on the larger aircraft. Markets using small aircraft tend to operate in smaller markets in small and mid-sized cities where there is insufficient capacity to fill larger aircraft. In Table 9.10 the number of flights with 50 seats or less that would be banned by this theoretical analysis is shown.[15] As demand increases in these markets, the airlines are likely to upgauge their aircraft reducing the number of flights that fall within this 50-seat threshold of this analysis.

Given the existing fleet mix, at JFK there would be 80 fewer flights. In the morning peak there would be about six fewer flights per hour; in the 4pm to 9pm, the reductions would total more than nine flights per hour, accounting for both arriving and departing flights. These bans would affect about 20 markets, most with only one or two flights in the peak hours in each direction. At EWR, the bans would have a still larger effect with 154 flights eliminated, or about 15 flights combined for departures and arrivals during the 3pm to 9pm peak period, affecting about 30 markets. Since aircraft using LGA tend to be smaller, a ban of flights with 50 seats or less would eliminate still more flights – about 12 per hour in each Table 9.11 estimates the number of passengers affected from each category.

The number of passengers affected at JFK would be about 3,100; at EWR over 6,000. The volume climbs to 12,000 a day at LGA. What options would these passengers have if the small-sized aircraft were no longer available?

[illegible] more than six peak period flights in each direction at JFK and EWR and no more than nine peak flights in each direction at LGA. None of the markets other than Boston and Washington exceeds that threshold, and those two markets need the service for non-connecting passengers.

15 Small-sized aircraft flights of less than 250 miles were included in the short-distance flight analysis and do not appear here.

TABLE 9.9

Market Impacts if a Total Ban Was Instituted for Short Distance Flights in Peak Periods

Market	JFK	EWR	LGA
Philadelphia, Boston, Washington-National, Washington-Dulles	Rail option remains, but missed connections / disrupted schedules	Rail option remains, but missed connections / disrupted schedules	Rail option remains, but disrupted schedules
Albany	Likely elimination as air market	Likely elimination as air market	Rail option remains, but disrupted schedules
Providence	No service now	Likely elimination as air market	Rail option remains, but disrupted schedules
Baltimore	Likely elimination as air market	Likely elimination as air market	Rail option remains, but disrupted schedules
Syracuse	Likely elimination as air market	Likely elimination as air market	Likely elimination as air market
Hartford	Likely elimination as air market	Likely elimination as air market	No service now
Nantucket (seasonal)	Likely elimination as air market	No service now	Likely elimination as air market
Ithaca, Manchester, NH	No service now	Likely elimination as air market	Likely elimination as air market
Harrisburg, Scranton	No service now	Likely elimination as air market	No service now
Martha's Vineyard, Hyannis (seasonal)	No service now	No service now	Likely elimination as air market

Based on service in place in July 2009

Source: Regional Plan Association

TABLE 9.10

Possible Flight Reductions for Short-Distance Flights

	JFK		EWR		LGA	
Market	# Flights - Two Directions	% Connecting Passengers	# Flights - Two Directions	% Connecting Passengers	# Flights - Two Directions	% Connecting Passengers
Philadelphia	2	94	9	89	24	90
Scranton	0	na	4	75	0	na
Hartford	2	97	2	94	0	na
Harrisburg	0	na	4	74	0	na
Albany	1	90	5	93	7	57
Providence	0	na	4	87	8	65
Baltimore	4	86	4	91	18	50
Boston	14	67	11	60	73	22
Manchester	0	na	3	87	8	50
Nantucket	1	16	2	16	8	41
Ithaca	0	na	2	81	6	45
Syracuse	4	63	4	75	16	41
Hyannis	0	na	0	na	4	27
Martha's Vineyard	0	na	0	na	8	28
Washington National	12	65	9	62	57	22
Washington Dulles	9	60	11	74	12	73

Source: OAG and Regional Plan Association

TABLE 9.10

Small Sized Aircraft Flight Ban Analysis

JFK	Arrivals	Arrivals	Departures	Departures
Peak Hours	5am - 7am	1pm - 8pm	7am - 10am	4pm - 10pm
# Small Flights	0	36	18	26
# Total Flights	35	276	124	239
% Small	0	13.0	14.5	10.9
Small Flights per Hour	0	5.1	6.0	4.3
Markets	0	20	16	17

EWR	Arrivals	Departures	Departures
Peak Hours	1pm - 10pm	6am - 10am	3pm - 9pm
# Small Flights	69	37	48
# Total Flights	320	267	215
% Small	21.6	13.9	22.3
Small Flights per Hour	7.7	9.3	8.0
Markets	34	31	30

LGA	Arrivals	Departures
Peak Hours	7am - 9pm	7am - 9pm
# Small Flights	173	159
# Total Flights	521	499
% Small	33.2	31.9
Small Flights per Hour	12.4	11.4
Markets	37	37

Source: OAG and Regional Plan Association

TABLE 9.11

Passengers Affected by Small-Sized Flight Ban – 2009

	JFK		EWR		LGA	
	Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
Total Passengers	1,406	1,711	2,746	3,386	6,274	5,766
Non-connecting	825	1,004	1,999	2,465	5,151	4,734
Connecting	581	707	747	921	1,123	1,032
% Connecting		41.3		27.2		17.9

Source: OAG and Regional Plan Association

Reductions in service of such magnitudes would have impacts greater than the impacts associated with short flight bans. Not only are there many more flights involved, but the alternatives for the passenger are much more limited. Intercity rail and bus are no longer a reasonable or even a possible option in most markets. The rail option is not a likely choice; many of the cities in question are typically a five-hour or more rail trip away. For the small-sized aircraft flight ban, these passengers are by definition beyond 250 miles,[16] making driving a poor option.

For passengers on small-sized aircraft that would be banned, the options are poor, not only for the 5,100 connecting to other destinations, but also for the 16,200 passengers originating or destined for the region. The modal options, occasionally workable for the short distance trips, are all either unrealistic or unavailable. A few have options for traveling on larger aircraft, but only in about one-quarter of the markets affected. Of course, the airlines, when faced with a ban on small-sized aircraft, may in time increase the size of their aircraft if they have the aircraft in their fleet, but it could still reduce service frequency in these markets. In the short term, when faced with a ban, some passengers may not travel to the region, or connect elsewhere. For the cities that would be affected by the small-sized flight ban, there arise no express bus service today, leaving these 16,200 non-connecting passengers without this option. As with the short distance flight ban, the impact on connecting passengers would be greater than for non-connecting passengers. In Table 9.12, a summary of the choices that passengers could have and the impacts for both groups of passengers is presented.

Effect on Markets Curtailed or Abandoned.

The elimination of peak flights with small aircraft would have widespread negative effects. Unlike short-distance flights, none of the 48 affected markets have workable rail access to fall back on, nor are they close enough to New York to allow for driving as a realistic option. However, the possibility exists for some consolidation of arrivals and the upsizing of the aircraft, but this will result in lower frequencies in those cases where the market survives. In Table 9.13 the implications of banning these flights on the affected markets is shown. Twenty-two markets are likely to be totally cut off from air service to New York. These are predominantly mid-sized cities in the southeast and Midwest with infrequent service

today. Four markets would lose service to two of the three major airports, and another 16 markets would lose service to one of the three airports. Lower service frequencies would be widespread, affecting 21 markets.

In some cases, the airlines could combine flights, increasing the size of the aircraft in the market, avoiding the ban. However, combining flights is not possible where there is only one flight in the peak period without service being lost. Of the 18 markets served by departing flights at JFK in the 7am to 10am morning peak, 16 are served by only one flight. Of the 26 flights departing from 4pm to10pm peak, ten of the 17 markets have only one flight. Ten on the 20 arriving markets in the seven-hour peak have only one flight.

The picture is similar at EWR. Of the 37 flights departing for 31 markets in the 6am and 10am peak period, 23 have only one flight in that four-hour period; 17 of 30 markets are served by only one flight in the afternoon peak from 3pm to 9pm. Arriving flights over the nine-hour arrival peak fare a little better with only 14 of the 34 markets served with one flight.

16 Flights of less than 250 miles and with 50 seats or less were included in the short distance category.

Choices for Passengers Faced with Small-Sized Aircraft Flight Bans

	Non-connecting Passengers	
Total in Peak	16,178	5,1[illegible]
JFK	1,829	1,2[illegible]
EWR	4,464	1,6[illegible]
LGA	9,885	[illegible]
Change travel time	Greater loss of productivity for business travelers than short flight ban; highly inconvenient	May make connection impossible; loss of time inconvenient
Intercity Rail	Rail times non-competitive	Unrealistic; times long passenger in Manhatt[illegible]
Intercity Bus	No express bus service in these markets	Service not available in this market; if available would leave passengers Manhattan.
Drive	These markets all have driving times to NY of five hours or more.	Driving times too far.
Connect elsewhere	NA	Poor choices may lead to rerouting via another airport
Not make trip	Poor choices above may lead to trip not made	Might consider if only way to reach destination is through NY airport.

Source: OAG and Regional Plan Association

Consolidation with larger aircraft at LGA would have less impact on small markets because there are fewer markets with only one or two flights in the peak. Of the 37 markets served with small aircraft in the 14-hour peak, only five markets have only one arriving and one departing flight over those 14 hours.

At the other end of the spectrum, six markets[17] have more than seven flights in each direction in the 14 hours. These six markets differ in some interesting ways. The two Canadian markets each have a Canadian and American flag carrier. All of Air Canada's flights to and from both cities have more than 50 seats (and as much as 140), and all of American Airlines flights have fewer than 50 seats. A ban on small aircraft would lower American's presence in these markets, and thus eliminate competition, likely putting upward pressure on fares. Two other markets – Buffalo and Rochester – each have seven flights in each direction in the peak hours, and each has only one carrier, USAir. Since the frequency of service averages two flights per hour in each direction, consolidation to larger aircraft would affect the quality of service for both important New York State markets.

The last two markets present still a different situation. Both Columbus, Ohio, and Raleigh/Durham are served by three carriers, all more or less equally. All flights with one exception are with 50-seaters, or less. Columbus, with 13 flights in each direction, averages less than one per hour, and consolidation would limit service. Having the three carriers in the market keeps fares down. For Raleigh/Durham with 22 arriving and 22 departing flights in the 14-hour peak period, a consolidation to larger aircraft could still leave this market with high service frequencies. How this would be accomplished fairly to all airlines is less clear. Still, in the search for squeezing more capacity from the existing air system, having 44 flights a day between Raleigh/Durham and LGA with aircraft of 50 seats or less, appears to be excessive. One flight per hour in each direction would eliminate 16 flights over the 14-hour peak, or just over one per hour. Upgauging could result in the same number of seats being provided, even if the service frequency were reduced to one per hour in each direction. In essence, this would be a frequency cap, not unlike what has been illustrated for Boston and Washington National in the earlier discussion.

17 Rochester, Buffalo, [illegible]

Market Impacts If a Total Ban Was Instituted for Small-Sized Aircraft Ban

Markets	JFK	EWR	LGA	Implications for Market
Charlottesville, Ottawa, Bangor, Roanoke, Charleston, WV, Quebec, Dayton, Wilmington, NC, Lexington, Halifax, Ashville, Columbia, SC, Grand Rapids, Knoxville, Charleston, SC, Greenville/Spartanburg, Madison, Savannah, Birmingham, Fayetteville, Kansas City, Nassau	No service now	Likely loss of all service	Likely loss of all service	Loses all air connections to New York
Columbus, Indianapolis, Rochester	Likely loss of all service	Likely loss of all service	Larger aircraft available	Loss of service at JFK and EWR; less frequent at LGA
Nashville	Likely loss of all service	Likely loss of all service	No small aircraft in use	Loss at service at JFK and EWR
Montreal, Toronto	Likely loss of all service	Upsizing of aircraft likely	Larger aircraft available	Loss of service at JFK, less frequent at EWR and LGA
Buffalo	Large aircraft available	Likely loss of all service	Upsizing aircraft likely	Loss of service at EWR; less frequent at JFK and LGA
Pittsburgh, Burlington, Norfolk, Richmond, Cleveland, Raleigh/Durham	Likely loss of all service	No small aircraft in use	Larger aircraft available	Loss of service at JFK; less frequent at LGA
St. Louis	Likely loss of all service	Upsizing of aircraft likely	No small aircraft in use	Loss of service at JFK; less frequent at EWR
Cincinnati, Louisville	No small aircraft in use	Likely loss of all service	Larger aircraft available	Loss of service at EWR; less frequent at LGA
Jacksonville	Large aircraft now	No small aircraft in use	Likely loss of all service	Loss of service at LGA; less frequent at JFK
Greensboro, Milwaukee, Omaha	No service now	Likely loss of all service	No small aircraft in use	Loss of service at EWR
Portland, ME	Large aircraft available	No small aircraft in use	Upsizing aircraft likely	Less frequent at JFK and LGA
Detroit	No small aircraft in use	Large aircraft available	Larger aircraft available	Less frequent at EWR and LGA
Chicago - O'Hare, Minneapolis	No small aircraft in use	Larger aircraft available	No small aircraft in use	Less frequent at EWR

Source: OAG and Regional Plan Association

At JFK and EWR, there are no markets with a high frequency of small aircraft to warrant consideration of small-sized aircraft consolidation.

Effect of a Short Distance and Small-Distance Flight Bans on Connecting Service

One concern, often expressed, is that that the elimination of short-distance and small-sized aircraft would weaken the economic viability of many flights that fly longer distances from New York, both to domestic and overseas locations. If large numbers of flights were banned, it is possible that the passengers that are not delivered to these connecting flights will be the difference between a profitable and non-profitable flight and market. While it is not possible to be certain, some flights could drop below their threshold of profitability, resulting in a loss of service not only for the connecting passengers, but also for those starting or ending their trip in the region.

Because of the time zone differences, flights to Europe and to the West Coast are especially vulnerable since they tend to leave in the late afternoon, which coincides with the period when connecting passengers in the short distance and small aircraft feeder markets would be barred from arriving at JFK and EWR. This is demonstrated in Table 9.14 for a sample of domestic and international destinations. The table shows the proportion of passengers to a number of markets that would likely have been on the banned flights.

At JFK, markets with only one flight a day could lose higher shares of their passengers, and would thus be more vulnerable. These include Nice, Accra, Kiev, Pisa and Amman. Brussels could lose one of its three flights. Among the U.S. markets, Portland appears to be very vulnerable to losing service, but other U.S. destinations would be much less likely to lose significant service.

At EWR, the middle-sized capital cities throughout Europe would be threatened with the loss of service, including Madrid, Brussels, Copenhagen and Stockholm. Tel Aviv also could lose service from EWR. Portland again seems to be highly vulnerable to loss of service. London and Las Vegas could see a thinning out of service.

While selectively banning peak flights that feed longer distance flights would certainly open up space for flights traveling longer distances and carrying more people, they would have deleterious effect on the traveling public. Six percent of JFK's and nine percent of EWR's passengers would be forced to travel when they do not wish to, or be deprived totally of their ability to reach New York, either because they are destined for the region or wish to connect to one of the flights to over 200 destination around the world, at some of the nation's most competitive fares. For most, alternative means to access our market are at a minimum, costly, impractical or entirely absent.

Potentially, dozens of cities in the United States would lose direct service into the New York airports or would have their service frequency seriously curtailed. The loss of connecting service from U.S. cities could jeopardize existing service to many destinations around the world, eroding New York's position as a world city.

The number of people potentially affected will surely grow, as flights that are removed and the effects multiplied, eviscerating service in many markets and cutting off dozens of markets to New York (and cutting off New York to them).

However, the foregoing discussion is based on a total ban on short-distance and small-sized aircraft ban. With a much more limited and surgical consolidation of flights only at LGA in Boston, Washington-National and Raleigh/Durham markets, the impact on connecting flights at JFK and EWR would be irrelevant.

Connecting Passengers if Both Short Distance and Small-Sized Peak Flights Were Banned - Sample of Destinations from JFK and EWR

JFK Market	Flights	Seats	Passengers	Connecting Passengers on Banned Flights	% of Passengers on Banned Flights
Portland, OR	2.0	310	248	29	11.7
Nice	1.0	214	171	12	[redacted]
Accra	1.0	246	197	13	6.5
Kiev	0.8	183	146	9	[redacted]
Pisa	0.8	183	146	8	5.2
Brussels	3.0	599	479	22	4.6
Amman	1.3	303	242	10	4.2
Las Vegas	9.7	1,568	1,254	52	4.1
New Orleans	2.9	429	343	9	2.6
Austin	1.9	232	186	5	2.5
Madrid	2.9	908	726	17	2.3
Tel Aviv	2.6	858	686	13	[redacted]
London/Heathrow	15.6	4,391	3,513	54	1.5
Dallas	2.0	266	213	1	[redacted]
Miami	7.9	1,663	1,330	5	0.4

EWR Market	Flights	Seats	Passengers	Connecting Passengers on Banned Flights	% of Passengers on Banned Flights
Portland, OR	3.0	471	377	70	18.5
Las Vegas	5.6	1,069	855	55	[redacted]
Madrid	2.0	349	279	15	5.3
Brussels	2.9	508	407	21	[redacted]
Copenhagen	1.9	401	321	17	5.1
Tel Aviv	2.9	700	560	23	4.2
Stockholm	2.3	567	454	19	4.1
London/Heathrow	7.9	1,852	1,482	54	3.6
New Orleans	2.9	368	294	9	3.1
Austin	3.0	456	365	8	2.1
Dallas	9.3	1,217	974	17	1.8
Miami	7.9	1,276	1,021	8	0.8

Source: USDOT, *Air Passenger Origin Destination Survey*; USDOT, Schedule T-100; Regional Plan Association and Landrum and Brown analysis

Federal and Airport Role in Demand Management

The current legal and institutional landscape must be considered when implementing any of the discussed demand management actions. In the United States, the airlines set operations, routes, and vehicle technology; the airports provide and manage infrastructure; and the FAA provides guidance and policy related to airline and airport operations. These actors are complementary, yet the bounds of their roles related to demand management are not always well defined.

Aircraft operators play a large role in choosing and altering operational frequency and vehicle types. Airlines incorporate passenger demand and preferences into their fleet selection and scheduling decisions, along with airport restrictions and competition. A major challenge for airlines to alter operational frequency, especially at congested airports, is that the right to land is highly protected. Property rights related to slots are not well defined. At slot-controlled airports in the United States, airlines must use their slots 80 percent of the time over a defined time. This rule (use-it-or-lose-it) ostensibly ensures that incumbent carriers do not hold slots they are not using in order to block new entrants. While this rule [illegible] can be manipulated if a carrier holds many slots, since the 80 percent threshold is based on the carrier's pool of slots at an airport and not on individual operations.[18] Guarding slots is wise from the carrier's competitive standpoint, as discussed earlier; the competitive pressure to hold on to a slot often drives an airline to schedule a flight rather than shed it.

Two examples highlight the challenge of encouraging peak spreading. In 2005, the FAA took a more proactive role in managing congestion and delay at Chicago O'Hare (ORD) after encouragement of the domestic carriers to self-regulate their operations schedule into ORD had little impact.[19] At the New York airport system, the FAA has determined the number of slots and the allocation of these slots since the 1960s. When additional LGA slots were made available through the 2000 "Air-21" Act, delays skyrocketed at LGA.[20]

In contrast, the FAA and airport operators have essentially no direct control of operational activity, including whether an airline serves a particular airport, the frequency or time of day of service, or the aircraft type or size used to provide service.[21] In managing operations, the FAA influences airline operations through restrictions and policies related to airports. Specifically to demand management, the FAA establishes restrictions on operations per hour, or caps, at the most congested airports (such as the New York airports). FAA also sets and refines policy related to the airport's ability to influence operations through pricing. The relationship between the airports and the FAA is complicated, as an airport both looks to the FAA for guidance and policy, yet asserts its own unique perspective on capacity management. The airport operator is not always in a position to respond to changes in allocations, since terminal facilities, including the number and size of gates, may not be interchangeable.

Restrictions on the number of operations per hour at an airport, or managing airport access to reduce congestion, has historically fallen in the purview of the FAA. The FAA manages the airspace per Title 49 of the United States Code (USC) subtitle VII[22], and has the ability to set operational limitations to "ensure the safety of aircraft and the efficient use of airspace." However, airports have long been able to establish fees and charges for aeronautical use of the airfield, yet this charge can only cover the cost of operating the airfield. This includes the right to set minimum landing fees designed to affect various weight classes of aircraft differently, with the intent of providing incentives to reduce airfield delay during periods of congestion. This ability was extended in 2008, when the FAA and the Office of the Secretary of Transportation amended the 1996 Rates and Charges Policy. The amendment allows airport proprietors to establish a two-part landing fee that can incorporate congestion concerns in a (peak) period and the weight of the aircraft; in effect, it can provide a price signal to give incentives to airlines to modify aircraft gauge and/or reduce frequency.[23]

18 Levine, Michael E., "Airport Congestion: When Theory [illegible] University Law and Economics Working Papers 159, 2008. http://[illegible] lewp/159

19 FAA. Congestion and Delay Reduction at Chicago O'Hare International Airp[illegible] Federal Register, Docket Number FAA-2005-20704. March 25, 2005.

20 Ball, M., Donohue, G. L., Hoffman, K. Auctions for the Safe, Efficient and Equi[illegible] Allocation of Airspace System Resources. In Cramton, P., Y. Shoham and R. Steinb[illegible] eds. Combinatorial Auctions. MIT Press, Cambridge. Chapter 22, pp 507-538, 20[illegible]

21 The exception is the Port Authority's Perimeter Rule imposed on aircraft at LGA

22 Ibid

23 United States Government Accountability Office, National Airspace System: [illegible] and FAA Actions Will Likely Have a Limited Effect on Reducing Delays during Su[illegible] 2008 Travel Season. Testimony before the Subcommittee on Aviation Operations, Safe[illegible] and Security, Committee on Commerce, Science, and Transportation, U.S. Senate. GAO

While the amendment to the 1996 *Rates and Charges Policy* was welcomed by airports and the airport trade organization (Airports Council International-North America, ACI-NA) because it gives airport managers localized control, there are complicating factors and a history of challenges related to imposing differentiated charges. The first challenge is related to the assurances of Airport Improvement Program (AIP) grant recipients by Title 49 USC 47107. Airports accepting AIP funds must make their airports available for public use without discriminating and must not impose substantially different charges on air carriers. This is in clear conflict with the new policy on two-part landing fees; furthermore, there have been examples that illustrate this conflict. As mentioned earlier in this chapter, in 1988, The Massachusetts Port Authority (Massport) implemented higher landing fees for small aircraft at Logan to manage congestion, resulting in a significant drop in small regional aircraft. This program was part of a larger demand management initiative called Program for Airfield Capacity Efficiency (PACE). The landing fee charging scheme was found to be in violation of Title 49 USC 47107 requiring the airport to be available to all aeronautical users on "reasonable terms without unjust discrimination."

A limiting factor in making this a viable alternative is maintaining revenue neutrality, i.e., that the total amount that an airport operator can charge the air carriers collectively cannot exceed the reasonable cost to operate the airfield. This gives the operator limited flexibility in varying the fees. Since it takes a significant variation in fees to affect behavior and the off-peak "valleys" are so close to the peak volumes, there is limited room to shift traffic. It becomes impossible for the Port Authority to maintain revenue neutrality while encouraging upgauging and increased use of the off-peak through two-part landing fees. This is particularly true for airports where demand exceeds capacity for many hours of the day, such as LGA. Compounding the problem are the Port Authority's long-term flight fee agreements with the airlines that define how those costs are assigned. Although regulations have changed that enable airport operators to charge carriers certain other airport costs, the flight fee agreements do not have these provisions. It is not clear that either party would be amenable to modifying the agreements to include these provisions.

In a session of the 87th Annual Meeting of the Transportation Research Board in 2008 on capacity issues at the New York airport system and airport capacity issues nation-wide, an airline representative noted that the airlines reluctantly realized that caps were necessary, but felt the number was too low. This suggests caps could be tolerated and understood by those who have to endure them if they felt they had input into their development. Furthermore, despite limiting new entrants, caps keep competition alive at a single airport by limiting a carrier with a hub from defending its turf by increasing the schedule and decreasing fares in response to a new entrant. However, with caps, the incumbent is in a much better position than a new entrant. An incumbent can use its large number of slots to drive out new entrants despite a cap.

An airport is uniquely positioned to develop demand management solutions. Coogan et al. (2009) discuss how airport operators understand their airport in a very detailed way, and that cookie-cutter solutions do not necessarily work for individual airports. The authors present a mechanism through which the FAA provides guidance and empowers airports to manage delay in a way that is tailored to the individual airport. Airport knowledge is particularly important when it comes to policies that involve a direct interaction of the air side and land side, such as slot auctions or slot lotteries of existing slots. There is a need to balance all the functions related to airport operations. Airlines invest in terminals; they hold long-term leases over gates and balance their schedules with their infrastructure. If there were a lottery or slot auction, it is unclear how landside resources should be allocated, should an entrenched airline lose slots to a competitor. The core of this issue, balancing the land side with the air side, is in effect a policy issue of balancing the actions of the FAA (airside) at the airport (landside). When the FAA makes policy that directly affects the airside and indirectly impacts the landside (such as operational limitations), an airport may disagree; this action is however within the purview of the FAA. However, if the FAA makes policy that directly effects the landside operations, the operation of an airport and an airports relationship with the carriers is directly impacted. Based on experience, the airport could intervene. In 2006-2008 as the FAA looked to set operational limitations and auction slots at the airports operated by the Port Authority, the airports along with ACI-NA rejected these actions.[24]

Summary

Increasing throughput in the absence of increased capacity will meet many challenges in the region. As a highly congested system and one that is under fierce competition, voluntary peak spreading is unlikely to yield results. However, in a slot-controlled environment, adding flights in the off-peak, rather than moving them from the peak to the off-peak can be helpful.

Implementing peak-period pricing could yield little response if airlines are making a large profit by serving a market at a particular time, or if they are avoiding a loss of profit by not ceding market share to a competitor. Peak period pricing has a similar problem to peak spreading as it is limited by the high level of operations throughout the day at the three major airports. Unlike peak spreading and peak-period pricing, auctions are able to ensuring the value of a particular slot to the airline is maximized, however auctions and lotteries have the problem of balancing the requirements of the various institutions involved – primarily the airport operators and FAA. Banning smaller aircraft is in direct conflict with the Essential Air Service (EAS) Program; furthermore, it could run counter to how an airline values serving a particular market. Each of these actions has its individual benefits. For example, auctions or the lottery can assist new entrants and hybrid peak period landing fees can create incentives for the use of larger aircraft. However, they all face the pitfalls discussed here. They also do not ensure that throughput at an airport will increase. Increasing the cost faced by the airlines does not necessarily mean the price seen by the passenger increases, as it is highly dependent on how the airline values service in a particular market in a particular period.

As a result, there are limited actions available to increase throughput in the absence of increased capacity. If throughput alone is the goal, actions that influence gauge more directly may be required. These could include minimum seat capacity requirements in the peak period or other related policies such as frequency caps in a market. They achieve what pricing may not, which is guaranteed higher gauges in the peak. However, such policies raise their own challenges as to the institution empow-

24 United States Department of Transportation, Federal Aviation Administration. Comments of the Port Authority of New York and New Jersey on operating limitations at New York LaGuardia Airport. Docket Number 25709. December 29, 2006

ered to make such a policy. Furthermore, increased gauges can cause other problems: a study of LGA found that upgauging of a certain fleet type can actually decrease throughput because of spacing requirements.

A main challenge in discussing the increase of throughput is that there are many competing goals to throughput, including delay, passenger service, airline business practices, and institutional relationships. Certainly, if throughput is the goal, the Port Authority could only allow heavy jet aircraft to land at the New York airports, but this is not practical from many perspectives. As such, perhaps for the management of new capacity, the FAA and airports must work together to establish a common metric that includes these competing goals. Once this common metric, or a set of constraints related to the competing goals, is established, strategies to increase throughput could be better defined.

In sum, of all the actions examined in this chapter, three stand out as having the greatest merit. These are a) addition of flights in the off-peak for a slot-controlled environment, b capping frequency in selected short-haul markets, and c) using auctions and lotteries as a means to allocate newly created capacity. Of these actions – adding off-peak flights is in reality a non-action. It has occurred over time and this trend would continue, especially at EWR and JFK. Peak spreading allows the airports to serve more passengers without requiring any active steps of either a regulatory or pricing nature. However, over time as demand rises, without any gains in the airspace and runway capacity at the three major airports, peak spreading will become ineffective, with the off-peak hours no longer able to absorb the growth.

Actions such as the banning of flights of a given set of characteristics can be measured by their known outcomes – there will be so many fewer flights at known times, and that many passengers who would be affected. In contrast, the impacts of pricing measures are less certain, with little empirical data as guidance, and their results more speculative. Consequently, considerably more analysis was possible for regulatory actions.

