

MARKET INTELLIGENCE

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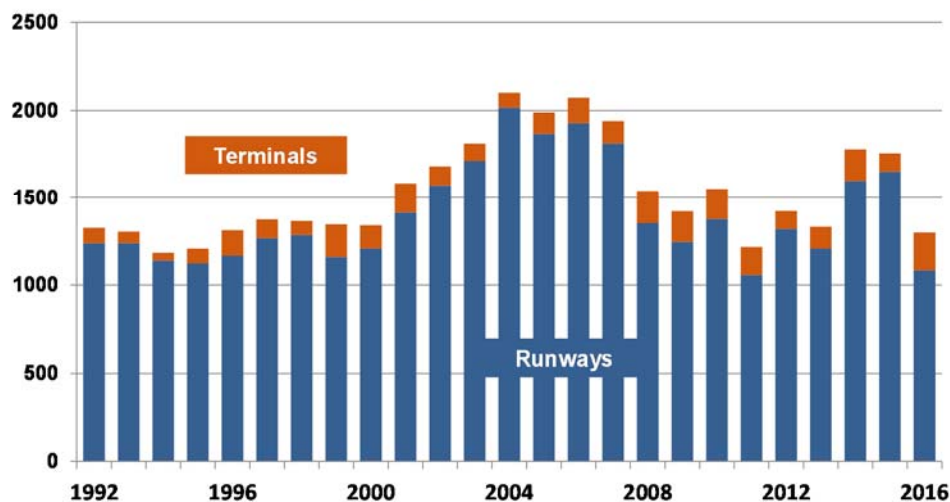
Airport-Related Cement Consumption Outlook

Overview

PCA's Market Intelligence Group is engaged in a comprehensive research project that estimates long term opportunities for cement consumption. The study provides a 25 year outlook and evaluates both vertical (buildings) and horizontal (non-buildings) markets. The study not only estimates growth in building activity based on economic, demographic, and structural issues, such as technology changes that are likely to impact demand, but also measures material market share trends in each construction segment and identifies the areas of erosion from least severe to most severe as well as opportunity.

This report focuses on the United States' airport market. As Congress considers new legislation that could increase investment in aviation infrastructure, PCA takes a long-run view of potential cement consumption attributed to airports. PCA expects cement consumption in the airports market to approach 2.4 million metric tons by 2040 compared to 1.5 million metric tons currently. Two key forces determine airport construction activity. They include expansion in the number and size of airports, and maintenance of existing airports at both the runway and terminal levels of activity.

Airport-Related Cement Consumption (000) Metric Tons



Airports are a critical part of the nation's infrastructure, and because they are an important ingredient in the United States' logistical system, their condition can impact overall economic growth. The U.S. airport system not only facilitates domestic and international commerce, it directly supports nearly half a million jobs and is indirectly responsible for 7.6 million jobs in logistics, construction, and tourism.¹

Construction spending dedicated to the airport category averages \$4 billion annually. Of this, spending is split equally between runways and terminals construction activity. The airport market consumes approximately 1.5 million metric tons. With respect to cement consumption runways are much more cement intensive and account for approximately 90% of cement consumed in the airports market in a given year. Of this, nearly three quarters is due to replacement/repaving of existing runways.

Future airport related concrete consumption opportunities exist in the form of replacement/repaving of the existing runway system, terminal expansion, and runway expansion. PCA has quantified these airport construction components in terms of the cement consumption associated with each. This report will expand on each segment of the airport construction sector, what drives the demand for each, how PCA arrived at the size and potential of each market, and provide a baseline and high and low scenario projections for cement consumption.

