Eastern Virginia
Airport Capacity Enhancement Plan

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Richmond International Airport
Norfolk International Airport
Newport News/Williamsburg
International Airport

May 1994

Prepared jointly by the U.S. Department of Transportation, Federal Aviation Administration, the State of Virginia, Department of Aviation, the Capital Region Airport Commission, the Norfolk Airport Authority, the Peninsula Airport Commission, and the airlines and general aviation operators serving the Eastern Virginia Region.

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Summary

Recognizing the problems posed by congestion and delay within the National Airspace System, the Federal Aviation Administration (FAA), airport operators, and aviation industry groups initiated joint Airport Capacity Design Teams at various major air carrier airports throughout the United States. Each Capacity Team identifies and evaluates alternative means to enhance existing airport and airspace capacity to handle future demand, decrease delays, and improve airport efficiency, and works to develop a coordinated action plan for reducing airport delay. Over 35 Airport Capacity Design Teams have either completed their studies or have work in progress.

The Eastern Virginia (EVA) Region represents a land area of about 6,840 square miles with a 1991 population of about 2.8 million persons. Projected growth within this area will result in increased demand for improved and expanded aviation services. The region is currently served by three air carrier airports: Richmond International Airport, Norfolk International Airport, and Newport News/Williamsburg International Airport.

Richmond International Airport (RIC) handled 973,887 revenue passenger enplanements and 52,331 tons of cargo in 1992. In 1992, the airport handled 148,720 aircraft operations (takeoffs and landings).

Norfolk International Airport (ORF) handled 1,261,644 revenue passenger enplanements in 1992. In 1992, the airport handled 136,876 aircraft operations.

Newport News/Williamsburg International Airport (PHF) handled 160,838 revenue passenger enplanements in 1992. In 1992, the airport handled 174,708 aircraft operations.

Three Planning District Commissions in the EVA Region, the Hampton Roads, Crater, and Richmond Regional Planning District Commissions, have cosponsored a study intended to develop an Eastern Virginia Airport System Plan with a forty-year planning horizon to the year 2030. The intent of the system plan is to investigate the requirement for a regional system of air carrier, reliever, and general aviation airport facilities designed to meet the aviation needs of the EVA Region through the forty-year planning period. The system plan will also address the development of a new air carrier airport, if the combined incrementally improved facilities of the three existing airports cannot meet these needs, or if a new airport would be necessary to accommodate hubbing or international gateway development. The forty-year forecasts developed as a part of the Eastern Virginia Airport System Plan will be provided to Richmond, Norfolk, and Newport News/Williamsburg International Airports for their master planning efforts.

According to an Eastern Virginia Air Service Demand Study prepared in 1991, the EVA Region has the origin and destination market potential to support a major airline connecting hub when viewed as a single market area. The Eastern Virginia Air Service Demand Study also states that EVA's mid-coastal location is suitable for a north/south domestic hub, and, if established, for an international gateway to European, Canadian, Caribbean, and Latin American markets.

The EVA Region could continue to be served by the three existing airports. This will require incremental improvements at each airport to meet steadily increasing demands. In order to provide the airport facilities necessary to support an airline hub in the future or to become an international gateway, any one of the three existing airports may be expanded, or a new site may be selected for the construction of a large domestic/international air carrier airport to provide an international gateway.

An Airport Capacity Design Team for Eastern Virginia was formed in 1992. The EVA Capacity Team identified and assessed various actions which, if implemented, would increase capacity and improve operational efficiency in response to future demand at RIC, ORF, and PHF. 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 environmental, socioeconomic, or political issues associated with these actions.

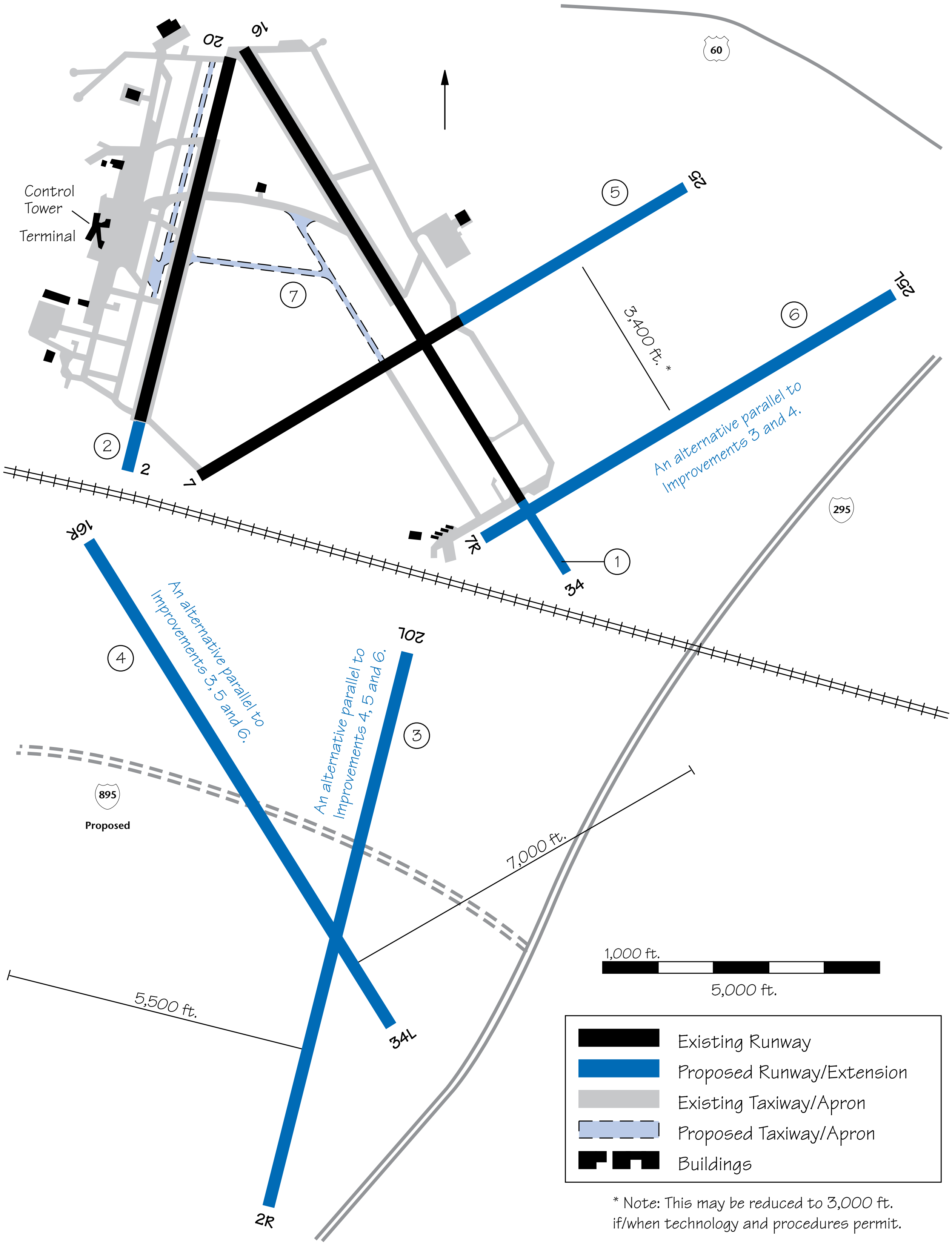
Selected alternatives identified by the Capacity Team were tested using a computer model developed by the FAA to quantify the benefits provided. Different levels of activity were chosen to represent potential growth in aircraft operations in order to compare the merits of each action. These annual activity levels are referred to throughout this report as:

- Baseline—160,000 operations,
- Future 1—290,000 operations,
- Future 2—430,000 operations.

The Future 2 activity level represents a domestic "connecting hub" airport. The Capacity Team did not study the operation of an international gateway airport.

A brief summary follows for each of the airports, Richmond, Norfolk, and Newport News/Williamsburg, including an airport layout, a listing of improvement options considered by the Capacity Team, and a synopsis of findings from the technical analysis. More detailed discussions can be found in Section 2, Capacity Enhancement Alternatives, Section 3, Summary of Technical Studies, and Section 4, Summary of Results.

Figure 1. Richmond International Airport



* Note: This may be reduced to 3,000 ft. if/when technology and procedures permit.

Figure 2. Capacity Enhancement Alternatives and Annual Delay Savings Richmond International Airport

Airfield Improvements

1. Extend Runway 16/34 1,450 feet to southeast to total 10,450 feet long
2. Extend Runway 2/20 1,000 feet to south to total 7,600 feet long
3. Build 10,500 foot Runway 2R/20L 5,500 feet east and 2,600 feet south of extended Runway 2/20
4. Build 10,500 foot Runway 16R/34L 7,000 feet west of Runway 16/34
5. Reconstruct Runway 7/25 to total 10,000 feet long and 150 feet wide
6. Build 8,000 foot Runway 7R/25L 3,400 feet south of Runway 7/25 (includes PRM)
7. Improve exits and associated taxiways

Facilities and Equipment Improvements

8. Install HIRL on Runway 2
9. Install MALSR on Runway 2
10. Install centerline lights on Runway 2/20
11. Install touchdown and rollout RVRs on Runway 2
12. Install CAT II/IIIa ILS on both ends of all air carrier runways

Operational Improvements

13. Dependent Converging Instrument Approaches (DCIA) on Runways 2 and 34 with Converging Runway Display Aid (CRDA)
14. Simultaneous Converging Instrument Approaches (SCIA)
15. Reduce in-trail separations to 2.5 nm between similar class aircraft

Improvement Packages*	Estimated Annual Delay Savings (in hours and millions of 1992 dollars) Baseline 160,000	Future 1 290,000	Future 2 430,000
A. Improve exits and taxiways to allow full use of Runway 34 for arrivals	†	†	754/$1.0
B. Extend three existing runways (5) Reconstruct Rwy 7/25 to total 10,000 x 150 ft. (1) Extend Runway 16/34 to 10,450 ft. (2) Extend Runway 2/20 to 7,600 ft. (7) Improve exits and associated taxiways	†	1,616/$2.1	46,600/$61.9
C. Build Runway 2R/20L and extend Runways 16/34 & 2/20 (3) Build 10,500 ft. Runway 2R/20L (1) Extend Runway 16/34 to 10,450 ft. (2) Extend Runway 2/20 to 7,600 ft. (7) Improve exits and associated taxiways	†	2,254/$2.9**	119,924/$159.3
D. Build Runway 7R/25L and extend three existing runways (6) Build 8,000 ft. Runway 7R/25L (5) Reconstruct Rwy 7/25 to total 10,000 x 150 ft. (1) Extend Runway 16/34 to 10,450 ft. (2) Extend Runway 2/20 to 7,600 ft. (7) Improve exits and associated taxiways	†	2,254/$2.9**	124,415/$165.2
E. Build Runway 16R/34L and extend Runways 16/34 & 2/20 (4) Build 10,500 ft. Runway 16R/34L (1) Extend Runway 16/34 to 10,450 ft. (2) Extend Runway 2/20 to 7,600 ft. (7) Improve exits and associated taxiways	†	2,254/$2.9**	124,899/$165.9

* Not all of the improvement alternatives were simulated. There is a description of each improvement alternative in Section 2, Capacity Enhancement Alternatives.

** Estimated annual delay savings for a parallel runway at Future 1.

† Improvement packages were not simulated at these activity levels.

Figure 3 shows the capacity and delay curves for the current airfield configuration at RIC under instrument flight rules (IFR) and visual flight rules (VFR). It shows that, under IFR, aircraft delays can begin to escalate rapidly as hourly demand exceeds 54 operations per hour.

Figure 4 illustrates that, while hourly demand does not exceed 54 operations at Baseline demand levels, 54 operations per hour is frequently exceeded at the demand levels forecast for Future 1 and Future 2.

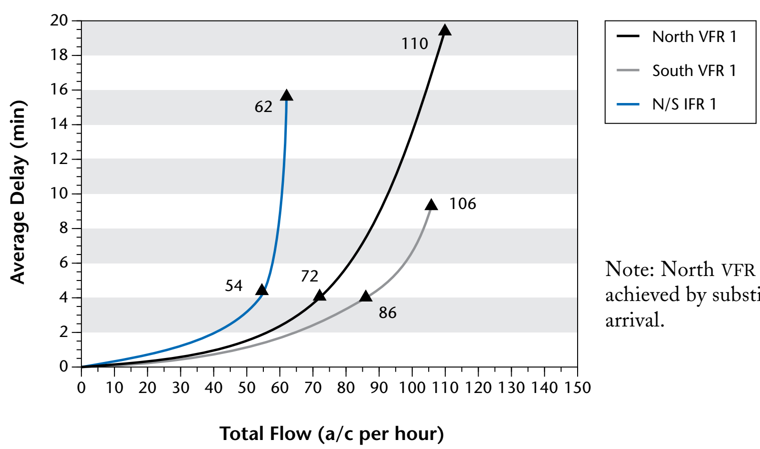
Figure 5 depicts how delay will continue to grow at a substantial rate as demand increases if no improvements are made in capacity, i.e., the Do Nothing scenario. Annual delay costs will increase from 957 hours or $0.9 million at Baseline to 7,192 hours or $9.4 million by Future 1 and 148,414 hours or $197.1 million by Future 2.

Figure 5 also shows the delay-savings benefits from the improvement alternatives studied by the Capacity Team:

- Improve exits and taxiways to allow full use of Runway 34 for arrivals.
- Extend three existing runways and improve exits and taxiways.
- Build Runway 2R/20L; extend Runways 16/34 and 2/20; and improve exits and taxiways.
- Build Runway 7R/25L; extend Runways 7/25, 16/34, and 2/20; and improve exits and taxiways.
- Build Runway 16R/34L; extend Runways 16/34 and 2/20; and improve exits and taxiways.

Figure 6 shows the average delay in minutes per aircraft operation for these same alternatives. Under the Do Nothing alternative, the average delay per operation of 0.4 minutes at Baseline will increase to 1.5 minutes by Future 1 and 20.7 minutes by Future 2.

Figure 3 Airport Capacity Curves—Hourly Flow Rate Versus Average Delay



Note: North VFR 1 curve shows capacity achieved by substituting a departure for an arrival.