The other two actions – capping flights to some markets and incremental auctions -- can offer some capacity gains, without major negative consequences. Capping some flights between LGA and Boston and Washington-National can open up space for about four more flights per hour over the 14-hour peak at LGA, but can do little at the other two major airports where shortfalls of capacity will be worse. An incremental auction, combined with lottery features could also help expand the ability of the airports to handle more passengers. A judgment about whether to pursue this approach will depend on how they work in concert with others being considered in this report and whether they can be accomplished without onerous regulation or difficult to achieve legislation.

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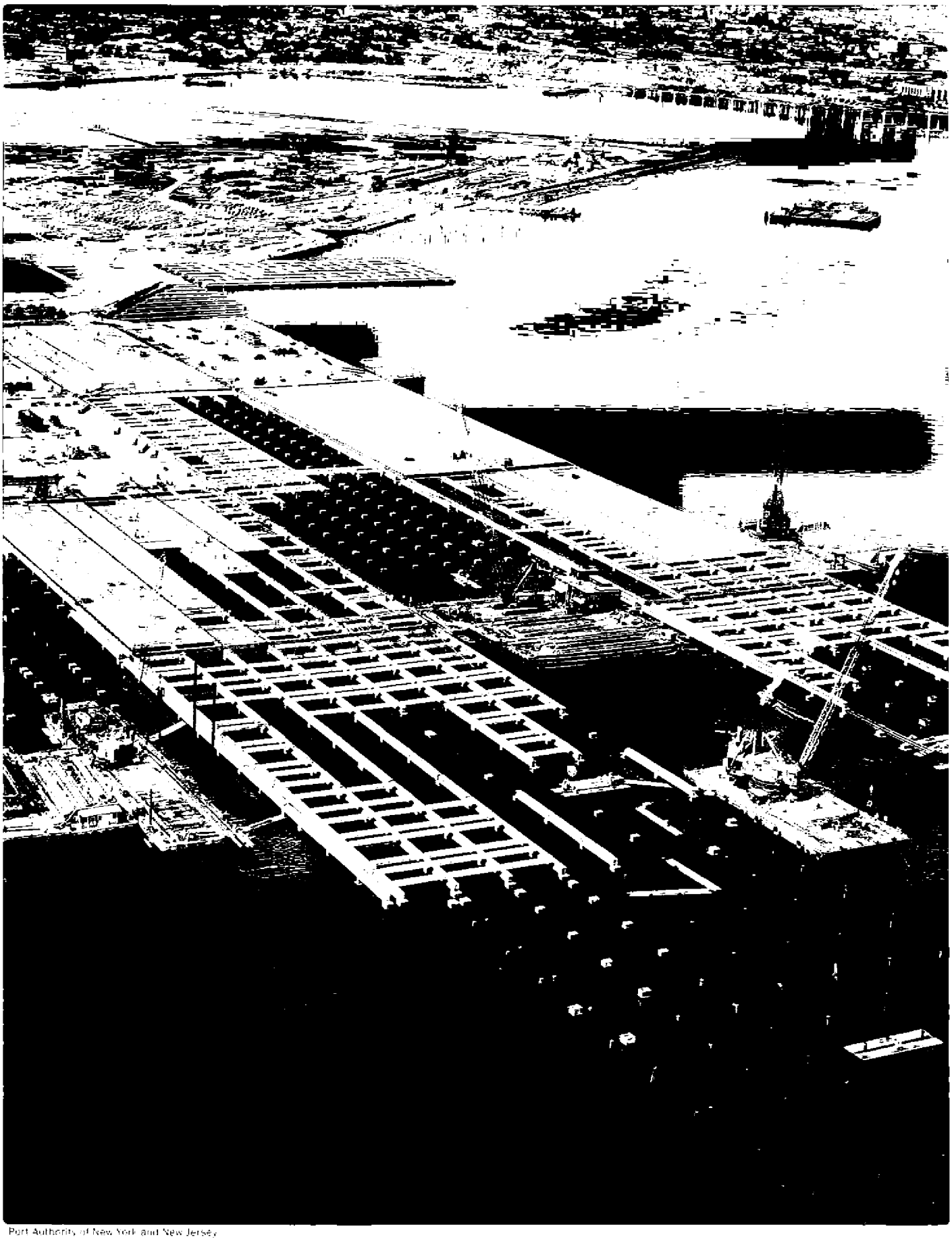
Construction of Runway Extension at LaGuardia Airport



Port Authority of New York and New Jersey

Options to Expand the Major Airports

This chapter explores the potential to physically expand (or reconfigure) the three major airports to meet the projected demand that cannot be accommodated by the various other actions discussed in this report. Any expansion of these airports is bound to face serious opposition because of their location in a highly developed region. Yet, expansion is not unheard of in our region historically, elsewhere in the United States more recently, and around the world today.

Airport Expansion: Then and Now

Expansion of the three major airports in our region has occurred in the past as Figures 10.1 to 10.3 make clear, each having grown dramatically since they opened. Figure 10.1 shows how LGA was expanded from a 137-acre facility in the 1920s to 568 acres with its opening by Mayor LaGuardia for commercial passenger service in 1939. Further expansion was accomplished through a mix of landfill and the construction of piers to extend its runways to their current length of 7,000ft, bringing the footprint to 758 acres in 1964; and it has expanded only slightly since[1].

At EWR expansion occurred in two major steps in 1947 and 1957, enlarging its footprint from a scant 78 acres to the 2,207 acre-airport that it is today. In 2000 the two parallel 4/22 runways were extended northward, as illustrated in Figure 10.2. This airport's layout has been radically altered throughout the years, with the terminal area shifting from the northern part of the site to its western edge when the Port Authority substantially reconfigured the airport in the 1970's.

JFK's footprint has essentially remained the same since it opened in 1948, a testament to the foresight of the airport planners and public officials at the time. Almost 5,000 acres was set aside for the site, more than twice the size of EWR's current footprint. However, as seen in Figure 10.3, the orientation of JFK's runways have changed repeatedly over the years, with the present central terminal area and runway configuration not appearing until the 1960's. The most recent expansion of the airport occurred in 1998 when the Port Authority acquired off-airport properties to extend the AirTrain from the airport to Jamaica and Howard Beach (which is not reflected on the map above).

Historically, these airports have not remained static, but have been expanded and reconfigured, responded to traffic growth and technological change. This evolution has been critical to meeting growth in aviation in the region in the past, and further changes to these airports may be needed to meet projected growth.

Airport expansion projects are underway all over the world, especially in Asia where airports are being modernized at a breathtaking pace and, as covered in Chapter 7, new *greenfield* facilities are being constructed to accommodate the rapid rise in air passenger travel. China has plans to construct 97 airports in the next twelve years, meaning that 82 percent of Chinese will live 100 kilometers or less from an airport in 2020.[2]

Expanding an airport is a complex process; there are many issues to be considered and impacts mitigated. In some countries, regulations are less stringent and local communities are not as empowered as they are here in the United States. This does not mean that airport expansion is no longer a viable option in this country; it just requires more consultation, time and is typically more expensive. Expansion projects are being planned or underway at several U.S. airports right now. Two are discussed below.

Two Domestic Airport Expansion Examples - Chicago and Philadelphia

Like Mayor LaGuardia in his time, Chicago's Mayor Richard M. Daley has been the driving force behind airport expansion. Under his leadership, a $6.6 billion dollar modernization of Chicago O'Hare International Airport is underway. A massive reconfiguration and expansion of the airport will remove two intersecting runways, build four new runways, close two others, and lengthen two runways to create a modern seven runway airport with five parallel runways, which is shown in Figure 10.4. New terminals, taxiways, aprons and a control tower will also be constructed, requiring the taking of 433 acres of property. Some of these projects have already been completed (one new runway, a runway extension and an air traffic control tower) and the construction of five of the six parallel runways is scheduled for completion by 2014. The expansion of O'Hare will reduce departure delays by twelve minutes per aircraft by 2018, from today's average of 17.1 minutes to 5.8 minutes[3].

Philadelphia's International Airport is embarking on $5.2 billion dollar expansion program. The final plan, shown in Figure 10.4, would extend two existing runways, construct a new 9,103 feet parallel runway and build a new commuter terminal, adding 3.6 million square feet of new terminal space and 30 new gates[4]. The FAA has calculated that these improvements

1 The acreage figures for LGA include a section of Bowery Bay, runway piers and a public park that is adjacent to the airport; these areas are not officially part of the airport. The existing airfield (aside from the piers), terminals, garages and internal roadways total only 680 acres.

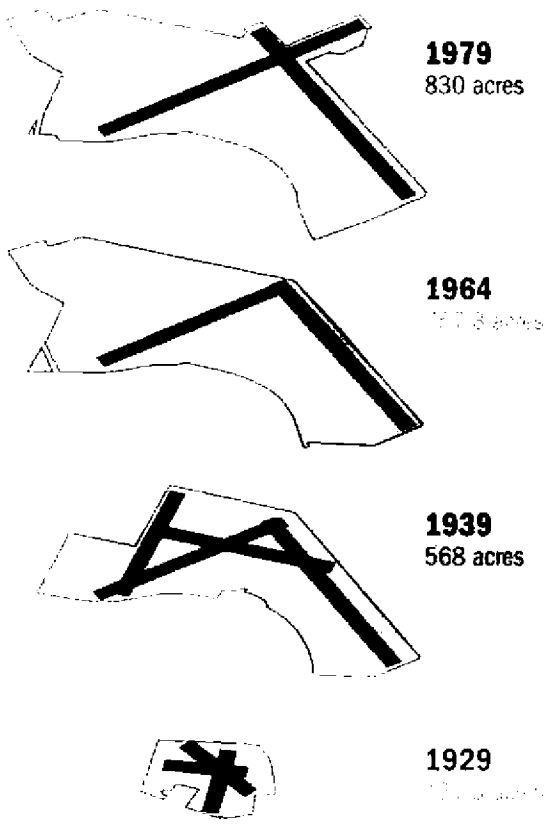
2 http://www.chinadaily.com.cn/bizchina/2008-03/25/content_6563240.htm

3 Chicago O'Hare Final Environmental Statement, Federal Aviation Administration, July 2005, Section III, pg 56.

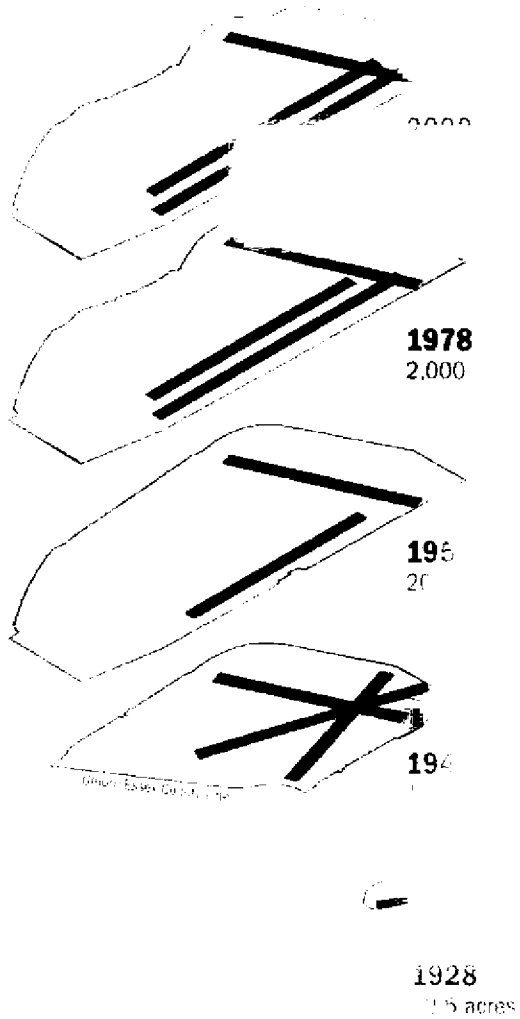
4 http://www.phl-cep-eis.com/pdfs/feis/Final_FEIS_ch3_md_080910.pdf, page 50

The Development of LGA

Source: Port Authority and Regional Plan Association



The Development of EWR



would reduce the average annual delay per aircraft from ten[5] to five minutes. The FEIS and record of decision are expected by the end of the year and construction is estimated to start by the summer of 2011[6].

Challenges of Expansion – Regional Airspace

The relatively close proximity of the three major airports to each other and to other busy airports such as Teterboro, combined with the high volume of air traffic being handled in the entire system and configuration of the airspace, limits the range of options available to expand each individual airport. When the New York region's airports operate at their highest capacity, they use intersecting and converging runway operations. Using intersecting and converging runway operations increases the volume of airspace required to operate each airport, creates airspace conflicts between operations of adjacent airports, and increases the system vulnerability to disruption by poor weather.

By contrast, examination of the airport development programs for the Chicago and Dallas metropolitan areas show that individual airports and airport systems operate most efficiently when all of their operations are conducted in parallel. Atlanta, Chicago O'Hare and Dallas Ft. Worth airports have master plans for the development of up to six parallel runways that support up to four independent parallel arrival airspace corridors. All three of these airports now have or will soon have five parallel runways supporting three parallel arrivals airspace corridors. These plans replaced intersecting and converging operations from their original designs.

Substantially increasing the capacity of the New York airport system requires realigning the airspace system to create parallel operations between the airports and eliminate crossing operations as much as possible. Similar to the large airport opera-

5 The ten minute delay figure for PHL is based on 2009/2010 annual average delays (departure/arrival).

6 Hampp, Timothy J. *An Eye Toward the Future*, Airports of the World Magazine, September October 2010 Issue 81, pages 48 to 53.

Figure 5.3

The Development of JFK

Source: Port Authority and Regional Plan Association

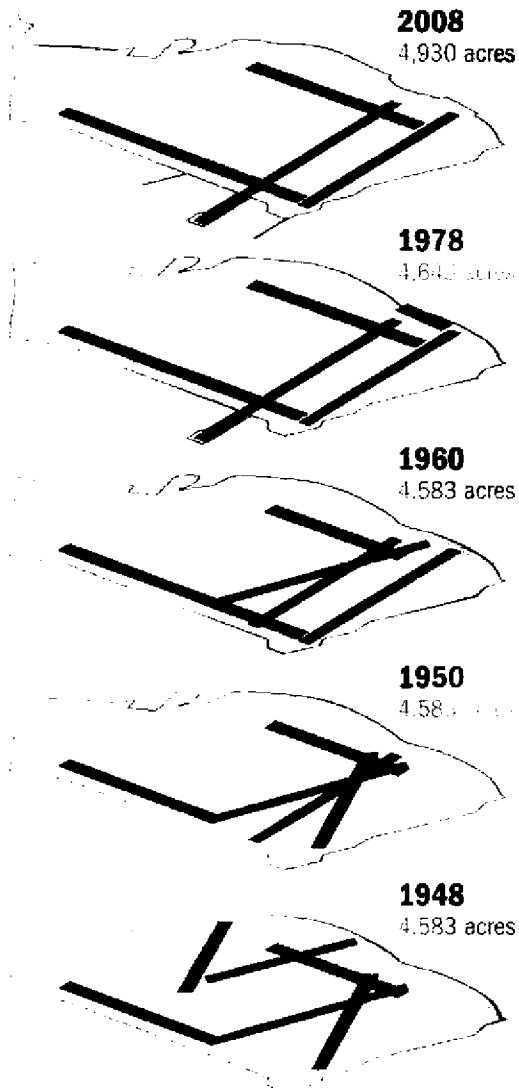
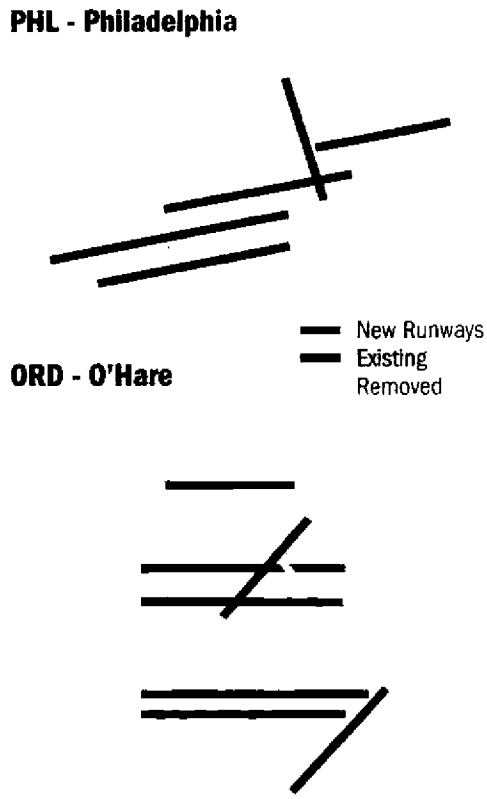


Figure 5.4

Philadelphia & Chicago Airport Expansion

Source: City of Philadelphia



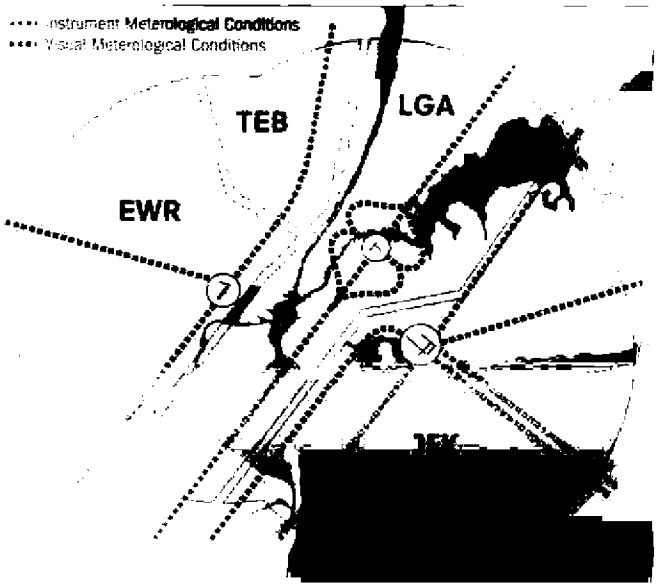
tions of Atlanta, Chicago, and Dallas, the New York system also ideally needs an airspace design that supports four parallel independent final approach corridors since this configuration would provide better all-weather availability of airspace capacity.

The airport expansion options presented in this Chapter fit within four regional airspace structures:

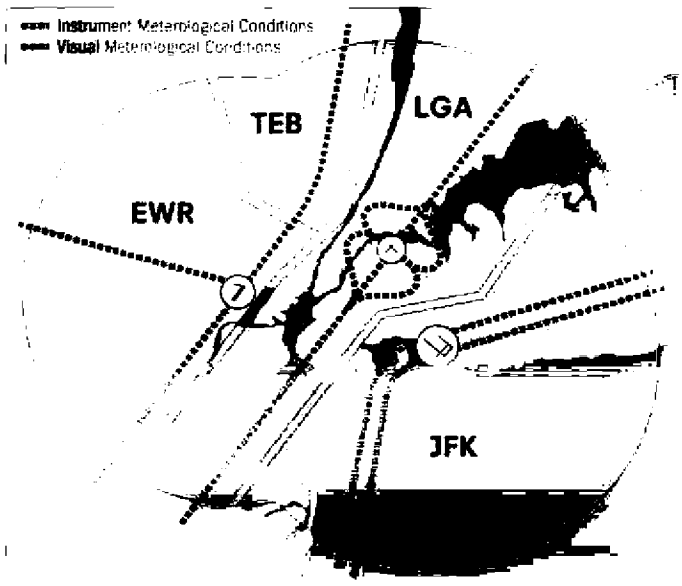
- The existing airspace – this group of airport expansion options examines optimizing the current airfields within the current airspace structure.
- Realign the airspace at JFK to a more east-west orientation to reduce some of its conflicts with LGA, but retain the existing airspace at LGA and EWR (also described as the "JFK 7/25" airspace).
- Realign the airspace to optimize airport operations in a northeast-southwest orientation (also described as the "All 4/22" airspace).
- Realign the airspace to optimize airport operations in a northwest-southeast orientation (also described as the "13/31" airspace).

All the airport expansion options are evaluated and classified here using one or more of these four airspace categories, both with and without implementation of the FAA's NextGen program. This program provides opportunities to create new airspace geometry, which will ease many of the requirements for long, straight-in flight paths for arriving flights and for closer spacing of parallel airspace routes. This in turn reduces the level of airspace conflicts and increases the number of airport development options available. The JFK 7/25 and 13/31 airspaces require G-BAS or RNP 0.3, two NextGen technologies that were detailed Chapter 5.

Existing Airspace
Source: Regional Plan Association



Modified Existing Airspace (7-25)
Source: Regional Plan Association



Expanding Airports within the Existing Airspace

The current airspace patterns at the four airports, including TEB, are depicted in Figure 10.5. The existing airspace provides single northeast/southwest airspace corridors for each airport. JFK also has the option to use a northwest arrival corridor for dual arrivals. However, this option is only available about 40 percent of the time due to prevailing winds. LGA uses Runway 13 for the majority of departures. This usage limits JFK to a single arrival corridor for its dual 4/22 runways. EWR has an arrival corridor to Runway 11. However, this corridor overlaps with the arrival corridor to Runway 6 at Teterboro, which limits its use. These conflicts are graphically illustrated in Figure 2.12 in Chapter 2.

However, even within the limitations of the current airspace, it is possible to improve the airport runway systems by eliminating runway intersections or through development of closely spaced parallel runways. Closely spaced parallel runways allow controllers to more easily separate airborne departures from arrivals. Eliminating runway intersections or decoupling the runways reduces the coordination required between arrivals and departures under many conditions.

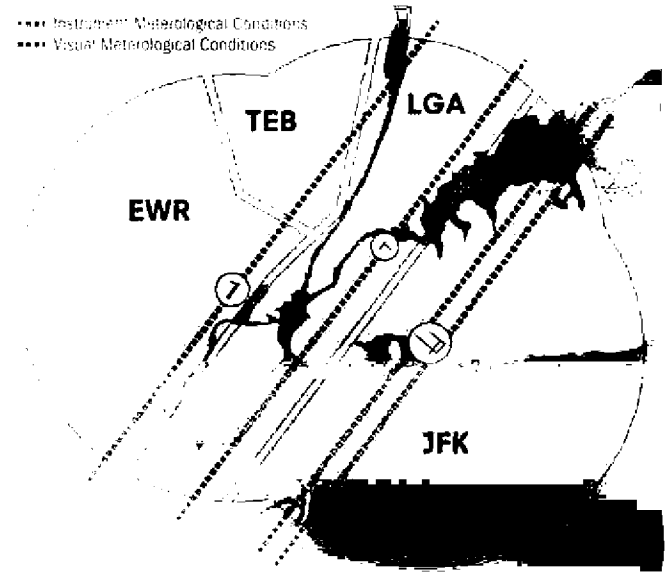
Elements of the FAA's NextGen program will improve the existing airspace in two ways. First, more precise navigation under RNP allows closer spacing of routes, which allows development of additional routes, especially for departures leaving the airspace. These options can be implemented during the first phase of the NextGen program. The FAA will need to redesign the airspace to create these additional routes. These routes may also reduce the interaction of LGA departure on Runway 13 with JFK operations. Second, curved or segmented arrival routes, which should become available in the first phase of the NextGen program, will allow more operations on secondary arrivals corridors to Runways 11/29 at EWR or Runways 13L or 13R at JFK.

Expand Airports within JFK 7-25 Airspace

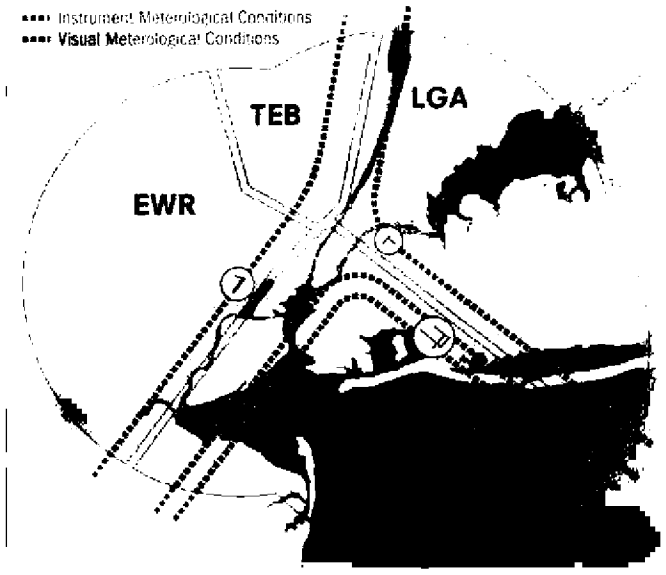
Realigning the JFK airspace approximately 30 degrees clockwise from its current 4/22 orientation, as shown in Figure 10.6, will allow LGA to operate Runway 13 departures as operated today, but without conflict with JFK air traffic. This airspace option also requires the rotation of JFK runways 30 degrees clockwise from their current 4/22 orientation to 7/25. While this option eliminates conflicts to the north of JFK, it creates new conflicts to the south. These southern conflicts can only be relieved using new curved altitude-separated or segmented arrival paths that are anticipated under the first phase of the NextGen program. Therefore, without NextGen, this option falls by the wayside. In addition, it relocates JFK arrival and departure traffic from their current corridors to areas that have fewer aircraft with the existing airspace.

This option makes no changes to EWR or LGA airspace. Thus, the options available to expand these airports within the existing airspace are also available within this option.

New Conventional Airspace (4-22)
Source: Regional Plan Association



New NextGen Airspace (13-31)
Source: Regional Plan Association



Expand Airports with New All 4-22 Airspace

This airspace design, depicted in Figure 10.7, draws upon the airspace design experience of Chicago, Atlanta and Dallas, where efficiency was improved by reorienting previously converging or intersecting flows to make them operate in parallel. This airspace option delivers its highest capacity when each of the three airports has at least two parallel runways.

Wind conditions at JFK and LGA dictate that they operate only on their 13/31 runways about two percent of the time, or about 180 hours a year. However, these hours occur only a few hours at a time, therefore affecting anywhere from 18 to 30 days in a year. To avoid impacts on so many days, the airspace design must also retain some of the existing airspace structure that supports operating in the 13/31 directions. Wind conditions at EWR are sufficiently different from JFK and LGA to allow a potential closure of Runway 11/29. In contrast, the wind conditions that force use of Runway 11/29 at EWR occur less than one percent per year.

Redesigning the airspace to the 4/22 configuration does not require NextGen. However, it is possible to further optimize this airspace with the NextGen program.

It is possible to implement this airspace design without improving the runway system at LGA. In this case, LGA would operate as a single 4/22 runway airport supporting about 54 aircraft per hour, sacrificing about one-third of its current capacity. With NextGen I LGA's capacity would essentially remain the same as it is today, 71 operations per peak hour, by quickly turning departures off Runway 13/31 to a 4/22 flight path. If NextGen does not materialize as anticipated, an additional runway would be required at JFK to replace the capacity lost at LGA.

Expand Airports with a New 13-31 Airspace

Similar to the Runway 4/22 airspace, the 13/31 airspace design, shown in Figure 10.8, draws upon the experience of Chicago, Atlanta and Dallas. However, the tall buildings in Lower Manhattan and significant site constraints preclude implementation of this airspace orientation at EWR. Thus, EWR would maintain its existing airspace corridors (4/22) within the 13/31 airspace design. This airspace design requires parallel runway operations on the northwest/southeast 13/31 runways at LGA and JFK.

Wind conditions at JFK and LGA require the use of their 4/22 runways up to four percent of the time as a sole operating direction. Thus, the airspace design must contain the elements of the existing airspace to support operations on the 4/22 runways during these times.

The tall buildings in Lower Manhattan currently preclude simultaneous arrival operations on Runways 13L and 13R at JFK. This restriction may be removed with airspace design improvements enabled by the first phase of the NextGen program. NextGen would allow for altitude-separated parallel turns to both 13/31 runways, eliminating the conflict with Manhattan's skyscrapers. Given this limitation, the 13/31 airspace design option is only available after the implementation of the NextGen program.

Similar to the All 4/22 airspace design, it is possible to leave LGA unchanged, but limit its operation to a single runway. This option requires development of an additional parallel runway at JFK to replace capacity lost at LGA unless the precision in NextGen II reaches a level that would allow LGA to quickly turn departures off its 4/22 runway to the 13/31 airspace, remaining north of the JFK airspace. Unlike the All 4/22 airspace, the 13/31 approach for JFK is within two nautical miles of potential departure routes from LGA and both aircraft would be heading directly at each other. The capability to enforce the safely margin required to make this configuration a reality is beyond what is currently envisioned for NextGen I and possibly NextGen II.

