Newark International Airport

Capacity Enhancement Plan

Newark International Airport Capacity Enhancement Plan

May 2000

Prepared jointly by the U.S. Department of Transportation,
the Federal Aviation Administration, the Port Authority of New York and New Jersey,
and the airlines and users serving Newark International Airport and Teterboro Airport.

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Figure 1. Newark International Airport

The airport diagram is not intended for Master Planning purposes. It only illustrates the location of capacity enhancement alternatives.

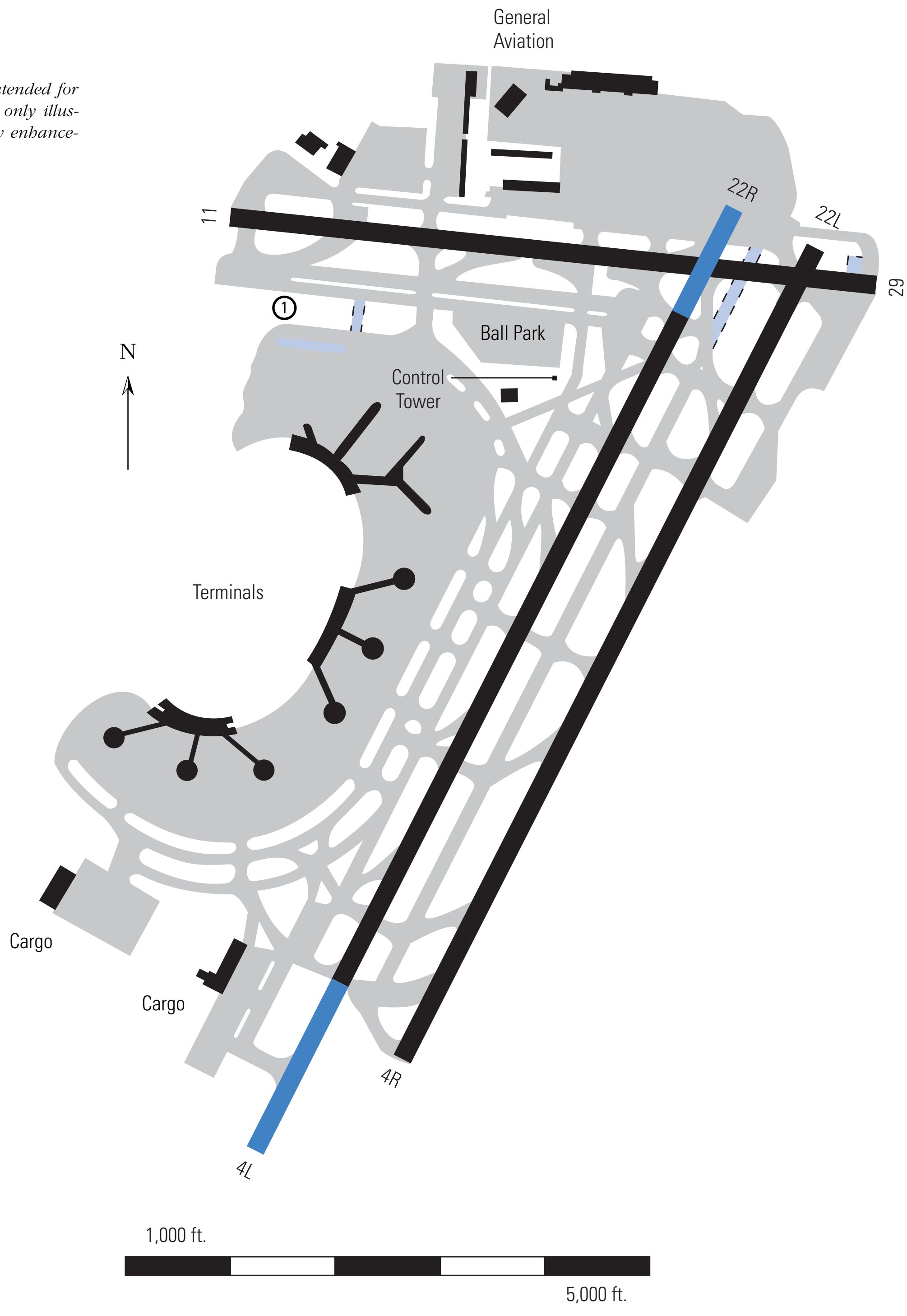


Figure 2. Capacity Enhancement Alternatives and Annual Delay Savings

	Estimated Annual Delay Costs (HRS and $M)		
	Baseline (454,000)	Future 1 (500,000)	Future 2 (550,000)
Do Nothing			
2.5 NM Minimum In-Trail IFR Spacing–Between Similar Class Non-Heavy Aircraft on Final Approach	120,286/$264.6	367,519/$808.5	765,034/$1,683.1
	Estimated Annual Delay Savings		
Airfield Improvements			
1. Taxiway to Runway 11/29 between Y and C3 Ramp	1,049/$2.3	1,541/$3.4	Note 1
2. Off-Gate Holding Areas in Addition to Ball Park	Note 1	Note 1	Note 1
3. New Runway with Independent Arrivals in All Weather Conditions	83,059/$182.7	278,880/$613.5	557,229/$1,225.9
4. Alternate Departure Queuing Scheme for Extended 4L/22R	Note 1	Note 1	Note 1
Facilities and Equipment Requirements			
Localizer Directional Aid (LDA) Equipment	See Alternative 6	Note 3	Notes 1&3
Simultaneous Offset Instrument Approaches (SOIA) Equipment	See Alternative 7	Note 3	Notes 1&3
Dependent Converging Instrument Approaches (DCIA) Equipment	See Alternative 8	Note 3	Notes 1&3
Operational Improvements			
5. Parallel Dual Visual Approaches	3,856/$8.5	10,404/$22.9	Note 1
6. Localizer Directional Aid (LDA) Offset Approach to Inboard Runway (4L/22R) by Non-Heavy Aircraft and Commuters NE and SW Flows - 50% in VFR2	6,432/$14.2	15,582/$34.3	Note 1
7. Simultaneous Offset Instrument Approaches (SOIA) NE and SW Flows - 100% in VFR2	9,008/$19.8	20,759/$45.7	Note 1
8. Dependent Converging Instrument Approaches (DCIA)–SW Flow	3,371/$7.4	3,846/$8.5	Note 1
9. Simultaneous Converging Instrument Approaches (SCIA)–NE Flow	6,530/$14.4	9,718/$21.4	Note 1
10. Reduce Minimum In-Trail IFR Separations to 2.0 NM–Between Similar Class Non-Heavy Aircraft	2,101/$4.6	4,955/$10.9	Note 1
11. Immediate Divergent Turns for Turboprop/Prop Aircraft	9,560/$21.0	28,608/$62.9	78,840/$173.4
User or Policy Improvements			
12. Vertiport and Tiltrotor Aircraft	Note 1	Note 1	411,071/$904.4
13. More Uniform Distribution of Traffic within the Hour	Note 1	Note 2	Note 1
14. 1996 Fleet Mix at Future Demands	Note 1	Note 2	Note 1

Note 1: This improvement was not simulated at this demand level.

Note 2: Annual delay costs and savings were not computed for this improvement. The results for Future 1, VFR-1, showed nominal benefit and indicate this improvement will not make Future 1 levels of operations achievable.

Note 3: NAVAIDS and Equipment required to allow use of procedures.

Figure 3. Capacity Enhancement Alternatives and Technical Study Results*

* Study results based on computer simulations

** This equipment is required for the referenced alternative.

Alternatives	Technical Study Results	Actions and Steps Necessary Prior to Decision/Implementation: Environmental	Capital Investment Cost/Benefit	Airport Planning	Airspace/Procedures	Concept or Technology Development
Airfield Improvements						
1. Taxiway to Runway 11/29 between Y and C3	Significant Delay Savings Recommend Next Steps	•	•	•		•
2. Off-Gate Holding Areas in Addition to Ball Park				•		
3. New Runway with Independent Arrivals in All Weather Conditions	Significant Delay Savings Recommend Next Steps	•	•	•	•	
4. Alternate Departure Queuing Scheme for Extended 4L/22R	Not Simulated					
Operational Improvements						
5. Parallel Dual Visual Approaches	Significant Delay Savings Recommend Next Steps	•		•	•	
6. Localizer Directional Aid (LDA) Offset Approach to Inboard Runway (4L/22R) by Non-Heavy Aircraft and Commuters	Significant Delay Savings Recommend Next Steps	•	•	•	•	
7. Simultaneous Offset Instrument Approaches (SOIA)	Significant Delay Savings Recommend Next Steps	•	•	•	•	
8. Dependent Converging Instrument Approaches (DCIA)–SW Flow	Significant Delay Savings Recommend Next Steps	•			•	
9. Simultaneous Converging Instrument Approaches (SCIA)–NE Flow	Significant Delay Savings Recommend Next Steps	•	•		•	•
10. Reduce Minimum In-Trail IFR Separations to 2.0 NM–Between Similar Class Non-Heavy Aircraft	Significant Delay Savings Recommend Next Steps	•				•
11. Immediate Divergent Turns for Turboprop/Prop Aircraft	Significant Delay Savings Recommend Next Steps	•			•	
User or Policy Improvements						
12. Vertiport and Tiltrotor Aircraft	Significant Delay Savings Recommend Next Steps	•	•	•	•	•
13. More Uniform Distribution of Traffic within the Hour	Delay Saving Airline Prerogative					
14. 1996 Fleet Mix at Future Demands	Less Than Significant Delay Savings					
Facilities and Equipment Requirements **						
Localizer Directional Aid (LDA) & Glide Slope (GS)–Required for Alternatives 6&7		•	•	•		
Precision Runway Monitor (PRM)–Required for Alternative 7		•	•	•		
Converging Runway Display Aid (CRDA)–Required for Alternative 8		•	•			

Summary

This process is done outside the context of normal airport master planning because it only identifies the operational benefits or delay savings of capacity enhancement alternatives.