Figure 4. Profile of Daily Demand—Hourly Distribution

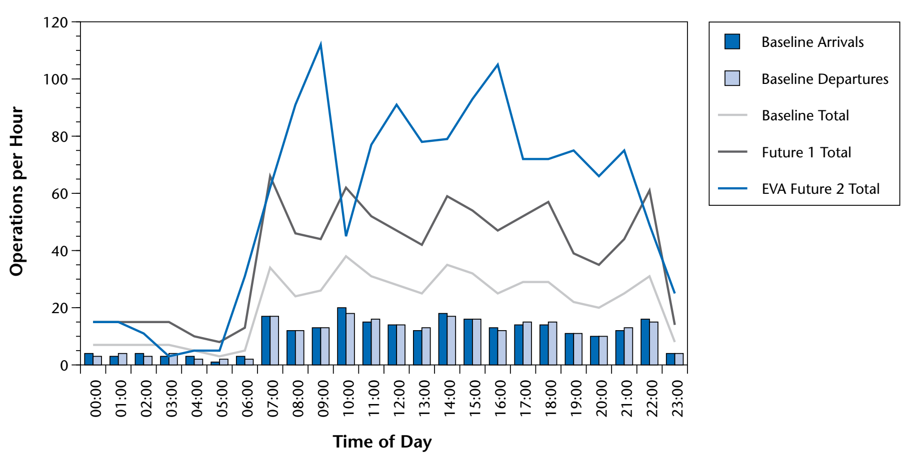


Figure 5. Airport Delay Costs—Capacity Enhancement Alternatives

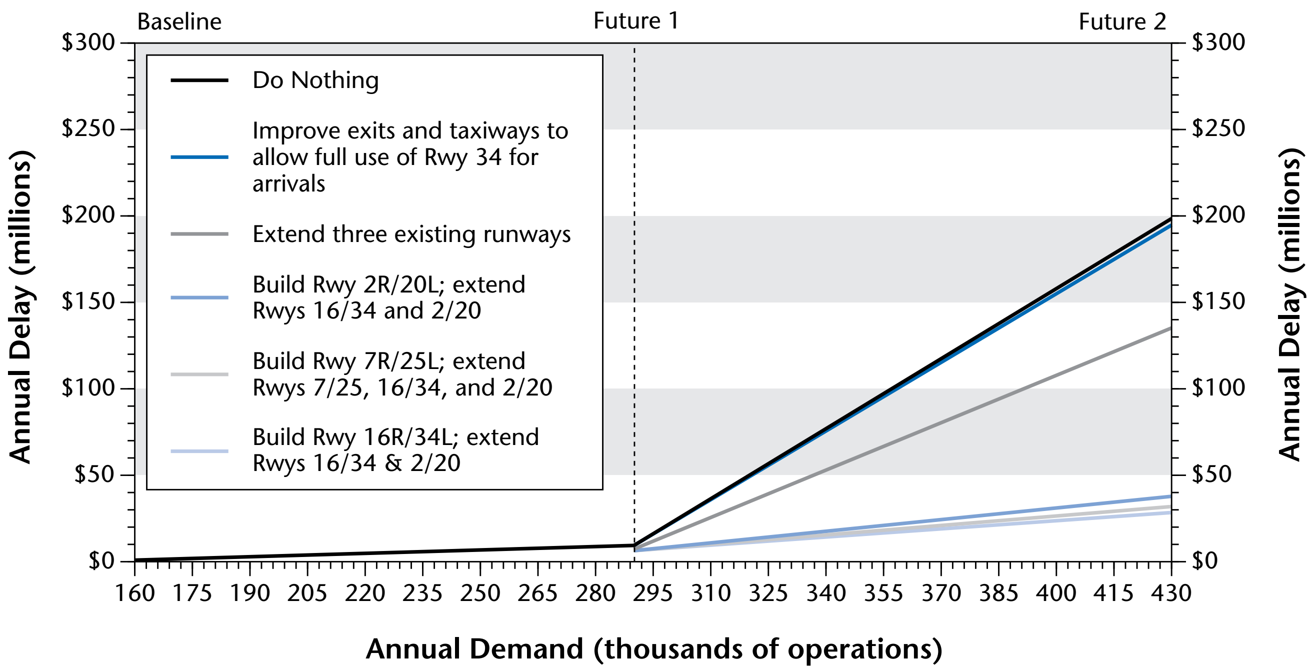
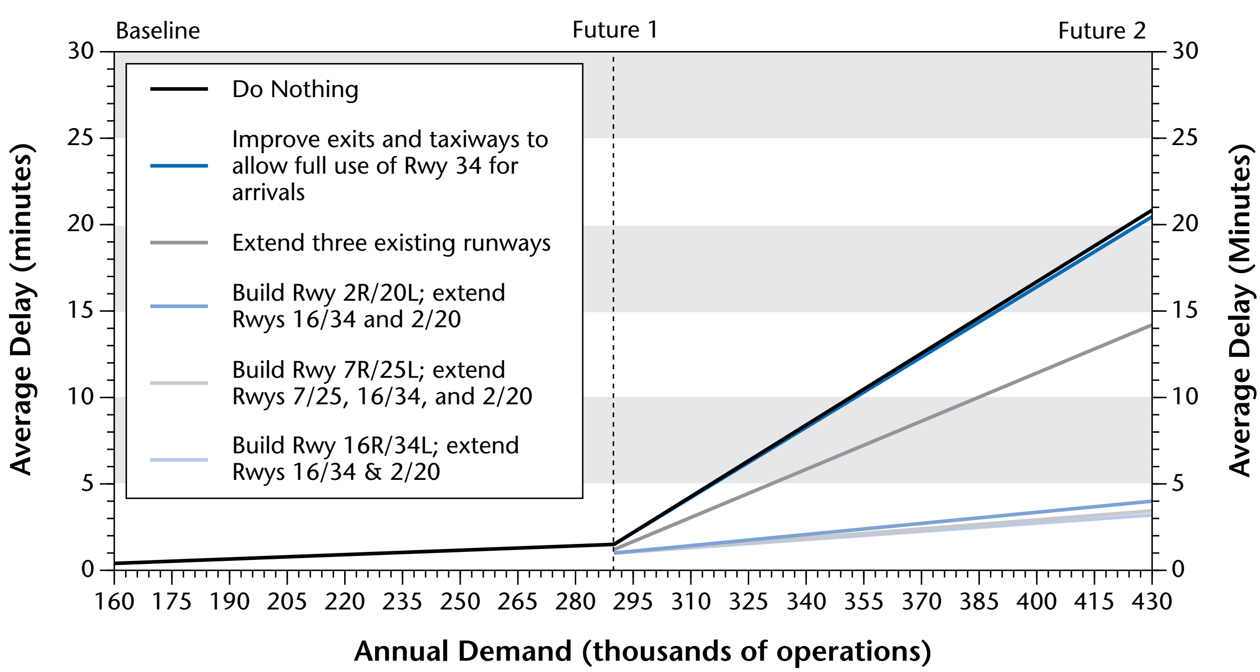


Figure 6. Average Delays—Capacity Enhancement Alternatives



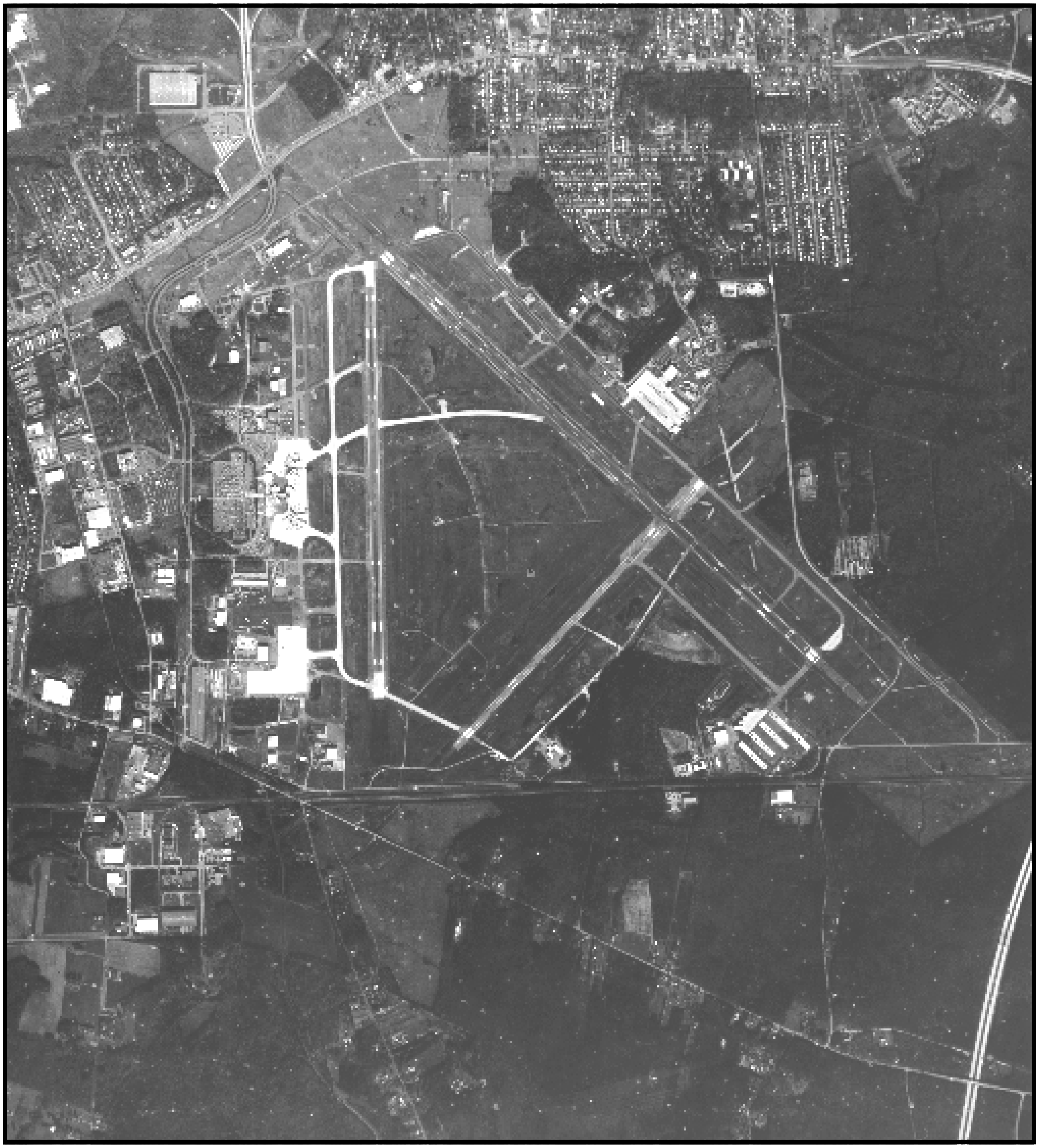


Figure 7. Norfolk International Airport

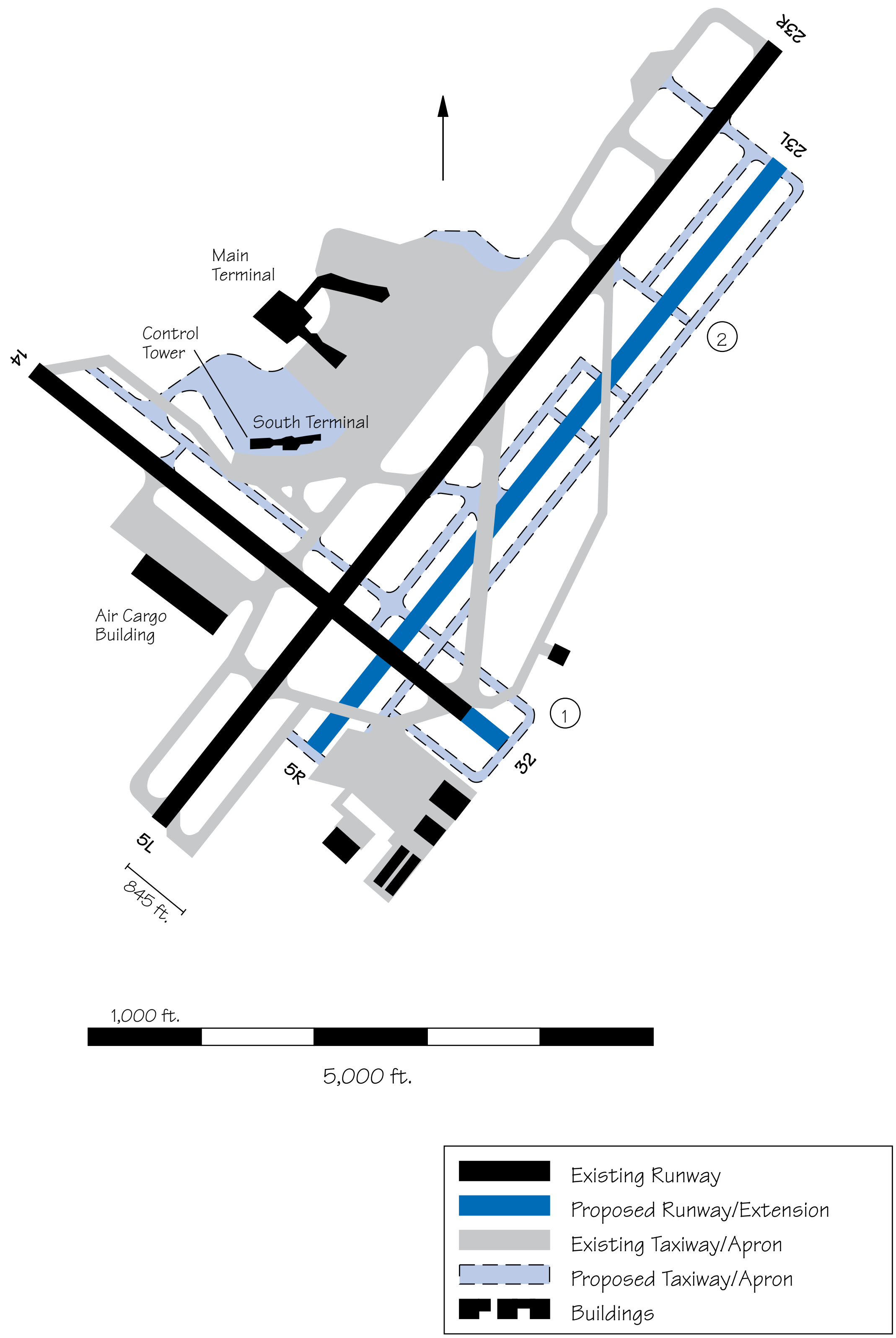


Figure 8. Capacity Enhancement Alternatives and Annual Delay Savings Norfolk International Airport