Challenges of Expansion – Local Development Constraints

Airport expansion often involves issues that go beyond the technical engineering challenges that are part of every major construction project. In many cases off-site expansion impacts tend to be more intractable and costly than the construction on the airport. These issues include:

- Noise impacts to surrounding communities
- Offsite property acquisition, takings of private property or expansion through the use of fill
- Obstructions to flight paths, manmade and natural
- Construction impacts, onsite to airport operations and offsite
- Proximity to protected open spaces (Gateway National Recreation Area) or other highly significant infrastructure (Port Newark and Elizabeth or major highways)

The nature of aviation dictates that aircraft must operate outside the confines of an airport. In many cases aircraft noise associated with new approach and departure paths extending over residential areas generates the greatest local opposition to expansion. If a new runway is constructed at any of our airports, especially with a new orientation, communities that might have not experienced aircraft noise in the past will now have aircraft operating above them. These new approaches may also limit development in these corridors, as building heights must conform to aircraft descent paths so they do not obstruct their approach to the new runway(s). In the New York region the three urban airports are largely surrounded by residential areas. Noise impacts to residential areas are therefore unavoidable and any changes to the configuration of one of our airports could expose more residents to aircraft noise, even as others might experience less. In the long term, precision navigation and continuous descent approaches under NextGen might reduce the population affected by limiting the variability in an aircraft's flight path, narrowing the area exposed to high noise levels. However, this precision will mean that some affected residential areas would experience more frequent aircraft noise, unless flight paths can be rerouted over highways or other non-residential areas. Noise impacts are a current reality and any expansion at the three airports will likely alter areas exposed to noise – creating new areas and reducing current areas. There are also local constraints unique to each airport.

JFK Local Development Constraints

Many expansion options at JFK will likely require fill in Jamaica Bay. This would face considerable challenges from local and national environmental advocacy groups, since the Bay is part of the federally-protected Gateway National Recreational Area. Currently, the authorizing legislation for Gateway explicitly prohibits the future expansion of JFK's runways into the Bay[7].

A portion of the Bay that borders the airport includes a "dead" section called Grassy Bay along the edge of runway 13R/31L (Bay Runway) that was dredged to 60 feet to construct JFK in the 1950's and a section of wetlands adjacent to the 4/22 parallel runways. The borrow pits in Grassy Bay are over 50 feet deeper than the rest of Jamaica Bay, preventing the natural "flushing" process from taking place and concentrating pollutants and toxic sediment. As a result, some scientists have suggested that reshaping the borrow pits would benefit water quality, fish and wildlife. JFK is also surrounded by highway infrastructure to the northwest and residential communities to the west, north and southeast.

Over the past decade, the Port Authority and the airlines have invested heavily in redeveloping the passenger terminals at JFK, additional investments are also planned over the next five years. Any changes to address airside needs that would require the modification or removal of these passenger facilities would have to be weighed against these prior investments and the costs of locating and constructing replacement facilities. Furthermore, legal issues that pertain to airline's terminals and their lease agreements with the Port Authority further complicate matters, arguing against advancing development options that require reconfiguration of the Central Terminal Area (CTA). In contrast, many of the cargo and maintenance buildings at JFK are older, and are not well configured to support more modern air cargo operations. Development options will consider reconfiguring or relocating these areas.

LGA Local Development Constraints

Many expansion options at LGA will likely require fill in Flushing or Bowery Bays, and could affect Riker's Island, just 256 feet at its closest from the northwestern corner of the airport. While Flushing Bay does not have the federal status of Jamaica Bay, these options would still face considerable challenges from local and national environmental advocacy groups. To the south of the Grand Central Parkway, expansion options affecting the bordering neighborhood of Astoria would also face opposition, as would options that impact Flushing to the east.

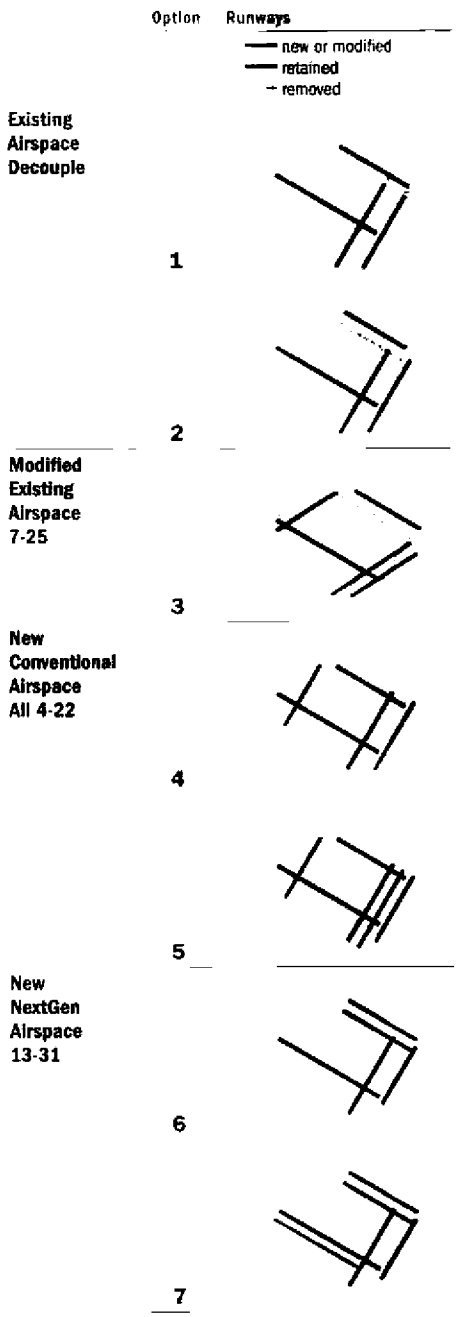
EWR Local Development Constraints

EWR is surrounded on all sides by commercial uses, the largest of which are the port complexes of Newark and Elizabeth located east of I-95/New Jersey Turnpike, which runs the entire length of the airport's eastern property line. Expansion to the west would potentially have to address impacts to the Northeast Rail Corridor, a major intercity and commuter rail right-of-way, U.S. Routes 1/9, several commercial properties and Weequahic Park located in the City of Newark.

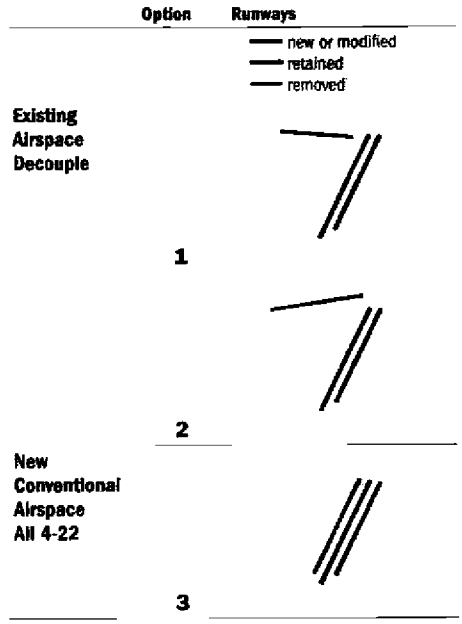
The use of Runway 29 for straight-in arrivals is limited by the height of buildings in Lower Manhattan. In addition, the low altitude airspace over the Hudson River has a high volume of air tour and helicopter operations. As a result, the use of this runway is limited to curved approaches using visual, GPS or GBAS navigation.

[7] H.R. 1121 Section 3(d) " The authority of the Secretary of Transportation to maintain and operate existing airway facilities and to install necessary new facilities within the recreation area shall be exercised in accordance with plans which are mutually acceptable to the Secretary of Interior and Secretary of Transportation and which are consistent with both the purpose of this Act [HR.1121] and the purpose of existing statutes dealing with the establishment, maintenance and operation of airway facilities: Provided, That nothing in this section shall authorize the expansion of airport runways into Jamaica Bay or air facilities at Floyd Bennett Field"

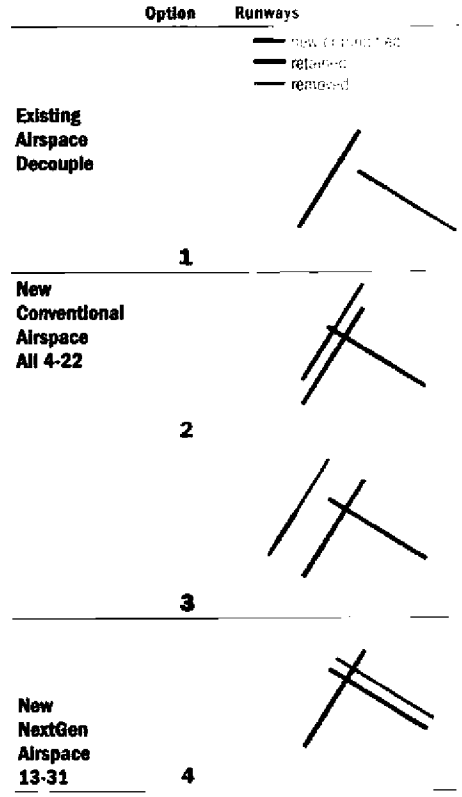
JFK Expansion Options



EWR Expansion Options



LGA Expansion Options



The Expansion Options

Expansion options were developed to address the airspace conflicts and landside constraints at each of the three airports. The development of the expansion options was an iterative process, with the options being refined throughout the evaluation phases of the analysis. Fourteen airport expansion options were generated – seven for JFK, four for LGA and three for EWR. The options developed are shown below using simplified diagrams that show only runways, but not any new taxiways or holding pads that would also be required.

Figure 10.9 arrays the seven development options for JFK airport. It was paramount that any expansion at JFK addressed its proximity to LGA, which is why options were generated for all four of the proposed airspace categories. Even though efforts were made to minimize the amount of fill required, all but one of the options will require some fill in Jamaica Bay. Any options that required relocating the Central Terminal Area were ruled out because of legal and sunk costs. Therefore, all the options leave the overall configuration of the terminal area unchanged. However, three options do propose to demolish most of the western cargo and administrative area to construct a new parallel runway. Options #3 suggests changing the orientation of the existing 4/22 runways to 7/25 and constructing a new runway in the western cargo area. Four options would demolish the northern cargo area to make space to shift or construct a new runway. There were two decoupling options for JFK, both requiring a large amount of fill in Jamaica Bay. The JFK expansion options, aside from option #3, do not extend the airport beyond its current borders into the surrounding residential neighborhoods of Queens.

Three options were developed for EWR, two addressed the existing airspace and one was proposed for the All 4/22 airspace. A 13/31 orientation/airspace was ruled out for EWR because there was insufficient space to clear the skyscrapers in Lower Manhattan and the massive relocations required within the vicinity of EWR. The two decoupling options (#1 and #2) both shift the crosswind runway offsite, impacting the Amtrak/ NJ TRANSIT Northeast Corridor rail line, the road network, commercial properties and Weequahic Park in Newark. Options #2 would change the orientation of EWR's 11/29 runway to 9/27, resulting in the demolition of the existing northern cargo area; option #3 would also require the relocation of the cargo area as well. The most ambitious scheme developed was the construction of a third western parallel runway, as shown in Figure 10.10. The existing terminal area would need to be completely reconfigured, as it was almost 50 years ago. The Port Authority is already considering plans to demolish and reconstruct Terminal A south-

west of the existing facility. The entire "bulb head" or semi-circle that protrudes into the airfield would be removed, along with Terminal B. Terminal C would be reconstructed in phases to the northwest of its existing footprint, it's uncertain whether a new Terminal B would be required as both Terminal A and C would be considerably larger than the facilities that they would be replacing. Runway 11/29 would also be closed to make room for the new parallel runway, the reconstructed Terminal C and to remove the intersect runway conflict. A wind analysis confirmed that it is possible to operate EWR with just a single orientation.

The options for LGA (Figure 10.10) were developed keeping in mind LGA's close proximity to JFK. The first option would decouple the two intersecting runways by shifting runway 13/31 east towards College Point, blocking the entrance to Flushing Marina and requiring the takings of commercial properties on the peninsula[8]. Options #2 and #3 both propose a new 4/22 parallel runway and would require the airport to operate primarily in a 4/22 configuration. Option #2 would construct the new parallel only 800 feet from the existing runway, preventing independent simultaneous parallel options, but limiting the impacts to Astoria and Riker's Island. The third option would separate the runways by 2,500 feet, which would allow for more independent operations, but extend the runway deeper into the neighborhood of Astoria and require the taking and demolition of over half of Riker's Island. The last option (#4) would construct a new parallel 13/31 runway on fill adjacent to the existing runway in Flushing Bay and require the airport to operate primarily in a 13/31 configuration. This option would also require a small taking on Riker's Island for the runway protection zone of the new parallel runway.

The Seven Criteria Defined and Evaluation of the Options

Until now, the expansion options have been evaluated qualitatively, based on observations and known physical constraints. This section quantifies the benefits and impacts of the various options using seven criteria - aircraft take-off and landing capacity, cost, landfill and the environmental and community impacts.

The criteria used to evaluate the expansion options were guided in part by the nineteen impact categories outlined in Appendix A of FAA Order[9] 1050.1E CHG1, *Environmental Impacts: Policies and Procedures*, which is referenced during formal environmental reviews. Specific criteria drawn from the order included noise, land use, historical/architectural and construction impacts. Determining the capacity benefits and estimating the cost of each option is considered essential to the evaluation process and was added as criteria. The resulting seven criteria are:

- Capacity
- Cost
- Fill Amount
- Noise
- Construction Impacts – Onsite and Offsite
- Off-Airport Land Use Impacts

Impact Criteria Scored

Noise Impacts (Population)	Off-Airport Land Use Impacts
0 = 0 1 = 1 - 40 2 = 41 - 60 3 = 61 - 80 4 = > 80	0 = no impact 1 = commercial, recreational or public institution impact 2 = residential impact
Construction Impacts	**Historical or Architectural Impacts**
0 = no impact 1 = minimal disruption (airfield only or undeveloped parcel) 2 = major disruption (airfield, terminal and/or landside or developed parcel, commercial or residential.	0 = No 1 = Yes

Source: Regional Plan Association

- Architectural and Historic Impacts

The incremental capacity benefits for each option were calculated by making several assumptions about the utilization and configuration of new/extended runways or reconfigured airfields. The details of this analysis can be found in Appendix E. Airspace, air traffic control and proximity to the surrounding airports were also factored into this calculus, with two "flavors" of capacity calculated for each option. One scenario assumes that the air traffic control system and current constraints would remain as they are today; this is referred to as Current Rules or ATC. The second scenario envisions the implementation of NextGen I and partial roll-out of NextGen II. This would remove a number of the airspace constraints that exist today and in most cases result in greater capacity benefits for the options. This is referred to as Next Gen or NG.

The costs are relatively first-cut estimates that are used primarily to determine the order of magnitude of the investment that would be required. They include the costs of terminal replacement (EWR, Terminals B and C) and relocation of major pieces of landside infrastructure (JFK, Van Wyck and JFK Expressways and AirTrain). However, they do not include the cost of environmental remediation (restoring wetlands in Jamaica Bay) or relocation costs associated with moving facilities. A three to five billion dollar reserve was put aside with the possibility that it could be required for mitigation of environmental and community impacts

Many of the JFK and LGA options would require fill. This landfill estimate was determined by calculating the area of runway, taxiways, holding pad(s) and associated safety buffer areas that extended into the bays. Aside from one option that filled a deep (60 feet) section of Jamaica Bay, the volume of fill required was not accounted for.

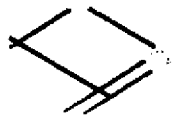
Noise impacts to the surrounding communities were approximated by creating a rough buffer that represented the 65Dbl noise contour area for each new configuration. The incremental increase in population and housing units impacted was then determined as part of geographical information systems analysis, the details of which are covered in Appendix E.

There were two types of construction impacts considered during the evaluation, onsite and offsite. Onsite construction impacts mainly concerned disruptiveness of the construction to airport operations. A severe example is the 7/25 options that would completely reorient the airfield and disrupt landside access to the airport. Offsite impacts included temporary extension of the airport outside of its boundaries, potentially impacting highway or rail infrastructure or residential properties during the construction process.

8 Citifield ballpark in Willets Point might also be a vertical obstruction during single engine takeoffs.

9 http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgOrders.nsf/0/2bb5c3876ba3126186257181004 7a403/$FILE/Order1050.1ECHG1.pdf

Select Criteria Applied to the Individual Expansion Options

Airport	Option	Runways (new or modified / retained / removed)	Name	Added Capacity (ops per peak-hour) Current Rules	Next-Gen 1	Cost (in billions)	Landfill (acres)	Noise Impacts	Off-Airport Land Use Impacts	Construction Impacts Onsite	Offsite	Historical or Architectural Impacts	Impact Score
JFK	1		Decouple - 4/22 Shift Only	24	34	1.0	472	1	0	1	1	0	3
JFK	2		Decouple - 4/22 and 13/31 Shift	[redacted]	34	1.2	360	2	0	1	1	0	4
JFK	3		New Triple 7/25s - Three Parallels	[redacted]	49	4.0	318	2	2	2	2	0	8
JFK	4		Triple 4/22s - Three Parallels - New Single Western Runway	[redacted]	49	1.5	200	2	0	2	1	0	5
JFK	5		Triple 4/22s & Western 5/23 - Four Parallels	70	73	3.5	390	[redacted]	0	2	1	0	7
JFK	6		Northern 14/32 Parallels & Existing Bay Runway - Three Parallels	0	49	1.0	-	2	0	1	1	0	4
JFK	7		Northern 14/32 Parallels and Southern 13/31 Parallels - Four Parallels	0	79	2.1	214	3	0	1	1	0	5

Off-airport land use impacts were determined through the use of geographical information systems to amass land use data for each of the three airports, in combination with aerial imagery. The focus of this analysis was to identify the residential, commercial and open spaces impacted by the extension of the runways and associated safety buffer areas. Residential impacts would be the most severe at LGA. At EWR some options would result in the taking of adjacent commercial properties and open space.

The evaluation of architectural and historical impacts was limited to only onsite facilities. Because JFK's central terminal area would be preserved, only EWR and LGA were considered under this criterion. The historic art deco Newark Airport Administration Building constructed in 1935 at EWR and the Marine Air Terminal that opened in 1940 at LGA were identified[10].

Each of the four impact criteria – noise, off-airport land use, construction and historical impacts – were given a score based on the values in Table 10.1. The sum of the four scores was added to an impact index for each option to come up to a total score. The higher the score the greater the impact. Noise carried the most weight, with a score of four being possible for noise and a score of nine the highest (worst) value for all criteria combined. The results are seen in Table 10.2A & B.

10 EWR's historic facility was added to the National Register of Historic Places in 1979 and LGA's in 1982.

Select Criteria Applied to the Individual Expansion Options

Airport	Option	Runways (new or modified / retained / removed)	Name	Added Capacity (ops per peak-hour) Current Rules	Next-Gen 1	Cost (in billions)	Landfill (acres)	Noise Impacts	Off-Airport Land Use Impacts	Construction Impacts Onsite	Offsite	Historical or Architectural Impacts	Impact Score
LGA	1		Decouple	6	10	0.5	118	3	1	1	2	0	7
LGA	2		Parallel Dependent 4/22s	6	10	1.5	73	3	1	1	1	1	7
LGA	3		Parallel Independent 4/22s	46	46	2.5	160	4	2	1	2	0	9
LGA	4		Parallel 13/31s	6	10	1.5	129	1	0	0	1	0	2
EWR	1		Decouple - 11/29	19	19	0.8	-	3	1	0	2	0	6
EWR	2		New 9/27	19	19	1.0	-	4	1	1	2	1	9
EWR	3		New 5/23 - OnSite	21	35	2.0	-	1	0	2	0	1	4

Some important patterns emerge when looking at the options in isolation.

- Higher cost options tend to generate greater capacity benefits.
- Decoupling options that remove intersecting runways at all three airports require large amounts of fill and have higher impact scores, yet provide some of the lowest capacity benefits.
- Many of LGA's options, in isolation, do not provide much additional capacity and have relativity high impact scores.
- EWR's triple parallel runway option does well, providing substantial capacity with modest impacts.
- At JFK, the four parallel runway options provide large increases in capacity, 70-73 additional operations per hour – more than double the capacity of EWR's preferred triple parallel option.
- Overall, the options at JFK provide the highest capacities, yet the fill numbers and environmental impacts are greater than at EWR and LGA.

These individual runway options at each airport cannot be viewed in isolation, but rather in workable combinations. The environmental/community impact scores, landfill figures, and cost and capacity estimates, are used to evaluate the combinations developed next. As discussed earlier, these individual options were developed to address existing airspace constraints

Existing Airspace (Decoupling)

Cat ID	Combo #	Configurations (options)			Capacity			Capacity /Cost			
		EWR	LGA	JFK	ATC	NG	Cost (billions of $)	ATC	NG	Landfill (acres)	Impacts Score
A	1	1	NC	1	43	53	1.8	24	29	472	9
A	2	1	NC	2	43	53	2	22	27	360	10
A	3	2	NC	1	43	53	2	22	27	472	12
A	4	2	NC	2	43	53	2.2	20	24	360	13
A	5	1	1	1	51	63	2.3	22	27	590	16
A	6	1	1	2	51	63	2.5	20	25	478	17
A	7	2	1	1	51	63	2.5	20	25	590	19
A	8	2	1	2	51	63	2.7	19	23	478	20

Modified JFK Airspace (7/25)

Cat ID	Combo #	Configurations (options)			Capacity			Capacity /Cost			
		EWR	LGA	JFK	ATC	NG	Cost (billions of $)	ATC	NG	Landfill (acres)	Impacts Score
B	1	1	NC	3	0	68	4.8	0	14	318	14
B	2	[redacted]			0	68	5	0	[redacted]	318	17

New Conventional Airspace (All 4/22)

Cat ID	Combo #	Configurations (options)			Capacity			Capacity /Cost			
		EWR	LGA	JFK	ATC	NG	Cost (billions of $)	ATC	NG	Landfill (acres)	Impacts Score
C	2	3	2	4	70	94	5	14	19	273	16
C	3	3	2	5	97	118	7	14	17	463	18
C	5	3	3	4	110	130	6	18	22	360	18
C	6	3	3	5	137	154	8	17	19	550	20
C	8	3	Only 4/22 or NC	4	44	84	3.5	13	24	200	9
C	9	3	Only 4/22 or NC	5	71	108	5.5	13	20	390	11

New NextGen Airspace (All 13/31)

Cat ID	Combo #	Configurations (options)			Capacity			Capacity /Cost			
		EWR	LGA	JFK	ATC	NG	Cost (billions of $)	ATC	NG	Landfill (acres)	Impacts Score
D	1	3	4	6	0	80	4.5	0	18	129	10
D	2	3	[redacted]	6	0	50	3	0	17	0	8
D	3	3	4	7	0	110	6	0	18	343	11
D	4	3	Only 13/31	7	0	80	4.5	0	18	214	9

by either improving how the existing airspace and airports function today or to suggest a redesign of the current airspace. Therefore, it's critical that they function together in combination, especially JFK and LGA due to their close proximity. The following section develops and evaluates the combinations for each of the four airspace categories – existing airspace, modified JFK airspace, new conventional airspace and new NextGen airspace.

The Expansion Combinations – The Airspace Criterion

Currently, over 80 percent of the northern New Jersey air market is served by EWR, with a large majority of New York residents choosing LGA or JFK[11], making the provision of sufficient capacity on each side of the Hudson highly desirable. To this end, each proposed combination includes capacity increases on both sides of the Hudson, i.e. at EWR and at either JFK or LGA, or at both. Out of 84 theoretically possible expansion combinations (7 x 4 x 3), only 20 survived the screening process. This process was primary driven by the four airspace categories.

11 FAA Regional Air Service Demand Study, 2007 – Passenger O/D Survey

Only the combinations that would improve upon the existing airspace were selected. The lone exceptions being the decoupling options that do not involve changes to the existing airspace, all possible combinations of these options were evaluated. For some combinations, expansion at LGA was not proposed or operations were limited to only one runway, effectively cutting its capacity by a third. In most cases this was the result of the combination including a more ambitious expansion option at JFK that required the additional airspace around LGA to function properly.

The seven criteria for these remaining combinations were summarized for all 20 combinations and are shown in Tables 3a to 3d along with the incremental capacity gains with and without NextGen and the amount of landfill required (in acres). The tables also include a capacity/cost ratio for each combination, with a higher score indicating a higher per-unit (capacity) cost. This ratio was generated for both the conventional air traffic control (ATC) and NextGen capacity estimates. The impacts score column combined the impact scores of all options, resulting in a possible total score of 27. NC indicates no change at the airport.

The eight **existing airspace combinations** in Table 10.3A are decoupling options at all three airports, with half of the eight combinations requiring no changes at LGA. The combinations that included a LGA option resulted in some of the highest impact scores and all required almost 400 acres of fill. Overall, these combinations were relatively inexpensive, with modest capacity benefits.

There were two **modified airspace combinations** (Table 10.2B), both with no changes at LGA. These configurations required NextGen to safely operate aircraft within the constraints of the existing airspace. Both had modest levels of fill at JFK (318 acres) and combined costs of about $5 billion. However, it would be difficult to justify the higher costs and impacts (at JFK) of these combinations when compared with the similar capacity benefits and the lower cost of the existing airspace combinations, detailed in Table 10.3A.

The **new conventional airspace combinations**, detailed in Table 10.3C, would shift the existing airspace entirely to a 4/22 orientation. The six combinations vary widely in capacity, cost and impacts. These combinations would remove the crosswind 11/29 at EWR and place the 13/31's at LGA and JFK on standby, since they would be needed on a limited basis under certain wind conditions. In some combinations new parallels were proposed at LGA and in others that airport's capacity would be cut by a third (from 74 to 54 operations per hour), requiring it to operate regularly only on just its 4/22 runway, or not change at all if NextGen I is implemented. At JFK different pairings of three or four 4/22 parallel runways were examined, some having much larger impacts, costs and fill. A third parallel runway located on the current airfield was examined at EWR.

Overall, the results of this analysis were mixed. These combinations required the most acres of fill and had the highest costs, yet offered the greatest capacity benefit. However, if NextGen benefits do not materialize then these combinations are likely to be the best course of action. Because these combinations vary so widely in the added capacity they offer, a choice among them is likely to be dependent on how much additional capacity will be needed when other actions recommended in this report are in place. This will be discussed in Chapter 12.

Four combinations were analyzed in the **new NextGen airspace**, which include multiple 13/31 runway options at LGA and JFK and the triple-parallel 4/22 runways at EWR. The results are arrayed in Table 10.3D. This airspace requires the airspace geometry changes made possible by the NextGen program. The 13-31 airspace does not provide any additional capacity with existing ATC technology. In this NextGen airspace, EWR would operate on its 4/22's only, fully independent of JFK's and LGA's airspace. At LGA two options were examined, a parallel 13/31 runway constructed on fill in Flushing Bay and placing its 4/22 runway on standby or restricting regular operations to its existing 13/31 only, essentially cutting LGA's capacity by a third. This reduction in capacity might be less if Next Gen II is implemented.

Two different airfield configurations were proposed at JFK – three or four parallel 13/31 runways, and placing the existing 4/22 runways on standby. Not surprisingly, the four parallel options in combination with parallel 13/31's at LGA resulted in high fill and impact scores. The four parallel options at JFK propose a new runway parallel to the existing Bay runway. However, this section of Jamaica Bay is over 60 feet deep necessitating greater amounts of fill. The combination with the lowest costs and least impacts involve triple 13/31's at JFK and the restriction of operations at LGA to just runway 13/31. This JFK option would construct one new 13/31's on the north side of the airport and retain the existing Bay runway as is. This combination requires no fill and has the lowest cost, but the capacity benefit is relatively low. The new NextGen airspace combinations resulted in fewer impacts and reduced amounts of fill – with one of the combinations requiring no fill at all. However, these options require that NextGen I be implemented to realize any capacity benefit. This places an additional risk and uncertainty on these investments, making these combinations an attractive choice only if NextGen and the benefits they promise materialize. Therefore, the best option among these should be kept under consideration until the benefits of NextGen become clearer.

Recommendations and Implementation Issues

Expansion of our region's major airports will deliver only modest gains unless it is accompanied by restructuring the regional airspace. This existing requirement is most severe at LGA and JFK which operate in close proximity to one another. The eight decoupling options do not substantially address this constraint. While it is possible to modify the existing airspace and JFK airfield to reduce the conflicts between JFK and LGA (7/25) with one of the two options, this is a high cost proposition that does not add much new capacity, even with the airspace geometry benefits delivered with the NextGen I program. This eliminates ten out of 20 combinations.

Reorienting the airspace to a single 4/22 operating direction delivers significant capacity with existing air traffic control procedures and does not link the airport capacity benefits to the successful implementation of NextGen airspace. The 13/31 NextGen airspace at JFK and LGA also results in significant capacity gains, but with fewer environmental impacts than most of the all 4/22 airspace combinations. However, this airspace redesign requires NextGen and is not possible under existing ATC procedures.

The remaining 10 combinations from one or both of these two categories – New Conventional Airspace (All 4/22) and New NextGen Airspace (13/31) – will be evaluated further and the finalists incorporated into several scenarios in Chapter 12. Implementation of either of these two new airspaces will require

FAA agreement and cooperation between various industry and labor groups. There are a number of actions that the agency must take for these concepts to become a reality:

- The FAA must be open to a major restructuring of the region's airspace. While the most recent airspace redesign process has been plagued by legal challenges, which has slowed implementation of the program, this does not reduce the need to undertake a new airspace redesign that focuses on accommodating higher activity at all three airports and expanded airfields at JFK and EWR.