This study considered the airport, its immediate airport terminal airspace, without regard for adjacent terminals and required en route supporting capacity. Several of the improvement initiatives require changes to airspace structure and procedures. This study did not evaluate the feasibility of accommodating these initiatives in the approach control or center airspace. It is possible that some procedures cannot be accommodated in the existing airspace environment, and their feasibility would be better considered in the ongoing redesign of the New York area airspace.

The purpose is to provide decision-makers with this information. The findings of this capacity plan are not recommendations to take an action. They are data and information to be used to further consider improvements in the full planning context, where capital costs, airspace management needs, environmental costs, alternatives, and other appropriate factors help yield the best plan for the airport. For this reason, the Design Team recommends follow on studies to make these choices.

Recognizing the problems posed by congestion and delay within the National Airspace System, the FAA, airport operators, and aviation industry groups have initiated joint Airport Capacity Design Teams (Design Teams) at various major air carrier airports throughout the U.S. Each Design Team identifies and evaluates alternative means to enhance existing airport and airspace capacity to handle future demand, decrease delays, and improve airport efficiency. Further, each team works to develop a coordinated action plan for reducing airport delay. Over 50 Design Teams have either completed their studies or have work in progress.

Newark International Airport (EWR) is a major hub airport, which was ranked 12th in enplanements in 1997. This hub operation has the highest average delay per operation in the U.S. The delays have system wide impacts on a regular basis.

In the past decade, EWR has been one of the nation's fastest growing airports. Enplanements rose from 3.4 million in 1976 to 14.9 million in 1997, an average annual growth rate of 4.3%. EWR's total aircraft operations (takeoffs and landings) reached 467,688 in 1997, an average annual growth rate of 2.5% over the 189,775 aircraft operations the airport handled in 1976.

Currently EWR is the only non-slot controlled, non-perimeter rule, free market solution for commercial service passengers in the New York Area.

A Design Team for Newark International Airport was formed in 1996. The EWR Design Team identified and assessed various actions that, if implemented, could increase EWR's capacity, improve operational efficiency, or reduce aircraft delays. The purpose of the process was to determine the technical merits of each alternative action and its impact on capacity. Additional studies will be needed to assess airspace, environmental, socioeconomic, or political issues associated with these actions.

Selected alternatives identified by the Design Team were analyzed using a computer model developed by the FAA to quantify the benefits provided. Aircraft classifications used were based on FAA separation standards after August 17, 1996. Different levels of activity were chosen to represent growth in aircraft operations in order to compare the merits of each action. These annual activity levels are referred to throughout this report as:

- Baseline - 454,000 operations
- Future 1 - 500,000 operations
- Future 2 - 550,000 operations

Since all the initiatives modeled show a delay reduction, it is recommended they be studied further to determine whether they should be undertaken. Planning for improvements in a complex environment such as Newark has become an iterative process requiring successive cycles of evaluation, proof of concept, comparison to costs and resources required, etc. The following initiatives should move on to the next steps in this process.

Based on the analysis completed during the study, the Design Team identified the following potential capacity enhancement or delay reduction alternatives.

Alternatives	Future 1 Annual Delay Savings ($M)
Divergent Turns for Turboprop/Prop Aircraft	$62.9
Simultaneous Offset Instrument Approaches (SOIA) (100%)	$45.7
Localizer Directional Aid (LDA) Equipment (50%)	$34.3
Parallel Dual Visual Approaches	$22.9
Simultaneous Converging Instrument Approaches (SCIA)	$21.4
Dependent Converging Instrument Approaches (DCIA)	$8.5
New Runway with Independent Arrivals in All Weather Conditions	$613.5

Alternatives	Future 2 Annual Delay Savings ($M)
Divergent Turns for Turboprop/Prop Aircraft	$173.4
Vertiport and Tiltrotor Aircraft	$904.4
New Runway with Independent Arrivals in All Weather Conditions	$1,225.9

Figure 4. Airport Capacity Curves - Flow Rate Versus Average Delay

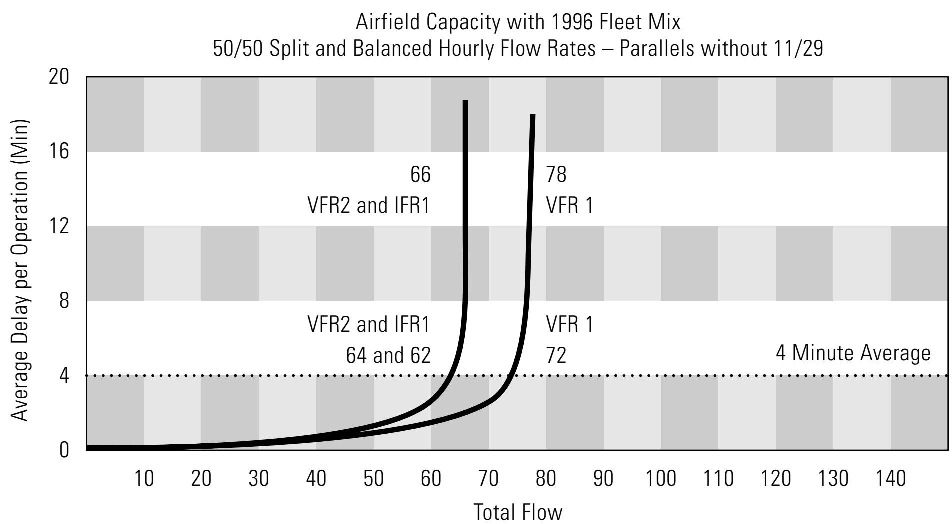


Figure 5. Airport Delay Costs (in Hours and Dollars)

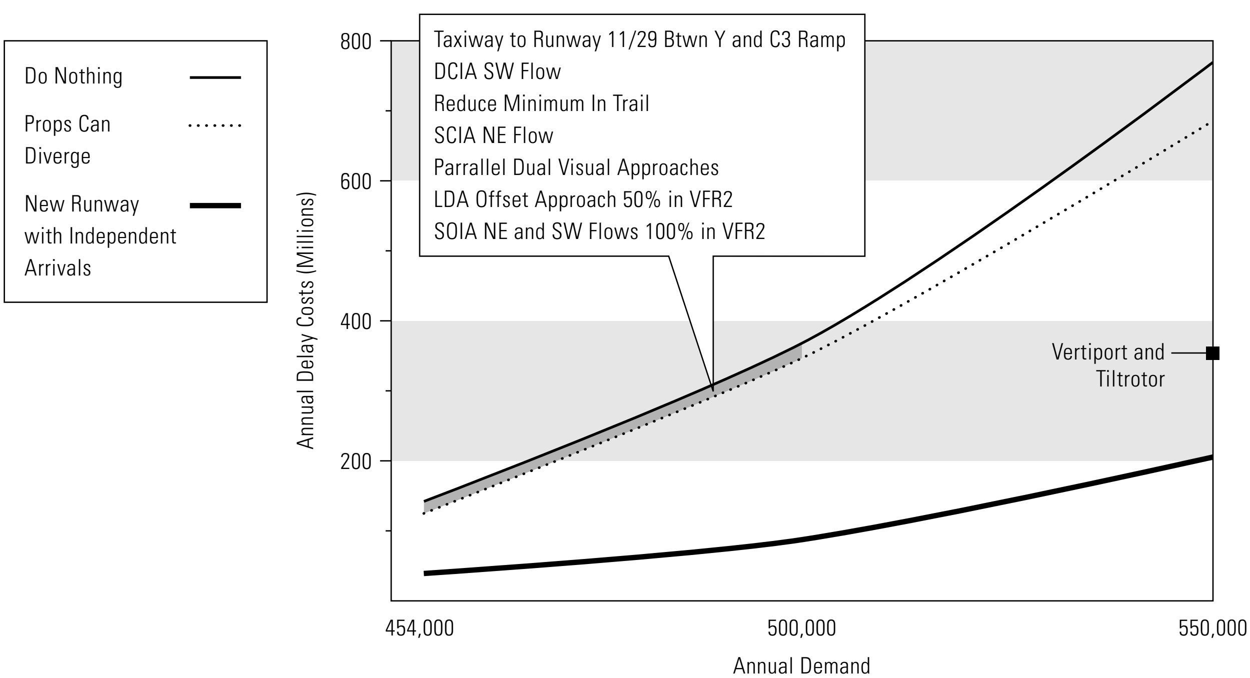
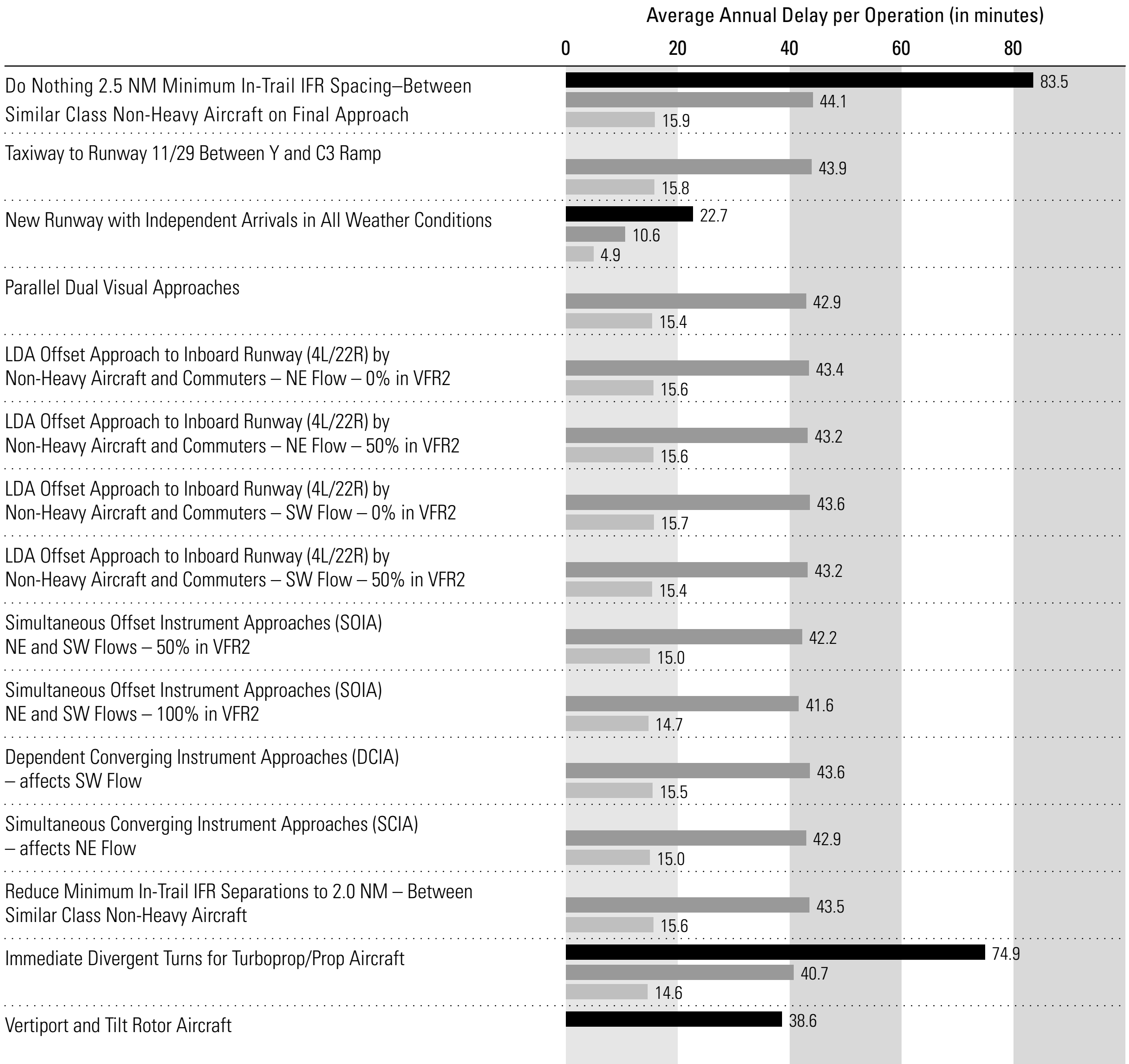