Airfield Improvements

1. Extend Runway 14/32 824 feet to southeast to 5,700 feet long
2. Build 7,000 foot Runway 5R/23L 845 feet south of Runway 5/23

Facilities and Equipment Improvements

3. Install CAT II/IIIa ILS on Runway 5
4. Install ALSF-2 and inner marker on Runway 5
5. Install midpoint and rollout RVRs on Runway 5
6. Install centerline and touchdown zone lights on Runway 5

Operational Improvements

7. Reduce in-trail separations to 2.5 nm between similar class aircraft

	Estimated Annual Delay Savings (in hours and millions of 1992 dollars)		
Improvement Packages*	**Baseline 160,000**	**Future 1 290,000**	**Future 2 430,000**
A. Extend Runway 14/32	†	346/$0.4	3,072/$4.1
(1) Extend Runway 14/32 to 5,700 ft.			
B. Build Runway 5R/23L and use 2.5 nm spacing	†	3,319/$3.7	57,286/$76.1
(2) Build 7,000 ft. Runway 5R/23L			
(7) Reduce in-trail separations to 2.5 nm			
B+A. Build 5R/23L, extend 14/32, and use 2.5 nm spacing	†	3,215/$3.6	56,624/$75.2
(2) Build 7,000 ft. Runway 5R/23L			
(1) Extend Runway 14/32 to 5,700 ft.			
(7) Reduce in-trail separations to 2.5 nm			

* Not all improvement alternatives were simulated. There is a description of each improvement alternative in Section, Capacity Enhancement Alternatives.

† Improvement packages were not simulated at these activity levels.

Figure 9 shows the capacity and delay curves for the current airfield configurations at ORF under IFR and VFR. It shows that, under IFR, aircraft delays can begin to escalate rapidly as hourly demand exceeds 54 operations per hour.

Figure 10 illustrates that, while hourly demand does not exceed 54 operations at Baseline demand levels, 54 operations per hour is frequently exceeded at the demand levels forecast for Future 1 and Future 2.

Figure 11 depicts how delay will continue to grow at a substantial rate as demand increases if no improvements are made in capacity, i.e., the Do Nothing scenario. Annual delay costs will increase from 1,082 hours or $0.8 million at Baseline to 9,846 hours or $11.0 million by Future 1 and 140,040 hours or $186.0 million by Future 2.

Figure 11 also shows the delay-savings benefits from the improvement alternatives studied by the Capacity Team:

- Extend Runway 14/32 to 5,700 ft.
- Build Runway 5R/23L and use 2.5 nm spacing.
- Build Runway 5R/23L; extend Runway 14/32 to 5,700 ft.; and use 2.5 nm spacing.

Figure 12 shows the average delay in minutes per aircraft operation for these same alternatives. Under the Do Nothing alternative, the average delay per operation of 0.4 minutes at Baseline will increase to 2.0 minutes by Future 1 and 19.5 minutes by Future 2.

Figure 9. Airport Capacity Curves—Hourly Flow Rate Versus Average Delay

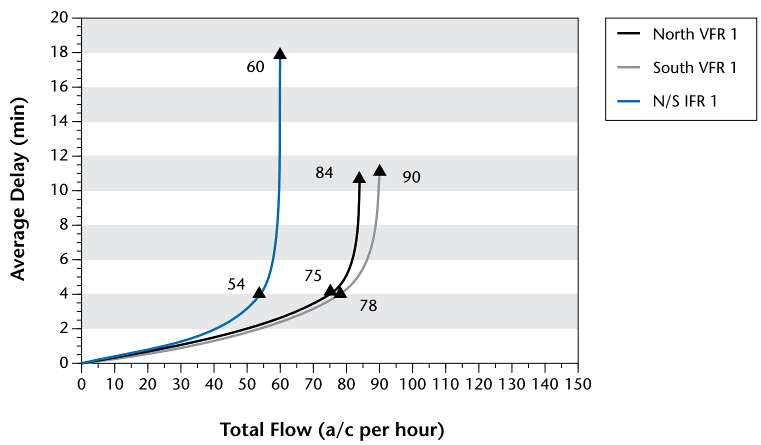


Figure 10. Profile of Daily Demand—Hourly Distribution

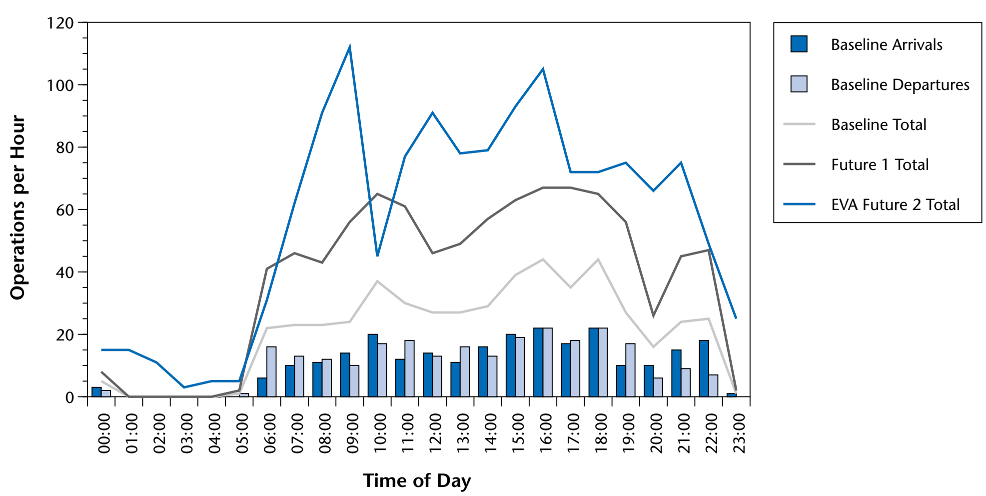


Figure 11. Airport Delay Costs—Capacity Enhancement Alternatives

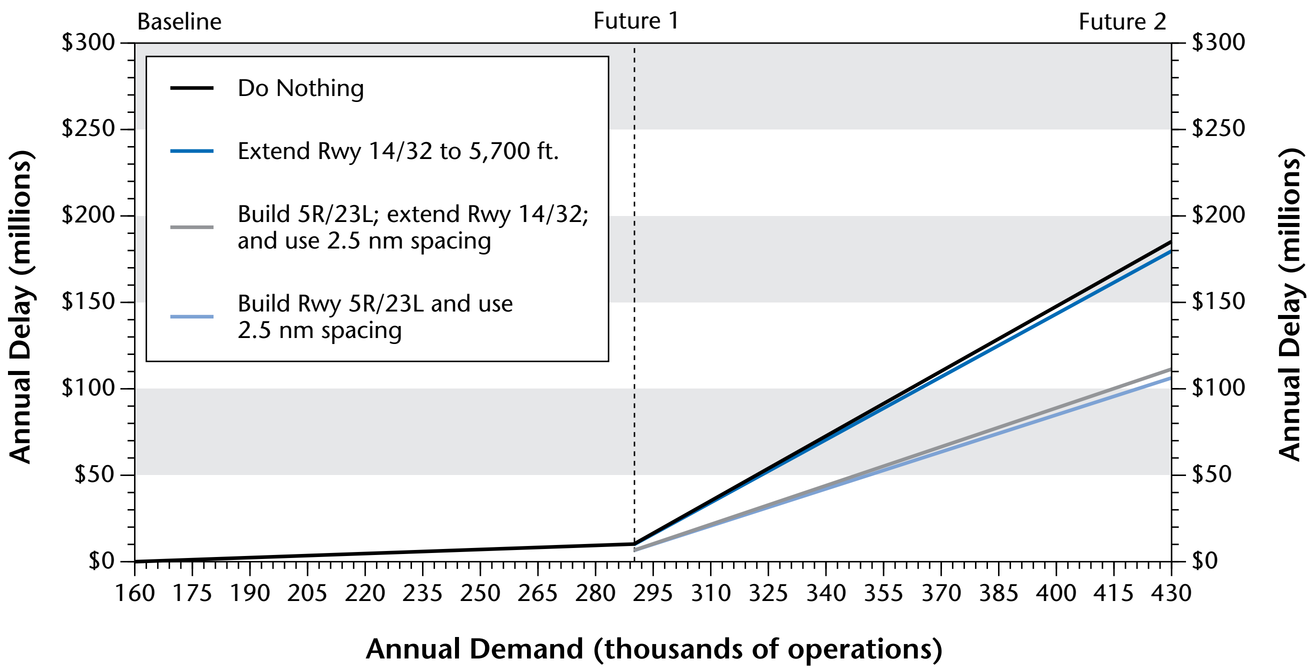


Figure 12. Average Delays—Capacity Enhancement Alternatives

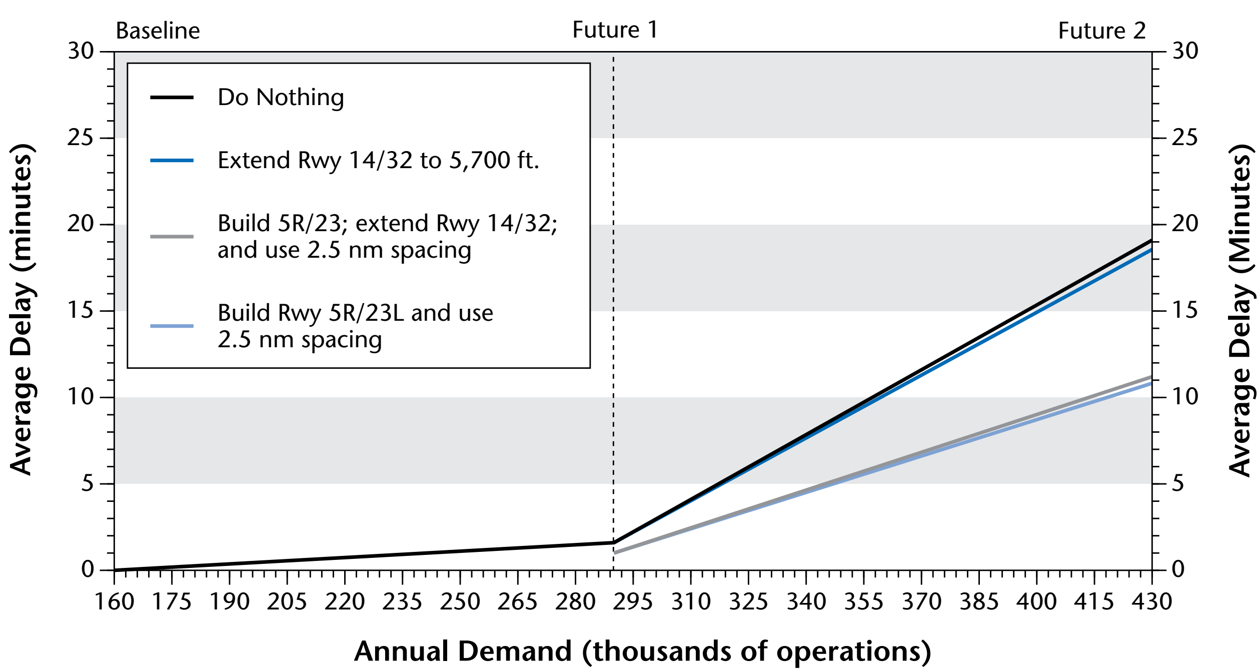


Figure 13. Newport News/Williamsburg International Airport

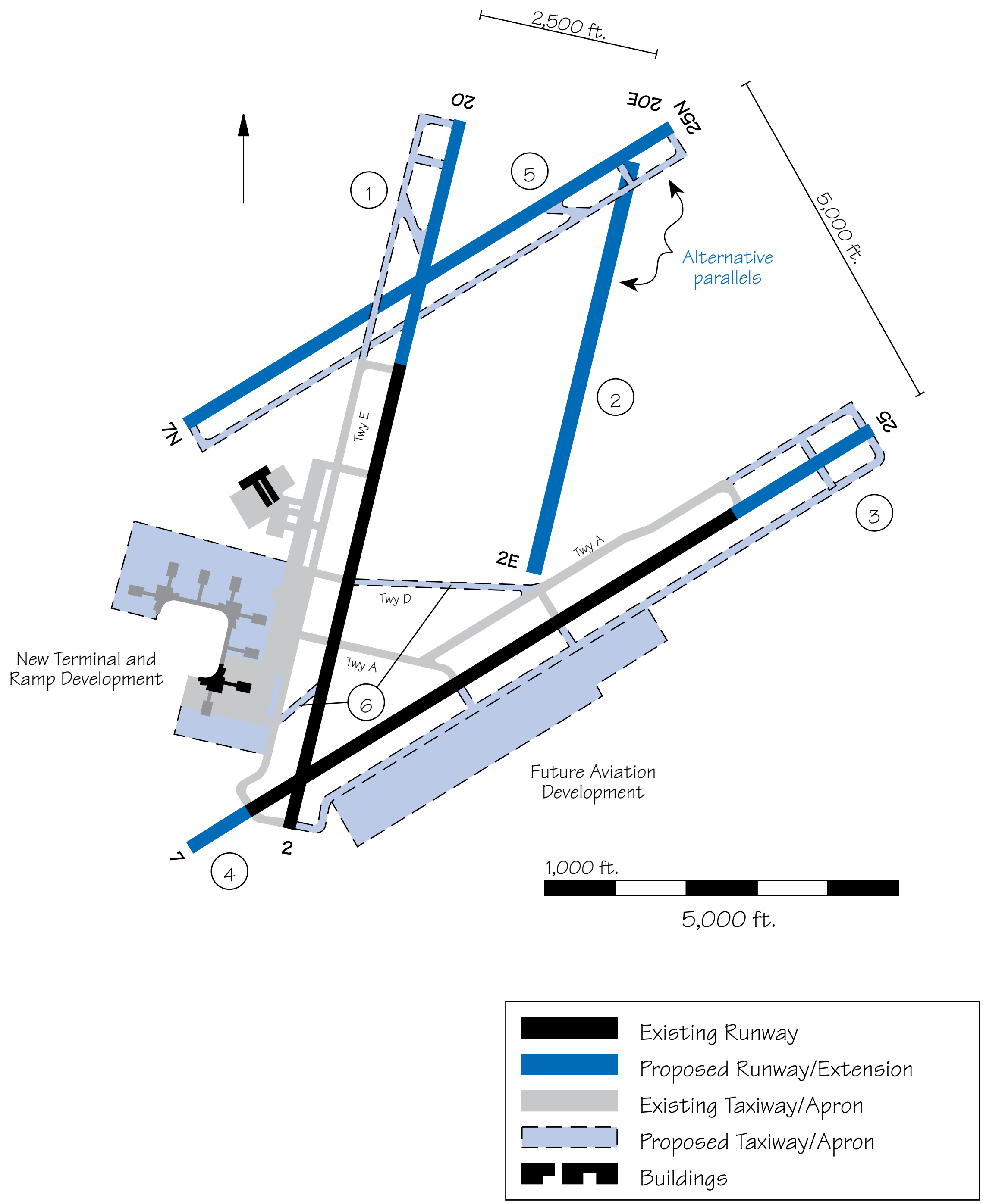


Figure 14. Capacity Enhancement Alternatives and Annual Delay Savings Newport News/Williamsburg International Airport