- NextGen I capabilities must include an RNP precision of 0.3 or Ground Based Augmentation Systems (GBAS) must be installed at LGA and JFK. This would forward the implementation of the 13/31 or 7/25 JFK airspace or reduce the amount of pavement needed at JFK under the all 4/22 airspace.

- The FAA working with labor and the airlines must accelerate the implementation of the NextGen program; tangible progress is the only means of increasing confidence in the program. Without a clear implementation timeline, it will be difficult to make capital decisions that hinge on NextGen's implementation.

NextGen not only makes some of these expansion combinations possible, but also increases their capacity benefits (in most cases), resulting in cost savings and reduced environmental/noise impacts.

In our region these environmental and noise impacts are more acute than in other places. Noise is a major factor at all three airports that will require consultation with community organizations and support from local governments. NextGen might help alleviate some of the variation in flight paths, reducing the number of neighborhoods impacted by new or modified approaches.

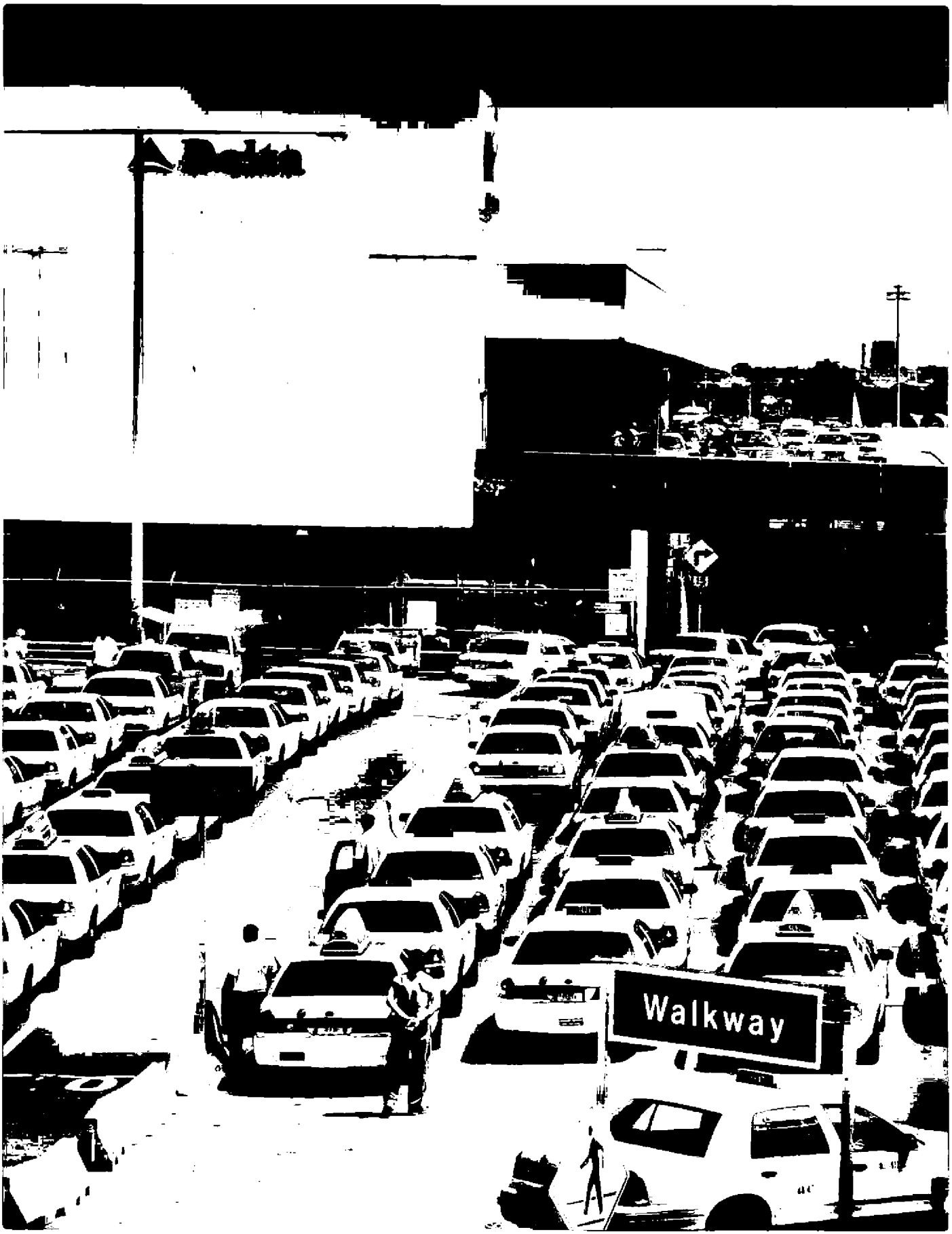
Expansion at LGA and/or JFK would most likely involve landfill and disruption to the environment, requiring the Port Authority to consider the following mitigation measures to:

- Regenerate and restore wetlands that have eroded or been eliminated in Jamaica Bay and potentially other areas on the inner south shore of Long Island.
- Rehabilitate the shoreline, park areas and open spaces of Floyd Bennett Field or Flushing Marina.
- Fund improvements to Flushing Meadows Corona Park
- Help to create new public waterfront access areas for local residents

Expansion at these two airports requires striking a balance between filling in open water/wetlands and the impacts (noise/land) to surrounding residential communities. In most cases, mitigating direct impacts to the residential neighborhoods will be given priority in selecting the final combinations.

The preferred alternative at EWR is the 4/22 triple-parallel configuration and removal of 11/29, which would act as the primary operating direction in both the all 4/22 and 13/31 (JFK and EWR) airspaces. Expansion at EWR will be mostly contained within the airport's existing boundaries; noise impacts would not be as severe as those involving expansion at JFK and LGA.

The size and timing of airport expansion depends upon the success of non-development options that increase capacity or manage demand in the region, and the region's tolerance of higher aircraft delays. The interaction of airport expansion and non-development options to increase capacity is discussed more fully in Chapter 12.


Walkway

Airport Ground Access Issues

This chapter examines ground access to the region's airports. It addresses the concern that the ability to reach (and leave) the airports on the ground will be compromised as air passenger traffic grows. The means to accommodate the growing number of air passengers were examined to determine how well the existing surface system can handle the expected growth. Emerging from this analysis is a suggested program for study and possible implementation.

Currently, the highway networks in the proximity of the three airports are subjected to major congestion, as documented in Chapter 2. The addition of more air passengers using the highway system, competing with overall traffic growth, will translate into more congestion and delays, requiring more time to get to and from the airports.

This chapter first examines how air passengers travel to the three airports today and how they are likely to reach these airports in the future in the absence of material changes in the current transit and highway services available. The chapter then highlights the airport access implications of projected air passenger growth and the opportunities to address those implications by transit and highway improvements.

Also discussed are the access opportunities for the two existing outlying airports – Stewart and MacArthur – that were identified in Chapter 6 as having a role in shifting air travelers from the three major airports, thereby freeing up capacity. Improved access can increase their attractiveness to air passengers and potentially shift some travelers from the major airports.

For each of the five airports, the opportunities to improve transit access are discussed. Steps that should be taken to address these ground access problems are also suggested.

Ground Access to Airports in the Region, the United States and Overseas

The best way to gain a better understanding of the ground access situation is to examine how air passengers reach the airports today. One valuable source of information is the Port Authority's sample travel surveys at the three airports.[1] Table 11.1 shows the distribution of mode and trip origin, in absolute number and percentage terms, for an average day in 2009 for trips to the airports. Since the data was collected only for trips to the airports, the analysis here must assume that the trips from the airports have similar characteristics.

The origins are grouped into five categories – Manhattan, the other four boroughs, the counties outside New York City but within RPA's 31- county region definition, and counties beyond that region, but in the four immediate states of New York, New Jersey, Connecticut and Pennsylvania, and beyond. Perhaps the most striking, but not surprising, feature of this table is the high percentage of passengers who reach the airports in motor vehicles, either personal or hired. With the severe congestion found on many of the highways that serve the three airports, this highlights the problem of relying on highway access to reach the airport. This is particularly an issue for time-sensitive business travelers. About 80 percent or more of the air passengers from the "other" boroughs and the suburban counties reach the airports in cars, and even for Manhattan-originating trips, the percentages are high. For Manhattan trips, only about 20 percent reach JFK by rail or bus, to EWR the public transit share climbs to 35 percent, and to LGA it is only 9 percent, all by bus. For all origins, the transit shares are 15.7 percent for JFK, 17.7 percent for EWR, and 11 percent for LGA (excluding the local shuttles from hotels and remote parking lots). For the three airports combined, 85 percent (95,600 of the 112,600) of the passengers daily arrive at the airports in automobiles. Passengers using local buses or vans to reach the airport from private remote parking facilities or using hotel shuttles are shown separately and not included in the bus totals, since opportunities to shift them to rail or other bus services are limited.

Unfortunately, despite the value of this data, cross-checking the EWR results with actual rail ridership to EWR indicates that the survey estimates are about 50 percent too high. The share of all trips by rail at 13.5 percent exceeds the value found by dividing the ridership counts by the local generated air passengers at EWR. The methods used to sample data require careful review by the Port Authority, and modifications to the sampling method should be explored. The JFK data was also cross-checked and appears to be more accurate.

While these percentages of transit use to the three airports are low, they are not out of line with shares of transit to other airports in the United States. A compilation of data for 27 U.S. airports[2] indicates that the transit shares vary from 6 percent to 23 percent. Of those with rail service to the airport, the average transit share (rail and bus) was just under 13 percent and of those without rail, the transit share was 10 percent. The rail shares alone varied from 13 percent at DCA (Washington, D.C.) to just 2 percent in Cleveland, with an average of just 6 percent. The airports with the higher than average rail shares

1 This sample is based on interviewing passengers at gate waiting areas. The low sample rates – one in 25 or more, and the sampling process could lead to significant margins of error. The sampling method also could lead to biases. Although it cannot be certain whether these sampling biases favor one mode over another, the difficulty in securing an unbiased sample at an airport makes these data suspect, when they are stratified too finely.

2 Airport Cooperative Research Program Report 4 – *Ground Access to Major Airports by Public Transportation* by Coogan, M, et al., 2008.

Ground Access Modes to Three Major Airports, 2009

Origin and Mode of Access to JFK

Trips	Manhattan	Other Boroughs	Suburbs in Region	Outside Region - Four States	Other USA	Total
Personal Car	7,166	7,583	5,649	811	1,451	22,661
Hired Car	8,917	3,676	1,983	175	1,306	16,058
Subway / AirTrain	2,788	732	463	30	322	4,334
LIRR / AirTrain	[illegible]	[illegible]	754	0	159	[illegible]
Bus	1,107	375	127	122	67	1,798
Local Shuttle	1,513	1,048	438	152	745	3,896
Total	22,094	13,692	9,415	1,291	4,049	50,541
% of Total	43.7	[illegible]	18.6	2.6	8.0	[illegible]

% Trips	Manhattan	Other Boroughs	Suburbs in Region	Outside Region - Four States	Other USA	Total
% Personal Car	32.4	55.4	60.0	62.8	35.8	44.8
% Hired Car	40.4	26.9	21.1	13.6	32.3	31.8
% Subway / AirTrain	12.6	5.3	4.9	2.3	7.9	8.6
% LIRR / AirTrain	2.7	2.0	8.0	0.0	3.9	3.5
% Bus	5.0	2.7	1.4	9.4	1.7	3.6
% Local Shuttle	6.8	7.7	4.7	11.8	18.4	7.7
Total	[illegible]	[illegible]	[illegible]	100.0	[illegible]	[illegible]

Origin and Mode of Access to EWR

Trips	Manhattan	Other Boroughs	Suburbs in Region	Outside Region - Four States	Other USA	Total
Personal Car	1,357	753	11,966	1,297	1,468	16,841
Hired Car	3,939	439	4,444	155	957	9,934
Rail to EWR	2,088	130	1889	54	431	4591
Bus	849	[illegible]	274	159	11	1,442
Local Shuttle	285	32	425	106	438	1,285
Total	8,517	1,503	[illegible]	1,770	3,306	34,094
% of Total	25.0	4.4	55.7	5.2	9.7	100.0

% Trips	Manhattan	Other Boroughs	Suburbs in Region	Outside Region - Four States	Other USA	Total
% Personal Car	15.9	50.1	63.0	73.3	44.4	49.4
% Hired Car	[illegible]	[illegible]	[illegible]	[illegible]	29.0	[illegible]
% Rail to EWR	24.5	8.6	9.9	3.0	13.0	13.5
% Bus	10.0	9.9	1.4	9.0	0.3	4.2
% Local Shuttle	3.3	2.1	2.2	6.0	13.2	3.8
Total	100.0	100.0	[illegible]	100.0	[illegible]	[illegible]

Origin and Mode of Access to LGA

Trips	Manhattan	Other Boroughs	Suburbs in Region	Outside Region - Four States	Other USA	Total
Personal Car	1,222	1,537	2,398	95	1,224	6,477
Hired Car	10,433	2,816	1,752	160	2,579	17,740
Bus	1,159	959	273	110	524	3,025
Local Shuttle	239	180	56	0	193	669
Total	13,054	5,493	4,480	365	4,520	27,911
% of Total	46.8	[illegible]	16.0	1.3	16.2	100.0

% Trips	Manhattan	Other Boroughs	Suburbs in Region	Outside Region - Four States	Other USA	Total
% Personal Car	9.4	28.0	53.5	26.1	[illegible]	[illegible]
% Hired Car	79.9	51.3	39.1	43.8	57.1	63.6
% Bus	8.9	17.5	6.1	30.0	11.6	10.8
% Local Shuttle	1.8	3.3	1.3	0.0	4.3	2.4
Total	100.0	100.0	100.0	100.0	100.0	[illegible]

Source: Port Authority of New York and New Jersey and Regional Plan Association

were those that typically had frequent service and a one-seat ride – Washington, D.C., Atlanta, and San Francisco, or where there was a two-seat ride with relatively frequent service -- Oakland, JFK and Boston. Perhaps as telling, the two with the highest shares – Washington, D.C., and Atlanta – had direct service to the terminal, not even requiring a transfer to an internal circulator.

The U.S. transit shares are small when compared with systems overseas. The 19 foreign airports studied range from 22 percent to 64 percent transit use, all higher than the U.S. airports. This striking contrast can be explained in part by factors unrelated to the quality of the service – land uses outside the United States that are more compact and more conducive to transit use, a greater inclination to use transit, and higher gasoline prices that drive up the cost of using a motor vehicle. While not always easy to distinguish because of the variety of idiosyncratic features of the airport access options in each city, the data both in the United States and overseas suggest that many features of the transit service are important to attract air passengers to transit. These include:

- Short travel times that are competitive with highway access modes;
- A one-seat ride, making the trip more convenient and easy to negotiate;
- A ride directly into the air terminal, with no more than moving walkways required;
- A reliable service that is not at the mercy of road delays;
- A service that connects to a regional transit network to draw from a wider area;
- Frequent service reducing waiting time and the need for consulting a schedule;
- Availability of weekend, late night and "reverse" commute service;
- Few stops between boarding point and the airport, which creates both the perception and reality of a faster trip;
- Easy to use including ticketing and wayfinding; and
- Easy baggage handling with vehicles, grade changes (elevators and escalators), platforms, and walkways that are "baggage friendly."

Many of the systems overseas have most of these features, and more often than not, the U.S systems lack many of them. These features can serve as guideposts in the review of the opportunities in this region.

While it would seem logical to include low fares as a feature to attract passengers to transit, the evidence as reported by Airport Cooperative Research Program: Report 4 – *Ground Access to Major Airports by Public Transportation* does not consistently support this.

The relatively low transit use at all the three major airports, particularly compared to overseas airports, implies that the transit facilities offered are not as attractive to the air passenger as they might be if they featured more of the characteristics of overseas transit systems. This becomes imperative as air passenger volumes grow. Without improvements in the quality of the transit options available, the reliance on unreliable highway travel will continue, and the door-to-door experience of air travel in the region will inevitably deteriorate. Meanwhile, in addition to transit improvements, actions that lower the demand on the

Highways At or Near Capacity by 2035
Source: NYMTC, 2035 BPM Model

highways, such as more group riding or higher prices to drive, as well as improvements themselves will have to be part of the airport access solution.

Ground Access Opportunities by Airport

As detailed in Chapter 2, each of the airports in the region – the three majors and the outlying airports as well – have distinct ground access challenges. At JFK the highway network that delivers passengers, employees and cargo to the airport consists of four major access highways – the Van Wyck Expressway (VWE), which also handles most of the cargo trips to and from the airport, the Belt Parkway from west and east, and the Nassau Expressway. The VWE and the Belt Parkway are often congested and the Nassau Expressway handles only a small fraction of JFK traffic.

The primary transit option to JFK is the AirTrain, accessed by the Long Island Rail Road at Jamaica or via four subway lines, three at Jamaica, or one at Howard Beach. Ridership has been growing, but its attractiveness is hampered by the need for a transfer. If using the subway to reach AirTrain, many stops slow the trip. If using the LIRR, there are limited access points, and only one in Manhattan at Penn Station. Express bus service to JFK is subject to highway delays.

The highways around EWR are becoming increasingly congested, as port-related and retail developments in the area continue to grow. Highway access from Manhattan is particularly problematic, requiring the use of one of the two Hudson River tunnels, which are often the subject of extensive delays. In peak direction commuting hours, this problem becomes still worse. Taxis from Manhattan to EWR are a poor choice for many since taxis are forced to charge a high fare because of local regulations dictating that New York taxis cannot pick up at the airport.

There are two transit access choices from midtown Manhattan to EWR – NJ TRANSIT's Northeast Corridor line to the airport stop, or direct bus service from the Port Authority Bus Terminal and other midtown locations. From Lower Manhattan, transit choices are limited, requiring a trip to midtown. The PATH system does not reach EWR, and using it from Manhattan requires a three-seat ride. Transit access from New Jersey is possible using rail from the many lines, but multiple transfers are required. Bus service is mostly focused on near-in municipalities in Union and Essex counties and can be spotty.

LGA's highway access is primarily by the crowded Grand Central Parkway, although a network of nearby arterial roads offers options to bypass some of the congestion. LGA has no rail option to fall back on and although there is limited bus service. Most LGA passengers use taxis or private cars to reach that airport. A number of bus lines can be used to reach LGA, each requiring a subway to bus transfer, and are subject to road traffic delays.

The two outlying airports – SWF and ISP – have little access problems by highways to serve their local constituencies, but they might be more attractive to others, particularly the New York City markets, if made more accessible. Against this background, each of these airports is treated separately.

The New York Metropolitan Transportation Council has modeled how much traffic will increase on the region's roadways by 2035.

Figure 11.1 highlights (in red) the expressways and major roadways that would experience a volume-over-capacity ratio (V/C) of 0.8 or greater by 2035 or the 150 MAP level. These segments of the network would experience severe levels of congestion, which will result in increased recurrent delays and greater travel times. Almost the entire roadway network around JFK and LGA would be affected. In contrast, most of the highway network serving EWR would not experience severe levels of congestion by 150 MAP, with the exception of a few segments on I-78 and I-95. This furthers the argument for robust transit improvements at JFK and LGA by the time the 150 MAP level is reached.

As will be discussed later in this chapter, transit systems will be hard pressed to limit the growth in highway use related to the airports. Other ways of reducing vehicular traffic will also have to be considered. Taxi and car growth might be lessened with more pooled taxi trips to and from the three airports. While this has been tried in the past with mixed success, the greater use of taxi stands for joint riding to the airport (both LGA and JFK) and at major generating points in Manhattan, including at major hotels, could reduce the traffic impacts. Worthy of a careful look is the notion of charging private cars a toll to enter the airports, which could encourage a greater diversion of air passengers to use transit to access our airports. This strategy is used by some airports today to limit vehicular traffic and raise revenue. For example at Dallas/ Fort Worth International (DFW) the main roadway (International Parkway) that serves the airport and bisects the terminals is tolled at both ends. DFW uses variable tolls to discourage cruising. The variability of this toll is not great since there is no reason to promote modal shift at an airport that currently lacks any compelling transit options.[3] However, a more aggressive variable tolling structure based on the level of congestion, the time of day or vehicle occupancy could be implemented at LGA and JFK to encourage drivers to shift to transit. Finally, in limited cases, expansion of the roadway network might be a necessary action.

For each of these airports, transit opportunities will be discussed, with the objective of limiting the impacts of added traffic on an already congested highway network

JFK Access Opportunities

For each of the three major airports, it would be desirable to lower the reliance on the highway network, given current and projected highway congestion. However, in light of a) the modest share of air passengers attracted to transit even with these gains, b) worsening highway congestion conditions on roadways near the three airports, and c) the projected growth in locally generated air passengers, we can expect that without further transit or highway improvements, road congestion near JFK will grow worse. Table 11.1 was used to calculate how many air passengers would have to shift to transit to keep air passengers contribution to road use from growing. This is an ambitious and probably unrealizable goal, but of value in setting a target for transit.

As shown in Table 11.1 there were about 50,500 air passengers traveling to the JFK on an average day in 2009. Of these, 38,700 passengers traveled by personal or by hired car. The number of trips to the airport is expected to grow by 42.7 percent by the time the region reaches 150 million air passengers.[4] Thus, if all geographic segments were to grow equally, and modal shares did not change, there would be 42.7 percent more passengers using cars, and when factoring in occupancy data for cars and taxis to JFK, would bring the number of vehicles to about 55,300, or 16,600 more vehicles entering the airport than do so today. Subtraction of the passengers using hotel and fringe parking shuttle buses and vans traveling locally and not using the highways brings the added vehicles on the highways, if modal shares remained, to 14,200 vehicles. Thus, if the objective were to keep highway use to the airports constant, then this would be the target for the transit system.

This is a huge challenge, and may not be realistic. The current share of 12 percent for all trips would have to grow to over 35 percent. In absolute terms, the number of air passengers using transit daily would need to go from 7,900 to 25,500 trips. Since it would be more difficult to achieve this growth outside of Manhattan, where transit options are inherently more limited and less attractive, and less able to compete with the private car, Manhattan-originating trips would have to have a still higher share. For example, if the non-Manhattan trips achieved a 25 percent transit share – about double of their share today – then Manhattan would have to achieve a 59 percent transit share, up from 20.3 percent today (rail and bus combined). This would represent a growth from 4,500 transit riders from Manhattan today to 18,700, about at fourfold increase. In sum, to avoid any increase in JFK's contribution to motor vehicle traffic, transit shares would have to grow significantly. To the extent that this is not accomplished, more capacity would be needed on the highway network, or higher occupancies per car would have to be encouraged, or more congestion and slower trip times tolerated.

Highways Now

The level of congestion on the highways around the airports is a "deficiency" of the regional airport system. The Van Wyck Expressway (VWE) is a major access highway to JFK; it is a congested six-lane roadway, with closely spaced exits and entrances and narrow shoulders. Traffic movement is further complicated by the merging of traffic where the Grand Central Parkway and the Jackie Robinson Parkway join it. The highway is flanked by fully developed land uses, much of it residential, and by service roads, making widening difficult. The VWE is also burdened by a high share of truck traffic, since alternate highway routes such as the Grand Central, Belt, and Southern State parkways all do not permit commercial traffic and truck routing via major arterial streets is restricted. The trucks destined for JFK are forced to use the VWE, adding time penalties to air-cargo traffic.

Level-of--service (LOS) data[5] for the 3.5-mile segment of the VWE from the Grand Central Parkway south to the Belt Parkway shows that the highway operates mostly at LOS E or F in both directions, in both morning and evening peaks. Level of service E is associated with "heavy traffic, but still at speeds close to free-flow," and level of service F, "represents poor traffic conditions (congested flow involving various degrees of delay)," which in most of the observations are at densities (vehicles per mile) that result in traffic speeds ranging from 15 to 40 miles per hour.

Of the 36 rated road segments / time / directions combinations, a LOS F was found 22 times, and LOS E ten other times. For the two-mile segment of the Belt Parkway from the Cross Bay Boulevard to the JFK Expressway, LOS E or F were recorded in some time segments, but the poorest levels of service were not nearly as extensive.

3 *Dallas/Fort Worth International Airport, FY 2011 Schedule of Charges* http://www.dfwairport.com/dfwucm1prd/groups/public/documents/webasset/p1_029764.pdf

4 Based on the projections in this report this would occur sometime after 2030.

5 *Performance Ratings of Traffic Flow on Selected New York Metropolitan Area Highways Fall 2007 (Draft One)* -Prepared by Skycomp, Inc. In Association with Parsons Brinckerhoff Quade & Douglas, Inc. for New York State Department of Transportation Region 11

Because conditions on the VWE are generally worse than on the Belt Parkway and over a longer stretch of highway, a closer look at the relationship between the VWE traffic and the airport is warranted. VWE congestion has grown, attributable both to the airport and to general traffic growth. The added vehicular traffic generated by the airport will only deteriorate general traffic conditions on the VWE. Conversely, higher traffic volumes generated by non-airport uses, can make access to the airport worse, and reduce airport use, especially for short-distance trips with ground options.

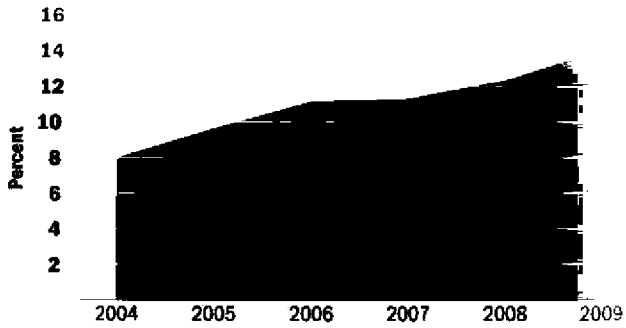
VWE traffic volumes associated with air passengers were estimated by converting the air passenger volumes in Table 11.1 to the number of vehicles, using average occupancies.[6] The 38,700 passengers in vehicles – personal and hired – convert to 23,700 vehicle trips on the major highways in the area. By using the county of origin of these trips from the sample survey, the proportion of these vehicles using each approach road was estimated; about 70 percent use the VWE, about 16,700 of these 23,700 vehicles. To this were added the vehicles carrying airport employees. The 35,000 employees at the airport are assumed to travel to work nine days of ten in a two-week period. It is estimated that about 4,500 southbound vehicles carry employees on the VWE to the airport daily.[7] About 150,000 vehicles travel on the VWE in both directions near its southern end on an average day. JFK accounts for about 22,100 (16,700 air passenger vehicles plus 5,400 employee vehicles) of the 75,000 southbound vehicles or about 29 percent of the daily traffic – 22 percent from air passengers and 7 percent from employees. These estimates are consistent with the percentages reported in a 1993 report indicating that air passengers made up 18 percent of the traffic in the morning peak hour and 34 percent of the traffic in the afternoon peak hour, and 12 percent and 7 percent of the traffic in those hours carried employees.[8]

If the transit system does not absorb higher shares of future traffic, it can be expected that the contribution by vehicles used by air passengers will grow by 42.7 percent on the VWE. This would amount to 16,700 x 0.427, about 7,000 additional daily southbound vehicles, or 14,000 vehicles in both directions. With daily traffic averaging 150,000 today, the added traffic from the passenger growth would add about nine percent to that total.

Fortunately, the transit system has been absorbing a disproportionate amount of the growth at JFK in the last few years. Figure 11.2 displays the growth in the share of air passengers using the JFK AirTrain since its first full year in 2004. This steady growth can be expected to continue, but probably at a declining rate. The introduction of LIRR service to Grand Central Terminal will boost the share still higher. These improvements will generate more transit use, lowering the vehicle growth attributable to air passengers. Based on Figure 11.2, it would seem that AirTrain's share rising to 25 percent or more is possible in the coming years. This would decrease the 16,700 vehicles on the VWE by about one-third to 11,200, resulting in only six percent of VWE traffic growth due to air passenger growth.

The VWE today is a severely congested roadway because it is one of the very few limited access highways in southern Queens, carrying much of the north-south movement in that part of the borough. Figure 11.3 dramatizes this well. To the west, there is no limited access highway in a north-south orientation for nine

Share of Air Passengers Using JFK AirTrain: 2004 to 2009
Source: Port Authority



miles until the Prospect Expressway in Brooklyn. To the east, the closest north-south highway is the Cross Island Parkway, three miles east. Drivers wishing to travel in a north-south direction are funneled to the Van Wyck Expressway. The southern portion of the Clearview Expressway was originally designed to complete the highway grid with another north-south link. It would have continued to the airport vicinity and the Belt Parkway and would have connected to the JFK Expressway, but was never built, having been abandoned in 1971. This puts the full burden on the VWE, and because most of the highways in the vicinity are parkways, the VWE is further burdened with commercial traffic. The city and state are taking steps to address some of the more severe bottlenecks on the Van Wyck and surrounding expressways, but none of these projects adds a significant amount of new highway capacity.