Figure 6. Average Delay per Operation



550,000 (Future 2)
500,000 (Future 1)
454,000 (Baseline)

Note: Future 2 was not simulated for most improvements because Future 2 levels of operation are not achievable.

Figure 4 shows the capacity curves (flow rate versus average delay) for the existing airfield configuration at EWR under instrument flight rules (IFR) and visual flight rules (VFR). It provides a 50/50 split of arrivals and departures and balanced flow rates for the parallel runways, without Runway 11/29. Under IFR, aircraft delays begin to escalate as the demand exceeds 31 arrivals per hour.

Figure 14 illustrates the hourly profile of daily demand for the Baseline activity of 454,000 annual operations. It also includes curves which depict the profile of daily operations for the Future 1 and 2 activity levels.

The information in Figure 4 illustrates that hourly demand exceeds 31 arrivals per hour at the Baseline activity level.

Figure 5 shows the delays and delay costs for the Do Nothing case and the improvements studied by the Design Team. Under the Do Nothing case, the annual delay costs of 120,286 hours or $ 264.6 million at the Baseline activity level will increase to 367,519 hours or $ 808.5 million by Future 1, and, 765,034 hours or $ 1,683.1 million by Future 2.

Figure 6 illustrates the average delay in minutes per aircraft operation for these same alternatives. Under the Do Nothing case, the average delay per operation of 15.9 minutes at the Baseline activity level will increase to 44.1 minutes by Future 1 and 83.5 minutes by Future 2.

Delays and delay costs at EWR escalate dramatically because the demand at EWR causes the airport to operate beyond the knee of the delay curve. An increase in demand results in a sharp increase in delay. Without some improvements or combination of improvements, it is unlikely that EWR will reach the Future 1 operational level.

Newark's arrival demand consistently exceeds its IFR capacity throughout the day. Consequently, the delays associated with its IFR operations escalate dramatically. However, delay reporting systems do not capture the delays associated with canceled flights. Therefore, to capture the costs associated with canceled flights, the Design Team simulated a full schedule in IFR and full days of IFR conditions.

This conclusion suggests that in the near term future, unless passenger services are provided at other regional airports, or by other modes of transportation, planning for improving the capacity of Newark International Airport should be undertaken now to select the best choices for the airport and its communities.

Section 1 - Introduction

Background

This process is done outside the context of normal airport master planning because it only identifies the operational benefits or delay savings of capacity enhancement alternatives.

This study considered the airport, its immediate airport terminal airspace, without regard for adjacent terminals and required en route supporting capacity. Several of the improvement initiatives require changes to airspace structure and procedures. This study did not evaluate the feasibility of accommodating these initiatives in the approach control or center airspace. It is possible that some procedures cannot be accommodated in the existing airspace environment, and their feasibility would be better considered in the ongoing redesign of the New York area airspace.

The purpose is to provide decision-makers with this information. The findings of these capacity plans are not recommendations to take an action. They are data and information to be used to further consider improvements in the full planning context, where capital costs, airspace management needs, environmental costs, alternatives, and other appropriate factors help yield the best plan for the airport. For this reason, the Design Team recommends follow on studies to make these choices.

Problems posed by congestion and delay within the National Airspace System resulted in the FAA asking the aviation community to study the problem of airport congestion through the Industry Task Force on Airport Capacity Improvement and Delay Reduction, chaired by the Airport Operators Council International.

By 1984, aircraft delays recorded throughout the system highlighted the need for more centralized management and coordination of activities to relieve airport congestion. In response, the FAA established the Airport Capacity Program Office, now called the Office of System Capacity (ASC). The goal of this office and its capacity enhancement program is to identify and evaluate initiatives, having the potential to increase capacity, and enhance the performance of the National Airspace System without compromising safety or the environment.

In 1985, the FAA initiated a renewed program of Design Teams at various major air carrier airports throughout the U.S. Each Design Team identifies and evaluates alternative means to enhance existing airport and airspace capacity to handle future demand and works to develop a coordinated action plan for reducing airport delay. Over 50 Design Teams have either completed their studies or have work in progress.

In 1997, 23 airports each exceeded 20,000 hours of airline flight delays. If no improvements in capacity are made, the number of airports that could exceed 20,000 hours of annual air carrier delay is projected to grow from 23 to 31 by 2007. The challenge for the air transportation industry as we began the year 2000, was to enhance existing airport and airspace capacity and to develop new facilities to handle future demand. As environmental, financial, and other constraints continue to restrict the development of new airport facilities in the U.S., an increased emphasis has been placed on the redevelopment and expansion of existing airport facilities.

For Newark International Airport, FAA and industry cooperatively maintain a Capacity Enhancement Task Force, comprised of FAA representatives, The Port Authority of New York and New Jersey, airline and satellite airport representatives, etc. This group meets periodically to discuss opportunities for delay reduction. This group concurred in the need for this Capacity Enhancement Plan in mid-1996 for several reasons. Primarily, it became evident that attempts to increase flight schedules resulted in sharp delay increases, indicating capacity saturation. Since Newark is the only airport in the three-airport system providing passenger service to New York City, New Jersey and the surrounding area without flight restrictions (High Density Rule), it was important to know how much additional service the airport could provide. Also, a recently completed study of capacity and delay reducing initiatives done for The Port Authority of New York and New Jersey ("Delay Reduction Strategy Study" Leigh Fisher, 1995) called for additional study. The Capacity Enhancement Design Team study was launched the following year.

Newark International Airport

Newark International Airport (EWR) is a major hub airport, which was ranked 12th in enplanements in 1997. This hub operation has the highest average delay per operation in the U.S. The delays have system wide impacts on a regular basis.

In the past decade, EWR has been one of the nation's fastest growing airports. Enplanements rose from 3.4 million in 1976 to 14.9 million in 1997, an average annual growth rate of 4.3%. EWR's total aircraft operations (takeoffs and landings) reached 467,688 in 1997, an average annual growth rate of 2.5% over the 189,775 aircraft operations the airport handled in 1976. Currently EWR is the only non-slot controlled, non-perimeter rule, free market solution for commercial service passengers in the New York Area.

Currently Newark International Airport is owned and/or leased and operated by the Port Authority of New York and New Jersey. The airport is located on approximately 2,200 acres of land about three miles from downtown Newark and primarily serves the greater New York/New Jersey area. The airfield was modeled with runway lengths of:

- Runway 4L/22R at 8,200 feet long and 150 feet wide.*
- Runway 4R /22L at 9,300 feet long and 150 feet wide.
- Runway 11/29 at 6,800 feet long and 150 feet wide.