Airfield Improvements

1. Extend Runway 2/20 to northeast to at least 10,000 feet long
2. Build 6,000 foot Runway 2E/20E 2,500 feet east of Runway 2/20
3. Extend Runway 7/25 to northeast to at least 10,000 feet long
4. Extend Runway 7/25 1,000 feet to southwest
5. Build 8,000 foot Runway 7N/25N 5,000 feet north of Runway 7/25
6. Improve exits and associated taxiways

Facilities and Equipment Improvements

7. Install CAT II/IIIa ILS on both ends of all air carrier runways

Operational Improvements

8. Dependent Converging Instrument Approaches (DCIA) on Runways 20 and 25 with CRDA
9. Simultaneous Converging Instrument Approaches (SCIA)
10. Reduce in-trail separations to 2.5 nm between similar class aircraft
11. Operate in southwest flow under VFR during calm wind conditions

		Estimated Annual Delay Savings (in hours and millions of 1992 dollars)		
Improvement Packages*		**Baseline 160,000**	**Future 1 290,000**	**Future 2 430,000**
A.	Improve taxiway system to allow full use of Runway 2 for small GA departures	172/$0.1	2,108/$0.9	24,928/$33.1
B.	Southwest flow preferred in VFR 1 (11) Operate in southwest flow in VFR 1	455/$0.2	7,842/$3.5	34,252/$45.5
C.	Extend runways (1) Extend Runway 2/20 to at least 10,000 ft. (3) Extend Runway 7/25 to at least 10,000 ft.	†	2,162/$1.0	58,458/$77.6
D.	Extend runways, southwest flow preferred in VFR 1 (1,3) Extend existing runways to at least 10,000 ft. (11) Operate in southwest flow in VFR 1	†	8,755/$3.9	73,278/$97.3
E.	Build east parallel and extend runways (2) Build 6,000 ft. Runway 2E/20E (1,3) Extend existing runways to at least 10,000 ft.	†	†	75,738/$100.6
F.	Build north parallel runway (5) Build 8,000 ft. Runway 7N/25N	†	14,254/$6.4	173,158/$230.0
F+C.	Build north parallel runway and extend runways (5) Build 8,000 ft. Runway 7N/25N (1,3) Extend existing runways to at least 10,000 ft.	†	†	173,826/$230.8
	Savings over Package F			*668/$0.9*
	Additional savings in taxi time			*4,773/$6.3*

* Not all of the improvement alternatives were simulated. There is a description of each improvement alternative in Section 2, Capacity Enhancement Alternatives.

† Improvement packages were not simulated at these activity levels.

Figure 15 shows the capacity and delay curves for the current airfield configurations at PHF under IFR and VFR. It shows that, under IFR, aircraft delays can begin to escalate rapidly as hourly demand exceeds 50 operations per hour.

Figure 16 illustrates that, while hourly demand exceeds 50 operations only during peak hours of the day at Baseline demand levels, 50 operations per hour is frequently exceeded at the demand levels forecast for Future 1 and Future 2.

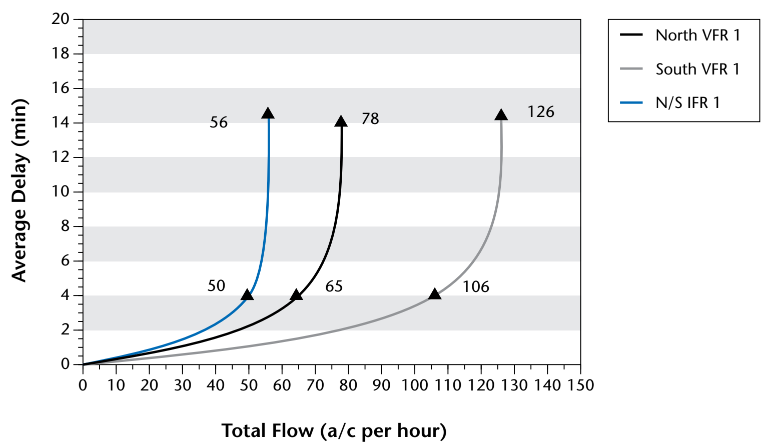
Figure 17 depicts how delay will continue to grow at a substantial rate as demand increases if no improvements are made in capacity, i.e., the Do Nothing scenario. Annual delay costs will increase from 2,091 hours or $0.9 million at Baseline to 19,001 hours or $8.6 million by Future 1 and 196,127 hours or $260.5 million by Future 2.

Figure 17 also shows the major delay-savings benefits from the improvement alternatives studied by the Capacity Team:

- Improve taxiway system to allow full use of Runway 2 for small GA departures.
- Operate with southwest flow preferred in VFR 1.
- Extend Runways 2/20 and 7/25 to at least 10,000 ft. with southwest flow preferred in VFR 1.
- Build 8,000 ft. north parallel Runway 7N/25N and extend Runways 2/20 and 7/25 to at least 10,000 ft.

Figure 18 shows the average delay in minutes per aircraft operation for these same alternatives. Under the Do Nothing alternative, the average delay per operation of 0.8 minutes at Baseline will increase to 3.9 minutes by Future 1 and 27.4 minutes by Future 2.

Figure 15. Airport Capacity Curves—Hourly Flow Rate Versus Average Delay



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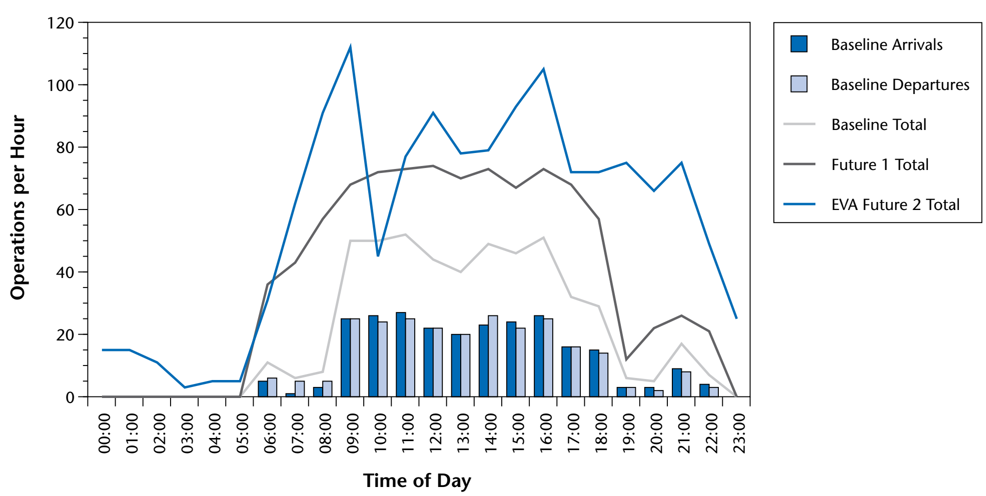


Figure 17. Airport Delay Costs—Capacity Enhancement Alternatives

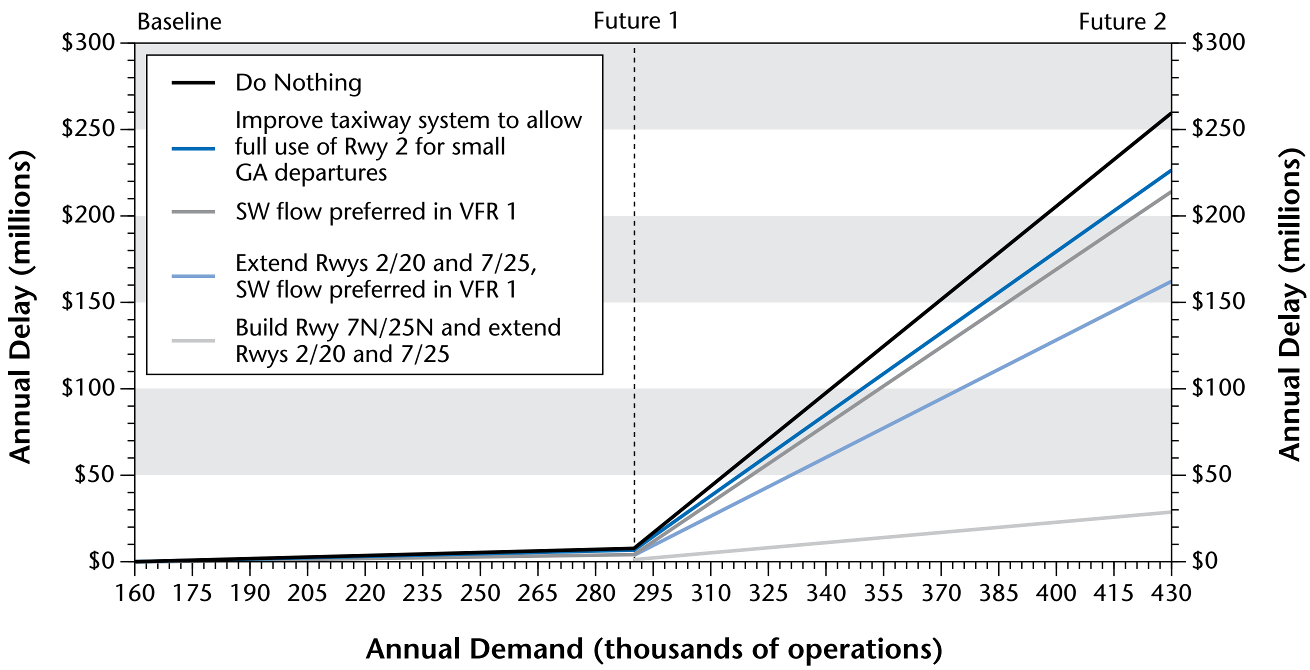
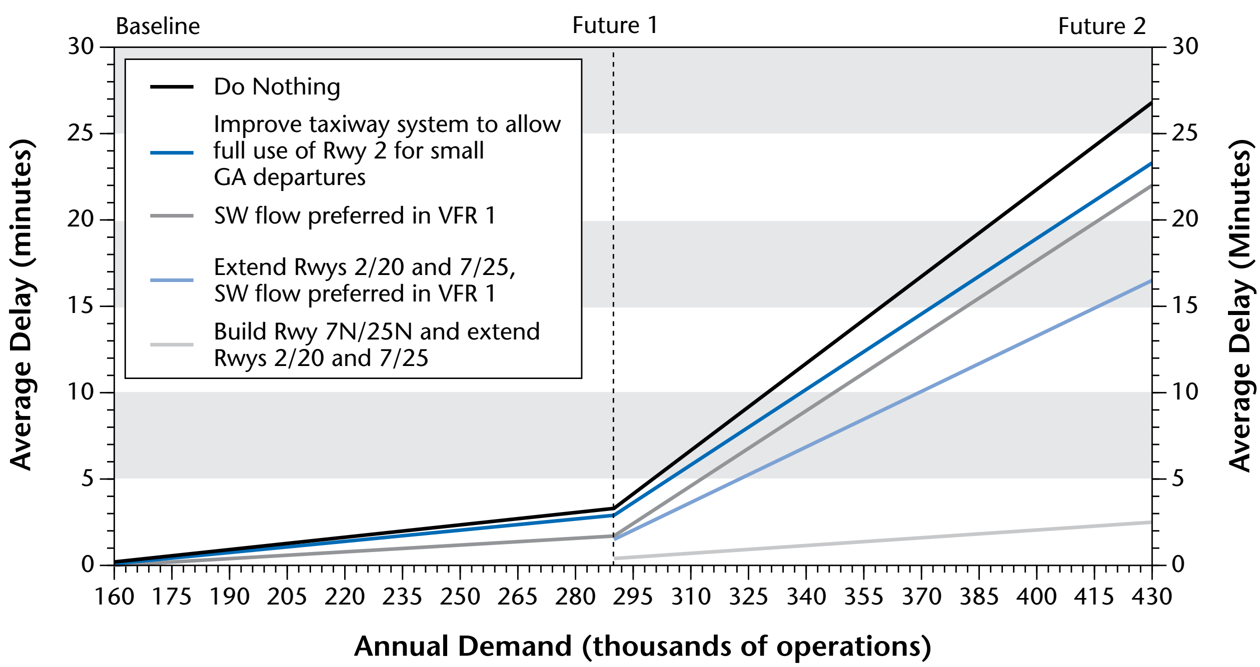
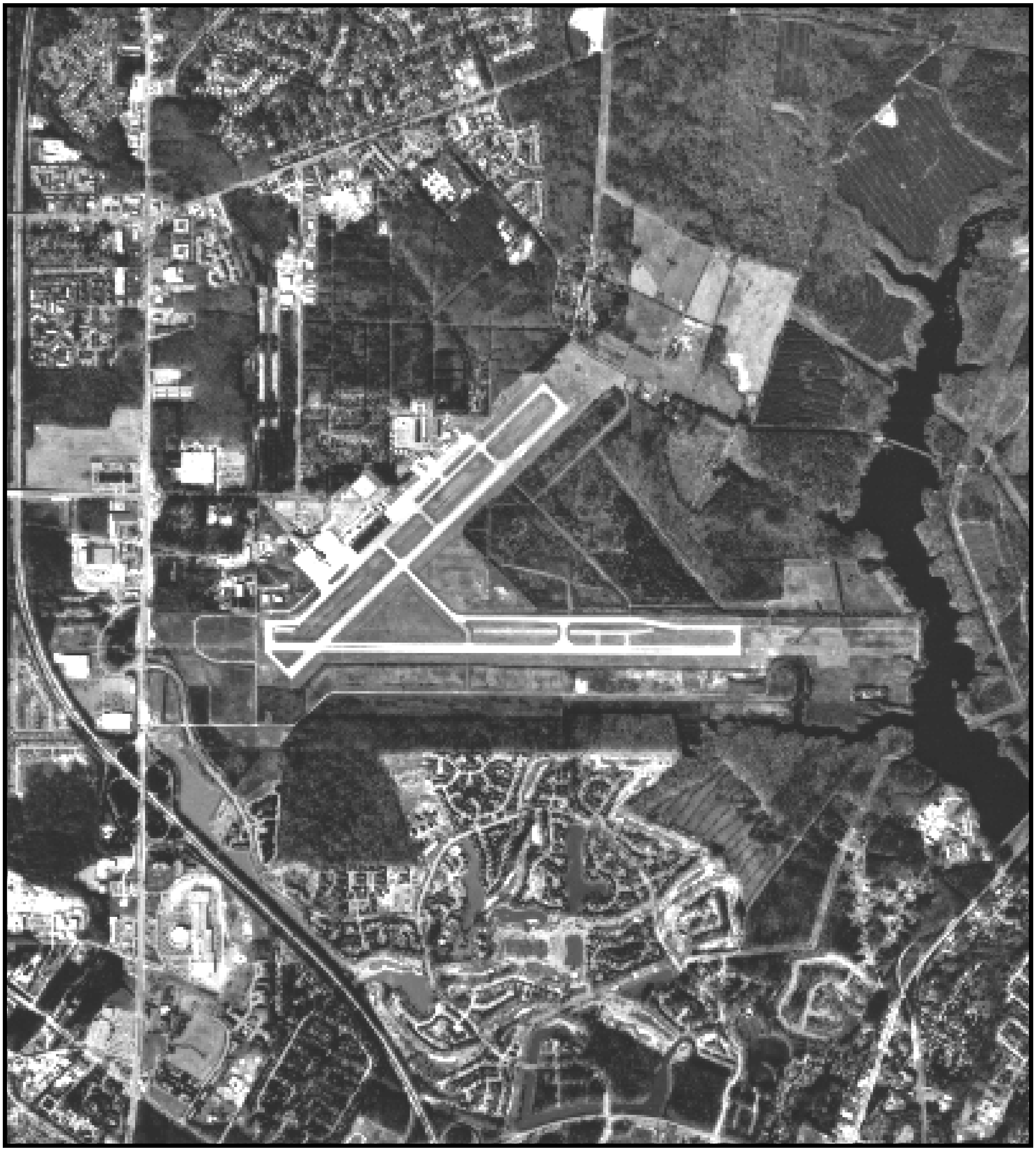