Currently, the New York State Department of Transportation (NYSDOT) is investing $146.5 million dollars to improve the safety and traffic flow at the Kew Gardens Interchange on the Van Wyck. This project began in 2010 and should be completed by 2015; it involves the construction of a new southbound travel lane for the Van Wyck Expressway, improving the connectivity between the Expressway, Jackie Robinson Expressway and Grand Central Parkway.[9]

In 2009 the New York City Department of Transportation (NYCDOT) initiated the first phase of a project to reconstruct seven bridges on the Belt Parkway. The NYCDOT will remove several geometric and physical bottlenecks that contribute to accidents or non-recurrent congestion on the Parkway. It will bring large portions of the Parkway into compliance with national highway standards, improving sight distances, increasing lane widths to 12 feet, adding and widening shoulders and medians and, most importantly, increasing clearance under overpasses to 14 feet and 6 inches, which will allow the roadway to accommodate most commercial vehicles.[10] As shown in Figure 11.3, the Belt Parkway currently prohibits commercial traffic, limiting trucks to just the Van Wyck, a chronically congested corridor. If commercial traffic was allowed on the Belt, trucks would also be able to directly access the airport from Woodhaven Blvd[11] which allows commercial traffic. Currently trucks must exit at Conduit Avenue to access the airport via Rockaway Blvd, which are both prone to severe congestion. This is another north/south arterial route that runs parallel to the Van Wyck

6 The occupancy estimates are based on Port Authority surveys.

7 The assumptions: 4.5/7 of 35,000 employees travel to the airport on a given day. Sixty percent use cars with a car occupancy of 1.5 and 60 percent of those use the VWE to access JFK. These assumptions assume that many flight crews not locally based travel by van.

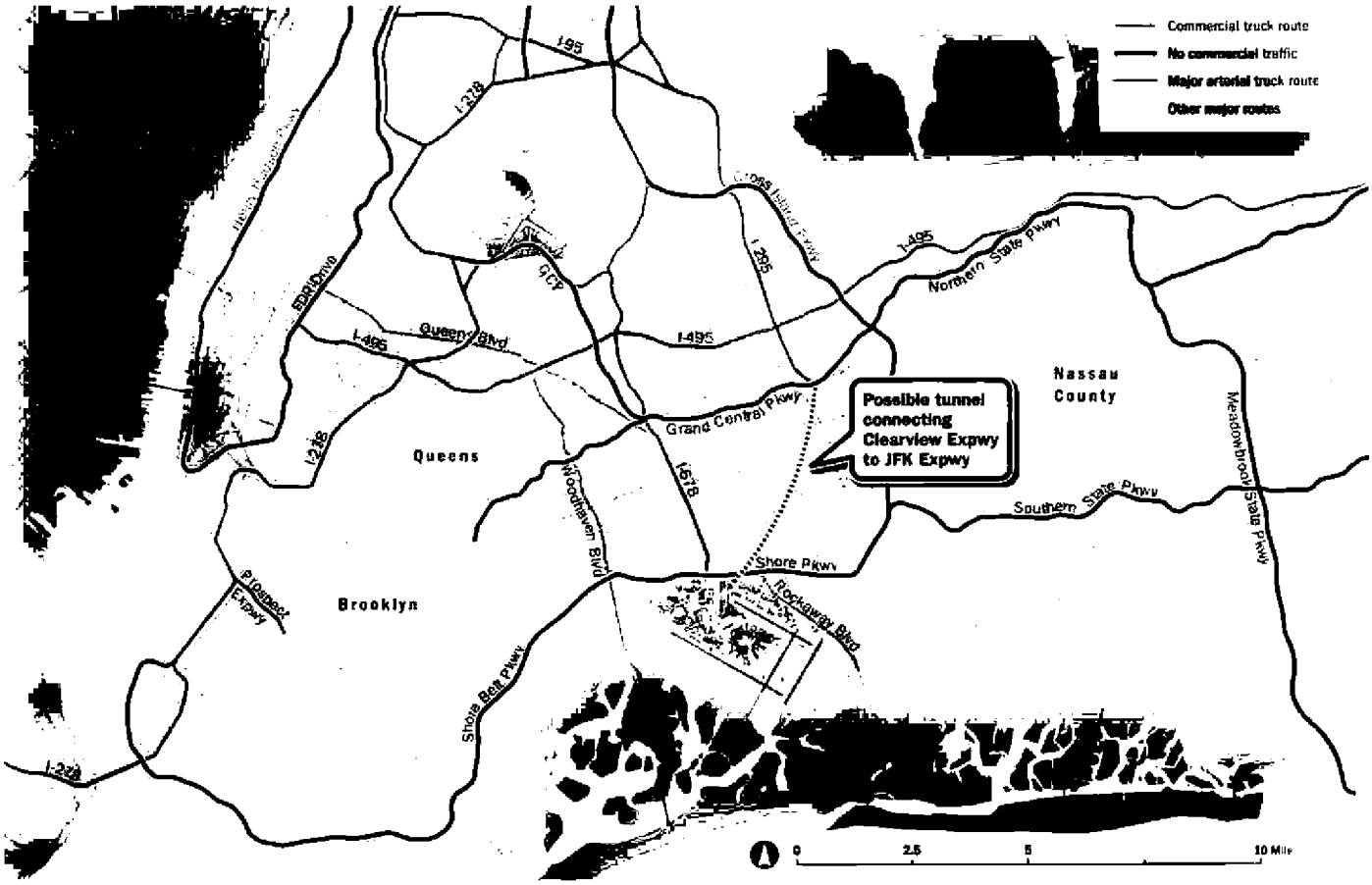
8 Van Wyck Expressway/Woodhaven Boulevard Corridor TSM Study. Technical Memorandum I, Vollmer Associates, 1993.

9 [illegible]

10 http://www.nyc.gov/html/dot/html/bridges/reconstruction.[illegible]

11 While this route is congestion in both morning and evening peak-period directions (LOS E and F), there is considerable "untapped" capacity in both reverse peak directions.

Commercial Access on Highways and Arterials Surrounding JFK
Source: New York City DOT and Regional Plan Association



and connects to the Belt Parkway. Trucks would also benefit from a more direct route to the Verrazano Narrow Bridge (I-278) to serve west of Hudson destinations.

NYSDOT is examining ways to improve local circulation around the airport as part of its Southeast Queens Transportation Study, which includes both the Nassau Expressway and the Cross Bay Boulevard[12]. Two of the study's stated objectives would directly impact vehicular access to JFK – to reduce delay and congestion in the corridor and to improve connectivity for goods movement. NYSDOT has also been studying various strategies to manage traffic on major highways in arterials in the five boroughs of New York City and Nassau and Westchester counties as part of a multi-year Managed-Use Lane Study. These managed-use lane strategies include preferential treatments (HOT lanes, truck lanes, bus on shoulder, reversible lanes, etc...), speed harmonization, queue warning, temporary peak shoulder use, junction control and dynamic rerouting at major interchanges using variable messaging boards. NYSDOT is currently evaluating the potential of these strategies to address bottlenecks and congestion on the Van Wyck Expressway, Grand Central Parkway, Clearview Expressway and Belt Parkway.

Physical improvements to the Van Wyck like the Kew Gardens Interchange reconstruction and planned/proposed measures to relieve congestion on the Belt Parkway and Nassau Expressway should help conditions on the Van Wyck from further deteriorating to an untenable level in the near term. Additional relief would also be possible if commercial traffic was allowed on the Belt Parkway. However trucks only make up at most 11 percent of the traffic on the Van Wyck. Transportation demand measures and/or tolling could also help dampen all vehicular traffic volumes, maintaining current levels of congestion by using pricing or other strategies to encourage drivers to divert to transit. Yet, to serve the additional air passengers that will, if current shares remain constant, drive to JFK by the 150 MAP level will require new capacity of the surface highway network. If the Clearview Expressway were extended as originally intended, the gap in the north-south highway grid would be filled and significant diversions form the VWE would be likely. The obstacles to expanding highway capacity for general traffic on the north-south and east-west corridors to JFK are high, but the need to assure reliable access to this growing airport for passengers, employees, and cargo is critical. The city and state agencies should evaluate creative options for long-term improvements emphasizing managed-use lane opportunities. Without an increase in highway capacity, JFK would have to rely on transit much more than it does today by the time it reaches the 150 MAP level.

Transit Opportunities

Those using transit to reach JFK can do so by using the LIRR to Jamaica and then transferring to the JFK AirTrain. The AirTrain is also reachable at two locations by transfer from the NYC subway, one at Jamaica where three services (E, J and Z) converge and the other at Howard Beach (A line) near the western edge of the airport. This LIRR to AirTrain link is available to anyone who can reach Jamaica by the LIRR from Nassau and Suffolk counties, from Brooklyn and Queens, or Penn Station on the west side of Manhattan. The subway lines linking to

12 NYSDOT – Region 11 Office, Southeast Queens Transportation Study Presentation, Fall 2010

Passenger Oriented Screening for JFK Transit Access Options

#	Option	Travel Time Under 45 Minutes	One-seat	Reliable	Network Connections	High Frequency	Retain?
1	Hybrid Train to Penn Station	Yes	Yes	Yes	Fair	Yes	Yes
2	Amtrak to JFK	Yes	Yes	Yes	Fair	No	No
3	Amtrak to Jamaica	Yes	No	Yes	Fair	No	No
4	Atlantic Branch from Downtown Brooklyn to JFK as AirTrain	No	Yes	Yes	Good	Yes	Yes*
5	Subway to JFK Using Hybrid AirTrain / Subway Technology	Yes	Yes	Yes	Good	Yes	Yes
6	Bus Preferential Treatments	Yes	Yes	No	Good	Yes	Yes

*provisionally

Source: Port Authority

the AirTrain stop in dozens of locations in the four of the five boroughs wherever the A, E, J, and Z subway lines operate. In the peak commuting direction, these subway lines may be crowded, and an unattractive options for some air passengers. Express buses from Manhattan deliver people directly to the airport as well. There is also limited local bus service, largely used by airport employees living in southeast Queens.

The AirTrain, which functions as both a link to transit off the airport and as an internal circulator, has seen its ridership grow dramatically since it opened in late 2003. The off-airport passenger total stood at 2.6 million in 2004; it has doubled to 5.2 million in 2009, as passengers and employees become more familiar with the service. A boost to the growth rate can be expected in 2016 when the East Side Access project, which will connect the LIRR to Grand Central Terminal, is completed. Air passenger trips starting in east midtown and throughout the east side of Manhattan will find the LIRR to AirTrain at Jamaica an attractive option. In addition, Metro North territory passengers in the Hudson Valley and Connecticut will be able to use this new connection once they reach Grand Central Terminal.

The existing JFK AirTrain right-of-way was purposely constructed to accept a hybrid vehicle that could operate on both the current AirTrain right-of-way and the LIRR or a differently designed hybrid vehicle that could operate on the current AirTrain right-of-way and the subway system ("B" division, the lettered lines). It could be designed to operate on the commuter rail and AirTrain systems with some modifications to one or the other. Each of these possibilities offers multiple benefits. If designed for the LIRR and the AirTrain, the system can provide a one-seat ride from Penn Station (and from Grand Central Terminal in the future) at a relatively high speed. If designed for the subway and AirTrain, it can gain the advantages of broad coverage and connectivity that the NYC subway system provides, plus a one-seat ride.

With these possibilities in mind, a series of options are arrayed below that include services that use a hybrid vehicle and those that do not. The latter group does not combine modes, but uses only intercity rail (Amtrak), commuter rail (LIRR), subway (NYCT), or buses. All of the options are described below and several preferred options are depicted in Figure 11.4.

1. **Hybrid Vehicle to Penn Station:** Connect AirTrain to commuter rail network, using a hybrid vehicle that can operate on the existing AirTrain right-of-way and then onto the LIRR Mainline and continue into Penn Station. For those starting their trip near Penn Station, the trip to the airport would be a one-seat ride, other than those who need a second vehicle, probably the subway or taxi to reach Penn Station. The right-of-way would bypass Jamaica station. Those passengers arriving at Jamaica by subway or from the LIRR other than Penn Station would continue to transfer to the existing AirTrain vehicles. The LIRR would operate the vehicle.

2. **Amtrak to JFK:** Extend Amtrak service over the LIRR Mainline and then on to the AirTrain right of way over the Van Wyck. This option suffers from numerous passenger-related flaws – poor connectivity in Manhattan, two seat ride, and infrequent and sporadic service.

3. **Amtrak to Jamaica:** Extend Amtrak from Penn Station to Jamaica. Like #2, it would have poor connectivity and lack a one-seat ride, and the transfer would be off airport, which would be a further deterrent to its use. It too would have infrequent and sporadic service. It is highly unlikely that Amtrak would be able to adjust its service plan to provide the frequency of service required for this option or for option #2.

4. **Atlantic Branch from Downtown Brooklyn to JFK as AirTrain:** Using a hybrid vehicle, this service would operate on the Atlantic Branch of the LIRR from Atlantic Avenue in Downtown Brooklyn, and then diverge to operate through southern Queens, possibly via Conduit Avenue and onto the airport and the Central Terminal Area AirTrain stations or via the existing AirTrain right-of-way at Jamaica. Travel time could be slow and require Manhattan passengers to transfer in Brooklyn. This is also far from the greatest area of concentration of passengers in midtown Manhattan.

5. **Subway to JFK Using Hybrid AirTrain / Subway Technology:** Extend the Second Avenue subway from Lower Manhattan to Atlantic Avenue and then operate as an express via the Atlantic Branch right-of-way to Jamaica and onto the AirTrain right-of-way using Hybrid AirTrain /Subway vehicles. This service would capture riders along the east side of Manhattan and via transfers from the existing subway, from many other locations in Manhattan. It would require mixing the hybrid vehicles with the subway fleet. Presumably, the MTA would operate the service.

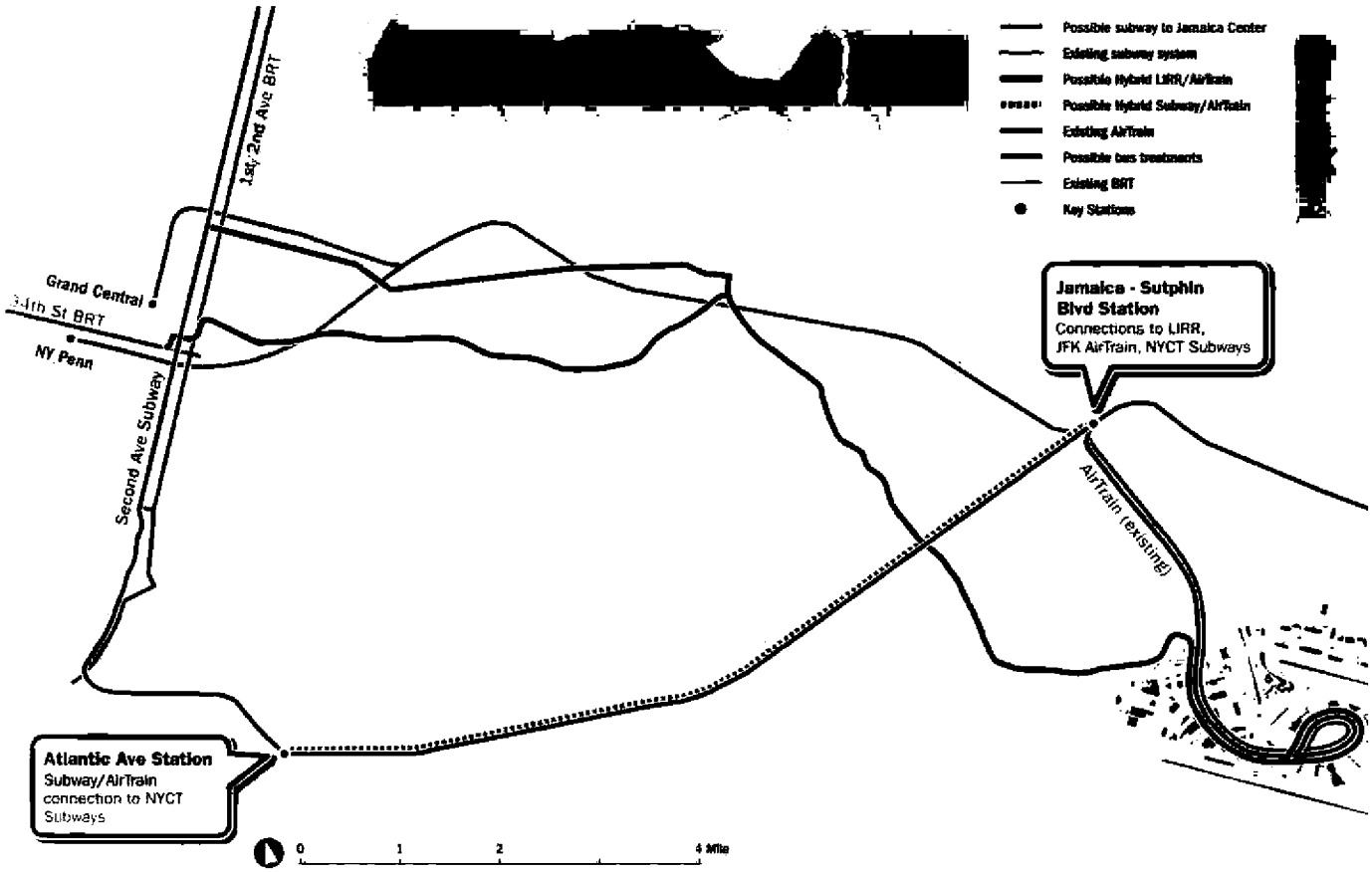
6. **Busway Preferential Treatment to JFK:** Create a system of bus preferential treatments combining features of proposed BRT lines, extending and connecting them to minimize mixing in general traffic from Manhattan to JFK.

Table 11.2 is a passenger-based screening matrix that uses those desirable features for an airport access transit system discussed early that can help discriminate among options from a passenger's perspective.[13]

Option #1 lacks full connectivity to the transit network. Prospective passengers would have to make their way to either Penn Station or to Grand Central Terminal (when East Side Access was completed). Once there however, they would have a one-seat ride to the airport. Because it uses Amtrak equipment onto the airport, option #2, Amtrak to JFK, would not be able to stop at each terminal, requiring an on-airport transfer for most

13 "Yes" scores are: travel times from Manhattan is less than 40 minutes, reliability if highway use is avoided, network connections if there are multiple entry points with subway line intersections, and frequency is high if service is every ten minutes or less.

Preferred Transit Access Options to JFK
Source: Regional Plan Association



riders. It would not be able to take advantage of East Side Access. Most damaging is Amtrak's inability to offer frequent service. This option is rejected for further analysis.

Option #3 would operate Amtrak service only as far as Jamaica, where a transfer to AirTrain would be required. It shares the shortcomings of #2 and it requires another transfer. It too is rejected.

Option #4 would operate from downtown Brooklyn, limiting its attractiveness for Manhattan travelers, adding to the number of transfers and travel time and slowing the trip. However, since it could be the first phase of option #5, which will be retained, it is retained provisionally.

Option #5 does not have any obvious passenger deterring characteristics. It could offer a fast, no-transfer service well connecting to the region's transit system. It is retained.

Option #6, bus preferential treatments, will serve the passenger only as well is it can be made reliable, avoiding roadway traffic congestion. This will depend on how well it can be designed to do that. If it does, it should be retained as a transit option.

Options 1, 4, 5, and 6 should be retained for further consideration, given the first-level screening process; Option #4 should be retained only as a first segment of the larger project, #5. The second-level screening examined the physical and operating issues for these remaining options, which are discussed next.

Hybrid Vehicle to Penn Station

This option would require a track connection between the existing AirTrain station at Jamaica and the LIRR Mainline. There are numerous obstacles to this approach. First, the current AirTrain vehicles are completely automated and do not require a human operator. This would have to change in order to run a vehicle directly on to the LIRR's system. The Hybrid AirTrain cars would need to operate in dual-modes, automated on the AirTrain system and under manual (human) control on the commuter rail network. Second, the intermingling of AirTrain vehicles on tracks with commuter rail and Amtrak intercity trains requires that AirTrain have sufficient "buffer" strength to withstand a collision with heavier rolling stock. This Federal Railroad Administration requirement could have difficulty receiving a waiver in the dense operating environment of the LIRR mainline from Jamaica Station to Penn Station. Third, the use of Penn Station for trains to JFK would usurp scarce capacity into and out of Penn Station, especially in the peak for trains that would likely carry only a small fraction of the volume of passengers that commuter trains do, thus using station capacity less effectively. This problem might be somewhat less of an issue once the LIRR's East Side Access project to Grand Central Terminal is completed in 2016. However, the LIRR has shown a reluctance to give up any of its Penn Station capacity then, and Metro North and Amtrak are both eyeing the added capacity for their needs. Fourth, the AirTrain system would require major retrofitting of various elements, including vehicles, power, signals, and stations. Finally, the AirTrain station platform heights would have to be adjusted to be compatible with the LIRR car floor heights. Alternatively, the station platforms at Penn Station would have to be modified, removing their use for commuter trains, an unacceptable impact for the LIRR. Another possibility is making the hybrid vehicle's height adjustable. While this is theoretically possible, it would likely add to the cost and maintenance of the vehicle and still require gap fillers at the LIRR's

terminals to accommodate the narrower railcar. None of these issues is trivial. Despite them, the inherent advantage of the long sought one-seat ride from both Penn Station and Grand Central Terminal warrants its retention.

Atlantic Branch from Downtown Brooklyn to JFK as AirTrain

Once the LIRR's East Side Access project is complete, the LIRR plans to replace service now operating through Jamaica to Brooklyn with a shuttle. Because it would no longer be mixing with current commuter trains this service could conceivably use a vehicle that could operate on this right-of-way and on the AirTrain right-of-way without encountering the buffer strength issue. This service would be of limited benefit to Manhattan-based air passengers who would require a subway ride to Brooklyn. To overcome that, the Atlantic Branch could be extended into Lower Manhattan, possibly near the reconstructed World Trade Center. Alternative ways of doing this were studied, under the auspices of the Lower Manhattan Development Corporation, an organization set up in the wake of the September 11, 2001 tragedy. Options using existing subway tunnels were found to be fatally disruptive of existing subway service and have since been rejected. Subsequent analysis by the MTA and partner agencies further developed the concept of a new LIRR or subway service via a new East River tunnel between Lower Manhattan and Jamaica, though this proposed project has lost momentum in the current budgetary climate. This option should be dropped from consideration unless it is envisioned as a first-step for AirTrain to JFK using option #6.

Subway to JFK Using Hybrid AirTrain / Subway Technology

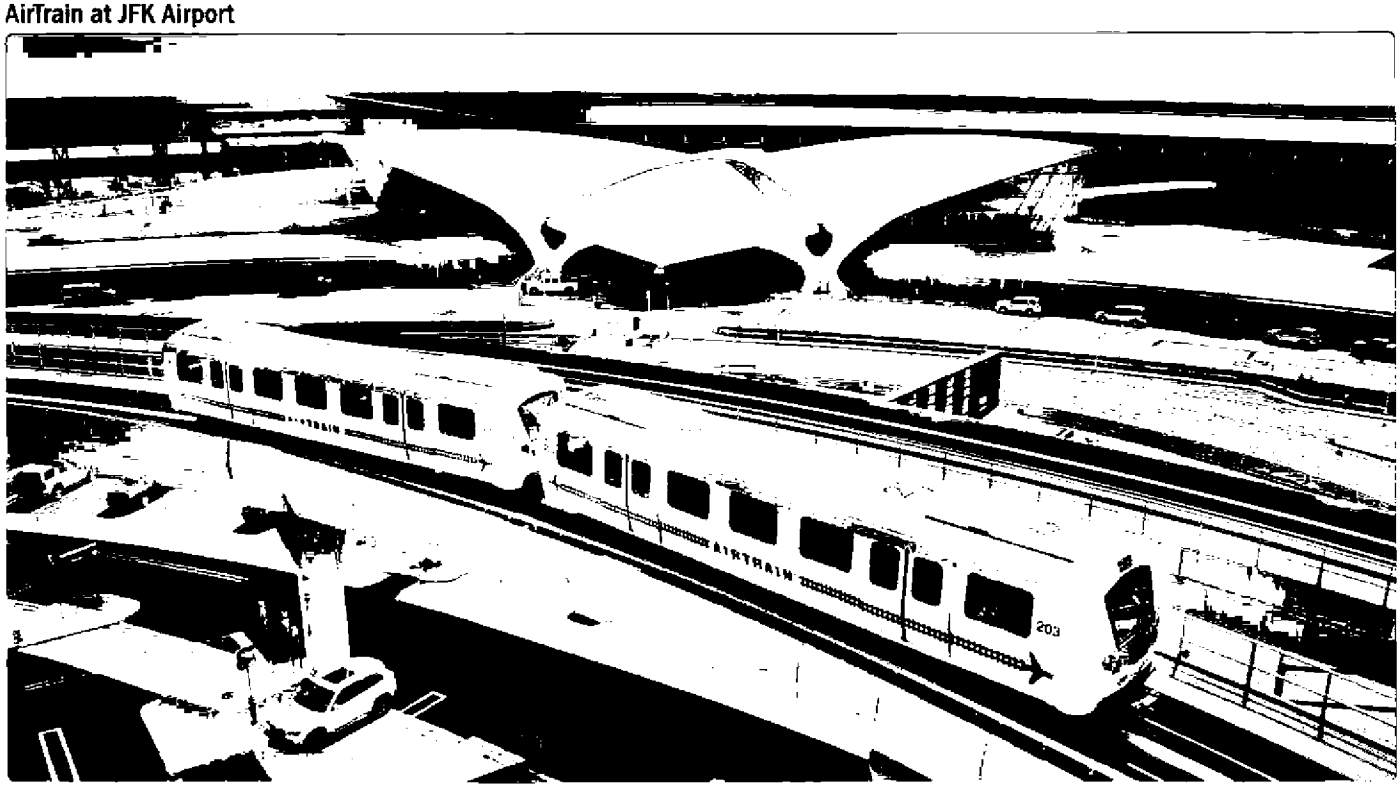
The hybrid vehicles for this service would be designed to operate on the New York City subway lettered lines (B Division). The transition from automation on the AirTrain right-of-way to manual operation would be required. However, since the existing AirTrain vehicles are the same dimensions as Division B railcars, changes to the platforms at the AirTrain or subway stations would not be needed.

This option requires a significant expansion of the subway. It would use the Atlantic Branch of the LIRR as the previous concept did. The line from Brooklyn would be extended under the East River to the south end of the Second Avenue subway when it is completed in Manhattan. In this option, the line from Manhattan and downtown Brooklyn would connect to the existing AirTrain alignment in Jamaica and could operate with vehicles that would be compatible with the AirTrain, creating one-seat ride service from all the East Side stations served by the Second Avenue subway, and from downtown Brooklyn. It would have the advantage of a multi-stop line, broadening its catchment area. The greater use of the subway to AirTrain shown in Table 11.1 suggests that frequent service and lower fares are important attractions. The airport service would operate as express. Because the AirTrain platforms at JFK are short, the airport trains operating in the subway would have to be short as well. A second service on this line would use the high capacity that a subway line offers, spreading the cost associated with airport access.[14] This option should be retained as a long-term option.

Busway to JFK

This option would use the Queens-midtown Tunnel and the short stretch of exclusive bus lanes near the tunnel. The route would continue on the Long Island Expressway with its extensive traffic congestion. Some routes might extend over the Queensboro Bridge and be incorporated into Queens Boulevard with preferential treatments. A routing to reach the airport would have to found, possibly along Woodhaven Boulevard as a bus only lane. Buses could then connect to the AirTrain at Howard Beach, making it a two-seat ride. Alternatively, the buses could continue to each terminal, bringing the riders closer to

AirTrain at JFK Airport



[14] For a fuller description of this concept, see *Innovative Transit Access Alternatives for the Region's Urban Core* - Regional Plan Association, October 2008.

the terminals than AirTrain does today. It has the advantage of building upon the existing JFK express bus service, offering better distribution in Manhattan. Depending on how much construction would be necessary for busway elements, it could have a much lower cost than the other options for JFK presented here.

The busway option could be part of a bus rapid transit network, building on the current efforts by the NYC Department of Transportation and the MTA. Special bus services (branded *Select Bus Service*) are now in place on First and Second avenues in Manhattan, on 34th Street which could be extended into the Queens Midtown Tunnel. Added BRT rights of way are possible on the Queensboro Bridge and on Queens Boulevard. Taken together they can be beginning of a bus network that can offer access to JFK and serve other transit functions locally.

JFK Prognosis

In the short run, the establishment of a bus oriented option with a route that gives buses preference over other vehicles should be explored by the NYC and NYS DOTs, and the Port Authority. Use of the a lane in the Queens-Midtown Tunnel and the Queensboro Bridge, the latter also to be used by buses destined for LGA, and continuation onto the Long Island Expressway and Queens Boulevard, and the use of Woodhaven Boulevard could increase the reliability of today's express buses destined for JFK. If high occupancy vehicles are included, it could reduce some of the passenger car traffic headed for the airport. The bus option could produce significant benefits, especially as part of a bus rapid transit system, improving the reliability for bus passengers, and perhaps attracting more air passengers.