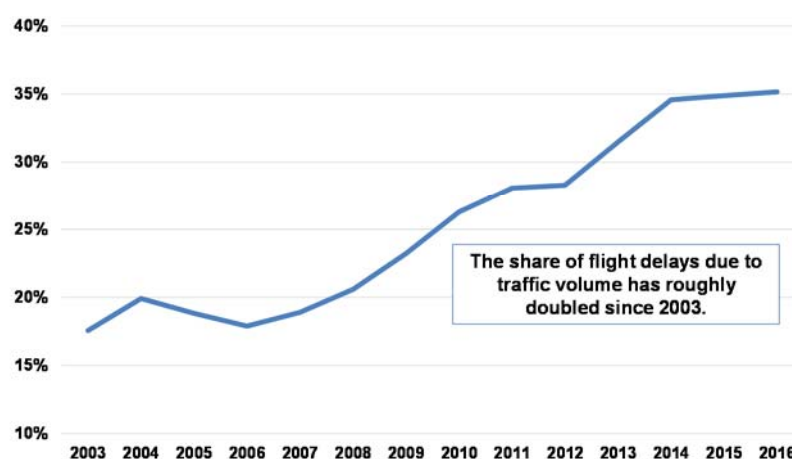
The Airport Sector Construction Market

Based on the total number of airports, the majority are small private hubs. Of these roughly half are unpaved. Taking flight activity into account virtually the opposite is true. Large public hubs account for nearly two-thirds of annual departures. Both small and large airports are characterized by a fairly robust maintenance schedule to keep the system in proper condition. In fact, 80 percent of these runways are classified as in 'good' condition and only two percent are considered 'poor.'²

Despite a solid track record on maintenance of existing runways, demographics, population, and economic growth have resulted in significant increases in air-travel. Expansion of airport facilities has generally not kept pace with these trends resulting in elevated air traffic and terminal congestion.

Cost of No Investment: Congestion-Related Delays

Share of Total Delays Caused by Traffic Volume



Source: U.S. Department of Transportation, Federal Aviation Administration

¹ Economic Development Research Group, *The Role of U.S. Airports in the National Economy*, 2015

² U.S. Department of Transportation, Federal Aviation Administration, *National Plan of Integrated Airport Systems*.

Funding for the U.S. airport system is a mix between federal and state & local dollars. Historically, the federal government has supported roughly 60% of airport construction projects. On the federal side, money for airport construction is drawn from the Airport/Airway Trust Fund (AAFT). The AAFT is sustained by various taxes and fees related to the use of the aviation network. Currently, the AAFT has a cash balance of approximately \$15 billion from a high of around \$28 billion in the early 1990's. The GAO has expressed concerns over the fund's low uncommitted balance and in recent years, the aviation fuel tax has been diverted to the Highway Trust Fund. There have been several recent proposals for alternative ways to fund the AAFT.

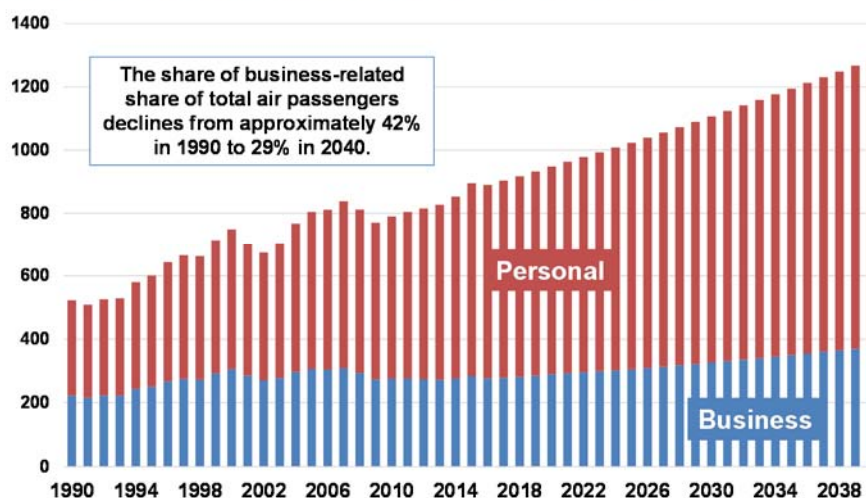
PCA assumes that in the long term, Congress will find ways to properly fund the AAFT and adverse financial conditions won't affect airport construction projects. Cement consumption estimates associated with airport expansion is based on assessments made regarding congestion levels and is not based on spending assumptions. Not only is this approach consistently used across other horizontal markets (roadways, airports, etc.), but it rests upon the idea that the level of congestion is directly linked to the level of urgency to spend and urgency dictates funding levels and expansion efforts. The potential that funding levels will diverge from need as reflected in congestion levels does pose a risk to the airport market cement consumption levels in the longer term.

Airport Construction Demand Drivers

Demand for airport construction, both new and replacement, is ultimately generated by demand for air travel in the form of personal, business, and cargo. While new terminals and runways are required to service increased air traffic, with each additional enplanement, erosion and stress are put on the existing runway system, creating the need for repaving/rehabilitation.