* Runway extended to 11,000 feet in 2000

Newark International Airport Capacity Design Team

A Design Team for Newark International Airport was formed in 1996. The EWR Design Team identified and assessed various actions that, if implemented, would have the potential to increase capacity, improve operational efficiency, or reduce aircraft delays. The purpose of the process was to determine the technical merits of each alternative action and its impact on capacity. Additional studies will be needed to assess airspace, environmental, socioeconomic, or political issues associated with these actions.

This report has established benchmarks for development based upon traffic levels and not upon any definitive time schedule, since actual growth can vary from year to year from projections. As a result, the report should retain its validity until the highest traffic level is attained regardless of the actual dates paralleling the development.

A Baseline activity level of 454,000 aircraft operations (takeoffs and landings) was established based on the annual traffic level for 1996. Two future traffic levels, Future 1 and Future 2, were established at 500,000 and 550,000 annual aircraft operations, respectively; they were based on Design Team consensus of potential traffic growth at EWR. If no improvements are made at EWR, annual delay levels and delay costs are expected to increase from an estimated 120,286 hours and $264.6 million at the Baseline activity level to 367,519 hours and $808.5 million by the Future 1 demand level, and to 765,034 hours and $1,683.1 million by the Future 2 demand level. Another way of describing delay is the average delay per operation. If no improvements are made at EWR, average delays – will increase from 15.9 minutes at the Baseline activity level to 44.1 minutes at Future 1 and 83.5 minutes at Future 2.

The improvements evaluated by the Design Team are delineated in Figure 2 and described in some detail in Section 2, Capacity Enhancement Alternatives.

Objectives

The major goal of the Design Team was to identify and evaluate proposals to increase airport capacity, improve airport efficiency, or reduce aircraft delays. To achieve this objective, the Design Team:

- Assessed the current airport capacity.
- Examined the causes of delay associated with the airfield, the immediate airspace, and the apron and gate-area operations.
- Evaluated capacity and delay benefits of alternative air traffic control (ATC) procedures, navigational improvements, airfield development, operational improvements, and policy changes.

Scope

The Design Team limited its analyses to aircraft activity within the terminal air airspace, 5NM from threshold, and on the airfield. It considered the operational benefits of the proposed airfield improvements, but did not address environmental, socioeconomic, or political issues regarding airport development. These issues need to be addressed in future airport planning studies, and the data generated by the Design Team can be used in such studies.

This study considered the airport, its immediate airport terminal airspace, without regard for adjacent terminals and required enroute supporting capacity. Several of the improvement initiatives require changes to airspace structure and procedures. This study did not evaluate the feasibility of accommodating these initiatives in the approach control or center airspace. It is possible that some procedures cannot be accommodated in the existing airspace environment, and their feasibility would be better considered in the ongoing redesign of the New York area airspace.

Methodology

The Design Team, which included representatives from the FAA, the Port Authority of New York and New Jersey, and various aviation industry groups see (Appendix A), met periodically for review and coordination. The Design Team members considered capacity improvement alternatives proposed by the FAA's Office of System Capacity, the FAA's Technical Center, the FAA's Regional Aviation Capacity Program Manager, The Port Authority of New York and New Jersey, and other members of the team. Alternatives which were considered technically practicable were developed into experiments that could be tested by simulation modeling. The Technical Center provided expertise in airport simulation modeling. The Design Team validated the data used as input for the simulation modeling and analysis and reviewed the interpretation of the simulation results. The data, assumptions, alternatives, and experiments were continually reevaluated, and modified where necessary, as the study progressed. A primary goal of the study was to develop a set of initiatives, that if able to be implemented after the study, would provide capacity enhancement or delay reduction.

These initiatives can then be considered by decision-makers, who can compare them to the capital costs, airspace management needs, environmental impacts, alternatives, and other appropriate factors, to identify the best plan for the airport.

Initial work consisted of gathering data and formulating assumptions required for the capacity and delay analysis, and modeling. Where possible, assumptions were based on actual field observations at EWR. Proposed improvements were analyzed in relation to current and future activity levels using an FAA computer model, the Airfield Delay Simulation Model (ADSIM). Appendix B briefly explains the model.

The simulation model considered air traffic control procedures, airfield improvements, and traffic demands. Airfield configurations were prepared from present and proposed airport layout plans. Various configurations were evaluated to assess the benefit of projected improvements. Air traffic control procedures and system improvements determined the aircraft separations to be used for the simulations under both visual flight rules (VFR) and instrument flight rules (IFR).

Aircraft fleet mix and schedule assumptions were derived from Official Airline Guide, C.A.T.E.R. (Collection and Analysis of Terminal Records) data, historical data, FAA ATCT sources, and the Design Team. Aircraft volume, mix, and peaking characteristics were considered for each of the three different demand levels (Baseline, Future 1, and Future 2). From this, annual delay estimates were determined based on implementing various improvements. These estimates took into account historic variations in runway configuration, weather, and demand. The annual delay estimates for each configuration were then compared to identify delay reductions resulting from the improvements. Following the evaluation, the Design Team developed a plan of recommended alternatives for consideration.

The cost of the EWR Fleet Mix, computed at $2,200 per hour by the FAA Technical Center and used to determine delay savings figures, represents the 1997 (4th quarter) direct operating costs of the airlines serving EWR. The costs include: cockpit crew; fuel and oil; rentals; insurance; taxes; total flying operations; maintenance, and depreciation. The costs do not consider intangible factors such as lost passenger time or disruptions to airline schedules.

The total delay cost savings are based upon no cancellation or deviation of scheduled flight during periods of inclement weather or high delay. While removing those cancellations or deviations from the schedule would reduce the delay cost savings, there is still a cost for those flights that would need to be added to the delay costs. The costs include passenger costs, hotel costs, reissued tickets, disruption to the schedule and bank integrity, and equipment and crew repositioning and rescheduling. Some of the costs are very difficult to measure, and most of the cost information is proprietary. Also, those costs of cancellations and deviations vary greatly between airlines. So rather than further complicate the delay costs methodology and benefit of delay cost savings through reduced delays, the delays are calculated without deviating from the schedule.

Section 2 - Capacity Enhancement Alternatives

The capacity enhancement alternatives are categorized and discussed under the following headings:

- Airfield Improvements
- Facilities and Equipment Requirements
- Operational Improvements
- User or Policy Improvements

In the opening Summary of this report, Figure 1 shows the current layout of the airport, plus the airfield improvements considered by the Design Team.

Figure 2 lists the capacity enhancement alternatives evaluated by the Design Team and presents the estimated annual delay savings benefits for the improvements studied. The annual savings are given for the Baseline, Future 1, and Future 2 activity levels, which correspond to annual aircraft operations of 454,000, 500,000, and 550,000 respectively.

Figure 7 presents the Capacity Enhancement Alternatives that the Design Team considered during the study and are recommended for further study.

Figure 7. Capacity Enhancement Alternatives and Recommended Actions

Note: NAVAIDS and Equipment required to allow use of procedures

		Action
Airfield Improvements	1. Taxiway to Runway 11/29 between Y and C3 Ramp	Further Study
	2. Off-Gate Holding Areas in Addition to Ball Park	Further Study
	3. New Runway with Independent Arrivals in All Weather Conditions	Further Study
	4. Alternate Departure Queuing Scheme for Extended 4L/22R	Further Study
Facilities and Equipment Requirements	Localizer Directional Aid (LDA) Equipment	See Alt 6 and Note
	Simultaneous Offset Instrument Approaches (SOIA) Equipment	See Alt 7 and Note
	Dependent Converging Instrument Approaches (DCIA) Equipment	See Alt 8 and Note
Operational Improvements	5. Parallel Dual Visual Approaches	Further Study
	6. Localizer Directional Aid (LDA) Offset Approach to Inboard Runway (4L/22R) by Non-Heavy Aircraft and Commuters	Further Study
	7. Simultaneous Offset Instrument Approaches (SOIA)	Further Study
	8. Dependent Converging Instrument Approaches (DCIA) - affects SW Flow	Further Study
	9. Simultaneous Converging Instrument Approaches (SCIA) - affects NE Flow	Further Study
	10. Reduce Minimum In-Trail IFR Separations to 2.0 NM - Between Similar Class Non-Heavy Aircraft	Further Study
	11. Immediate Divergent Turns for Turboprop/Prop Aircraft	Further Study
User or Policy Improvements	12. Vertiport and Tiltrotor Aircraft	Further Study
	13. More Uniform Distribution of Traffic within the Hour	Further Study
	14. 1996 Fleet Mix at Future Demands	Further Study

Airfield Improvements

1. Taxiway to Runway 11/29 between Y and C3 Ramp

This taxiway would provide an additional access to the terminal apron from Runway 11/29. It would allow more flexibility, provide a more direct route for commuter and regional jet aircraft, and reduce congestion around the existing Taxiway U. The additional access to Runway 11/29 would provide the greatest benefit in VFR-1 and VFR-2 conditions, when use of Runway 11 is permitted.

Annual delay savings would be 1,049 hours or $2.3 million at the Baseline activity level; and 1,541 hours or $3.4 million at Future 1. This improvement was not simulated at Future 2.

2. Off-Gate Holding Areas in Addition to Ball Park

The Technical Center developed an analytical tool to perform a gate analysis at EWR using aircraft schedules (gate areas, arrival times, and departure times) and the existing infrastructure. The analysis did not compare aircraft size to gate size. It did not consider lateness distributions, gate service times, runway usage, or other model inputs. Towing of international aircraft from Terminal B3 to Terminal C1 was simulated.