In the mid-term, the prospect of building upon the AirTrain service should be examined more fully, taking advantage of its distributional capabilities on the airport, and extending its service more directly into Manhattan using hybrid vehicles, with either Long Island Rail Road or subway infrastructure. The idea of a one-seat ride from Penn Station to JFK has drawn great interest in the past. In this report, the many barriers to its implementation have been discussed. If this option is to be kept alive, then these issues must be seriously addressed. The transportation agencies – the MTA/LIRR, MTA/Metro North, NJ TRANSIT, and Amtrak will need to cooperate on the issue of Penn Station capacity use and the many physical issues involved.

In the long-term, the option to build upon the Second Avenue subway into Brooklyn and then onto the Atlantic Branch appears to have many of the features needed for a successful transit service to an airport – reliability, coverage, frequency, connectivity to the transit network, and the long-desired one-seat ride. The advancement of the Second Avenue subway in Manhattan can be an important first step in meeting JFK's transit access needs.

The subway option has the advantage of not consuming scarce Penn Station space. Moreover, because it will be a valuable addition to the subway system its cost effectiveness is not solely dependent on attracting air passengers, as the other options discussed here do.

However, these options require subway system expansion for which there is no funding available at this time. Given the current state of transit capital funding, it may not be available for many years.

Meanwhile, there are actions underway that will bring the transit share closer to the targets. The opening of East Side Access for the LIRR to the Grand Central Terminal will be an important addition for access to JFK, as Manhattan and Metro North territory customers in Westchester and Connecticut will have a new transit option. The success of AirTrain ridership, demonstrated by its strong ridership growth rates, will undoubtedly continue as more air passengers become familiar with it, pushing up the transit shares from wherever the subway operates to the AirTrain and along the LIRR's territory. Tolling access to JFK and other "Transportation Demand Management" strategies are other ways to encourage the shift of passengers to AirTrain. AirTrain has room to grow to meet added demand, having been designed for four-car train operation, but using only two cars today.

JFK Ground Access Recommendations for 115, 130 and 150 MAP

Recommended at	Transit Improvements	Highway Improvements
115 MAP (2015-2021)	Busway/BRT via Woodhaven Blvd and / or other corridors	Trucks on Belt Parkway & Preferential Treatments for 59th Street Bridge and Midtown Tunnel
130 MAP (2021 - 2034)	Hybrid Vehicle on Atlantic Branch	Tolling Access to JFK
150 MAP (2030 -2042+)	Extension of Second Avenue Subway to JFK via Atlantic Branch	Extension of Clearview Expressway to JFK Expressway

Source: Regional Plan Association

The discussion of transit options to JFK have focused on serving the Manhattan – JFK market. The other markets are inherently more difficult to serve. This does not mean that there are not opportunities to increase transit use from non-Manhattan locations. The rail options suggested can be used by passengers of existing transit systems who reach Penn Station, Grand Central Terminal or Jamaica in the other boroughs or from the suburban counties. More direct services from these locations are likely to be more difficult to establish, except as a by-product of the new services suggested here.

There also is a role for local bus services from portions of Queens and Brooklyn. These should be encouraged, but given the advantages of auto travel for close trips, they are not likely to make a telling difference in the transit share changes needed.

Even assuming success in planning and funding ambitious rail transit improvements for JFK access, some physical expansion of the existing highway network likely will be necessary to assure reliable access to the airport – including for buses and taxis as well air cargo, the 24/7 airport work force and other road-dependent trips. The need to serve this key economic asset as well as the surrounding communities should be reflected in NYSDOT's long-term planning and capital investment agenda, in concert with NYC agencies and the Port Authority. The value of the capacity improvements in southeastern Queens calls out for a better understanding of what these improvements might achieve and how they might also benefit the surrounding local communities. Accordingly, the NYSDOT should perform traffic assignments analysis to estimate what the impact of the alternative highway improvements is, particularly as they affect VWE level of service. Projects that could reduce congestion levels should be advanced.

The recommended sequence for implementing these transit and highway improvements, as they relate to each of the three projected air passenger demand levels, is shown in Table 11.3. The timing of the initiatives in this Table (and in the following tables for EWR and LGA) are only illustrative; much will depend on available funding, projected rates of growth being realized and other uncertainties.

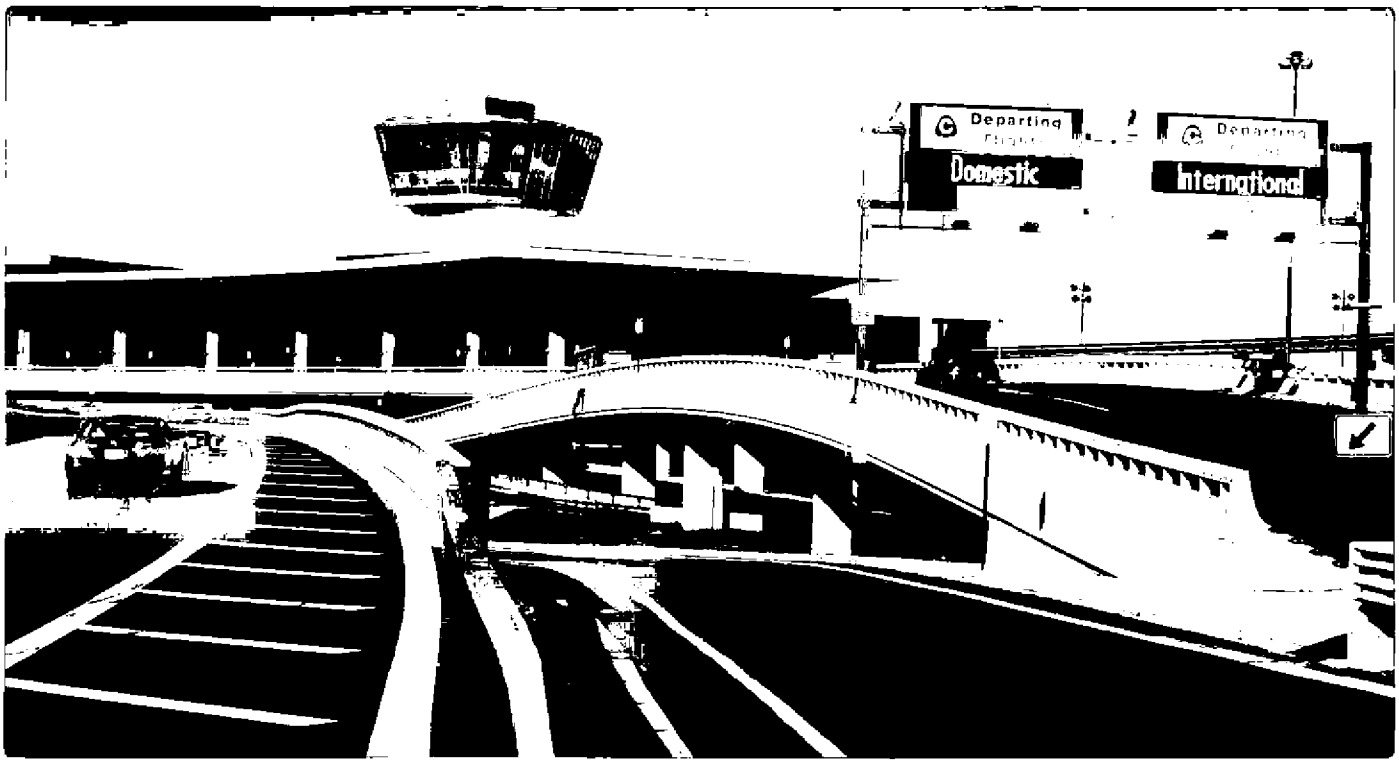


Photo: Port Authority

EWR Access Opportunities

As was done for JFK, the required number and share of transit riders that would make it possible to keep car traffic at current levels was determined. Because the critical bottleneck is across the Hudson, these calculations were confined to Manhattan to EWR trips. If transit shares from Manhattan did not increase, by the time the region reached 150 million air passengers there would be 1,900 more air passengers a day traveling to EWR in personal or hired cars. For these air passenger volumes using cars not to materialize transit use from Manhattan would have to grow from 2,900 today to 5,900, just about double, bringing the Manhattan to EWR transit share from its 35 percent today to 51 percent in the future. Put another way, transit would have to be about 50 percent more attractive than it is today.

Highways Now

Table 11.1 indicates that most of those starting their trip to EWR from outside of Manhattan travel by car. Of the 34,100 trips made by air passengers to EWR daily, almost 27,000 are in cars. The highway network they use is robust and crowded in spots, but they do have numerous routing choices. The New Jersey Turnpike is 12 lanes wide, and Interstate 78, US 1/9 and Route 21 are all options. However, these highways will become more crowded particularly by truck traffic to the Port of Newark and Elizabeth, and to allied industries. Retail developments adjacent to the airport and port – Jersey Gardens Outlet Mall and Elizabeth Center (IKEA) – also attract increasing numbers of automobiles that are competing for roadway capacity. Over time, growing congestion issues, largely from non-airport traffic, would have to be addressed. Transit options might play a role here.

Transit Opportunities

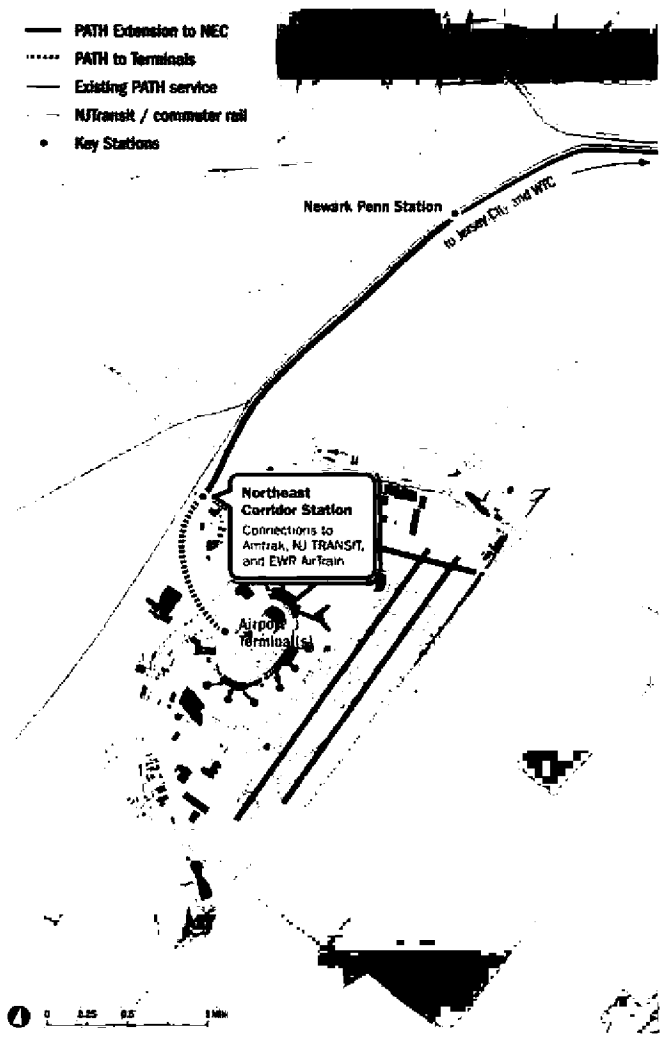
EWR's automated AirTrain circulator, built originally as an airport circulator in the 1990s was extended to and connected to a new station on the Northeast Corridor in 2001. The new station allowed airport passengers and employees to use NJ TRANSIT and Amtrak to reach Penn Station in midtown Manhattan, downtown Newark, and points south. However, Amtrak service is very infrequent with only nine trains stopping daily in each direction. The NJ TRANSIT service is much more frequent with 81 trains in each direction on weekdays and 61 on weekends. Some peak direction-peak period service is less frequent with gaps of up to 45 minutes as NJ TRANSIT juggles its commuter service with service to the airport. Express bus service operates from the Port Authority Bus Terminal, and must face the uncertainties of the congested highway network. Air passengers from Lower Manhattan must travel to midtown to avail themselves of these services. Passengers starting their trip from locations in New Jersey have still fewer transit options. Only those who can reach Newark and take its bus service, or who can access the Northeast Corridor have a realistic means of using transit to reach EWR.

There are efforts underway to improve transit access to EWR for those residing in New Jersey. The New Jersey Department of Transportation has received funding from the federal government to construct a Bus Rapid Transit (BRT) system that would expand transit access to the airport for residents of Union and Essex counties, with an added emphasis being placed on improving connections for Newark residents. This BRT system is part of a larger project called the Liberty Corridor, which is referred to as a "corridor of corridors" to improve multi-modal transportation systems in eight counties that include over 232 municipalities.[15] NJ TRANSIT has used some of this funding to put in place the first phase of the BRT corridor, which runs from Bloomfield through downtown Newark to the airport. This new

15 http://www.state.nj.us/transportation/works/libertycorridor/

Summary of Preferred Transit Options for EWR

Source – Regional Plan Association



service, called the GO Bus 28, was launched in October of 2009. The system does not use a dedicated right-of-way or off-board fare collection that are typically standard features of BRTs, however, it does leverage signal priority technology and limits the numbers of stops (only 20) to reduce travel times. The service is also branded with shelters that have improved lighting and additional seating. Eventually, the Liberty Corridor BRT will connect downtown Newark to the port complexes as well, it will also be upgraded incrementally to include other BRT features such as off-board fare collection.

New Jersey Transit is also evaluating the possibility of a new BRT service for Union County that would run from Plainfield to Elizabeth and terminate at EWR. The BRT would use an abandoned rail right-of-way between the Elizabeth Train Station and Roselle Park/Roselle (junction with Raritan Valley line), with on-street enhancements west to Plainfield and east to the Newark Airport and Jersey Gardens. Some additional elements that will be evaluated as part of the study include a dedicated bike/pedestrian path adjacent to the exclusive busway and preferential treatments to allow bus queue jumping for vehicles operating off the busway.

Taxi trips from Manhattan are very expensive and both personal vehicles and taxis face the uncertainties of congestion at the two tunnels under the Hudson River. Because New York yellow cabs are not allowed to pick up fares at EWR, they must charge a higher fare for a trip from Manhattan. The drive in a hired or personal car to EWR also encounters the traffic uncertainties of the Lincoln and Holland tunnels. These barriers to the use of private vehicles, which are unlikely to change, suggest a focus on the opportunities to improve transit from Manhattan.

The possible means of shifting more air passengers, with the focus on establishing more Manhattan transit options that can avoid the trans-Hudson traffic congestion, are explored next.

1. **New AirTrain to Newark Penn Station.** The EWR AirTrain, built in 1996 currently has insufficient peak hour capacity and will have to be replaced with a higher capacity, more technologically advanced and reliable system. This provides an opportunity to extend the replacement service from the Northeast Corridor (NEC) station northward into Newark-Penn Station. This option would make it possible to use the PATH line from Lower Manhattan, Exchange Place and Journal Square in Jersey City to reach EWR with a single transfer in downtown Newark, rather than the two transfers today from Lower Manhattan. For Northeast Corridor riders there would be more frequent service than there is today, since all NJ TRANSIT and Amtrak trains stop in Newark. Downtown Newark riders would have a one-seat ride. Service would be frequent and inexpensive, although a premium fare for trips to the airport could be charged. The alignment between the existing NEC station and Newark would present some difficult engineering challenges, particularly crossing the NEC from the east to the west side to avoid local impacts, along with the construction of a new AirTrain station at Newark Penn Station.

2. **Extension of PATH to the NEC Station Combined with AirTrain Upgrade.** With this option, the PATH service now terminating at Newark-Penn Station would be extended about 2 miles to the NEC station, creating a two-seat ride (PATH and AirTrain) for Lower Manhattan and Jersey City riders. Air passengers originating in Downtown Newark would have a more frequent service to EWR, but would still require a transfer to the new circulator on the airport. Common to all options that extends PATH onto the airport is the need to cross from the west side to the east side of the NEC. However, in this option, crossing the NEC could be avoided if the new PATH station were constructed to the west side of the NEC.

   Construction issues might be somewhat more difficult than for the previous option along the right-of-way, since PATH is larger, heavier and less flexible than the AirTrain replacement would likely be. On the plus side, PATH currently has tracks along a portion of the NEC (which might be utilized for the extension) and there would be no need for a new station in Newark Penn Station. This option, like the others assume that the current AirTrain system would be upgraded.

3. **Extension of PATH onto EWR.** This option takes the previous option a step further by extending PATH onto the airport to one or more terminal stations. This would eliminate the transfer for Lower Manhattan, Jersey City and Downtown Newark originating passengers. The extension might still stop at the existing NEC station to pick up riders from Penn Station-New York and from points south. A sub-option would eliminate the NEC stop altogether, shifting the transfer point for NEC riders to Newark Penn Station where they would board PATH to reach the airport. Those coming

from the south on the NEC would have to backtrack from Newark-Penn Station if the NEC station were dropped. Eliminating this station may also create complications, since the Passenger Facility Charge levied on passengers at EWR was used to build the station. On the airport, some of riders would still require a transfer to internal circulator to reach one or more of the terminals or ancillary facilities (parking). The redevelopment plan for EWR, which is covered in Chapter 10, is not completely formed, leaving the final alignment of this option and the terminals it would serve open for future revisions.

4. **Amtrak Service Added at NEC Station.** Theoretically, Amtrak could stop more than the nine trains each way each day that stops today. However, the trade-off would be greater intercity travel time for the passengers not destined for the airport. The recent decision to abandon, for now, the Access to the Region's Core project makes it even less likely that Amtrak would stop more trains at this station. For local travelers to the airport added Amtrak stops at the NEC would provide only marginal gains in frequency, since NJ TRANSIT stops many more trains than Amtrak does. NJ TRANSIT might be able to improve the scheduled frequency somewhat, but these improvements would not result in substantially better service; more frequent service should be seen as a complement to the other transit options discussed here rather than a replacement for them.

EWR Prognosis

Among these options, some version of the extension of PATH shows the most promise, which is illustrated in Figure 11.5. Providing a reliable, frequent, one-seat ride from Lower Manhattan, Jersey City and Newark would give many air passengers a better transit option than they have now. The AirTrain extension to Newark does not provide a one-seat ride from Manhattan or from Jersey City, and the added service by Amtrak or NJ TRANSIT offers only marginal improvement. Because the high cost of a taxi ride to EWR is likely to remain and Holland and Lincoln tunnel congestion is unlikely to ease, a PATH extension option can offer significant gain for trips from Lower Manhattan, with lower fares, even if a premium is charged to the PATH fare for trips to the airport. The service would also provide Exchange Place and Journal Square in Jersey City, and downtown Newark with the same high quality service. All the PATH-to-EWR options merit further study.

There are other opportunities to improve transit service to EWR upgrading bus services between points in New Jersey, and possibly from Staten Island. Single priority, off-board fare collection and in limited cases exclusive rights-of-way for the existing Liberty GO 28 (Liberty Corridor) should be considered to ensure the reliable performance of this service along with implementation of the Union County BRT to serve EWR as local congestion increases. Many of these services by NJ TRANSIT and possibly by private bus carriers will expand organically, as demand warrants. These should be encouraged, but they will not require major public policy decisions.

TABLE 11.4

EWR Ground Access Recommendations for 115 and 130 MAP

Recommended at	Transit Improvements	Highway Improvements
115 MAP (2015-2021)	Increased NJT service to NEC station; new AirTrain circulator; PATH Extension NEC station; local bus service improvements	Signal priority, off-board fare collection and limit preferential treatments for Go 29 BRT (Liberty Corridor) and other feasible corridors
130 MAP (2021 - 2034)	Extension of PATH to EWR Terminals	As needed to maintain reliable access

Source: Regional Plan Association

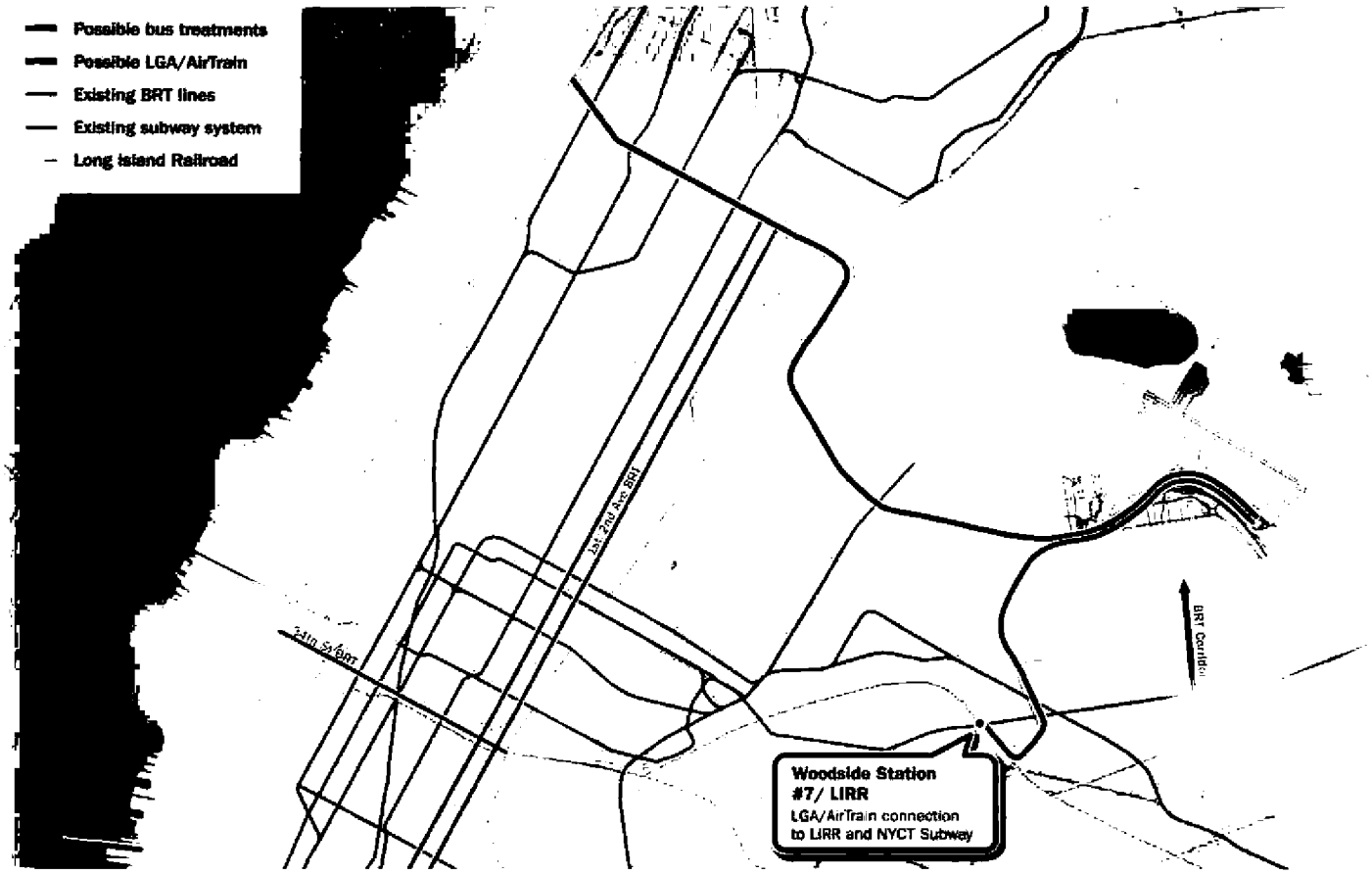
Table 11.4 summarizes the EWR transit and highway recommendations for each of the air passenger demand levels. The urgent need to replace the existing AirTrain system, which would need to be compatible with an on-airport extension of the PATH, dictates a more aggressive implementation schedule. The improvements recommended here would be sufficient to serve air passenger demand at both the 130 MAP and 150 MAP levels.

LGA Access Opportunities

LGA is the only one of the three airports without rail access. Current transit options are either by direct bus service from midtown, or subway to bus transfers in Queens on the Queens Boulevard line at 74th Street, and at various stations along 125th Street in Manhattan. The limited options and the relatively quick taxi ride from midtown Manhattan explain why the transit share from Manhattan is so low, just 9 percent, despite considerable traffic congestion on the Grand Central Parkway, which is the main highway serving the airport. The traffic level of service on the Parkway consistently registers LOS F near the Parkway in the westbound direction during the three morning peak hours and in both directions in the evening peak. Arterial roadways in the vicinity are also crowded. To establish a target for public transit, similar calculations were done for LGA, as were done for JFK and EWR. To avoid any increase of auto trips to LGA generated by growth in air passenger volumes transit share would have to increase from the current 9 percent to 39.2 percent. Changes of that magnitude may be unrealistic; nevertheless, a review of how they might be attempted is worthwhile.

In the later 1990s, the MTA investigated options for direct rail service from Manhattan. The greatest emphasis was given to the extension of the Astoria line from the Astoria section of Queens, where the N train now terminates. This option and others are discussed here, with the preferred options depicted in Figure 11.6.

Summary of Preferred Transit Options for LGA
Source – Regional Plan Association



1. **Extension of the N Train Subway to LGA.** This option would provide a direct one-seat ride with frequent service for all those with access to the more than 20 subway stations at which the N train stops in Manhattan, Queens and Brooklyn. Upon entering LGA the line would serve the Central Terminal Area and could also be routed to the USAir and Delta terminals at the east end of the airport. This subway extension option was favored earlier in the study phase of the LGA access project, but its most serious flaw turned out to be its undoing. The current terminus of the subway line is elevated, and the extension would have to continue as an elevated structure through a residential area (on either Ditmars Boulevard or 19th Avenue). The local opposition to this alignment was very strong and the idea was dropped. There is no reason to believe that there would be a different outcome if this proposal was advanced again and therefore is not considered any further here.

2. **A Rail Spur from the LIRR to LGA.** This option would involve the construction of a spur of the LIRR from the Port Washington branch east of the Harold Interlocking in Sunnyside, Queens. Much of the new right-of-way would be adjacent to existing highways and rail lines, but some takings would be inevitable. Two stops, 0.6 of a mile apart would be constructed, one at the Central Terminal Building and the other at the USAir / Delta terminals. Service could be from both Penn Station and Grand Central Terminal; the latter becomes available when the East Side link opens in 2016. Thus, for those starting their trip near either of these two stations, there would be a one-seat ride. As with the commuter rail alignments from JFK, there is the issue of peak period capacity for more lightly used airport-destined trains. An alternative to this is to operate these trains as AirTrain type vehicles; it might lessen the right-of-way issues, but will create serious compatibility issues, similar to those described for the JFK service. Taken together, these flaws are fatal to this concept.

3. **Subway Line.** This is the subway variant to the prior option. It would use the underused capacity of the 63rd Street subway tunnel, with service to the west side via Sixth Avenue or, when it opens, the Second Avenue subway to the east side. This line would use much of the same right-of-way used by the previous LIRR alternative, with similar construction issues. It would offer a one-seat ride from all the subway stations that it serves, but it would be an expensive new subway line that would usurp subway capacity under the East River and in Manhattan for a lower passenger volume purpose, although it could bring new subway service to Jackson Heights, an area without subway service today. However, because of the aforementioned construction issues and excessive costs this option is not retained for further consideration.

4. **New AirTrain to Woodside Station of the LIRR with Transfer to Subway and LIRR.** This option, while requiring a two-seat ride from Manhattan locations[16] would be considerably less expensive. It would most likely have less of a construction

16 The two-seat issue is somewhat misleading, since many potential riders of a one-seat solution would also use another transit vehicle to reach their starting point in Manhattan.

impact compared to the LIRR spur or a new subway line. This new AirTrain line would begin in Woodside, Queens, where LIRR's mainline and the #7 Flushing subway line passengers could transfer to it. This option would offer a two-seat ride with an escalator transfer for all those near Penn Station, Grand Central and all the stops on the Flushing line in Manhattan and Queens, and all stops on the LIRR other than the Atlantic Branch in Brooklyn.

The line would continue above the LIRR Port Washington Branch, then turn north onto the Bay Ridge line freight connecting track, and then be constructed along the eastern connecting leg of the Brooklyn-Queens Expressway where it meets the eastbound Grand Central Parkway, and then on into LGA. The Flushing Line, with its connection to all north-south subway lines in Manhattan would be especially useful in attracting those air passengers not wedded to using taxis, the predominant mode of access to LGA from Manhattan today. Despite the two-seat ride feature, this option has two key advantages – it connects to both the subway and commuter rail system (much like the JFK AirTrain does), and it can operate independently of these other systems. It should be retained for consideration.

5. **Busway to LGA.** A busway option could be constructed using the some of the same alignments as the rail options to LGA. Ramps to the Queens-Midtown Tunnel portals in Queens would be needed. Creating a dedicated lane on the Queensboro Bridge could be used by both LGA- and JFK-bound buses. Costs would certainly be lower than any of the rail options, but like any highway-based option, the portion of its operation on crowded roadways would be subject to serious delays; its routing on roads should be minimized to maximize reliability. A proposal now under consideration by the NYS Department of Transportation would reconstruct the shoulders of the Grand Central Parkway as a preferential lane for buses to speed up the M60 buses. The dedicated lane could be extended onto the Robert F. Kennedy Bridge and across 125th Street to the west side of Manhattan – stopping at the Metro North station and five subway lines.