PCA assessed the demand drivers behind each personal, business, and cargo travel separately and then forecasted each to 2040. In each forecast, high and low scenarios are provided, which eventually translate to cement tonnage scenarios.

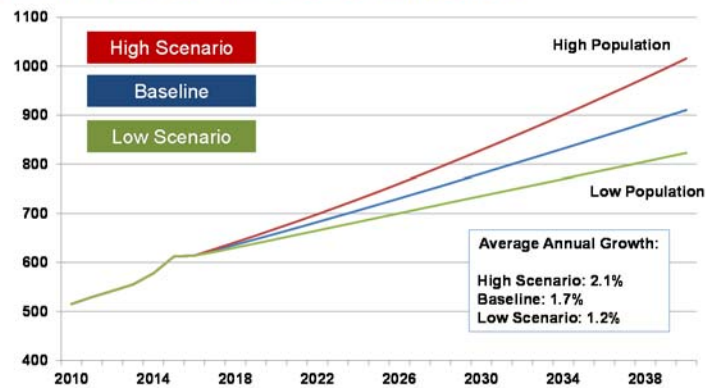
Millions of Passengers on All Scheduled U.S. Based Flights



Source: U.S. Department of Transportation, Federal Aviation Administration, PCA

Demand: Personal Air Travel

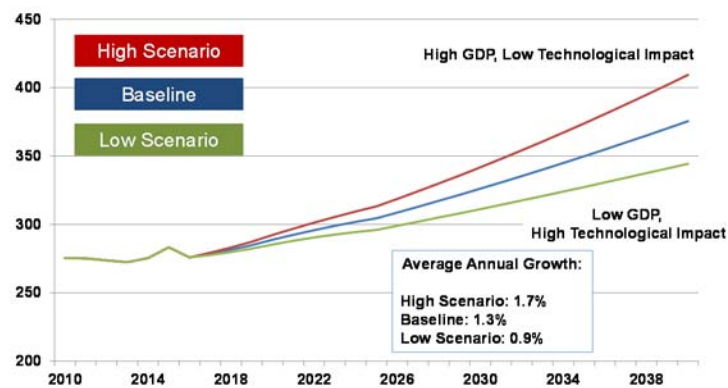
Millions of Passengers on All Scheduled U.S. Based Flights



Source: U.S. Department of Transportation, Federal Aviation Administration, PCA

Demand: Business Air Travel

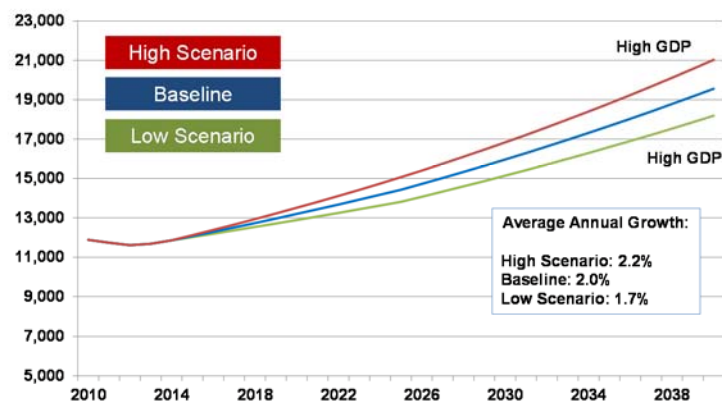
Millions of Passengers on All Scheduled U.S. Based Flights



Source: U.S. Department of Transportation, Federal Aviation Administration, PCA

Demand: Cargo Carried by Air

Enplaned Revenue Tons; Freight and Mail



Source: U.S. Department of Transportation, Federal Aviation Administration, PCA

For personal travel, high and low population growth forecasts were employed to arrive at potential scenarios going out to 2040. There is a strong long-run correlation between population and air travel. The average correlation is extended through the forecast horizon – allowing population to drive growth. Personal travel passengers are projected to grow to 910 million passengers by 2040. The low scenario reflects only 823 million passengers by 2040, compared to 1.015 billion passenger growth under the high scenario.

PCA's business travel projections are driven by GDP growth assumptions. There is also a structural component that was taken into account – namely the amount of business conducted via phone or web conference for cost saving reasons, thus diminishing air travel demand. This is referred to as high technological impact. Under the high GDP growth scenario, for example, there is assumed to be low technological impact because net income is stronger and corporate cost control measures may be less stringent. These factors are reversed in the low scenario. Combining these market forces, baseline business passenger growth is expected to average 1.3% growth in personal travel - to 2040, which equals between 375 million and 409 million total business travelers in 2040.