Analysis of the international gates revealed Terminal B3 is at or below capacity during the mid-afternoon hours at the Baseline and Future 1 activity levels. At Future 2, Terminal B3 exceeds capacity.

Analysis of the Domestic gates at the Baseline level showed Terminals A1, A3, B1 exceed gate capacity overnight, starting at 2100 hours. Terminals C1 and C2 are at capacity overnight. At Future 1 and 2: Terminals A1, A3, B1, and C1 exceed gate capacity overnight. At all activity levels, Terminal A3 exceeds gate capacity the most.

At all activity levels, the commuter area at Terminal C3 may be used to store aircraft overnight. Other areas, such as Ball Park, may also be used.

There is a need for more off-gate holding in addition to the Ball Park. Areas closer to other terminal aprons could provide additional flexibility, improved gate utilization, and less congestion in the Ball Park and terminal area.

3. New Runway with Independent Arrivals in All Weather Conditions

None of the initial alternatives simulated showed enough delay reduction to indicate a viable airport operation by Future 1. The Design Team, with the permission of the full Newark Capacity Enhancement Task Force, calculated the delay cost savings that could be realized by an additional, independent, all-weather traffic stream. In this case, an independent parallel runway was explored. This alternative was explored as a capacity concept only. Extensive discussion, planning, public participation, and environmental assessment would be required before this concept could begin to be considered as a viable alternative.

The addition of a new runway could permit 2 independent parallel arrival streams in all weather conditions. For the simulation of the Baseline activity level, 25 percent of the arrivals used the new runway. At the Future 1 and 2 levels, approximately 33 percent of the arrivals used the new runway. The NE and SW flows were simulated with 2 arrival runways and 2 departure runways. These configurations provided greater delay savings than could be obtained by putting arrivals on Runway 11.

It should be noted that the new runway could provide additional delay savings if departing turboprops/props could do divergent turns.

The new air carrier runway is included in the list of improvements for the sole purpose of providing delay cost savings. Its inclusion should not be viewed as a change to the Airport Layout Plan. This report considers only the operational benefits of the proposed airfield improvements, and does not address airspace, environmental, socioeconomic, or political issues regarding airport development. These issues would have to be addressed in future airport planning studies, and the data generated by this report could be used in such studies.

Annual delay savings would be 83,059 hours or $182.7 million at the Baseline activity level; 278,880 hours or $613.5 million at Future 1; and 557,229 hours or $1,225.9 million at Future 2.

4. Alternate Departure Queuing Scheme for Extended 4L/22R

Runway 4L/22R is being extended to the north by 1,000 feet and 1,800 feet to the south. This extension eliminates the need for cockpit crews to request the outboard runway for departure. Separate queuing schemes to best utilize this extension are being analyzed under a separate study.

Facilities and Equipment Requirements

Localizer Directional Aid (LDA) Equipment

The navigational equipment needed to conduct LDA approaches to Runway 4L/22R consists of offset localizers, some type of Distance Measuring Equipment (DME) guidance, and possibly a Glide Slope for each end of the runway.

Simultaneous Offset Instrument Approaches (SOIA) Equipment

The navigational equipment needed to conduct SOIA approaches to Runway 4L/22R is a Precision Runway Monitor (PRM) and the equipment associated for its operation, offset localizers, some type of DME guidance and a Glide Slope for each end of the runway.

Dependent Converging Instrument Approaches (DCIA) Equipment

The surveillance equipment and ARTS software needed to conduct DCIA approaches to Runways 4R and 11 is the Converging Runway Display Aid (CRDA) to provide the electronic “ghost” images to assist in the separation of the arrival aircraft.

Operational Improvements

5. Parallel Dual Visual Approaches

This improvement would allow two arrival streams to the parallel runways in VFR-1. Aircraft in a heavier class cannot overtake an aircraft in a lighter class on the other runway. Therefore, dependent approaches were simulated and wake vortex separations were applied between the closely spaced parallels.

The simulation allowed arrivals to land on the inboard runway only during peak arrival times in order to minimize their impact on departures.

Annual delay savings would be 3,856 hours or $8.5 million at the Baseline activity level; and 10,404 hours or $22.9 million at Future 1. This improvement was not simulated at Future 2.

6. Localizer Directional Aid (LDA) Offset Approach to Inboard Runway (4L/22R) by Non-Heavy Aircraft and Commuters

An LDA would allow two arrival streams to the parallel runways 4L/22R and 4R/22L in VFR-1 and some portion of VFR-2. As a NAVAID in VFR-2, an LDA would permit dual parallel arrival streams to lower minima. The expected minima for an LDA are approximately 3,000 feet and 5 miles, which is 500 feet less than the VFR-1 minima. Aircraft in a heavier class cannot overtake an aircraft in a lighter class on the other runway. Therefore, dependent approaches were simulated and wake vortex separations were applied between the closely spaced parallels.

The simulation allowed arrivals to land on the inboard runway only during peak arrival times in order to minimize their impact on departures.

Because the frequency of occurrence of the minima is unknown, the Design Team performed a sensitivity analysis by varying the of use of an LDA in VFR-2: 0% of the time in VFR-2 and 50% of the time in VFR-2.

Annual delay savings for an LDA used 50% of the time in VFR-2 operations in NE flow would be 2,450 hours or $5.4 million at the Baseline activity level; and 7,833 hours or $17.2 million at Future 1. This improvement was not simulated at Future 2.

Annual delay savings for an LDA used 50% of the time in VFR-2 operations in SW flow would be 3,982 hours or $8.8 million at the Baseline activity level; and 7,749 hours or $17.0 million at Future 1. This improvement was not simulated at Future 2.

7. Simultaneous Offset Instrument Approaches (SOIA)

Currently under development, SOIA is a combination of technology and procedures which would use a Precision Runway Monitor (PRM), an offset ILS Localizer and Glide Slope, and a new procedure to permit dual parallel arrival streams to lower minima. The expected minima for SOIA are approximately 1,600 feet and 4 miles, which is 1,900 feet and 1 mile less than the VFR-1 minima. Because the frequency of occurrence of the minima is unknown, the Design Team performed a sensitivity analysis by varying the use of SOIA in VFR-2: 50% of the time in VFR-2 and 100% of the time in VFR-2.

SOIA would allow 2 arrival streams to the parallel runways in VFR-1 and some portion of VFR-2. Aircraft in a heavier class cannot overtake an aircraft in a lighter class on the other runway. Therefore, dependent approaches were simulated and wake vortex separations were applied between the closely spaced parallels.

The simulation allowed arrivals to land on the inboard runway only during peak arrival times in order to minimize their impact on departures.

Annual delay savings for SOIA used 50% of the time in VFR-2 conditions in the NE and SW Flows would be 6,432 hours or $14.2 million at the Baseline activity level; and 15,582 hours or $34.3 million at Future 1. This improvement was not simulated at Future 2.

Annual delay savings for SOIA used 100% of the time in VFR-2 conditions in the NE and SW Flows would be 9,008 hours or $19.8 million at the Baseline activity level; and 20,759 hours or $45.7 million at Future 1. This improvement was not simulated at Future 2.

8. Dependent Converging Instrument Approaches (DCIA) - Affects SW Flow

This improvement could permit arrivals to Runway 11, in addition to runway 22L in the SW Flow in IFR-1a conditions (600 feet and 2 miles). The DCIA requires a CRDA (Converging Runway Display Aid) and ARTS software. The CRDA tool will assist controllers in maintaining the stagger distances established between aircraft using DCIA.

The DCIA order requires that aircraft be separated by 2NM from a Non-Heavy ghost target and 5NM from a Heavy ghost target. Consequently, a slot is lost when there is a Heavy arrival. In simulating the DCIA in their ETG (Enhanced Target Generator) Lab, the TRACON staggers the arrivals and places aircraft 5NM in-trail on 22L.

Annual delay savings would be 3,371 hours or $7.4 million at the Baseline activity level; 3,846 hours or $8.5 million at Future 1. This improvement was not simulated at Future 2.

Note: The savings are less than that of Simultaneous Converging Instrument Approaches (SCIA) because there are dependent approaches in DCIA and weather conditions will permit DCIA less often than SCIA.

9. Simultaneous Converging Instrument Approaches (SCIA) - Affects NE Flow

Simultaneous Converging Instrument Approach rules permit simultaneous ILS approaches to non-intersecting arrival runways. At EWR, candidate runway pairs would be Runways 11 and 4R using Flight Management System (FMS) equipped aircraft on the converging runway. The current minimums for testing this procedure are a 650 foot ceiling and 2 miles visibility. With some additional funding for research, the minimums could be reduced to match that of Runway 11: 600 foot ceiling and 2 miles visibility. In addition, the missed approach procedure for Runway 11 would need to be changed. Other missed approach procedures for other runways at other airports may also need to be changed. The NY Area Airspace would require major redesign for these changes in missed approach procedures. See DOT-FAA-AFS-450-74, Independent Converging FMS/LNAV Missed Approach Evaluation, Final Report dated June 1997.

Annual delay savings would be 6,530 hours or $14.4 million at the Baseline activity level; and 9,718 hours or $21.4 million at Future 1. This improvement was not simulated at Future 2.

10. Reduce Minimum In-Trail IFR Separations to 2.0 NM - Between Similar Class Non-Heavy Aircraft

The minimum in-trail separation under IFR for aircraft within the terminal area inside the outer marker is 2.5 NM when wake turbulence is not a factor. when wake turbulence is a factor (e.g., when a small aircraft trails a heavy jet), separations can be as high as 6.0 NM within the terminal area. This option would reduce minimum in-trail separations under IFR to 2.0 NM unless wake turbulence separation requirements dictate otherwise.