LGA **Prognosis**

In the short term, a dedicated bus route using the RFK Bridge and the Grand Central Parkway would improve access. Buses on the new *Select Bus Service* lane on First and Second Avenues and as proposed along 34th Street could be rerouted onto the dedicated lane to serve the airport. This option should be considered, along with others, as part of City DOT's forthcoming study that will evaluate various surface transit improvements for LGA.

The relatively easy auto access from Manhattan to LGA, with a multiplicity of local driving shortcuts to avoid congestion, suggests that transit options may be problematic and that a program to encourage or possibly require for-hire vehicles to have at least two passengers might be considered.

Yet, the last two options discussed here, the Woodside Transfer to a new LGA AirTrain and the busway, have enough positive features that they should not be discarded. The AirTrain option is similar to the successful JFK AirTrain, connecting to both the LIRR and the subway network. In time, the growing difficulty of today's roadway options should generate a revisit of the more promising opportunities for transit access to LGA and a more aggressive approach to managing traffic on the Grand Central Parkway. The recommended implementation sequence

LGA Transit and Highway Recommendations for 115, 130 and 150 MAP

Recommended at	Transit Improvements	Highway Improvements
115 MAP (2015-2021)	Busway/Increase Service Freq of M60; potential BRT links to subways	Preferential Treatments on GCP for Buses
130 MAP (2021 - 2034)	Busway/BRT Service via 125th Street and the GCP to LGA	Preferential Treatments on RFK Bridge and 125th Street for Buses
150 MAP (2030 -2042+)	AirTrain from LGA to Woodside Station (#7 and LIRR)	Managed Use Lane Strategies for GCP and Airport Tolls

Source: Regional Plan Association

TABLE 11.6

Annual Passenger Shift to Stewart Airport from Major Airports with Stewart Access Improvements (000's) by 2030s (150 MAP)

	JFK	EWR	LGA	System
BRT from Salisbury Mills	33	62	42	137
Direct Rail Connection	46	85	58	189

Source: West of the Hudson **Regional Transit Study and Regional Plan Association**

for these transit and highway improvements as they relate to each of the three projected air passenger demand levels is shown in Table 11.5.

Stewart Airport (SWF) Transit Opportunities

Currently, most air passengers using SWF originate in the Hudson Valley – Orange, Dutchess, Putnam, and Ulster counties – and most reach the airport by passenger car. The ability to expand the use of the airport by offering better transit access options, especially to the core of the region, has been the subject of the West of Hudson Regional Transit Access Study, jointly led by the Port Authority and the MTA. Much of the early interest in the transit access options focused on rail access from Manhattan to the airport. The Port Jervis line operated by NJ TRANSIT for the MTA has a station – Salisbury Mills – four miles as the crow flies from the airport. There is also shuttle bus service from Metro North's Beacon Station on the Hudson Line.

The agencies' study has looked at the extension of the line to the airport, and has expanded its scope to examine a full range of bus and rail options. To date, the study has concluded that in the short term only improved express bus service from the two Port Authority bus terminals in midtown Manhattan and Washington Heights and the continuation of the Metro North Beacon station service are worth considering. Travel times from Manhattan would range from 97 to 115 minutes and attract less than 700 air passengers daily (350 in each direction). The study has also suggested that a bus-only exit from the Thruway south of the Newburgh exit 17 could provide a 14-minute shortcut to the airport for express bus service to and from Manhattan. The next phase of SWF access planning will evaluate this option further, in consultation with the NYS Thruway Authority.

In the mid-term, the study findings have retained an option that would construct an exclusive busway from the Salisbury station to the airport; it would attract 800 air passengers a day (400 in each direction), and cost from about $120 million to $150 million to construct. In the long term, the study recommends that an extension of the rail line be retained for consideration. Based on an analysis that assumed the ill-fated ARC project were in place, the rail extension would cost from $600 million to $850 million and attract 1,100 air passengers daily (550 in each direction), including the Beacon shuttle riders. .

These estimates of air passengers are based on the assumption that SWF would eventually carry 7 million passengers annually, more than twice the projected estimate by the 2030s discussed in Chapter 6 of this report. In Table 11.6 the results of the MTA / Port Authority airport access options were factored to account for this difference and converted to annual passengers diverted from each airport. This would add only about 10 percent to the shift to SWF from the three airports estimated in Chapter 6. Given the small impacts and low ridership, and the uncertainty of implementation this implies, the shift to SWF resulting from the rail extension is not accounted for in the major airports' shortfalls discussed in the next and concluding chapter.

The study also envisions the possibility of commuter rail service attracting 3,700 riders a day for the full rail extension option. These estimates assumed the completion of the ARC project, which unfortunately has now been postponed indefinitely. Over time, as SWF traffic grows, the feasibility of more local bus services could increase, with service directly from the Port Authority Bus Terminal in midtown Manhattan, and locally from key concentrations of air passengers that may emerge.

MacArthur Airport (ISP) Opportunities

Chapter 6 showed the impact by MacArthur Airport for shifting passengers from the three major airports, making it *de facto* part of the regional airport network, and warranting a look at its access issues. The terminal is located only 1 ½ miles from the Ronkonkoma station on the Long Island Rail Road's Ronkonkoma line. Thirty-four trains stop in each direction each weekday, with hourly service most of the day and as many as four trains per hour in the peak hour in the peak direction. There is hourly service on weekends. All trains start at Penn Station and stop in Jamaica for transfer from other LIRR lines and from the subway. The Penn Station to Ronkonkoma trip is scheduled for about 80 minutes, although a few of the peak trains shave off ten to fifteen minutes from the running time. East of Bethpage the line has only one track, which limits service frequency, especially in the reverse peak direction. The LIRR plans to add a track and has engineering funds in the 2010-2014 MTA capital program, which remains unfunded. This makes it uncertain when added service would be in place.

Currently, there is a shuttle bus from the rail station to the airport. It is unreasonable to replace it with rail connection for a low volume facility. A concept discussed in the past would eliminate the need for the bus shuttle by "flipping" the airport configuration to bring the terminal within walking distance of the rail station. To be successful, faster and more frequent rail service will be needed. Should the air terminal be relocated for other reasons and should train service be improved, it can be expected that there will be some further shift of air passengers from the two Queens airports. Unlike SWF, there has not been an independent study to rely on to make such an estimate. For the purposes of this report, no estimate of its ability to shift air passengers from LGA or JFK to ISP will be made. However, given the volume of air passengers at ISP, and the direct rail service, it can be expected to be similar to SWF's air passenger shifts, shown in Table 11.6. However, neither the volumes at SWF or at ISP are sufficiently high to take into account when considering the future of the three major airports.

Summary

This chapter concludes that, while there are opportunities to increase transit use to the three major airports, and to the two outlying airports with air service today, reducing the pressure on the surrounding highway networks will not come easily. However, many actions can be pursued to address the issue. In the short term, bus options can be helpful, overcoming their mixed-traffic limitations today through the introduction of preferential treatments to improve travel times and service reliability. In the medium term, the experience of the AirTrain at JFK and the opening of the LIRR connection to Grand Central Terminal, offer hope for increased transit use. In the long term, the most attractive transit options come at a heavy price, notwithstanding that in some cases their high capital costs could be shared because of their use for both airport access and other transit needs. Other long-term transit options – PATH to EWR or AirTrain from Woodside to LGA, while attractive, must make their case based on airport service benefits alone. Options that have non-airport purposes will not benefit from the Passenger Facility Charges, which by regulation are confined to airport uses. Investigation of all options highlighted here – and probably others – is needed to understand their cost, likely ridership, and physical and operational feasibility. As the other recommendations in this report are discussed and move toward implementation, the companion proposals for ground access should be studied and carried forward where warranted.

There may be other options to reduce airport-related traffic. The program of pooling taxi trips should be reinvigorated. To discourage unnecessary car trips to the airport, a program of entry fees to the airport should be considered. Such a program is in place today at the Dallas-Ft. Worth airport, where those not parking there are charged for entering the airport.

Highway congestion will continue to be a problem at all three major airports. At JFK, the NYSDOT should investigate the prospects of addressing the road congestion in southeastern Queens with an extension of the Clearview Expressway as a tunnel.

Congestion on the Queens roads will likely grow, but the proportional contribution of JFK to that congestion should decline, as transit improvements are made.

Major investments and policy shifts can encourage more air passengers to choose transit as they respond to a combination of transit improvements, higher costs to drive and increased road congestion. People will still be able to get to the airports at 150 MAP. Given what we know about the economic value of providing air capacity, ground access should not be allowed to be a barrier to investing in new capacity, but rather one of the many challenges worthy of investment to ensure the economic vitality of the region.

Ground access is a shared responsibility of all the transportation agencies in the region, not just the Port Authority – the DOTs in New York and New Jersey, NYCDOT, MTA, and NJ TRANSIT. We recommend that the appropriate mix of agencies in New York establish a task force to address JFK and LGA ground access issues and the same be done in New Jersey for EWR. The transportation agencies will have the responsibility establishing a new era of coordinated ground access investment to serve the region's airports, thereby strengthen their competitiveness and providing the region's citizens the mobility to meet the global challenges ahead.

Over time, as traffic grows there is no doubt that it will take longer to reach the airport; and passengers will need to allot more time for travel. However, today's congestion has not prevented growth and is not likely to do so in the future. In the 2002 to 2009 period, locally originating air passenger traffic to JFK grew 49 percent. During this same period, traffic volumes at VWE remained constant, and traffic conditions remained poor. This did not prevent prospective air passengers from using the airport. Undoubtedly, it helped that the JFK AirTrain was introduced in late 2003, offering a non-highway option. Rather than deciding that VWE traffic conditions were reason not to travel, passengers concluded that they had more reasons to fly, in good measure from the introduction of Jet Blue service at the right price flying to the right destinations. In short, while traffic congestion may be a nuisance, and may even give a few faint-of-heart prospective passengers some pause, it will not prevent them from flying if the reasons to do so are there. The conclusion that follows is clear: work to address traffic congestion; develop improved transit options to ease the trip, and plan for the growth, because it will be coming.

Newark Liberty International Terminal C Concourse

Evaluation, Conclusions and Recommendations

Analysis of Deficiency at 115 MAP (2015 to 2021)

					Peak Hour Capacity Shortfalls (Flights per Peak Hour)				Passengers Unserved (millions)				Annual Economic Impacts		
	Row	Delays	Actions	NG I Used for	JFK	EWR	LGA	System	JFK	EWR	LGA	System	Wages Lost (millions $)	Sales Lost (millions $)	Jobs Lost
115 MAP (2015 to 2021)	1	Existing	Base	NA	-7.0	-4.0	0.0	-11.0	-1.2	-0.7	-0.6	-2.5	476	1,307	10,256
	2	Existing	Programmed - Before NG I	NA	-6.6	-3.6	0.4	-10.2	-0.1	0.2	0.4	-0.1	20	54	418
	3	15-minute	Programmed With NG I	Delay Reduction	-9.6	-6.6	0.4	-16.2	-2.5	-2.6	1.0	-5.1	953	2,618	20,364
	4	Existing	Programmed With NG I	Capacity	4.4	-0.6	7.4	-0.6	3.8	0.9	2.7	0.0	0	0	0

This chapter brings together all the information about the various potential actions discussed in earlier chapters and uses that information to determine how best to meet projected air passenger demand. The evaluation process addresses the complex interplay among capacity, delay, passengers served, and the economic consequences at each of the three future demand levels.

The first step in this process is to determine the capacity and passenger shortfalls after accounting for all actions that can be reasonably expected to occur without any extraordinary steps. These are referred to as "programmed" actions. Then, depending on the results of that step, judgments are made about the possible next courses of action. The analysis is carried out chronologically, considering, in sequence the demand levels of 115 MAP, 130 MAP and 150 MAP.

At 115 MAP

Table 12.1 outlines expected shortfalls in capacity, passengers not served and the economic consequences at 115 MAP. Since the slot limits are in place today, the analysis uses this slot-controlled situation and the delay levels associated with it (23.5 minutes at JFK, 23.0 minutes at EWR, and 20.0 minutes at LGA) as the starting point for the 115 MAP level, which is expected to occur between 2015 and 2021. The first row in each of the three sections of the table is a base case, not accounting for any actions. In 2015 the effects of some limited added off-peak flights (discussed in Chapter 9), and continued growth of the outlying airports – SWF and ISP (as discussed in Chapter 6) are accounted for, but higher speeds on the intercity rail system will not yet be in place. The second row of the table indicates that these actions will have small, but beneficial impacts. NextGen I is expected to be in place by 2018. The benefits of these new air traffic control technologies could be targeted for delay reduction, as now planned by the FAA, or targeted for capacity improvements. If targeted for delay reduction (row 3), about five million passenger at the 115 MAP level would not be served, 20,000 jobs would not be added to the economy, and $2.6 billion sales and $1 billion in wages not realized annually. The value of the time savings if the benefits are targeted for delay reductions totals $204 million for air passengers and $194 million for the airlines. These estimates are based on the value-of-time factors discussed in Chapter 1. Thus, the value to the region in economic gains -- $2.6 billion in sales, and just under $1 billion in wages far outweighs the gains from passenger and airline delay reductions.

Not shown in Table 12.1 is the impact of regulatory or legislative interventions to manage demand – thinning out or eliminating peak period flights in a limited number of markets. As discussed in Chapter 9, these impacts are slight at JFK and EWR; they do not alter the conclusions reached here. Their impacts at LGA would be greater, but LGA would not have any deficits to contend with at 115 MAP. Therefore, demand reduction measures to thin out the number of flights would not be needed to serve all the passengers who wish to fly to and from LGA.

Theoretically, the capacity deficits of about 10 flights per hour at JFK, and seven at EWR could be eliminated with expansion projects at these airports. Implementation by 2021 or earlier is unrealistic, however. Rather, to serve all the estimated volume of passengers in this period, from the region's economic perspective, it is recommended that the benefits of NextGen be used toward an increase in capacity rather than the reduction in delays.

This analysis concludes that the retention of the existing delay levels is the price for serving all air passengers. In the 2010s the region's airports can serve the expected volume of air passengers, forestalling any economic losses, assuming the expected deployment of NextGen I, in the latter part of this decade is tailored for capacity increases.[1]

At 130 MAP

The situation in the 2020s is analogous to the 2010s. At that point, there would be 15 million more air passengers wishing to fly into and out of the region; NextGen I would be firmly in place. As the 2020s begin, NextGen II would not yet be

1 The dozens of small capacity improvements outlined in Chapter 2 as part of the Delay Reduction Task Force's recommendations may lessen these delays, which reached their zenith in 2007.

Analysis of Deficiency at 130 MAP (2021 to 2034)

	Row	Delays	Actions	NG I Used for	Peak Hour Capacity Shortfalls (Flights per Peak Hour) JFK	EWR	LGA	System	Passengers Unserved (millions) JFK	EWR	LGA	System	Annual Economic Impacts Wages Lost (millions $)	Sales Lost (millions $)	Jobs Lost
115 MAP (2015 to 2021)	1		Base	NA	-21	-14	-5	-40	-9.3	-5.3	-3.2	-17.7	3,395	9,317	73,006
	2	15-minute	Programmed Before NG II	NA	-17.2	-13.3	1.7	-30.5	-7.1	-4.6	-0.0	-11.7	2,223	6,101	47,494
	3	10-minute	Programmed With NG II	Delay Reduction	-19.2	-17.3	-1.3	-37.8	-11.5	-6.6	-1.5	-19.5	3,728	10,229	79,857
	4	15-minute	Programmed With NG II	Capacity	-9.2	-11.3	4.7	-20.5	-4.2	-4.1	1.3	-7.7	1,372	3,770	29,323

deployed: the FAA expects it to be in place by 2025. Table 12.2 shows the base case situation prior to applying any of the programmed actions. These actions include continued small increments of demand being met by added off-peak flights and steady growth at SWF and ISP which siphons off some air passengers from the major airports, and the first level improvements in intercity rail speeds, which does the same. Approximately seven million more passengers are served by the programmed actions as the unserved drop from 17.7 million (row 1) to 11 million (row 2). The peak-hour capacity shortfall at the airports has dropped to about 30 flights from 40. However, this leaves about 47,000 jobs uncreated, almost $6.1 billion in sales and $2.2 billion of wages unrealized annually. The advent of NextGen II raised the same issue as earlier – will NextGen improvements be directed to delay reductions or capacity gains? If used to bring the delays down further (row 3), the deficiencies rise – 19.5 million passengers unserved, a peak-hour flight shortfall of 38 flights, almost 80,000 jobs not created, and an annual loss of $10.2 billion in sales and $3.7 billion in wages. If the NextGen II benefits are directed toward capacity the losses are reduced (row 4) to 7.7 million unserved passengers, almost 21 flights per peak-hour and 29,000 jobs, $3.8 billion in lost sales and $1.4 billion in wages not earned. These gains to the economy are not offset by the value of the time savings for passengers and in operating costs for the airlines, which combined amount to slightly more than $400 million annually.

Either way, the shortfall remains large and indicates that other actions are needed. As stated earlier, regulatory or legislative intervention will do little, leaving expansion as the only remaining action. Understandably, it would be hard to justify airport expansion with the runway deficiencies shown in Table 12.2 – four at JFK and four more at EWR. If viewed in the longer term, however, having expansion in place by the 2020s would be prudent, but hardly prescient. Air passenger volumes will continue to grow beyond the 2020s, and as indicated in this report, 20 million more passengers would be added in ten years or so, probably in the 2030s. If the capacity were added in the 2020s, it would take care of the deficiencies then and prepare the region for the growth to come, preventing still greater future losses. Accordingly, the Port Authority should start planning for capacity expansion now, since projects of this scale are likely to require a decade or more to be realized.

At 150 MAP

Assuming that airport capacity expansion did not take place in the 2020s, the 2030s will be entered with a growing deficit in capacity, passengers unserved and the economic consequences that go along with it. By the 2030s, the outlying airports will have continued to mature, capturing a growing share of passengers from the three major airports, intercity rail service will be speeded up, yet still falling short of the truly high-speed line. There will no longer be room to add off peak flights. NextGen II will be in place and assisting in making the airspace more efficient, adding to capacity and reducing delays. Yet, the twin goals of delay reduction and sufficient capacity to handle the growth at 150 MAP will still be elusive without further actions.

Table 12.3 shows the dynamics at work at 150 MAP. The nominal shortages of the base case (row 1) will be lowered by the programmed actions – outlying airports, intercity rail, and NextGen II. Delays could be down to the 10-minute level (row 2), but the shortages would still be unacceptable – 31 million passengers unserved, 127,000 jobs not created, $16 billion in sales and $6 billion in wages unrealized. These losses would hardly be offset by the value of passenger time and airline cost savings, totally about $540 million.

The deficiencies at the airports would be great, with JFK falling short by 33 flights per hour, EWR by 25, and even LGA would be in deficit at seven flights per hour. Sacrificing the delay levels, rising back to 15-minutes to gain capacity (row 3) would help, but would still leave significant shortages. JFK would need capacity for 22 more flights; EWR would need 19, although LGA would no longer fall short. Still, 18 million passengers would be left without the capacity to use the three airports, with the concomitant economic losses. As with the earlier demand levels, regulatory or legislative interventions would be of limited help, and it would mostly affect LGA where the shortages are

Analysis of Deficiency at 150 MAP (2030 to 2042+)
Source: Regional Plan Association

	Row	Delays	Actions	NG I Used for	Peak Hour Capacity Shortfalls (Flights per Peak Hour) JFK	EWR	LGA	System	Passengers Unserved (millions) JFK	EWR	LGA	System	Annual Economic Impacts Wages Lost (millions $)	Sales Lost (millions $)	Jobs Lost
115 MAP (2015 to 2021)	1		Base	NA	-38.0	-26.0	-14.0	-78.0	-21.5	-11.1	-6.5	-39.0	7,496	20,568	161,101
	2	10-minute	Programmed With NG II	Delay Reduction	-32.7	-24.9	-7.3	-64.9	-18.3	-9.9	-2.8	-30.9	5,934	16,282	127,175
	3	15-minute	Programmed With NG II	Capacity	-21.7	-18.9	-1.3	-41.9	-10.8	-7.1	0.1	-18.0	3,425	9,402	73,204

Ten Remaining Expansion Combination

New Conventional Airspace (All 4/22)

Cat ID	Combo #	Configurations (options) EWR	LGA	JFK	Capacity ATC	NG	Cost (billions of $)	Capacity /Cost ATC	NG	Landfill (acres)	Impacts Score
C	2	3	2	4	70	94	5	14	19	273	16
C	3	[redacted]	[redacted]	5	97	118	7	14	17	483	18
C	5	3	3	4	110	130	6	18	22	360	18
C	6	3	3	5	137	154	8	17	19	550	20
C	8	3	Only 4/22 or NC	4	44	84	3.5	13	24	200	9
C	9	3	Only 4/22 or NC	5	71	108	5.5	13	20	390	11

New NextGen Airspace (13/31)

Cat ID	Combo #	Configurations (options) EWR	LGA	JFK	Capacity ATC	NG	Cost (billions of $)	Capacity /Cost ATC	NG	Landfill (acres)	Impacts Score
D	1	3	4	6	0	80	4.5	0	18	129	10
D	2	3	Only 13/31	6	0	50	3	0	17	0	8
D	3	3	4	7	0	110	6	0	18	343	11
D	4	3	Only 13/31	7	0	80	4.5	0	18	214	9

The Final Combinations

New Conventional Airspace (All 4/22)

Cat ID	Combo #	Configurations (options) EWR	LGA	JFK	Capacity ATC	NG	Cost (billions of $)	Capacity /Cost ATC	NG	Landfill (acres)	Impacts Score
C	8	3	Only 4/22 or NC	4	44	84	3.5	13	24	200	9
C	9	3	Only 4/22 or NC	5	71	108	5.5	13	20	390	11

New NextGen Airspace (13/31)

Cat ID	Combo #	Configurations (options) EWR	LGA	JFK	Capacity ATC	NG	Cost (billions of $)	Capacity /Cost ATC	NG	Landfill (acres)	Impacts Score
D	2	3	Only 13/31	6	0	50	3	0	17	0	8
D	4	3	Only 13/31	7	0	80	4.5	0	18	214	9

more manageable. Similarly, the introduction of true high-speed rail would chip away at some of the deficits, but also would be mostly beneficial to LGA.

With or without the 10-minute delay standard, more capacity would be needed at JFK and EWR. If the capacity added is in excess of the deficits at the 10-minute standard – as all of the options considered in Chapter 10 are – the region would be able to meet the twin goals of capacity and delay reduction. A closer look at the expansion options to select from is in order, with the minimum targets 33 flights per hour increased at JFK, 25 at EWR and seven at LGA.

Even as the three airports in the region experience reduced delays from the combination of NextGen implementation and expansion, delay reduction benefits at the other airports in the nation will likely occur. The high volumes at the New York airports and the proximity of the airports to one another will probably continue to translate to poorer delay rankings. Thus, while the region's airport will likely continue to appear worse than the other airports in the nation, all the airports, and its passengers will see widespread benefits. If left at the 15-minute level, however, the region's airports will suffer more by comparison.

Expansion and Reconfiguration

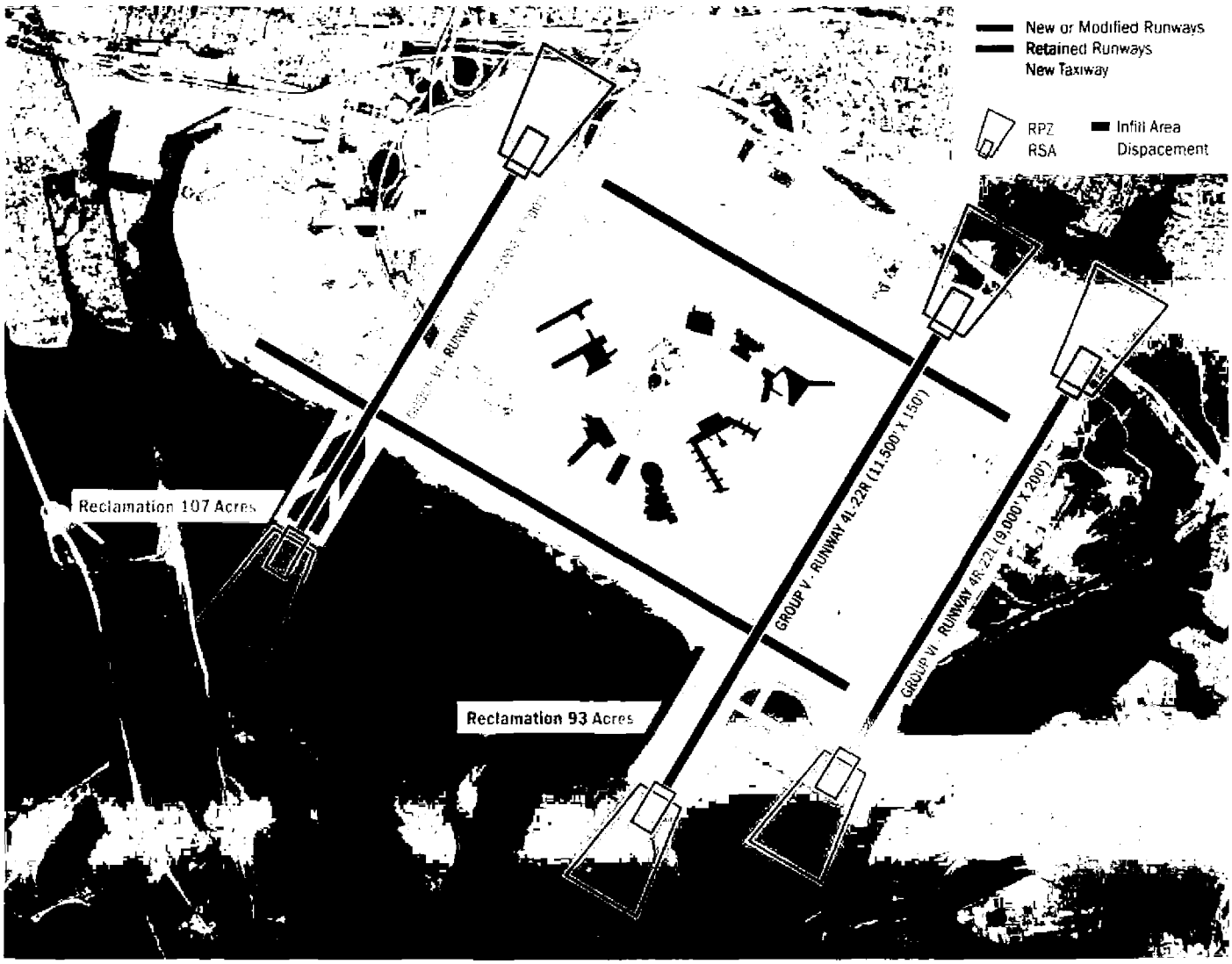
In Chapter 10, ten expansion combinations were still under consideration – six combinations using conventional airspace and 4/22 alignments and four making use of NextGen with 13/31 alignments. The key characteristics of these ten are shown in Table 12.4. These combinations included four individual reconfigurations at JFK, one at EWR and three at LGA, with the table nomenclature carried over from Chapter 10.

Most of the remaining combinations result in capacity benefits greater than 70 operations per hour and in some cases as high as 154 operations per hour. However, as shown in Table 12.3, with NextGen I and II in place and the 10-minute delay standard as a target, a shortfall of 65 would remain – 33 at JFK, 25 at EWR and 7 at LGA.

Of these remaining combinations, the high impacts values were mostly contributed by the physical expansion at LGA, with severe community and noise impacts. A large swath of Astoria would be directly affected by the construction of a new 4/22 runway, which would require the taking of residential properties and result in increased noise levels for the neighborhood as a whole. The construction of a new 13/31 would also increase noise around College Point and Flushing, two residential and commercial neighborhoods. Furthermore, as shown in Table 12.3, LGA will have the least capacity shortfall at 150 MAP. Based on these considerations, the LGA expansion options were dropped. This eliminated six of the ten combinations.

Table 12.5 lists the final four combinations, which include two combinations for each of the remaining airspace categories. The combinations consist of four options at JFK one at EWR.

JFK Expansion (Option #4)
Source: Regional Plan Association



Expansion /Reconfiguration at JFK

The added capacity needed at JFK of at least 33 movements per hour can be achieved by any one of the four remaining JFK expansion options (#4, #5, #6, and #7), which add 49, 73, 49 and 79 more flights per hour, respectively. Each would provide capacity in excess of the needed amount, allowing room for growth beyond 150 MAP; two of the options provide capacity well in excess of what will be needed at 150 MAP.

The choice among these four options at JFK is not obvious. Some cost more and provide more capacity, but have greater community and wetlands impacts. The comparative advantages of each are worth revisiting, therefore, a summary from the analysis in Chapter 10 is presented here.