The demand for cargo carried in the air was assessed on an enplaned revenue ton basis. There are several structural forces at play in the cargo market such as increased freight traffic with the advent of online retailers like Amazon but also a continual decline in the use of 'snail mail.' PCA's cargo forecast scenarios reflect high and low GDP growth assumptions. Baseline cargo freight tons are expected to grow an average of 2.0% to 2040.

Airport Expansion Assessments

Expansion activity for terminals and runways are based on demand assumptions for future flights. To begin to assess how much additional terminal construction will be needed to accommodate the expected additional passengers and cargo by 2040, PCA looked at this phenomenon through a congestion perspective.

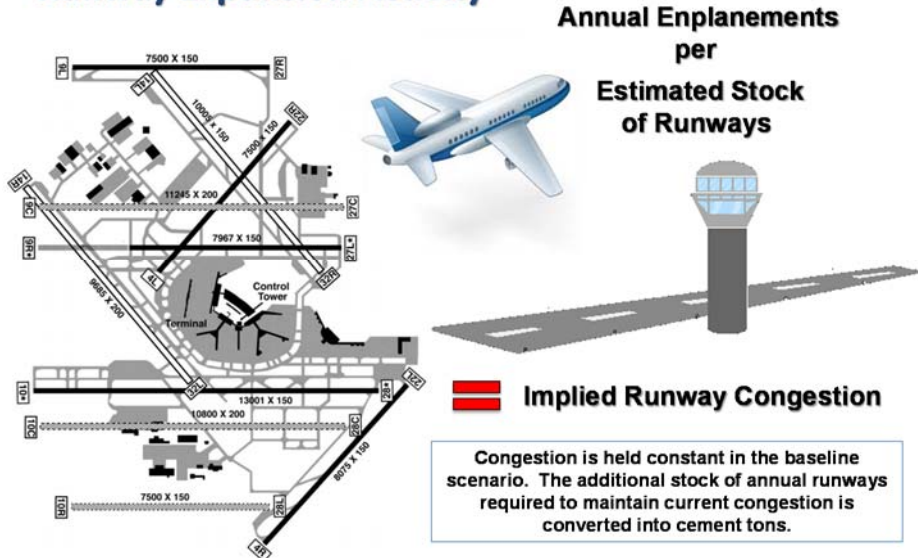
Terminal Expansions: As air travel increases, and terminals do not expand at an equal rate of growth, the number of passengers per square foot of terminal space increases – reflected in terminal overcrowding. To measure the overcrowding, PCA projects passengers per square feet of terminal space. These estimates were compared against a base level of space per passenger to determine total terminal expansion requirements.

The question becomes; what is that base level? According to fire and building codes, persons per square foot of building cannot exceed around 1.6. Using this ratio, however, could produce inflated estimates for the simple reason that while some terminals are indeed reaching their capacity limit, other terminals, particularly in smaller and medium hubs, have a lot of slack before they begin to reach the upper limits of their capacity. Instead, PCA evaluated past terminal construction against changes in passenger traffic and arrived at a historical ratio of 4.1 passengers per square foot of new expansion. To maintain prevailing congestion, terminal construction is assumed to hold the 4.1 ratio going to 2040. A 10% improvement in congestion would yield a ratio of 3.7 passengers per square foot while a 10% erosion would result in 4.5 passengers per square feet.