Figure 18. Average Delays—Capacity Enhancement Alternatives





Section 1

Introduction

Background

Recognizing the problems posed by congestion and delay within the National Airspace System, the Federal Aviation Administration (FAA) asked 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 and Requirements (ASC). The goal of this office and its capacity enhancement program is to identify and evaluate initiatives that have the potential to increase capacity, so that current and projected levels of demand can be accommodated within the system with a minimum of delay and without compromising safety or the environment.

In 1985, the FAA initiated a renewed program of Airport Capacity Design Teams at various major air carrier airports throughout the United States. Each Capacity 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 35 Airport Capacity Design Teams have either completed their studies or have work in progress.

Eastern Virginia Region

The Eastern Virginia (EVA) Region represents a land area of about 6,840 square miles with a 1991 population of about 2.8 million persons. Projected growth within this area will result in increased demand for improved and expanded aviation services. The EVA Region is currently served by three air carrier airports: Richmond International Airport, Norfolk International Airport, and Newport News/Williamsburg International Airport. Unless improvements are made in capacity, these three EVA airports may not be able to accommodate the forecast levels of demand from locally generated traffic without experiencing serious delays.

The Hampton Roads Planning District Commission (HRPDC), the Crater Planning District Commission (CPDC), and the Richmond Regional Planning District Commission (RRPDC) have cosponsored a study intended to develop an Eastern Virginia Airport System Plan with a forty-year planning horizon to the year 2030. This system plan will address the requirement for a regional system of air carrier, reliever, and general aviation airport facilities designed to meet the aviation needs of the EVA Region through the forty-year planning period. The system plan will also investigate the development of a new air carrier airport, if the combined incrementally improved facilities of the three existing airports cannot meet these needs, or if a new airport would be necessary to accommodate hubbing or international gateway development. The forty-year forecasts developed as a part of the Eastern Virginia Airport System Plan will be provided to Richmond, Norfolk, and Newport News/Williamsburg International Airports for their Master Planning efforts.

According to an Eastern Virginia Air Service Demand Study prepared in 1991, the EVA Region has the origin and destination market potential to support a major airline connecting hub when viewed as a single market area. Service area population and income levels are comparable to or larger than those of other metropolitan areas whose airports are operating as hubs. The Eastern Virginia Air Service Demand Study also states that EVA's mid-coastal location is suitable for a north/south domestic hub and, if established, for an international gateway to European, Canadian, Caribbean, and Latin American markets.

On one hand, the EVA Region may continue to be served by the three existing airports. This may require incremental improvements at each airport to meet steadily increasing demands. On the other hand, in order to provide the airport facilities necessary to support an airline hub in the future or to become an international gateway, any one of the three existing airports may be expanded, or a new site may be selected for the construction of a large domestic/international air carrier airport to provide an international gateway.

Richmond International Airport

Richmond International Airport (RIC) is situated on 2,500 acres located in Henrico County, seven miles southeast of the City of Richmond. It is owned and operated by the Capital Region Airport Commission.

RIC handled 973,887 revenue passenger enplanements and 52,331 tons of cargo in 1992, up 9.7 and 8.4 percent respectively over 1991. In 1992, the airport handled 148,720 aircraft operations (takeoffs and landings), up 5.5 percent over 1991. RIC is currently served by five major airlines and five commuter airlines. RIC has three paved runways:

- Runway 2/20 is 6,607 feet long and 150 feet wide. Runway 2 is equipped with an instrument landing system (ILS).
- Runway 7/25 is 5,316 feet long and 100 feet wide.
- Runway 16/34 is 9,003 feet long and 150 feet wide. Both runways are equipped with an ILS, and Runway 34 has a Category II ILS.

Norfolk International Airport

Norfolk International Airport (ORF) is situated on about 1,300 acres located seven miles northeast of downtown Norfolk. It is owned and operated by the Norfolk Airport Authority.

ORF handled 1,261,644 revenue passenger enplanements in 1992. In 1992, the airport handled 136,876 aircraft operations. ORF is currently served by seven major airlines and six commuter airlines. ORF has two paved runways:

- Runway 5/23 is 9,000 feet long and 150 feet wide. Both runways are equipped with an ILS.
- Runway 14/32 is 4,876 feet long and 150 feet wide.

Newport News/Williamsburg International Airport

Newport News/Williamsburg International Airport (PHF) is situated on 1,800 acres located in the City of Newport News and York County. It is owned and operated by the Peninsula Airport Commission.

PHF handled 160,838 revenue passenger enplanements in 1992. In 1992, the airport handled 174,708 aircraft operations. PHF is currently served by one major airline and three commuter airlines. PHF has two paved runways:

- Runway 2/20 is 6,526 feet long and 150 feet wide.
- Runway 7/25 is 8,003 feet long and 150 feet wide. Runway 7 is equipped with an ILS.

Military Operations

The table on the right gives a breakdown of current annual operations at the major military airfields in the EVA area. According to the military, operations at these airfields should remain relatively constant for the foreseeable future. There are many changes in aircraft basing being considered, but it would be premature to include them at this time.

The Virginia Air National Guard has 26 fixed-wing aircraft based at Richmond International Airport and conducts 10,000 itinerant military operations and 14,000

Operation	Annual Operations		
	NAS Norfolk NGU	NAS Oceana NTU	Langley AFB LFI
Fixed-Wing Arrivals & Departures	53,694	174,650	53,940
Helo Arrivals & Departures	80,542	8,000	1,680
Subtotal Itinerant	134,236	182,650	55,620
Fixed-Wing Touch & Go	9,476	46,350	310
Helo Touch & Go	14,213	400	0
Total Operations	157,925	229,400	55,930

practice operations for a total of 24,000 operations annually. The Army National Guard conducts an additional 146 itinerant fixed-wing and 3,700 itinerant helicopter operations annually. All of these operations are required at RIC to support unit mission statements and letters of agreement and cannot be conducted elsewhere.

There are no military operations nor plans for military operations at Norfolk International Airport. Military operations at Naval Air Station (NAS) Norfolk interact with ORF when operating in certain configurations.

For the simulation modeling, military operations at Richmond International Airport were held constant at all three demand levels. Military operations at Norfolk International Airport were considered insignificant and were not taken into account in the simulation modeling. For Newport News/Williamsburg, the current level of military operations was used for the Baseline simulation modeling, reduced for Future 1, and eliminated for Future 2.

Eastern Virginia Airport Capacity Design Team

An Airport Capacity Design Team for Eastern Virginia was formed in 1992. The EVA Capacity Team identified and assessed various actions which, if implemented, would increase capacity, improve operational efficiency, and reduce aircraft delays as demand grows at Richmond, Norfolk, and Newport News/Williamsburg International Airports. 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 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 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 date.

A Baseline benchmark of 160,000 aircraft operations (takeoffs and landings) was established based on the annual traffic level for 1990, the base year of the study. Two future traffic levels, Future 1 and Future 2, were established at 290,000 and 430,000 annual aircraft operations respectively, based on Capacity Team consensus of potential traffic growth in the EVA Region.

- If no improvements are made at RIC, the following annual delays could be expected: 957 hours and $0.9 million at the Baseline activity level; 7,192 hours and $9.4 million at Future 1; and 148,414 hours and $197.1 million at Future 2.
- If no improvements are made at ORF, the following annual delays could be expected: 1,082 hours and $0.8 million at the Baseline activity level; 9,846 hours and $11.0 million at Future 1; and 140,040 hours and $186.0 million at Future 2.
- If no improvements are made at PHF, the following annual delays could be expected: 2,091 hours and $0.9 million at the Baseline activity level; 19,001 hours and $8.6 million at Future 1; and 196,127 hours and $260.5 million at Future 2.

The Capacity Team studied various proposals with the potential for increasing capacity and reducing delays at RIC, ORF, and PHF. The improvements evaluated by the Capacity Team are delineated in Figures 19 (RIC), 20 (ORF), and 21 (PHF) and described in some detail in Section 2, Capacity Enhancement Alternatives.

Capacity Team Objectives

The major goal of the Capacity Team was to identify and evaluate proposals to increase airport capacity, improve airport efficiency, and reduce aircraft delays. In achieving this objective, the Capacity Team:

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

Scope

The Capacity Team limited its analyses to aircraft activity within the terminal area airspace and on the runway/taxiway system. They considered the technical and operational feasibility 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 Capacity Team can be used in such studies.

Methodology

The Capacity Team, which included representatives from the FAA, the Capital Region Airport Commission, the Norfolk Airport Authority, the Peninsula Airport Commission, the State of Virginia Department of Aviation, the Hampton Roads Planning District Commission (HRPDC), the Crater Planning District Commission (CPDC), the Richmond Regional Planning District Commission (RRPDC), and various aviation industry groups (see Appendix A), met periodically for review and coordination.

The Capacity Team members considered suggested capacity improvement alternatives. Alternatives that were considered practicable were developed into experiments that could be tested by simulation modeling. The FAA Technical Center's Aviation Capacity Branch provided expertise in airport simulation modeling. The Capacity 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 capacity-producing options, complete with planning and implementation time horizons.

The simulation model considered air traffic control procedures, airfield improvements, and traffic demands. Alternative 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 VFR and IFR.

Air traffic demand levels were derived from *Official Airline Guide* data, historical operations data, Capacity Team input, and other forecasts. Aircraft volume, mix, and peaking characteristics were considered for each of the three different demand forecast 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 Capacity Team developed a plan of recommended alternatives for consideration for each of the three airports, RIC, ORF, and PHF.

Airspace Assessment

During the course of the Airport Capacity Design Team Study, Capacity Team members expressed concern about the proposed airport improvements and the effects these improvements might have on the airspace surrounding the EVA Region. To address these concerns, a subgroup was formed to assess the overall impact of the proposed physical and operational changes to the three existing airports or the development of a regional hub airport, either by greatly expanding one of the three airports or by constructing a new, much larger international and domestic air carrier airport. The general conclusion of this subgroup was that the proposed changes could be assimilated into the air traffic system with minimum impact.

The Airspace Subgroup was made up of representatives from the Washington Air Route Traffic Control Center (ARTCC), the Airport Traffic Control Towers

(ATCTs) at Richmond, Norfolk, and Newport News/Williamsburg, Langley Air Force Base (AFB) (LFI), Naval Air Station (NAS) Norfolk (NGU), NAS Oceana (NTU), and the Fleet Area Control and Surveillance Facility, Virginia Capes (FACSFAC VACAPES). As a part of their study, the group was asked to investigate five specific questions. These questions and the results of their assessment are summarized below.

Assess whether the improvements proposed in the capacity team study would conflict with traffic to or from a nearby civilian or military airport.