Reduced in-trail separations would increase arrival runway capacity because more aircraft would be able to land on a runway during any given time period. The capacity team noted, however, that if in-trail separations are reduced, it may be necessary to construct new high-speed exits and make more efficient use of existing high-speed exits so that runway occupancy times (ROTs) are reduced to a level that does not restrict departure flow and an excessive number of missed approaches do not occur.

This procedural improvement would permit reduced in-trail IFR separations of 2.0 NM for similar class Non-Heavy aircraft. Simulations utilized reduced occupancy times by assuming that aircraft would exit within 6,500 feet of the threshold. This technique eliminated the high occupancy times (>70 seconds for Heavies) associated with exit Y on 4R/L and exit N on 22R.

Annual delay savings would be 2,101 hours or $4.6 million at the Baseline activity level; and 4,995 hours or $10.9 million at Future 1. This improvement was not simulated at Future 2.

11. Immediate Divergent Turns for Turboprop/Prop Aircraft

This improvement would permit turboprops/props on the parallel runways to diverge, eliminating the existing prop/jet departure penalty. The departure-to-departure separation would become 1.0 minute instead of the current 1.6 minutes.

The NY Area Airspace would require major redesign for the type of procedures associated with Immediate Divergent Turns for Turboprop/Prop Aircraft. Extensive discussion, planning, public participation and environmental documentation would be required before this alternative could be considered as viable.

Annual delay savings would be 9,560 hours or $21.0 million at the Baseline activity level; 28,608 hours or $62.9 million at Future 1; and 78,840 hours or $173.4 million at Future 2.

User or Policy Improvements

12. Vertiport and Tiltrotor Aircraft

The analysis of this alternative involved a joint venture with NASA Ames to simulate the introduction of vertiport operations and civil tiltrotor aircraft at EWR. The alternative was simulated only at the Future 2 activity level, and with the following assumptions:

- There were no operations on Runway 11/29,
- All tiltrotor arrivals and departures used the Continental Express area,
- Vertiport rollway was approximately 500 feet long, permitting a rolling takeoff,
- Vertiport was located at parking lot "E", parallel to Runways 4L/22R and 4R/22L,
- All Large Commuter Air Carriers arrived and departed on the Vertiport runway using tilt rotors,
- Vertiport rollway was independent of all other runways,
- Vertiport had 170 arrivals and 170 departures per day, and
- Vertiport and parallels were simulated with existing departure procedures.

Annual delay savings would be 411,071 hours or $904.4 million at the Future 2 activity level. Even with this improvement, Future 2 would not be feasible because the average annual delay per operation would be 38.6 minutes.

13. More Uniform Distribution of Traffic within the Hour

A more uniform distribution of airline flights during peak periods would promote a more orderly flow of traffic, reduce arrival and departure delays, and reduce ground congestion near the terminal and on the taxiway system.

Future 1, VFR-1, was simulated with a more uniform distribution of traffic within the hour in the NE Flow. It effectively smoothed out the arrival and departure peaks within each hour. The numbers of arrivals and departures per hour remained the same as the Do Nothing case.

This improvement showed a nominal benefit – a net savings of 0.7 minutes per operation in Future 1, VFR-1. The average daily delay per operation still exceeded 30 minutes.

Therefore, this improvement will not make Future 1 levels of operations achievable and was not simulated in other weather conditions. Annual delay costs and savings were not computed.

14. 1996 Fleet Mix at Future Demands

The original forecasts for Future 1 showed a significant number of 727s were expected to be replaced with 757s. During the study, the Design Team observed that some 727s were being replaced by 737-800s instead of 757s.

To determine the sensitivity of fleet mix changes on Future 1 operations, the Design Team simulated VFR-1, with the 1996 fleet mix. This improvement provided a net savings of almost 4 minutes per operation. However, the average daily delay for all operations was approximately 30 minutes.

Therefore, this improvement will not make Future 1 levels of operations achievable and was not simulated in other weather conditions. Annual delay costs and savings were not computed.

Section 3 - Summary of Technical Studies

Overview

The Newark International Airport Design Team evaluated the efficiency of the existing airfield and the proposed future configurations. A brief description of the computer models and methodology used can be found in Appendix B. Certain standard inputs were used to reflect the operating environment at EWR. Details can be found in the technical appendices produced by the FAA's Technical Center during the study. The potential benefits of various improvements were determined by examining airfield capacity, airfield demand, and average aircraft delays, as described below.

Figure 8 shows airfield weather conditions and runway utilization used for simulation. Figure 9 depicts historical runway utilization and weather conditions. Figure 10 defines the aircraft classifications. Figure 11 shows the aircraft approach speeds used for simulation. Figure 12 shows the length of final common approach. Figure 13 depicts the daily fleet mix by aircraft class for the aircraft operating at EWR at each of the three demand levels.

Figure 14 illustrates the hourly profile of daily demand for the Baseline activity level. For comparison, it also includes a curve that depicts the profile of daily operations for the Future 1 and Future 2 activity levels.

Figure 15 illustrates the average-day, peak-month demand levels for EWR for each of the three annual activity levels used in the study. Figure 11 depicts the annual operations for each activity level by aircraft category.

The average direct aircraft operating cost for EWR is to be $2,200 per hour in 1997 hours. It represents the costs for operating the aircraft and includes fuel, maintenance, and crew costs, but does not consider lost passenger time, disruption to airline schedules, or other intangible factors.

Daily operations corresponding to an average busy day in the peak month were used for each of the forecast periods. The Airfield Delay Simulation Model (ADSIM) was used to determine aircraft delays. Delays were calculated for current and future conditions. Daily delays were annualized to measure the potential economic benefits of the proposed improvements. The annualized delays provided a basis for comparing the benefits of the proposed changes. The potential benefits associated with various runway use strategies were also identified. The potential cost of a particular improvement was measured against its annual delay savings. This comparison indicated which improvements would be the most effective.

For expected increases in demand, a combination of improvements could be implemented providing delay reduction during those periods.

Figure 8. Airfield Weather Conditions and Runway Utilization - Simulated

		VFR-1	VFR-2	IFR-1a	≤IFR-1b	
	Ceiling Minimum	3,500 feet	1,000 feet	600 feet	200 feet	
	Visibility Minimum	5 miles	3 miles	2 miles	3/8 miles	Total
4, 11, 29	With Normal Use of 11	31.3%	6.8%	2.4%	2.4%	42.9%
	NE Flow Subtotal	31.3%	6.8%	2.4%	2.4%	42.9%
22, 11, 29	With Normal Use of 11	22.1%	4.5%	1.8%	1.7%	30.1%
22, 11, 29	With Restricted Use of 11 15 NM In-Trail for All ARR on 11 Half the Number of ARR to 11	24.1%	–	–	–	24.1%
22, 29	Without Use of 11 Arrive Only on 22L	–	2.9%	–	–	2.9%
	SW Flow Subtotal	46.2%	7.4%	1.8%	1.7%	57.1%
	Total	77.5%	14.2%	4.2%	4.1%	100.0%

Note: The table above represents the way the weather categories and configurations were simulated and shows how delays were annualized.

CAT I ILS: Runway 11: Minima are 604 feet and 2 miles. Currently, there are no arrivals on 11 in IFR-1a.
CAT I ILS: Runways 4s and 22s: Minima are 200 feet and 3/8 mile.
CAT II ILS: Runway 4R: Minima are 162 feet and 1,600 feet RVR.

Figure 9. Airfield Weather Conditions and Runway Utilization - Historical

		VFR-1	VFR-2	IFR-1a	≤IFR-1b	
	Ceiling Minimum	3,500 feet	1,000 feet	600 feet	200 feet	
	Visibility Minimum	5 miles	3 miles	2 miles	3/8 miles	Total
4, 11, 29	Winds Permit LAHSOs on 11	16.5%	5.8%	2.2%	2.3%	26.8%
4, 11, 29	Winds Prevent LAHSOs on 11	8.4%	0.6%	0.1%	–	9.1%
4, 29	Winds Prevent Use of 11	5.3%	0.2%	–	–	5.5%
	NE Flow Subtotal	30.2%	6.6%	2.3%	2.3%	41.4%
22, 11, 29	Winds Permit LAHSOs on 11	21.3%	4.3%	1.2%	1.3%	28.1%
22, 11, 29	Winds Prevent LAHSOs on 11	15.1%	2.0%	0.4%	0.3%	17.8%
22, 29	Winds Prevent Use of 11	8.1%	0.8%	0.1%	0.1%	9.1%
	SW Flow Subtotal	44.5%	7.1%	1.7%	1.7%	55.0%
4 only or 22 only		1.9%	0.4%	0.1%	0.2%	2.6%
11 only or 29 only		0.9%	0.1%	–	–	1.0%
	Total	77.5%	14.2%	4.1%	4.2%	100.0%

Note: The table above represents the existing daytime runway use by weather category based on 12 years data.

Source of weather categories, minimums, and percent occurrence: Based on EWR Study, 1995. The percentages were developed by Leigh Fisher Associates (LFA) for the 1995 Study. LFA tabulated the hourly weather data for January 1, 1981, through December 31, 1993, from the National Climatic Data Center, Asheville, North Carolina. The tabulations reflect percent of occurrence during daytime hours, 6am to 11pm.

CAT I ILS: Runway 11: Minima are 604 feet and 2 miles. Currently, there are no arrivals on 11 in IFR-1a.
CAT I ILS: Runways 4s and 22s: Minima are 200 feet and 3/8 mile.
CAT II ILS: Runway 4R: Minima are 162 feet and 1,600 feet RVR.