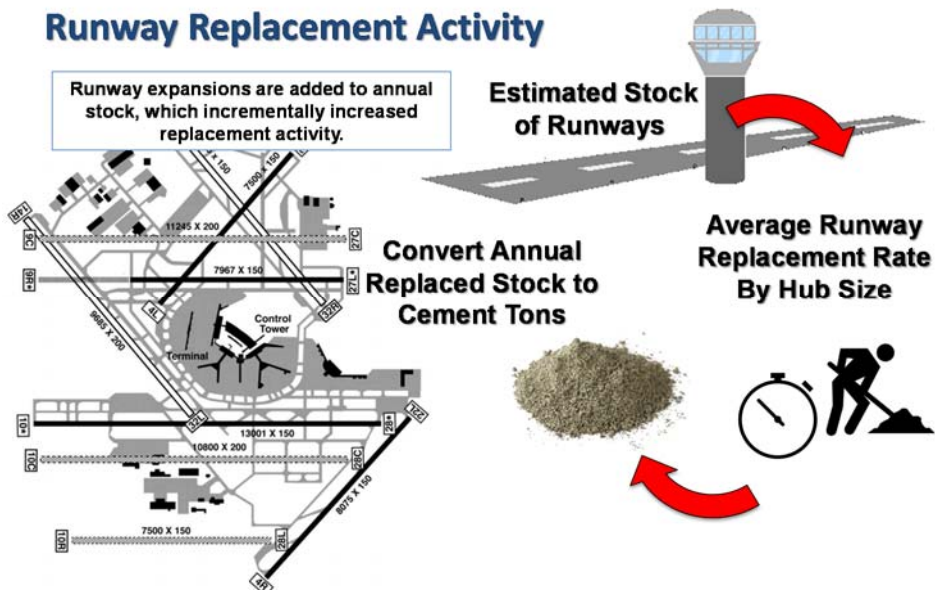
Once terminal expansion was forecasted, a use factor was applied to convert construction activity into cement consumption. All totaled, approximately 267,000 metric tons of cement are expected to be consumed in airport terminals by 2040 under the baseline scenario. The high and low scenarios, based on congestion assumptions, yield around 296,000 metric tons and 236,000 metric tons respectively.

Runway Expansions: To estimate future runway expansion needs, PCA first had to estimate the size of the total existing runway system. To this end, the Bureau of Transportation Statistics and Federal Aviation Administration have fairly detailed airport capacity profiles, which include runway specs of all large hub public airports. Once the runway length, width, and thickness are known, these runways can

Runway Expansion Activity



Runway Replacement Activity



be converted into cubic yard of concrete equivalents. While there is specific data on several hundred of the largest individual runways, some assumptions had to be made regarding smaller hubs' runways.

Once the entire stock of runways was established, PCA could begin to analyze runway expansion from a congestion standpoint. While increased passenger traffic drives terminal construction, what drives runway expansion is technically the number of enplanements. While this is a subtle difference, the number of passengers per enplanement has been steadily growing since the 1980's. That is to say planes are getting bigger. So not only did PCA's high and low scenarios for passenger traffic change based on population and GDP, but a continued increase in passengers per plane would affect the number of runway miles required in the future.

Like PCA's terminal expansion analysis, once the runway expansion required to maintain current levels of congestion – or enplanements per square yard of runway – were estimated, a cement use factor was applied to convert construction activity to cement. In sum, approximately 561,129 metric tons of cement are expected to be consumed by runway expansion by 2040. Under the low and high scenarios, around 528,554 metric tons and 607,731 metric tons are expected, respectively.

Airport Construction Replacement Activity

The runway replacement market represents the majority of cement consumed in airport construction. While there is undoubtedly maintenance to terminals that involves pouring concrete, for the purposes of this report, PCA assumes virtually all terminal construction activity is new construction.

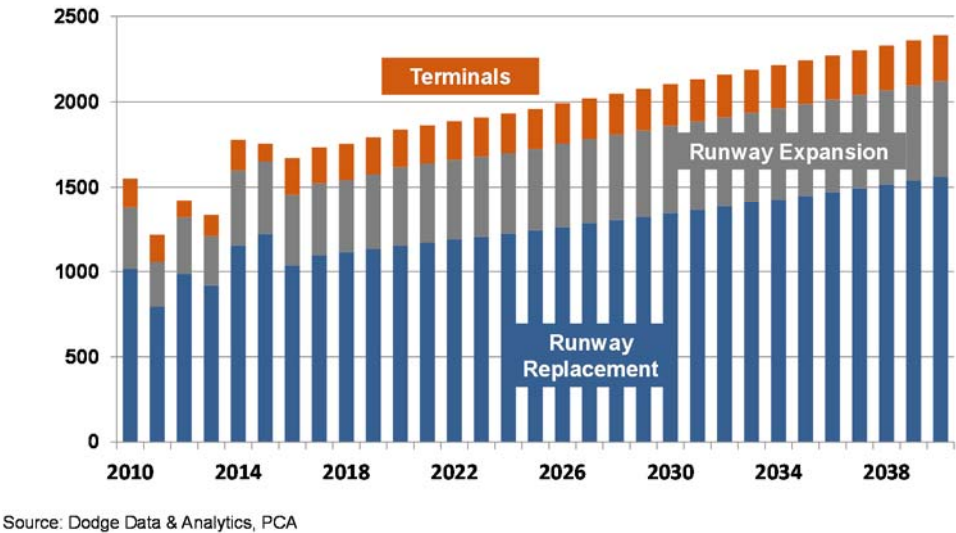
PCA used the total stock of runways to calculate the potential concrete poured in a given year. To estimate this the rate of runway replacement was required. To this end, PCA surveyed individual runways at various airports throughout the country. Once a listing was made of when these runways were constructed, they could be lined up against dates in which they were repaved or rehabilitated. Given this information and based on all individual observations, an average a time schedule could be constructed to arrive at the average rate of runway replacement. Different assumptions were made with regard to small, medium, and large hubs, as well as public and private airports. Runways with more traffic and heavier loads require replacement more frequently.