The only potential conflict with military traffic is 2.5 miles (mi) northeast of Norfolk International where the final approach course for Runway 23 intersects Runway 28 at NAS Norfolk. When both airports are operating in a southwest flow, the final approach courses are treated as one. This will not represent a significant impact unless operations at NAS Norfolk increase, and they are not expected to do so.

Assess whether independent arrival and departure routes can be developed to serve the proposed new runways.

Independent arrival and departure routes can be developed to serve new runways proposed at Newport News/Williamsburg and Richmond. Since the proposed parallel runway at Norfolk International is only displaced 845 feet from the existing Runway 5/23, the current arrival and departure routes will suffice.

Assess whether the proposed improvements and activity levels can be accommodated in the close-in airspace.

All improvements and activity levels can be accommodated in the close-in airspace. The military pointed out that, as traffic levels at both Norfolk International and NAS Oceana increase, use of airspace currently owned by NAS Oceana may be required for Norfolk departures. At higher traffic levels, delays can be expected at both NAS Oceana and NAS Norfolk as more aircraft compete for the same amount of airspace.

Assess whether the EVA area (ORF–PHF–RIC) is a practical area from which to climb increased flight operations into the en route structure without undue effect on the Washington area to the north, Raleigh-Durham and Charlotte/Douglas to the south, or en route traffic.

The EVA area is a practical area from which to climb increased operations into the en route structure due to its location and distance from the Washington area traffic flows. Raleigh-Durham and Charlotte/Douglas traffic would not significantly effect approach operations to the area. The military pointed out that if the en route structure experiences saturation from increased operations to and from the Norfolk area, delays for both military and civilian aircraft could be expected.

Assess whether the EVA area (ORF–PHF–RIC) is practical for international arriving and departing traffic.

With its mid-Atlantic location on the east coast, EVA could accommodate international traffic, subject to future study of domestic/international traffic flows and route structures. The military pointed out that an increase in international traffic could have an adverse effect on the military's ability to train in the warning areas. Additional oceanic routes could further segment the current warning-area airspace making scheduling of military missions more difficult.

Summary

The proposed physical and operational changes to the three existing airports or the development of a new regional airport in the EVA area could be assimilated into the air traffic system with minimum impact. Although this conclusion is based on a limited, subjective study, the Washington ARTCC, which controls the en route air traffic structure, has always worked closely with both civilian and military approach controls to ensure the best level of service and safety. Historically, when changes in air traffic patterns or activity levels occur, air traffic facilities work together to adjust traffic flows to minimize the effects of the changes. In addition, the FAA is undertaking an extensive program to replace the existing air traffic control equipment nationwide with an entirely new generation of automated equipment and technology that will allow more efficient use of airports and airspace and thus increase capacity. Taken together, these considerations, the absence of any obvious conflicts, and the long time frame (40 years) of the study, suggest the overall conclusion is sound.

Section 2

Capacity Enhancement Alternatives

Background

Capacity enhancement alternatives are categorized and discussed for each airport in turn, i.e., Richmond (RIC), Norfolk (ORF), and Newport News/Williamsburg (PHF), under the following headings:

- Airfield Improvements
- Facilities and Equipment Improvements
- Operational Improvements

In the opening Summary of this report, Figures 1 (RIC), 7 (ORF), and 13 (PHF) show the current layout for each of the airports and highlight the airfield improvement alternatives considered by the Capacity Team. Figures 2 (RIC), 8 (ORF), and 14 (PHF) in the Summary list the capacity enhancement alternatives evaluated by the Capacity Team at each airport and present the estimated annual delay savings benefits for selected improvements. The annual savings are given for the activity levels Baseline, Future 1, and Future 2, which correspond to annual aircraft operations of 160,000, 290,000, and 430,000 respectively. The delay savings benefits of the improvements are not necessarily additive.

In this section, to begin the discussion of the individual airports, Figures 19 (RIC), 20 (ORF), and 21 (PHF) present the recommended action and suggested time frame at each airport for each capacity enhancement alternative considered by the Capacity Team.

Figure 19. Capacity Enhancement Alternatives and Recommended Actions Richmond International Airport

Airfield Improvements	Action	Time Frame
1. Extend Runway 16/34 1,450 ft. to southeast to total 10,450 ft. long	On Approved ALP	Baseline
2. Extend Runway 2/20 1,000 ft. to south to total 7,600 ft. long	On Approved ALP	Baseline-Future 1
3. Build 10,500 ft. Runway 2R/20L 5,500 ft. east and 2,600 ft. south of extended Runway 2/20	Recommended/Study*	Future 1-Future 2
4. Build 10,500 ft. Runway 16R/34L 7,000 ft. west of Runway 16/34	Recommended/Study*	Future 1-Future 2
5. Reconstruct Runway 7/25 to total 10,000 ft. long and 150 ft. wide	Recommended/Study	Future 1
6. Build 8,000 ft. Runway 7R/25L 3,400 ft. south of Runway 7/25 (includes PRM)	Recommended/Study*	Future 1-Future 2
7. Improve exits and associated taxiways	On Approved ALP	Baseline
Facilities and Equipment Improvements		
8. Install HIRL on Runway 2	Recommended	Baseline
9. Install MALSR on Runway 2	Recommended	Baseline
10. Install centerline lights Runway 2/20	Recommended	Baseline
11. Install touchdown and rollout RVRs on Runway 2	Recommended	Baseline
12. Install CAT II/IIIa ILS on both ends of all air carrier runways	Recommended	Baseline-Future 1
Operational Improvements		
13. Dependent Converging Instrument Approaches (DCIA) on Runways 2 and 34 with CRDA	Not Recommended	—
14. Simultaneous Converging Instrument Approaches (SCIA)	Study	Baseline
15. Reduce in-trail separations to 2.5 nm between similar class aircraft	Recommended	Baseline

The Capacity Team limited its analyses to aircraft activity within the terminal area airspace and on the runway/taxiway system. They considered the technical and operational feasibility 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 Capacity Team can be used in such studies.

* The Capacity Team recommended a parallel runway be developed between the Future 1 and Future 2 level of operations. The alternative to be selected would be identified after further study.

Richmond International Airport

Airfield Improvements

1. Extend Runway 16/34 1,450 feet to southeast to total 10,450 feet long.

Extending Runway 16/34 by 1,450 feet to the southeast to a total length of 10,450 feet would improve the ability of the runway to accommodate the existing and future design criteria demands of transcontinental and international air-cargo aircraft.

This extension is on RIC's approved Airport Layout Plan, and the Washington Airports District Office has approved the project's justification because the extension would provide RIC's existing 'critical' air-cargo aircraft the ability to depart with minimal loss in effective payload capacity. (To eliminate most of these losses for all existing and future air-cargo aircraft, an additional extension to a total length of 11,500 feet would be necessary, though this additional extension will require further study.) Furthermore, this project would provide both existing and future air-cargo carriers with the ability to take greater economic advantage of their aircraft payload capability.

Estimated 1993 project cost is $12.0 million.

The extension of Runway 16/34 is recommended for implementation at the Baseline demand level.

2. Extend Runway 2/20 1,000 feet to south to total 7,600 feet long.

Extending Runway 2/20 by 1,000 feet to the south to a total length of 7,600 feet would improve the ability of the runway to accommodate the existing and future design criteria demands of air carrier aircraft.

This extension is on RIC's approved Airport Layout Plan. Runway 2/20 is the runway of preference for RIC's air carrier aircraft due to its close proximity to the terminal. However, the runway's current length precludes certain types of air carrier aircraft, both existing and future, from using it for arrivals and departures due to requirements in their operational manuals. This project would allow these additional aircraft to use Runway 2/20.

Furthermore, there would be at least a two minute savings in taxi time for each of these additional aircraft that could depart Runway 2 instead of Runway 34 in the north flow. RIC is in the north flow 67.8 percent of the time. These taxi savings are not included in the annual delay savings of any improvement package.

Estimated 1993 project cost is $8.0 million.

The extension of Runway 2/20 is recommended for implementation between the Baseline and Future 1 demand levels.

3. Build 10,500 foot Runway 2R/20L 5,500 feet east and 2,600 feet south of extended Runway 2/20.

The capacity of RIC would be significantly increased by the ability to conduct simultaneous (independent) parallel approaches in all weather conditions. With a separation between parallel runway centerlines of 5,500 feet, a new Runway 2R/20L on the southeast side of the airfield would provide for two simultaneous (independent) arrival and departure streams in all weather conditions.

Estimated 1993 project cost is $82.3 million.

The annual delay savings for building Runway 2R/20L and extending existing Runways 2/20 and 16/34 are 2,254 hours or $2.9 million (estimated) at the Future 1 demand level, and 119,924 hours or $159.3 million at the Future 2 demand level.

This project is one of three alternative parallel runways that have been identified. Further study is recommended to determine which of the alternatives to develop. A parallel runway is recommended for implementation between Future 1 and Future 2 demand levels.

4. Build 10,500 foot Runway 16R/34L 7,000 feet west of Runway 16/34.

The capacity of RIC would be significantly increased by the ability to conduct simultaneous (independent) parallel approaches in all weather conditions. With a separation between parallel runway centerlines of 7,000 feet, a new Runway 16R/34L on the south side of the airfield would provide for two simultaneous (independent) arrival and departure streams in all weather conditions.

Estimated 1993 project cost is $82.3 million.

The annual delay savings for building Runway 16R/34L and extending Runways 2/20 and 16/34 are 2,254 hours or $2.9 million (estimated) at the Future 1 demand level, and 124,899 hours or $165.9 million at the Future 2 demand level.

This project is one of three alternative parallel runways that have been identified. Further study is recommended to determine which of the alternatives to develop. A parallel runway is recommended for implementation between Future 1 and Future 2 demand levels.

5. Reconstruct Runway 7/25 to total 10,000 feet long and 150 feet wide.

Reconstructing and extending Runway 7/25 to 10,000 feet long by 150 feet wide would improve the ability of the runway to accommodate the existing and future design criteria demands of air carrier aircraft. The extension of Runway 7/25 will enable aircraft to depart on Runway 7 instead of Runway 34 in the north flow. RIC is in the north flow 67.8 percent of the time. Additionally, there would be at least a two minute savings in taxi time for each of these departures on Runway 7. These taxi time savings are not included in the annual delay savings of any improvement package.

Estimated 1993 project cost is $46.4 million.

The annual delay savings for reconstructing Runway 7/25 and extending existing Runways 2/20 and 16/34 are 1,616 hours or $2.1 million at the Future 1 demand level and 46,600 hours or

$61.9 million at the Future 2 demand level. (Future 1 annual delay savings are based on an assumption that there are no class 3 or 4 general aviation aircraft flying in IFR conditions. If, however, class 3 and/or 4 general aviation aircraft are flying in IFR conditions, then one would expect the Future 1 annual delay savings to be even greater.)

The reconstruction of Runway 7/25 is recommended for detailed study at the Baseline demand level and is recommended for implementation by the Future 1 demand level.

6. Build 8,000 foot Runway 7R/25L 3,400 feet south of Runway 7/25 (includes PRM).

The capacity of RIC would be significantly increased by the ability to conduct simultaneous (independent) parallel approaches in all weather conditions. With a separation between parallel runway centerlines of 3,400 feet and a Precision Runway Monitor (PRM), a new Runway 7R/25L on the southeast side of the airfield would provide for two simultaneous (independent) arrival and departure streams in all weather conditions.

The PRM has demonstrated that simultaneous (independent) parallel approaches can be conducted in all weather conditions on runways spaced less than 4,300 feet apart. The PRM relies on improved radar surveillance with higher update rates of aircraft positions and a new air traffic controller display system. National standards for simultaneous (independent) parallel approaches using the PRM to runways separated by 3,400 to 4,300 feet were published in November 1991. When PRM equipment becomes available, installing it at RIC would allow simultaneous (independent) parallel ILS approaches to be implemented once the new Runway 7R/25L is constructed.

Estimated 1993 project cost is $58.4 million.

The annual delay savings for building Runway 7R/25L and extending the three existing runways are 2,254 hours or $2.9 million (estimated) at the Future 1 demand level, and 124,415 hours or $165.2 million at the Future 2 demand level.

This project is one of three alternative parallel runways that have been identified. Further study is recommended to determine which of the alternatives to develop. A parallel runway is recommended for implementation between Future 1 and Future 2 demand levels.

7. Improve exits and associated taxiways.

These taxiway improvements are on RIC's approved Airport Layout Plan and would provide taxi time savings which are not included in the annual delay savings of any improvement package. Currently, the majority of RIC's existing air-cargo aircraft and, for the most part, all of RIC's future air-cargo aircraft must use Runway 16/34. Additionally, many existing and future air carrier aircraft are required by their operations manuals to use Runway 16/34.

The taxi time for each aircraft departing Runway 34 would be reduced by at least two minutes. Departures on Runway 34 occur when RIC is in the north flow, which occurs 67.8 percent of the time. Runway occupancy times would decrease due to the availability of additional exits. (These additional exits are not shown in Figure 1 because their exact locations will be derived by further study.) As a result of these additional exits, the taxi time for arriving aircraft would also decrease.

Estimated 1993 project cost is $8.9 million.

This project is recommended for implementation at the Baseline demand level.

Facilities and Equipment Improvements

8. Install High-Intensity Runway Lights (HIRL) on Runway 2.

Installing HIRL on Runway 2 would improve visibility minimums for approaches and departures in reduced visibility conditions.

Estimated 1993 project cost is $0.1 million.

This project is recommended for implementation at the Baseline demand level.

9. Install Medium-Intensity Approach Light System with Runway Alignment Indicator Lights (MALSR) on Runway 2.

Installation of a MALSR on Runway 2 would improve visibility minimums for approaches in reduced visibility conditions.

Estimated 1993 project cost is $0.7 million.

This project is recommended for implementation at the Baseline demand level.

10. Install centerline lights on Runway 2/20.

Installation of centerline lights on Runway 2/20 would reduce current visibility minimums for departures and help maintain capacity during instrument meteorological conditions (IMC).

Estimated 1993 project cost is $0.2 million.

This project is recommended for implementation at the Baseline demand level.