Figure 10. Aircraft Classifications

S	Small	Small, single or twin engine aircraft weighing 12,500 pounds or less (e.g., BE58, BE90, C340, C441, AC21, BE20, C210, DO27)
M	Small Commuter	Small commuter aircraft (includes business jets) weighing more than 12,500 pounds and and up to 41,000 pounds (e.g., BA31, BE02, E120, LR31, LR36)
LC	Large Commuter	Large commuter aircraft (includes small regional jets) weighing more than 41,000 pounds and up to 255,000 pounds (e.g., ATR-42*, DH8, DH7, E145, CRJ, BA41*, SF34*)
LJ	Large Jet	Large jet aircraft weighing more than 41,000 pounds and up to 255,000 pounds (e.g., DC9, B737, B727, MD80)
757	B757	Boeing 757 Only
H	Heavy	Heavy Aircraft weighing more than 255,000 pounds (e.g., L1011, DC10, B747, B767, DC8S, A300)

* The aircraft ATR-42, BA41, and SF34 are exempt from the small category and are classified as large aircraft for separation purposes.

Figure 11. Aircraft Approach Speeds*

Aircraft Class	VFR/IFR (Knots)
Small (S)	140
Medium (M)	140
Large Commuter (LC)	140
Large Jet (LJ)	140
B757	135
Heavy (H)	145

* EWR 1997 observed ground speeds along the common approach

Figure 12. Length of Final Common Approach (NM)

Class	S	M	LC	LJ	B757	H
VFR	5	5	5	5	5	5
IFR	5	5	5	5	5	5

Figure 13. Aircraft Daily Fleet Mix by Aircraft Class

Aircraft Class	Baseline (454,000)	Future 1 (500,000)	Future 2 (550,000)
Small (S)	20 (1.4%)	20 (1.3%)	20 (1.1%)
Medium (M)	114 (7.9%)	119 (7.5%)	127 (7.2%)
Large Commuter (LC)	304 (20.9%)	336 (21.0%)	370 (21.1%)
Large Jet (LJ)	772 (53.2%)	584 (36.6%)	644 (36.7%)
B757	118 (8.1%)	284 (17.8%)	314 (17.9%)
Heavy (H)	124 (8.5%)	254 (15.9%)	282 (16.1%)
Total Daily Number of Operations	1,452	1,597	1,757

Figure 14. Profile of Daily Demand - Hourly Distribution

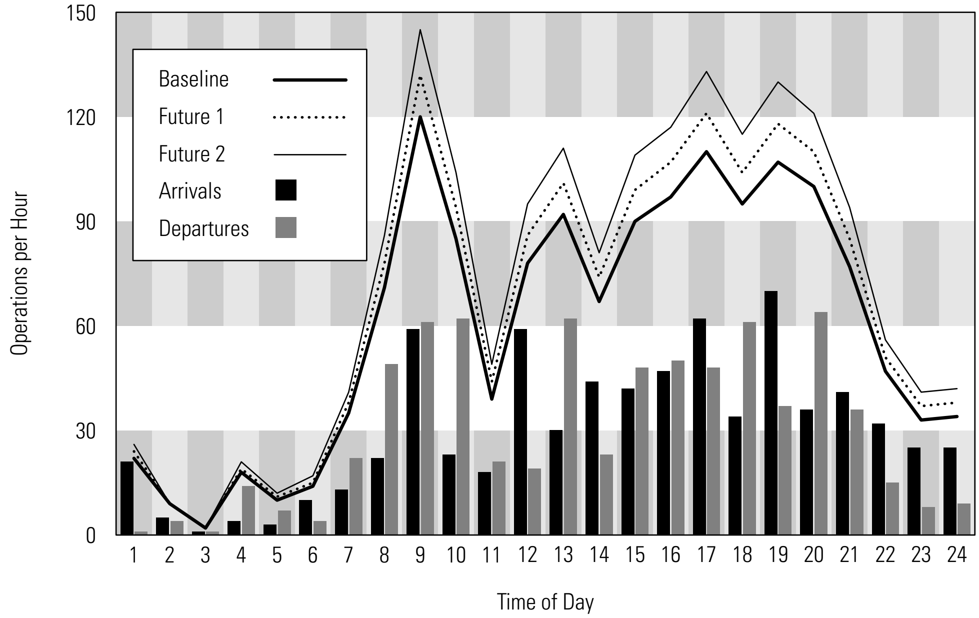
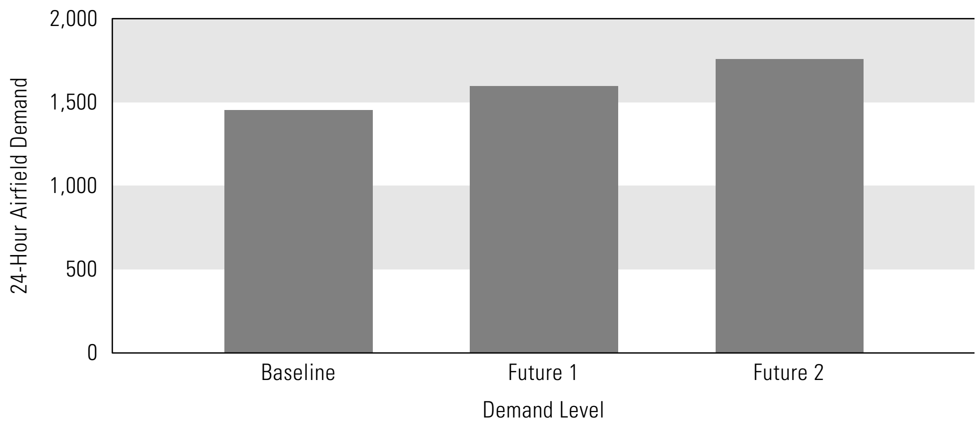


Figure 15. Daily Airfield Demand Levels



	Annual Operations	24-Hour Day (Average Busy Day, Peak Month)	Equivalent Days
Baseline	454,000	1,452	313
Future 1	500,000	1,597	313
Future 2	550,000	1,757	313

Note: Baseline, Future 1, and Future 2. The number of equivalent days is determined by dividing the number of annual operations by the number of daily operations. To capture the costs associated with flights that are cancelled, when the weather deteriorates and delays increase, the Design Team simulated a full schedule in IFR, as well as in VFR. The arrival demand consistently exceeds the IFR capacity throughout the day.

Airfield Capacity

The EWR Design Team defined airfield capacity to be the maximum number of aircraft operations (landings or takeoffs) that can take place in a given time. The following conditions were considered:

- Airspace constraints.
- Ceiling and visibility conditions.
- Runway layout and use.
- Aircraft mix.
- Percent arrival demand.

Aircraft Delays

Aircraft delay is defined as the time above the unimpeded travel time for an aircraft to move from its origin to its destination. Aircraft delay results from interference from other aircraft competing for the use of the same facilities.

The major factors influencing aircraft delays are:

- Ceiling and visibility conditions.
- Airfield and ATC system demand.
- Airfield physical characteristics.
- Air traffic control procedures.
- Aircraft operational characteristics.
- Demand characteristics and fleet mix.

Average delay in minutes per operation was generated by the Airport and Airfield Delay Simulation Model (ADSIM). A description of this model is included in Appendix B.

Conclusions

Figure 16 demonstrates the impact of delays at EWR. The chart shows how delay will continue to grow at a substantial rate as demand increases if there are no improvements made in airfield capacity, i.e., the Do Nothing case.

Figure 17 illustrates the delay per operation, or average delays for the various demand levels. The levels of average delay shown for the Do Nothing case at future activity levels, are probably too large for a viable operation. In other words, the delays and cancellations associated with these levels of operations at the existing airport, probably would not be acceptable for a hub operation, preventing the airlines from scheduling to such levels.

This conclusion suggests that in the near term future, unless passenger services are provided at other regional airports, or by other modes of transportation, planning for improving the capacity of EWR should be undertaken now to select the best choices for the airport and its communities.

Figure 16. Annual Delay Costs (In Hours and Dollars)