Once both the total stock of airports by hub size and average replacement rate by hub size were known, the annual stock of replaced runway could be calculated. From there, a conversion to concrete and finally cement could be made. An important dynamic in runway maintenance going forward is that the amount of runway expansion in a given year is added to the runway stock, which incrementally increases runway replacement activity.

In PCA's baseline scenario, annual cement consumed in runway replacement is projected to reach around 1.56 million metric tons by 2040. The high and low scenarios yield approximately 1.69 million metric tons and 1.47 million metric tons, respectively.

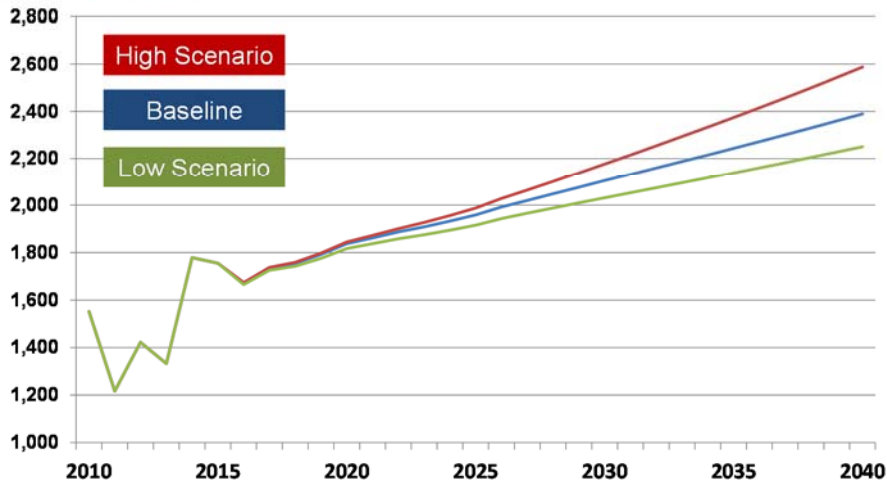
Airport-Related Cement Consumption Outlook: Baseline

(000) Metric Tons



Airport-Related Cement Consumption Outlook: Scenarios

(000) Metric Tons



Cement Consumption Projections

According to the baseline scenario, 2.39 million metric tons are expected to be consumed in airport construction by 2040. Of this, 65%, or 1.56 million can be attributed to runway replacement. Runway expansion is projected to contribute around 561,000 metric tons, accounting for about 23% of airport-related consumption. Finally, terminal expansion is expected to account for 11% of consumption in the airport market and generate around 267,000 metric tons of consumption.

Under PCA's high scenario, cement consumption in airports could reach 2.59 million metric tons by 2040. In the low scenario, growth is muted and cement consumed in airport construction is around 2.24 million metric tons in 2040.

Airport Cement Consumption Outlook (000 Metric Tons)

		2020	2025	2030	2035	2040
Terminal Expansion	Baseline	219	235	245	256	267
	Low	209	208	216	226	236
	High	227	255	272	283	296
Runway Expansion	Baseline	467	481	515	537	561
	Low	462	471	497	512	529
	High	469	489	533	569	608
Runway Replacement	Baseline	1,151	1,242	1,344	1,450	1,561
	Low	1,138	1,215	1,297	1,382	1,470
	High	1,156	1,261	1,390	1,534	1,691
Airports Total	Baseline	1,837	1,959	2,104	2,243	2,389
	Low	1,810	1,894	2,011	2,120	2,235
	High	1,852	2,005	2,195	2,386	2,595