Option #4's chief advantage, as shown in Figure 12.1, is that it requires only a limited amount of fill, and that fill is largely in the environmental dead zone of Grassy Bay. It also does not depend on NextGen to operate effectively. However, it creates a new noise corridor using the new 4-22 runway at the west end of the airport, which also consumes some of the cargo area.

As discussed in Chapter 10, this configuration does not require NextGen, but without it LGA capacity will be reduced to an unacceptable degree unless another runway at JFK was constructed, as is proposed in option #5. If JFK option # 4 is chosen, then NextGen I must be in place.

Option #5 requires significantly more fill in sensitive wetlands areas. This option, as shown in Figure 12.2, also adds the same new noise corridor and west cargo area of the airport. Its chief advantage is the large capacity gain it offers, 25 more per hour than #4, but at considerably higher costs. Some of that capacity would have to be used to offset the loss in capacity at LGA, if NextGen I was not in place.

As clearly seen in Figure 12.3, option #6 is entirely on the airport footprint, thereby requiring no fill and no wetlands problem. It is also relatively inexpensive. However, it creates new noise corridors and can only be implemented if and when NextGen improvements make it possible. It provides sufficient capacity for 150 MAP demand levels, but little room beyond that. Option #6 would also result in a 30 percent loss of capacity at LGA. It is possible that NextGen II might restore this capacity but this is far from certain. Another runway would likely be required to serve the projected 150 MAP.

JFK Expansion (Option #5)
Source: Regional Plan Association

Option #7 has the advantage of high capacity, considerably more than would be needed at 150 MAP, and its wetlands impacts are confined to the environmental dead Grassy Bay, as shown in Figure 12.4. It spares the west cargo area. However, it creates noise corridors affecting new neighborhoods and requires NextGen to operate successfully. Similar to the prior option, capacity at LGA will be reduced by 20 operations per peak hour. However, this option does provide sufficient capacity to serve the projected demand at the 150 MAP level, but would require a significant shift of traffic from LGA to JFK.

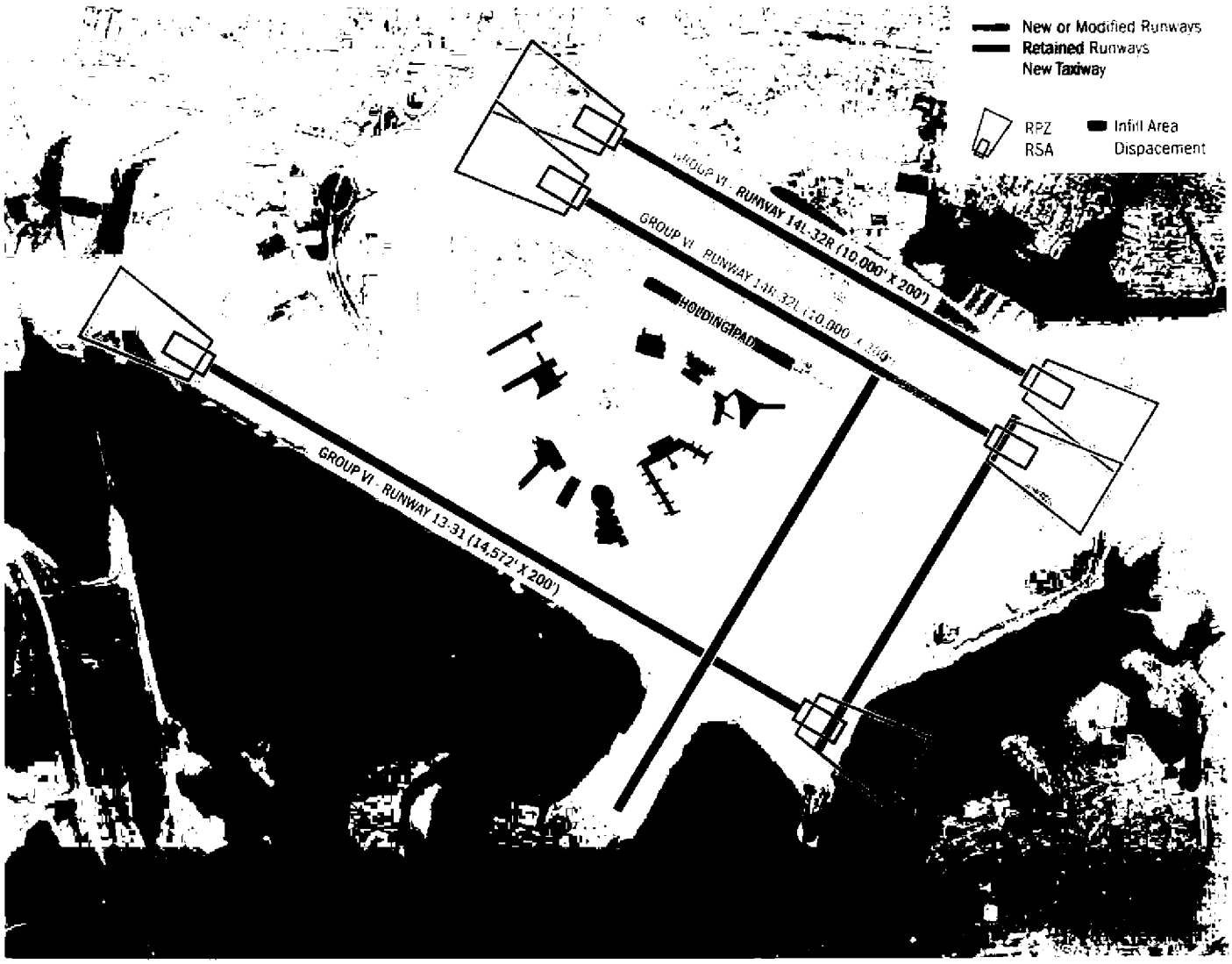
One way of thinking through the four remaining combinations is to see what the circumstances would be to trigger the elimination of an option. Because two of these combinations (JFK options #6 and #7) depend on NextGen, the successful deployment of the new air traffic control system will determine if they should be retained as options. If the assessment were negative, then they would both be dropped in favor of the All 4/22 combinations. The combinations that provide the most capacity should also be retained since having capacity beyond 50 movements per hour will likely be needed in the next half century.

The foregoing discussion indicates that it is premature to decide among the four options. Each has advantages and disadvantages. The 4-22 options are not dependent on NextGen improvements being implemented. The 13-31 options would each have less impact on Jamaica Bay, and in the case of option #7, can potentially improve the environment by filling much of Grassy Bay. Thus, if NextGen I improvements are assumed, then there are compelling reasons to pursue the 13-31 options. Still, NextGen II improvements would be needed to prevent capacity losses at LGA – a 30 percent reduction in peak hour flights. Even without NextGen II option #7 would still be viable because its large capacity gains would offset losses at LGA. And if NextGen II comes to pass, then greater capacity benefits would be realized. Once again, a major theme of this report emerges – the successful implementation of NextGen is vital to the future of the airports in the region.

It is not too soon to begin the process of decision-making, which will require community outreach efforts, preliminary engineering, and cost estimation. Accordingly, this report recommends that these four options, and any phasing or variations that might emerge, be carefully studied. This process should be started soon. The region cannot afford the economic losses of doing nothing by the 2020s as air passenger travel demand moves beyond the 115 million air passenger level. By the time

JFK Expansion (Option #6)

Source: Regional Plan Association



the 130 MAP level is reached, JFK's lack of capacity will leave about 4 million passengers unserved, 30,000 jobs uncreated, and $2 billion in annual sales unrealized and $700 million in wages not earned.[2] If demand increases at higher rates, the losses will mount earlier.

Expansion /Reconfiguration at EWR

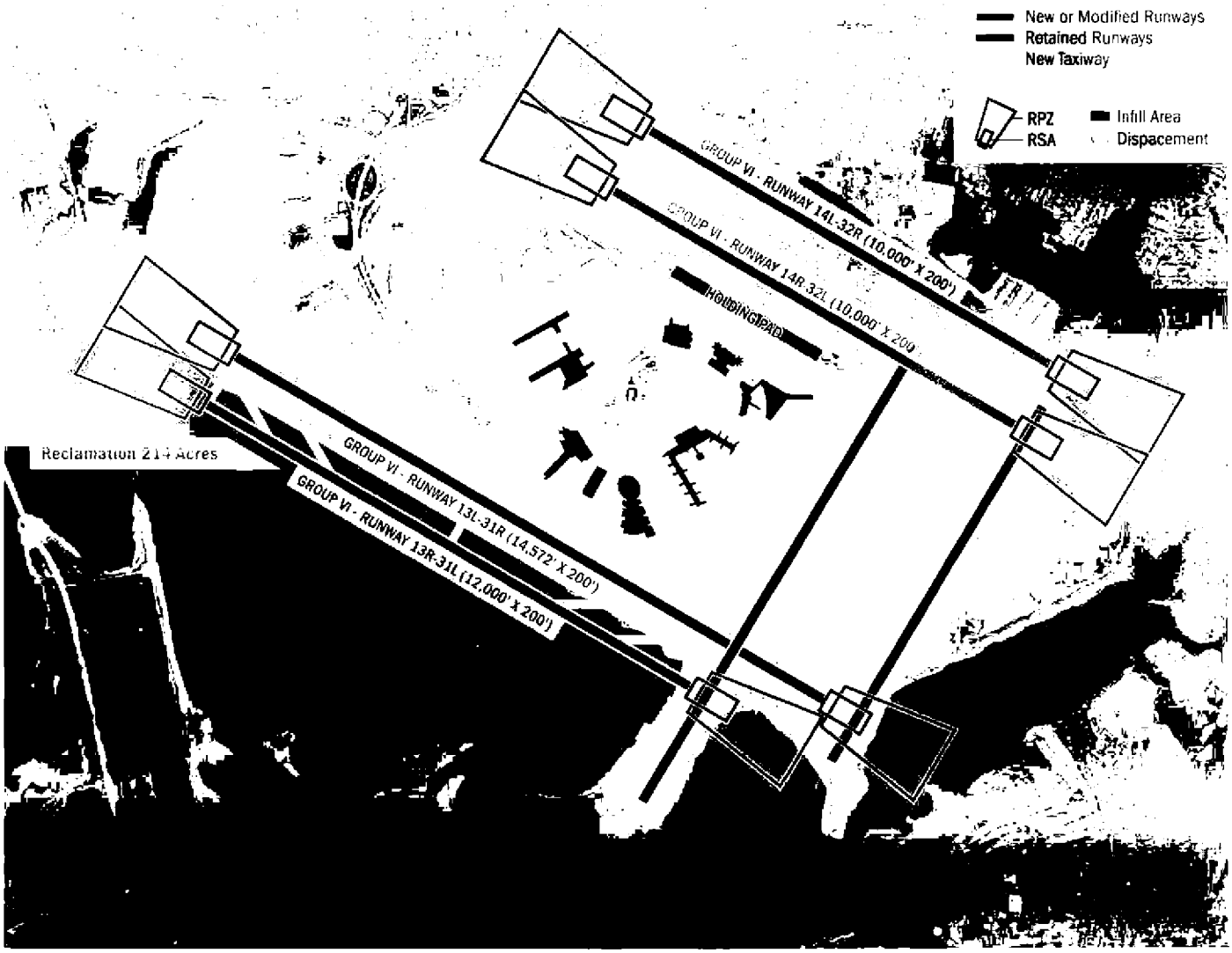
As Table 12.5 indicates, there is only one option left at EWR – the three parallel 4-22 runways – and it would yield 35 more flights per peak hour, this option would fit nicely the capacity shortfall of 25 movements per hour and allow room for growth beyond 150 MAP.

As shown in Figure 12.5, the remaining EWR option is an onsite triple-parallel 4/22 runway configuration, requiring the demolition and reconfiguration of the central terminal area and northern cargo area and the closing of runway 11/29.

The timing of the reconfiguration of EWR is critical. By the 2020s when 130 MAP is expected, EWR will be turning away about 4 million passengers per year, with about the same economic losses as JFK would, as reported above. Given the long lead time for public works it is not too soon to start the planning process now, which should be accelerated if air passenger growth rates increase at the higher projection rates.

[2] These economic losses are the portion of the losses shown in Table 12.3 that are attributable to JFK's deficiencies.

JFK Expansion (Option #7)
Source: Regional Plan Association



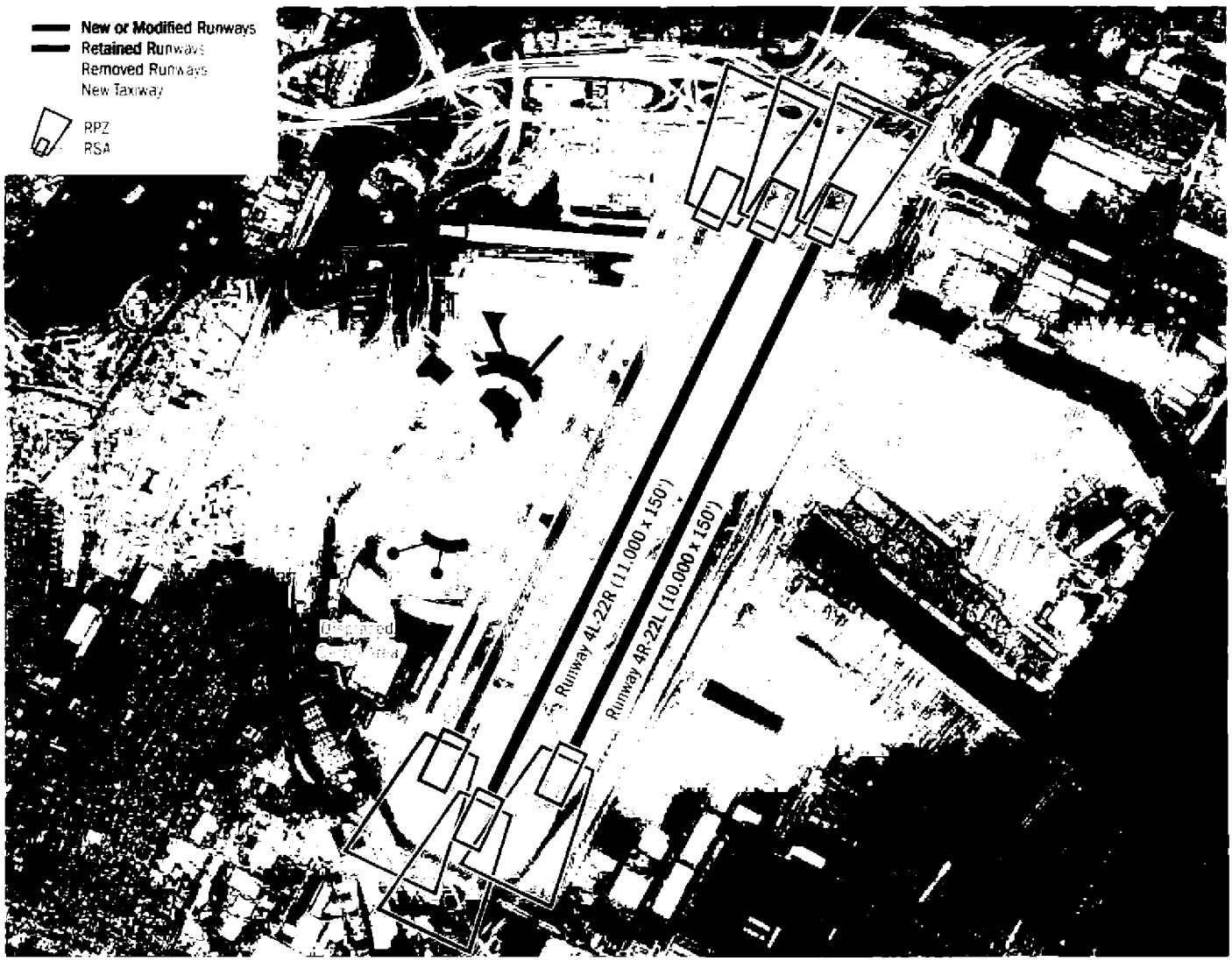
Expansion / Reconfiguration at LGA

Since none of the expansion / reconfiguration options for LGA survived the Chapter 10 analysis, then the other steps to reduce the projected deficiencies are needed, if the 10-minute standard is to be approached. Regulatory steps at LGA would have a major effect, lowering the slot deficiency by nine per hour. These actions are much more relevant for LGA and would be required to prevent shortfalls, especially important in light of the inability to expand capacity at this hemmed-in facility. As discussed in Chapter 10, the four expansion options remaining for JFK would require LGA to operate on a single runway, lowering its capacity, unless NextGen I were in place. Therefore, the successful operation at LGA with current capacity levels will depend on NextGen I to be in place when one of the JFK expansion options is implemented.

Economic Payoff

The expansion / reconfigurations at JFK and EWR are expected to cost as much as $10 billion. This would be a one-time cost. The cost of terminal replacements at EWR could be another $5 billion. In contrast, the economic value to the region of avoiding the loss of passengers in the year that the region's air passenger demand reaches 150 MAP will be $16 billion in sales and $6 billion in wages. These annual economic gains are, in rough terms, equal to the one-time cost of capital construction. The economic value of the project(s) would begin to accrue from the day the airport capacity projects were in place and continue for years afterward. There can be little doubt that the economic justification for expansion and /or airport configuration is present. Moreover, with the capacity expansion suggested here, the reduced delays that will accompany them will add to the economic argument to proceed with expansion of capacity.

EWR Expansion (Option #3)
Source: Regional Plan Association



Summary of Recommendations

The conclusions reached through the evaluation process are presented as short, medium and long-term recommendations, which loosely correspond to the 115, 130 and 150 MAP demand levels, respectively.

Short-Term Recommendations

In the short term, in the next five to ten years the most important thing that can be done is to plan. Planning is critical in preparation for the inevitable airport expansion that will be needed in the 2020s and will only become more imperative in the years beyond. It will be the Port Authority's responsibility to work through the design and engineering of the four options at JFK for expansion and to work with the airlines at EWR to redesign significant portions of the existing terminal area. At both airports, the expected growth in the number of passengers and the number of flights will require terminal expansion, and an accounting of the additional number of gates that will be required.

At all three airports, the projected impacts of climate change could require protection of the airports from various conditions, including, among others, flooding from sea-level rise and

storm surge, more intense and more frequent storms, and higher average temperatures. Sea-level rise, storm surge, and associated flooding are of particular concern at the two airports in Queens. Although the major impacts of climate change are predicted to occur beyond the time horizon of this report, improvements made by the Port Authority over the next 30 to 40 years will likely still be in place when climate change impacts are projected to become a serious problem. Future analysis of the expansion/reconfiguration options in this report should incorporate projections (site-specific, if possible) of climate change impacts. For example, any reconfiguration at JFK may require designs that prevent Jamaica Bay from flooding the airport. Fortifying LGA may also be required. An alternative approach to preventing flooding would be to consider resilient designs that allow critical infrastructure to be returned to service quickly after inundation. Regardless, planning for climate change at the airports should be coordinated with ongoing city and state efforts to plan for climate change impacts to regional access and other infrastructure.

The Port Authority will also need to start indentifying funding sources for expansion. Currently, capital improvements at our airports are funded by a compensatory system in the form of airline landing fees, a federally imposed Passenger Facility Charge (PFC) or direct federal grants distributed through the Airport Improvement Program (AIP). Funding for the AIP grants comes primarily from a federal passenger ticket tax (49 percent) and taxes on cargo and fuel, which also cover the operating expenses of the FAA. Airports are now forced to reduce the entitlement portion of their AIP funds if they impose PFCs at the $4.50 per passenger level. The last Congress considered an increase in the PFC from $4.50 to $7.00; however the likelihood of this passing in the new Congress is not very high.

The Port Authority will need to weigh the impact of this proposed expansion on the already high landing fees (the highest in the nation). The agency might also consider prohibiting the use of airport revenues to cross-subsidize other non-airport capital improvements, dedicating these funds over a several year period to solely aviation improvements. New York's unique position as a driver of the nation's economy could also be leveraged by our Congressional delegation to secure additional funding; furthermore, reducing delays in our region will only improve the efficiency of the national airspace. Finally, another approach might be to leverage private sector and international investment through a build-own-operate-and-transfer (BOT) arrangement; however, this might not be feasible since the Port Authority does not own its airports with the exception of a portion of EWR.

The FAA will be working to deploy the first stages of NextGen during this period. As described in Chapter 5, it will take many players to make NextGen happen in timely fashion. Congress is urged to fund the NextGen program, the FAA is urged to deploy it early in New York, the airlines are urged to equip their aircraft for this next generation of air traffic control, and the air traffic controllers are urged to be open to the changing technology. Any slowdown will add to delays and limit expansion of capacity. This report makes the economic argument that the improvements of NextGen be directed toward expanding capacity, rather than reducing delay. The FAA is urged to consider altering its policies to make this possible.

Meanwhile, steps underway to encourage air passengers to consider SWF should continue. Although Islip is not in the Port Authority's portfolio, that airport should be able to share some of the burden in the near and long term. Most of the passengers at these airports begin or end their trips locally – in the four Hudson Valley counties of Orange, Ulster, Dutchess and Putnam, and the two Long Island counties of Suffolk and Nassau for MacArthur. However, while they would have only a limited effect on the major airports' passenger and capacity shortfalls, they serve an important economic function in their respective communities.

Although it is not expected that significant gains in rail speeds will occur in the next ten years, the value of higher speed service, in addition to its value as a reliever to air traffic, indicates that public support for faster service should strengthen.

Short-term improvements in ground access described in Chapter 11 should be advanced during this period. Bus rapid transit routes to JFK should be considered along with other preferential treatments for buses to all three airports. Once the programmed Belt Parkway improvements are in place, this road should be opened for small commercial vehicles vital to the cargo operations at JFK. For EWR, more service by NJ TRANSIT to the NEC station should be operated to fill in holes in the current schedule. Planning should proceed for PATH access to EWR, and if the early results are favorable, the first phase to the NEC station should be constructed. At LGA, more frequent bus service should be put in place and the service promoted.

Medium-Term Recommendations

This report has shown that the other options for relief will have run their course by the 2020s. Early implementation of expansion plans in the 2020s will prevent growing economic losses from mounting. RPA recommends that the Port Authority strive to put the recommended expansion plans in place in the 2020s, with the pace of planning and construction guided by the pace of growth at the airports.

As with the short-term NextGen improvements, now the second phase (NextGen II) is vital. The timing of this phase is less certain, understandably because it is further off, and its impacts on delay and capacity are less certain too. Nonetheless, it will be vital for achieving capacity expansion, and any delays in implementation will have economic consequences to the region.

By the 2020s, intercity rail speeds should improve if Amtrak begins to implement its 2030 plan. Although it will play only a modest role in shifting air passengers, about 1.5 million passengers per year, Amtrak should pursue these improvements for this and other reasons. Similarly, the outlying airport should be supported as they grow into a larger force in their respective communities since some of their attractive power will siphon off air passengers from the major airports, about 1.8 million annually.

By the 2020s, ambitious transit access improvements to JFK should have taken shape, with the transportation agencies reaching agreement as to which of the long-term projects should be pursued – hybrid AirTrain /subway service via the Atlantic Branch, or hybrid AirTrain /commuter rail service to Penn and Grand Central Stations. The concept of charging vehicle tolls to enter or leave JFK should be fully vetted. At EWR, the extension of PATH into the airport proper should be advanced in a manner compatible with the three-parallel-runway redesign. LGA bus improvements, with a more widespread BRT network should be in place and investigation for the AirTrain connector to Woodside should be under study.

Long-Term Recommendations

By far the most significant finding of this analysis is the unequivocal need for airport expansion at JFK and EWR and that failure to implement these expansion plans by the 2030s, if not before, will have far-reaching and serious economic consequences. The result will be trips not taken, sales not generated, wages not earned, and jobs not created. The combination of other actions cannot avoid the need for expansion. And if the expansion plans

are implemented not only will these consequences be avoided, but the commensurate reduction in delays at the three airports can put them among the best performing airports in the nation, and prevent the propagation of delays nationwide.

At JFK, the choice among four expansion plans is not obvious. These four finalists each have features to recommend them and each have barriers to their successful implementation. Much work is needed here by the Port Authority to refine these options, reach out to the affected neighborhoods and to the environmental community in search for which of these plans, or variations, can best limit the negative impacts, while meeting the aviation needs.

At EWR, only one expansion option is practical. Here the consultation will be necessary between the Port Authority and their tenants, the airlines, and consultation with the local communities will be needed as well. However, if this project is seriously delayed, RPA has determined that some relief for EWR could be delivered by the introduction of scheduled service at Monmouth County Airport. By the 150 MAP level in the 2030s it could attract about 3 million passengers from EWR, about 30 percent of the unserved passenger there.

At LGA, the capacity shortfalls will not be addressed by expansion of the airport. Regulatory or legislative interventions do not have a material impact on the recommendations to expand JFK and EWR, since they would have only a minor impact on freeing up capacity or serving more passengers. As discussed in Chapter 9, there are many reasons why these actions have limited applicability. The airlines are wary of any changes in the rules they operate by, fearing that opening the door for only some relatively minor changes, can lead to further changes. They argue, correctly, that airline operations cannot be planned airport by airport, but rather must be thought through as a network. Change one link and the entire network can be affected. This report is cognizant of these concerns.

Nonetheless, there are a few changes in airline service discussed in Chapter 9 that warrant strong consideration if they are targeted to addressing the LGA shortfalls. Selective "thinning out" of flights in some markets, either voluntarily or through regulation could be warranted by the 2030s. Among these actions are caps on the frequency of flights between LGA and Boston and Washington. The success of Amtrak's Acela service, particularly to Washington, D.C., has thinned the air market to the point that smaller aircraft are now deployed in these markets. Three airlines serve them, two with hourly flights throughout the day. Similarly, the Raleigh/Durham – LGA market is served by multiple carriers with small aircraft and very frequent service. In both cases, larger aircraft with fewer flights would still leave the market with sufficiently convenient frequency.

Meanwhile, the supporting role of intercity rail can grow, even if it is not game-changing; by the 2030s, it can attract about 3 million and over 6 million passengers if truly operated at high speed. However, most of this will be at LGA where the shortages are less. Still, by relieving LGA some of the JFK service can be shifted to it to ease the burden at JFK.

The outlying airports should also be supported, attracting upwards of 2.4 million air passengers per year by the 2030s.

Regulatory intervention can also figure in the success of intercity rail and the outlying airports to free up capacity at the three airports, since this will largely depend on the reaction of the airlines. If they respond by lowering the aircraft size then there will be no fewer flights using the major airports. If they respond by eliminating some peak flights there will be a positive effect on airport capacity. However, there is no way of predicting what they will do, nor any means of encouraging them to drop flights, rather than downsize. Encouragement can be a form of regulation. It is recommended that these actions be retained; otherwise, the benefits of intercity rail improvements and the development of Stewart and MacArthur airports as relievers could be compromised.

How to accomplish these changes with the minimum of government interference or coercion is not clear. Recommended here is that the FAA, the Port Authority and the airlines discuss the next steps.

Improved ground access by transit to the three major airports will go a long way to providing the added ground capacity needed to serve the three airports. There are a number of promising proposals for each airport, but significantly more planning is needed to determine which, if any, warrant their construction. At JFK in particular, where the highway network is most congested, the long-term transit options are tied to expensive long-term investments that have wider regional benefit. Substantial highway capacity improvements are very unlikely, which will put more pressure on advancing these transit proposals.

Specific ground access improvements in the long term include the implementation of the agreed-to transit access options to JFK, including the construction of the full-length Second Avenue subway in Manhattan with connections to the Atlantic Branch. For JFK, the value of the Clearview Expressway as a reliever of the Van Wyck Expressway should be determined, and if the results are positive, the project should be pursued.

At both EWR and at LGA, current and past transit access proposals deserve careful examination. At EWR, the extension of PATH to the airport appears to be the most promising. At LGA, the findings from the study of an AirTrain-type service to Woodside should have been completed, and if favorable, the project should be underway.

As pointed out in Chapter 11, today's ground access congestion has not prevented the growth at the airports in the past and is not likely to in the future. However, this is no excuse for not improving the experience of reaching the three airports.

These ground access are long term and expensive. Meanwhile, ground access improvements in the short term should be pursued.

All the ground access proposals require cooperation among the transportation agencies in the region – the state and city departments of transportation, the MTA and NJ TRANSIT, working with the Port Authority.

The region's three major airports must meet the twin goals of capacity and delay reduction into the 2030s and well beyond. This will require the effective functioning of NextGen at the three airports and in the airspace above them. At JFK and EWR, it requires expansion or reconfiguration of the airport. At LGA, some regulatory interventions are likely to be necessary to meet these twin goals. Taken together, the region's airports can work as a world-class system, allowing its economy to remain strong, and affording its citizens the opportunity to travel the world for both business and pleasure. An effective working partnership among the Port Authority, the FAA, and the airlines will be necessary to turn these plans to reality, to the lasting benefit of the region.

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