11. Install touchdown and rollout Runway Visual Ranges (RVRs) on Runway 2.

Meteorological visibility is often observed and reported at a point distant from the runway. RVR is measured along the runway itself with transmissometers and provides the pilot with the distance he can expect to see down the runway. From an operations viewpoint, RVR is far superior to other measurements of meteorological visibility. Installing touchdown and rollout RVRs on Runway 2 would reduce visibility minimums for arrivals and departures. Their primary benefit would be in IMC.

Estimated 1993 project cost is $0.3 million.

This project is recommended for implementation at the Baseline demand level.

12. Install CAT II/IIIa ILS on both ends of all air carrier runways.

RIC experienced growth in its air-cargo activity at an average of 18 percent per year during the period from 1982 through 1992. With this increasing cargo activity, it is critical for RIC to maintain its ability to operate in all weather conditions. IFR that severely restrict operations (IFR 2—ceiling below 300 feet or visibility below 0.75 mi) occur about 240 hours per year, and the impact of the associated delays can be significant.

Estimated 1993 project cost is $2.5 million for each CAT II/IIIa ILS.

The installation of a CAT IIIa ILS on Runway 34 is recommended for implementation at the Baseline demand level. The installation of CAT II/IIIa ILSs on the remaining air carrier runways is recommended for implementation by the Future 1 demand level.

Operational Improvements

13. Dependent Converging Instrument Approaches (DCIA) on Runways 2 and 34 with Converging Runway Display Aid (CRDA).

Because of the reduced visibility and ceilings associated with IFR, simultaneous (independent) use of non-intersecting converging runways is currently permitted for aircraft arrivals only during relatively high weather minimums. However, a program is now available that would allow dependent (alternating) arrivals on non-parallel runways through the use of a Converging Runway Display Aid (CRDA) for air traffic controllers.

This project was not recommended. The CRDA is currently provided within the Automated Radar Terminal System (ARTS) IIIa software, but RIC is not now equipped with ARTS IIIa. The benefits of DCIA/CRDA at RIC would be minimal because they would not significantly reduce the separations required for converging approaches.

14. Simultaneous Converging Instrument Approaches (SCIA).

Under VFR, it is common to use non-intersecting converging runways for independent streams of arriving aircraft. Because of the reduced visibility and ceilings associated with IFR, simultaneous (independent) use of runways is currently permitted for arrivals only during relatively high weather minimums. Simultaneous converging approaches are designed using the “TERPS plus 3” criteria. This refers to the need for missed approach points to be separated by at least 3 nm and for missed approach obstacle-free surfaces not to overlap.

This project is recommended for implementation at the Baseline demand level.

15. Reduce in-trail separations to 2.5 nm between similar class aircraft.

Existing procedures for IFR require that arriving aircraft be separated by 3 nm or more. Reducing separation minimums to 2.5 nm for aircraft of similar class and less than 300,000 pounds would increase arrival rates and runway capacity. Most of the savings occur at the highest demand levels during IFR operations, but, if the runway exits are not visible from the tower, the 2.5 nm separation cannot be applied.

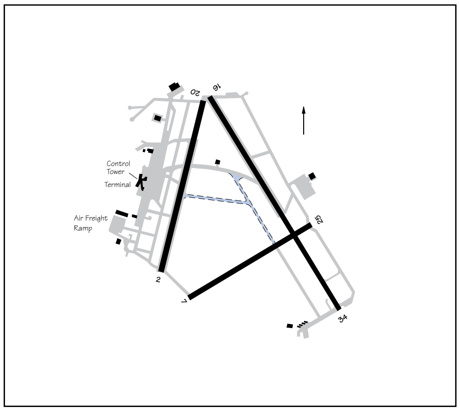
This project is recommended for implementation at the Baseline demand level.

Richmond Improvement Packages and Annual Delay Savings

Improvement Packages	Estimated Annual Delay Savings (in hours and millions of 1992 dollars) Baseline 160,000	Future 1 290,000	Future 2 430,000
A. Improve exits and taxiways to allow full use of Runway 34 for arrivals	†	†	754/$1.0
B. Extend three existing runways	†	1,616/$2.1	46,600/$61.9
(5) Reconstruct Rwy 7/25 to total 10,000 x 150 ft.			
(1) Extend Runway 16/34 to 10,450 ft.			
(2) Extend Runway 2/20 to 7,600 ft.			
(7) Improve exits and associated taxiways			
C. Build Runway 2R/20L and extend Runways 16/34 & 2/20	†	2,254/$2.9*	119,924/$159.3
(3) Build 10,500 ft. Runway 2R/20L			
(1) Extend Runway 16/34 to 10,450 ft.			
(2) Extend Runway 2/20 to 7,600 ft.			
(7) Improve exits and associated taxiways			
D. Build Runway 7R/25L and extend three existing runways	†	2,254/$2.9*	124,415/$165.2
(6) Build 8,000 ft. Runway 7R/25L			
(5) Reconstruct Rwy 7/25 to total 10,000 x 150 ft.			
(1) Extend Runway 16/34 to 10,450 ft.			
(2) Extend Runway 2/20 to 7,600 ft.			
(7) Improve exits and associated taxiways			
E. Build Runway 16R/34L and extend Runways 16/34 & 2/20	†	2,254/$2.9*	124,899/$165.9
(4) Build 10,500 ft. Runway 16R/34L			
(1) Extend Runway 16/34 to 10,450 ft.			
(2) Extend Runway 2/20 to 7,600 ft.			
(7) Improve exits and associated taxiways			

† Improvement packages were not simulated at these activity levels.
* Estimated annual delay savings for a parallel runway at Future 1.

Package A



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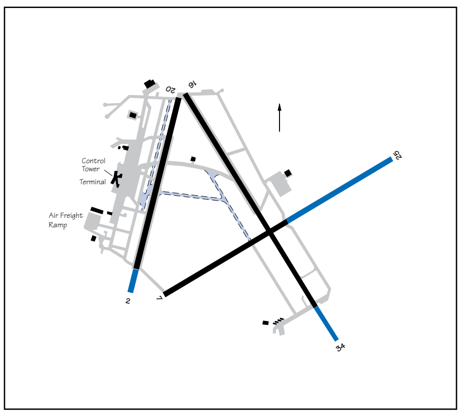

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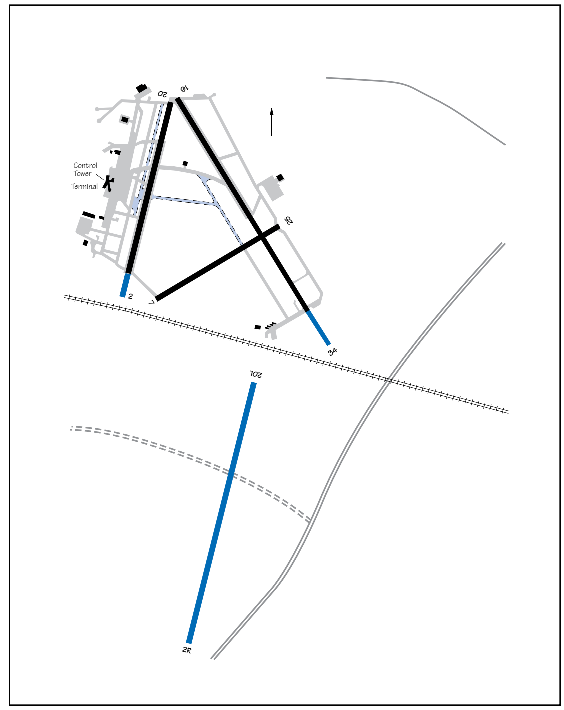

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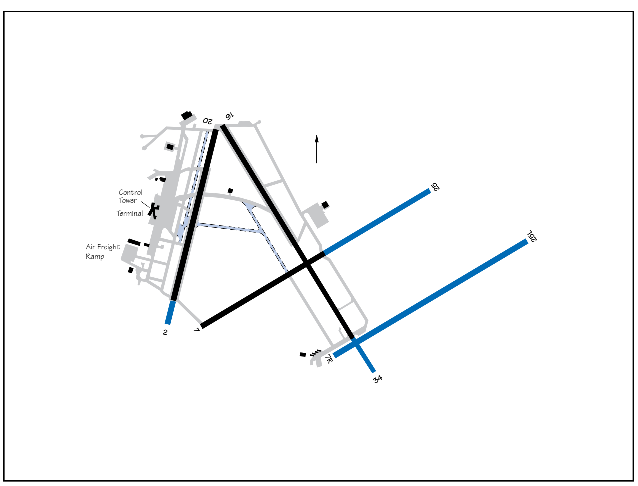

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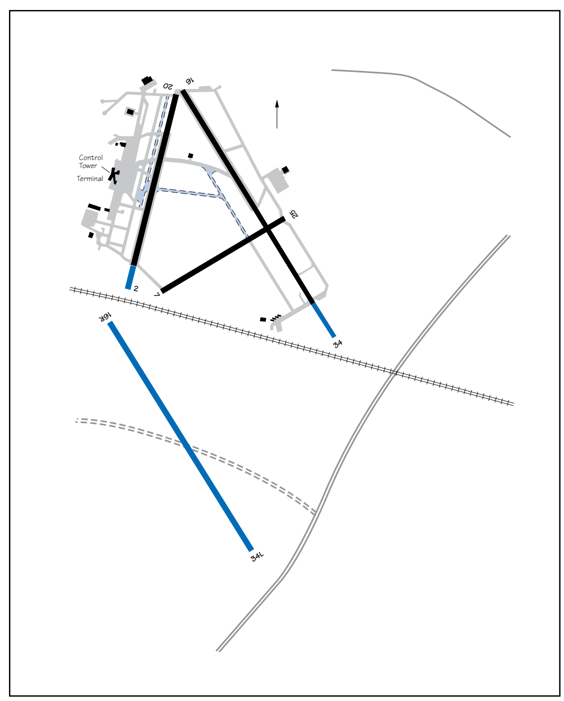


Figure 20. Capacity Enhancement Alternatives and Recommended Actions Norfolk International Airport

Airfield Improvements	Action	Time Frame
1. Extend Runway 14/32 824 ft. to southeast to 5,700 ft. long	Further Study	—
2. Build 7,000 ft. Runway 5R/23L 845 ft. south of Runway 5/23	Recommended	Future 2
Facilities and Equipment Improvements		
3. Install CAT II/IIIa ILS on Runway 5	Recommended	Baseline
4. Install ALSF-2 and inner marker on Runway 5	Recommended	Baseline
5. Install midpoint and rollout RVRs on Runway 5	Recommended	Baseline
6. Install centerline and touchdown zone lights on Runway 5	Recommended	Baseline
Operational Improvements		
7. Reduce in-trail separations to 2.5 nm between similar class aircraft	Recommended	Baseline

The Capacity Team limited its analyses to aircraft activity within the terminal area airspace and on the runway/taxiway system. They considered the technical and operational feasibility 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 Capacity Team can be used in such studies.

Norfolk International Airport

Airfield Improvements

1. Extend Runway 14/32 824 feet to southeast to 5,700 feet long.

Extending Runway 14/32 to 5,700 feet in length would enable the runway to accommodate regional airline commuter aircraft. If these smaller aircraft were to operate primarily on Runway 14/32, additional capacity would be available on Runway 5/23 for larger air carrier aircraft.

Estimated 1993 project cost for an 824 foot extension of Runway 14/32 and associated taxiway improvements is about $4 million.

It is recommended that the Master Plan review this runway extension for possible implementation.

2. Build 7,000 foot Runway 5R/23L 845 feet south of Runway 5/23.

A new 7,000 foot runway 845 feet south of the existing Runway 5/23 would provide for an additional arrival stream under visual meteorological conditions (VMC) and for separation of arrivals and departures in IMC. If parallel runways are less than 2,500 feet apart, they must be treated as a single runway under IMC. Currently, the separation between parallel runway centerlines must be at least 4,300 feet for independent operations in all weather conditions.

Estimated 1993 project cost for a new 7,000 foot Runway 5R/23L and associated taxiway improvements is about $70 million.

This project is recommended for implementation at the Future 2 demand level.

Facilities and Equipment Improvements

3. Install CAT II/IIIa ILS on Runway 5.

IFR that severely restrict operations (IFR 2/IFR 3—ceiling below 300 feet and visibility below 0.75 mi) only occur about 175 hours per year, but the impact of the associated delays can be significant. Installing a CAT II/IIIa ILS on Runway 5 would reduce visibility minimums and enhance operational flexibility and thereby help to maintain capacity during very low IMC. Alternatives 4, 5, and 6 must be in place in order to support CAT II/IIIa operations.

Estimated 1993 project cost is about $4.0 million.

This project is recommended for implementation at the Baseline demand level.

4. Install Approach Light System with Sequenced Flashers and Category II modification (ALSF-2) and inner marker on Runway 5.

Installation of an ALSF-2 on Runway 5 would improve visibility minimums for approaches in reduced visibility conditions. Alternatives 4, 5, and 6 must be in place in order to support CAT II/IIIa operations.

Estimated 1993 project cost is about $2.5 million.

This project is recommended for implementation at the Baseline demand level.

5. Install midpoint and rollout Runway Visual Ranges (RVRs) on Runway 5.

Meteorological visibility is often observed and reported at a point distant from the runway. RVR is measured along the runway itself with transmissometers and provides the pilot with the distance he can expect to see down the runway. From an operations viewpoint, RVR is far superior to other measurements of meteorological visibility. Installing midpoint and rollout RVRs on Runway 5 would reduce visibility minimums for arrivals and departures. Their primary benefit would be in IMC. Both alternatives 5 and 6 must be in place in order to reduce departure minimums. Alternatives 4, 5, and 6 must be in place in order to support CAT II/IIIa operations.

Estimated 1993 project cost is about $0.25 million.

This project is recommended for implementation at the Baseline demand level.

6. Install centerline and touchdown zone lights on Runway 5.

Installing centerline and touchdown zone lighting systems on Runway 5 would reduce visibility minimums for arrivals and departures. Their primary benefit would be in IMC. Both alternatives 5 and 6 must be in place in order to reduce departure minimums. Alternatives 4, 5, and 6 must be in place in order to support CAT II/IIIa operations.