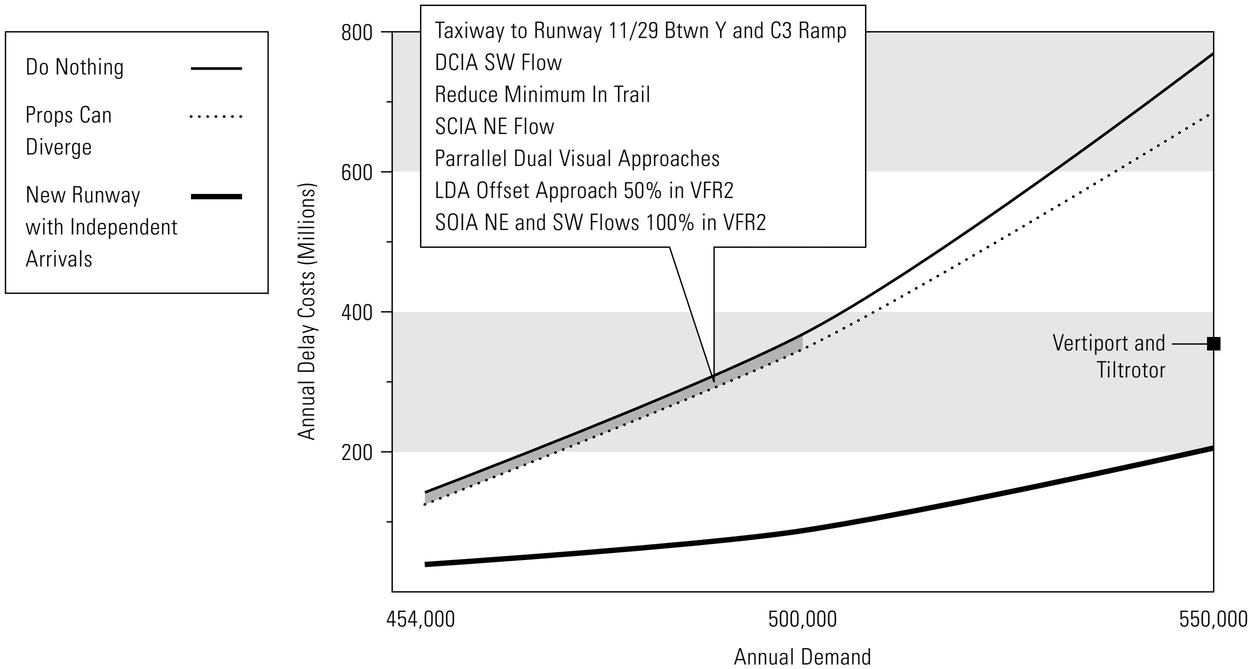
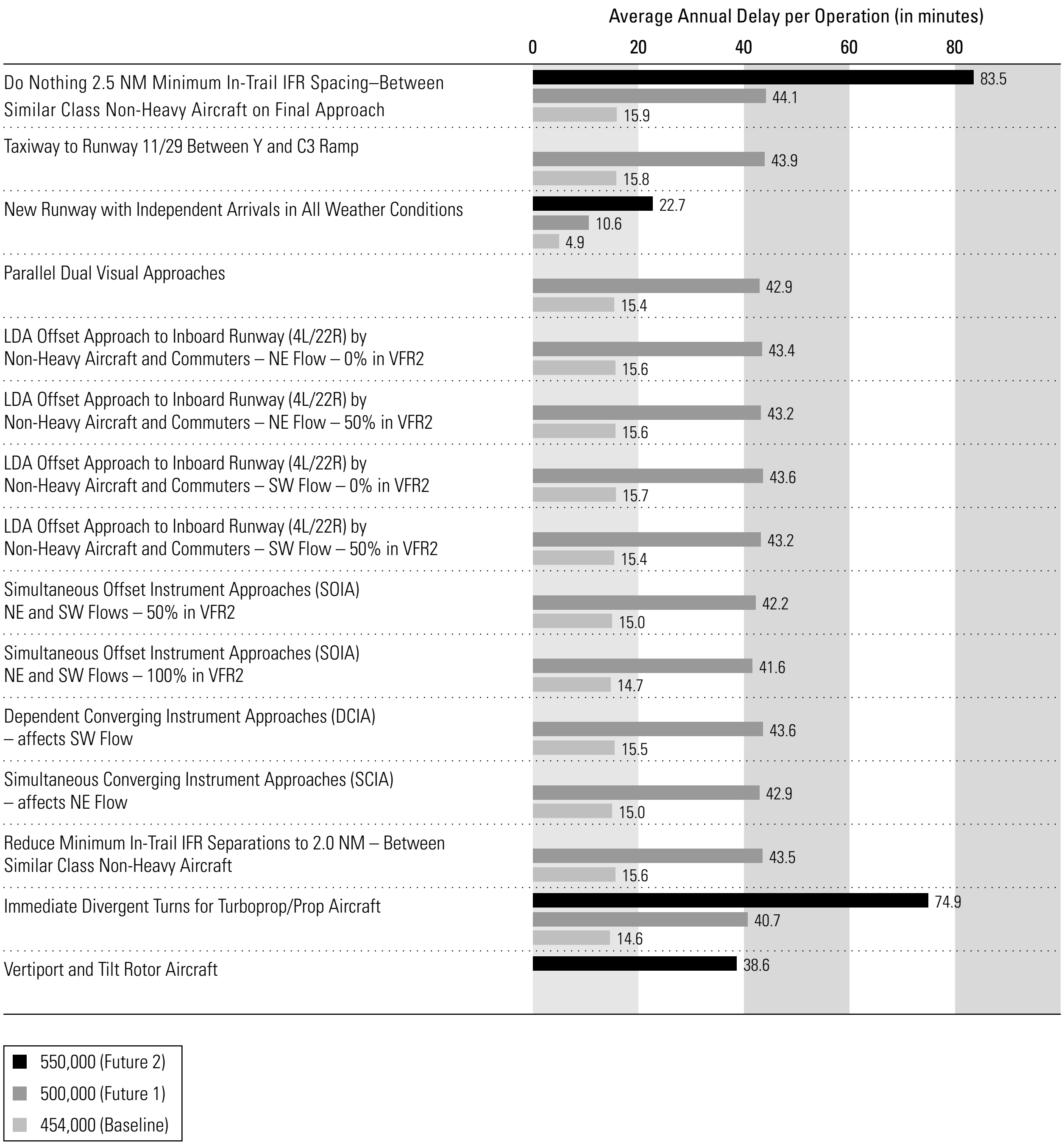


Figure 17. Average Delay per Operation



Since all the initiatives modeled show a delay reduction, it is recommended that each be studied further to determine whether or not the Alternative should or can be undertaken. Planning for improvements in a complex environment such as Newark is by nature an iterative process requiring successive cycles of evaluation, proof of concept, comparison to costs and resources required, etc. The following initiatives should move on to the next steps in this planning process.

Based on the analysis completed during the study, the Design Team identified the following potential capacity enhancement or delay reduction alternatives.

Alternatives	Future 1 Annual Delay Savings ($M)
Divergent Turns for Turboprop/Prop Aircraft	$62.9
Simultaneous Offset Instrument Approaches (SOIA) (100%)	$45.7
Localizer Directional Aid (LDA) Equipment (50%)	$34.3
Parallel Dual Visual Approaches	$22.9
Simultaneous Converging Instrument Approaches (SCIA)	$21.4
Dependent Converging Instrument Approaches (DCIA)	$8.5
New Runway with Independent Arrivals in All Weather Conditions	$613.5

Alternatives	Future 2 Annual Delay Savings ($M)
Divergent Turns for Turboprop/Prop Aircraft	$173.4
Vertiport and Tiltrotor Aircraft	$904.4
New Runway with Independent Arrivals in All Weather Conditions	$1,225.9

Appendix A - Participants

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Teterboro Airport

John Panarello

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ATA

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David Seavey

Delta

Bill Maloney

Federal Express

Bill Sanvidge | Steve Vail

United Parcel Service

Bill Schocke

Teterboro Users Group

Bill Mack | Rich Taub

Appendix B - Computer Model and Methodology

The Newark Design Team studied the effects of various improvements proposed to reduce delay and enhance capacity. The options were evaluated considering the anticipated increase in demand. The analysis was performed using computer-modeling techniques. A brief description of the model and the methodology employed follows.

Computer Model Airfield Delay Simulation Model (ADSIM)

The Airfield Delay Simulation Model (ADSIM) is a fast-time, discrete event model, which employs stochastic processes and Monte Carlo sampling techniques. It describes significant movements of aircraft on the airport and the effects of delay in the adjacent airspace. The model was validated in 1978 at Chicago O'Hare International Airport against actual flow rates and delay data. It was calibrated for this study against field data collected at EWR to insure that the model was site specific.

Inputs for the simulation model were derived from empirical field data. The model repeated each experiment 10 times using Monte Carlo sampling techniques to introduce system variability, which occurs on a daily basis in actual airport operations The results were averaged to produce output statistics. Total and hourly aircraft delay, travel times, and flow rates for the airport and for individual runways were calculated.

Methodology

Model simulations included present and future air traffic control procedures, various airfield improvements, and traffic demands for different times. To assess the benefits of proposed airfield improvements, different airfield configurations were derived from present and projected airport layouts. The projected implementation time for air traffic control procedures and system improvements determined the aircraft separations used for IFR and VFR weather simulations.

For the delay analysis, agency specialists developed traffic demands based on the Official Airline Guide, C.A.T.E.R. data, historical data, and various forecasts. Aircraft volume, mix and peaking characteristics were developed for three demand periods: Baseline, Future 1, and Future 2. The estimated annual delays for the proposed improvement options were calculated from the experimental results. These estimates took into account the yearly variations in runway configurations, weather, and demand based on historical data.

The potential delay reductions for each improvement were assessed by comparing the annual delay estimates with the Do Nothing.

Appendix C - List of Abbreviations

ADSIM	Airfield Delay Simulation Model
ARTCC	Air Route Traffic Control Center
ASC	Office of System Capacity (FAA)
ATC	Air Traffic Control
ATCT	Airport Traffic Control Tower
CAT	Category - of instrument landing system
C.A.T.E.R.	Collection and Analysis of Terminal Records
DCIA	Dependent Converging Instrument Approaches
EWR	Newark International Airport
FAA	Federal Aviation Administration
GA	General Aviation
GPS	Global Positioning System
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
LAHSO	Land and Hold Short
LBS	Pounds
LDA	Localizer Directional Aid
NE	Northeast
NM	Nautical Miles
PRM	Precision Runway Monitor
ROT	Runway Occupancy Time
RVR	Runway Visual Range
SCIA	Simultaneous Converging Instrument Approaches
SM	Statute Miles
SMGCS	Surface Movement Guidance and Control System
SOIA	Simultaneous Offset Instrument Approaches
SW	Southwest
TRACON	Terminal Radar Approach Control
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions

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