Estimated 1993 project cost is about $2.0 million.

This project is recommended for implementation at the Baseline demand level.

Operational Improvements

7. Reduce in-trail separations to 2.5 nm between similar class aircraft.

Existing procedures for IFR require that arriving aircraft be separated by 3 nautical miles (nm) or more. Reducing separation minimums to 2.5 nm for aircraft of similar class and less than 300,000 pounds would increase arrival rates and runway capacity. Most of the savings occur at the highest demand levels during IFR operations, but, if the runway exits are not visible from the tower, the 2.5 nm separation cannot be applied.

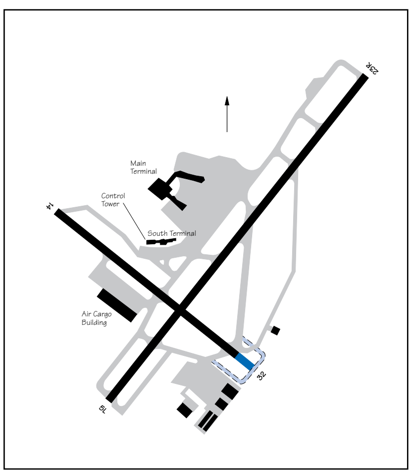
This project is recommended for implementation at the Baseline demand level.

Norfolk Improvement Packages and Annual Delay Savings

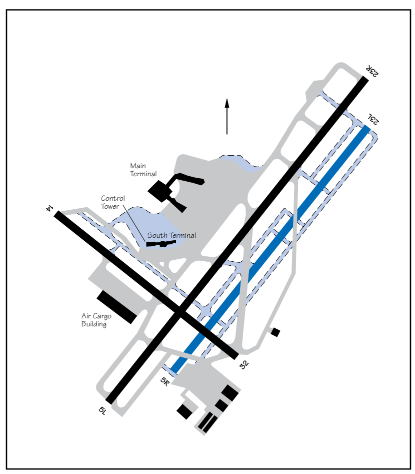
	Packages	Estimated Annual Delay Savings (in hours and millions of 1992 dollars) Baseline 160,000	Future 1 290,000	Future 2 430,000
A.	Extend Runway 14/32	†	346/$0.4	3,072/$4.1
	(1) Extend Runway 14/32 to 5,700 ft.			
B.	Build Runway 5R/23L and use 2.5 nm spacing	†	3,319/$3.7	57,286/$76.1
	(2) Build 7,000 ft. Runway 5R/23L			
	(7) Reduce in-trail separations to 2.5 nm			
B+A	Build Runway 5R/23L, extend Runway 14/32, and use 2.5 nm spacing	†	3,215/$3.6	56,624/$75.2
	(2) Build 7,000 ft. Runway 5R/23L			
	(1) Extend Runway 14/32 to 5,700 ft.			
	(7) Reduce in-trail separations to 2.5 nm			

† Improvement packages were not simulated at this activity levels.

Package A



Package B



Package B&A

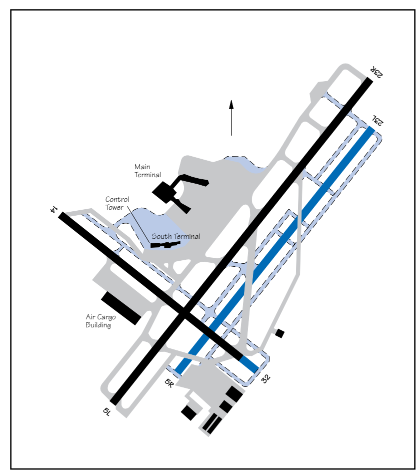


Figure 21. Capacity Enhancement Alternatives and Recommended Actions Newport News/Williamsburg International Airport

Airfield Improvements	Action	Time Frame
1. Extend Runway 2/20 to northeast to at least 10,000 ft. long	Recommended	Future 1
2. Build 6,000 ft. Runway 2E/20E 2,500 ft. east of Runway 2/20	Not Recommended	—
3. Extend Runway 7/25 to northeast to at least 10,000 ft. long	Recommended	Future 2
4. Extend Runway 7/25 1,000 ft. to southwest	Recommended	Future 1
5. Build 8,000 ft. Runway 7N/25N 5,000 ft. north of Runway 7/25	Recommended	Future 1
6. Improve exits and associated taxiways	Recommended	Baseline–Future 1
Facilities and Equipment Improvements		
7. Install CAT II/IIIa ILS on both ends of all air carrier runways	Recommended	Baseline–Future 1
Operational Improvements		
8. Dependent Converging Instrument Approaches (DCIA) on Runways 20 and 25 with CRDA	Recommended	Baseline–Future 1
9. Simultaneous Converging Instrument Approaches (SCIA)	Recommended	Baseline–Future 1
10. Reduce in-trail separations to 2.5 nm between similar class aircraft	Recommended	Baseline–Future 1
11. Operate in southwest flow under VFR during calm wind conditions	Recommended	Baseline–Future 1

The Capacity Team limited its analyses to aircraft activity within the terminal area airspace and on the runway/taxiway system. They considered the technical and operational feasibility 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 Capacity Team can be used in such studies.

Newport News/Williamsburg International Airport

Airfield Improvements

1. Extend Runway 2/20 to northeast to at least 10,000 feet long.

Extending Runway 2/20 to at least 10,000 feet in length would improve the ability of the runway to accommodate larger, heavier air carrier aircraft for transcontinental and international operations. A displaced threshold on Runway 2, placed north of the intersection of Runways 2 and 7, would enable large jets to depart on Runway 2 independent of departures on Runway 7.

Estimated 1993 project cost to extend the runway 3,475 feet is $29 million.

The annual delay savings for extending Runways 2/20 and 7/25 are 2,162 hours or $1.0 million at Future 1 traffic levels, and 58,458 hours or $77.6 million at Future 2.

This project is recommended for implementation for Future 1.

2. Build 6,000 foot Runway 2E/20E 2,500 feet east of Runway 2/20.

Building the new Runway 2E/20E 6,000 feet in length would provide for an additional arrival stream. Currently, the separation between parallel runway centerlines must be at least 4,300 feet for independent operations in all weather conditions (3,400 feet using the Precision Runway Monitor (PRM)). If parallel runway centerlines are spaced from 2,500 feet to less than 4,300 feet apart, the runways are considered dependent under IFR, and aircraft on approach to the two runways must be staggered.

Estimated 1993 project cost is $35 million.

The benefits of this runway are significantly less than those for Runway 7N/25N. There is also an air traffic conflict with Langley AFB.

This project is not recommended.

3. Extend Runway 7/25 to northeast to at least 10,000 feet long.

Extending Runway 7/25 to at least 10,000 feet in length would improve the ability of the runway to accommodate larger, heavier air carrier aircraft. A longer runway would provide air traffic control greater flexibility in the use of runways and thus enhance capacity.

Estimated 1993 project cost is $16 million.

The annual delay savings for extending Runways 2/20 and 7/25 are 58,458 hours or $77.6 million at Future 2 traffic levels.

This project is recommended for implementation for Future 2.

4. Extend Runway 7/25 1,000 feet to the southwest.

Extending Runway 7/25 1,000 feet to the southwest would improve the ability of the airport to accommodate larger, heavier air carrier aircraft by allowing long-haul departures on Runway 7/25. The threshold of Runway 7 would be displaced by 1,000 feet and remain in its current location.

Estimated 1993 project cost is $4 million.

This project is recommended for implementation for Future 1.

5. Build 8,000 foot Runway 7N/25N 5,000 feet north of Runway 7/25.

With a separation between parallel runway centerlines of 5,000 feet, a new Runway 7N/25N on the north side of the airfield would provide for two simultaneous (independent) arrival and departure streams in all weather conditions.

Estimated 1993 project cost is $45 million.

The annual delay savings for this project are 14,254 hours or $6.4 million at Future 1 traffic levels.

This project is recommended for implementation for Future 1.

6. Improve exits and associated taxiways.

Improving exits and associated taxiways, to include adding east/west dual Taxiway D parallel to Taxiway A between Runways 2/20 and 7/25, would reduce runway occupancy times, ease the flow of ground traffic for arriving and departing aircraft taxiing to and from the terminal, and reduce taxi interference and delays. By reducing runway occupancy times, improved exits would increase the likelihood of reducing the minimum in-trail separation to 2.5 nm (see alternative 10).

Estimated 1993 project cost is $8 million.

The annual delay savings for this project are 2,108 hours or $0.9 million at Future 1 traffic levels.

This project is recommended for implementation between Baseline and Future 1 traffic levels.

Facilities and Equipment Improvements

7. Install CAT II/IIIa ILS on both ends of all air carrier runways.

IFR that severely restrict operations (IFR 2/IFR 3—ceiling below 240 feet and visibility below 2,400 feet RVR) only occur about 175 hours per year, but the impact of the associated delays can be significant. Installing a CAT II/IIIa ILS on all air carrier runways would reduce visibility minimums and enhance operational flexibility and thereby help to maintain capacity during very low IMC. To support CAT II/IIIa ILS on all air carrier runways, PHF would need a touchdown runway visual range (RVR), touchdown zone lights (TDZ), centerline lights (CLL), inner marker (IM), outer marker (OM), and a standard approach light system with sequenced flashers and Category II modification (ALSF 2).

Estimated 1993 project cost is $15 million (i.e., $5 million for both ends of each air carrier runway).

This project is recommended for implementation between Baseline and Future 1 traffic levels.

Operational Improvements

8. Dependent Converging Instrument Approaches (DCIA) on Runways 20 and 25 with Converging Runway Display Aid (CRDA).

Because of the reduced visibility and ceilings associated with IFR, simultaneous (independent) use of non-intersecting converging runways is currently permitted for aircraft arrivals only during relatively high weather minimums. However, a program is now available that would allow dependent (alternating) arrivals on non-parallel runways through the use of a Converging Runway Display Aid (CRDA) for air traffic controllers. Potential conflicts with LFI operations reduce the benefit of this option in the north flow. However, this option could provide up to a 20 percent increase in arrival capacity in the south flow.

This project is recommended for implementation between Baseline and Future 1 traffic levels.

9. Simultaneous Converging Instrument Approaches (SCIA).

Under VFR, it is common to use non-intersecting converging runways for independent streams of arriving aircraft. Because of the reduced visibility and ceilings associated with IFR, simultaneous (independent) use of runways is currently permitted for arrivals only during relatively high weather minimums. Simultaneous converging approaches are designed using the "TERPS plus 3" criteria. This refers to the need for missed approach points to be separated by at least 3 nm and for missed approach obstacle-free surfaces not to overlap.

This project is recommended for implementation between Baseline and Future 1 traffic levels.

10. Reduce in-trail separations to 2.5 nm between similar class aircraft.

Existing procedures for IFR require that arriving aircraft be separated by 3 nm or more. Reducing separation minimums to 2.5 nm for aircraft of similar class and less than 300,000 pounds would increase arrival rates and runway capacity. Most of the savings occur at the highest demand levels during IFR operations, but, if the runway exits are not visible from the tower, the 2.5 nm separation cannot be applied.

This project is recommended for implementation between Baseline and Future 1 traffic levels.

11. Operate in southwest flow under VFR during calm wind conditions.

A southwest flow under VFR 1 would allow for a flow rate of 106 to 126 aircraft per hour versus a flow rate of 65 to 78 for the northeast flow. Trade-offs would have to be made in arrival airspace patterns to allow greater use of the southwest flow. As the preferred runway use in calm winds under VFR 1, the southwest flow could be used 66.5 percent of the year instead of 31 percent of the year.

The annual delay savings for this project are 7,842 hours or $3.5 million at Future 1 traffic levels.

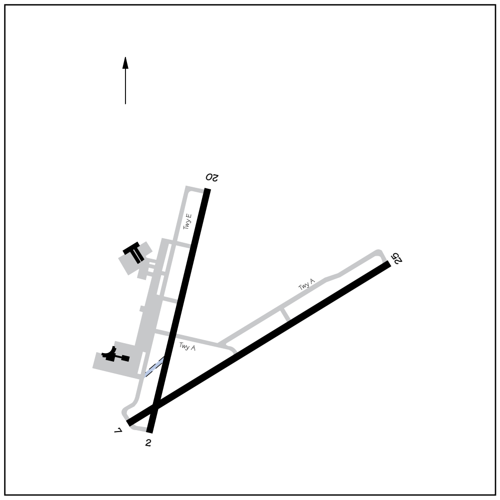
This project is recommended for implementation between Baseline and Future 1 traffic levels.

Newport News/Williamsburg Improvement Packages and Annual Delay Savings

Improvement Packages*		Estimated Annual Delay Savings (in hours and millions of 1992 dollars) Baseline 160,000	Future 1 290,000	Future 2 430,000
A.	Improve taxiway system to allow full use of Runway 2 for small GA departures	172/$0.1	2,108/$0.9	24,928/$33.1
B.	Southwest flow preferred in VFR 1	455/$0.2	7,842/$3.5	34,252/$45.5
	(11) Operate in southwest flow in VFR 1			
C.	Extend runways	†	2,162/$1.0	58,458/$77.6
	(1) Extend Runway 2/20 to at least 10,000 ft.			
	(3) Extend Runway 7/25 to at least 10,000 ft.			
D.	Extend runways, southwest flow preferred in VFR 1	†	8,755/$3.9	73,278/$97.3
	(1,3) Extend existing runways to at least 10,000 ft.			
	(11) Operate in southwest flow in VFR 1			
E.	Build east parallel and extend runways	†	†	75,738/$100.6
	(2) Build 6,000 ft. Runway 2E/20E			
	(1,3) Extend existing runways to at least 10,000 ft.			
F.	Build north parallel runway	†	14,254/$6.4	173,158/$230.0
	(5) Build 8,000 ft. Runway 7N/25N			
F+C.	Build north parallel and extend runways	†	†	173,826/$230.8
	(5) Build 8,000 ft. Runway 7N/25N			
	(1,3) Extend existing runways to at least 10,000 ft.			
	Savings over Package F			*668/$0.9*
	Additional savings in taxi time			*4,773/$6.3*

† Improvement packages were not simulated at these activity levels.

Package A



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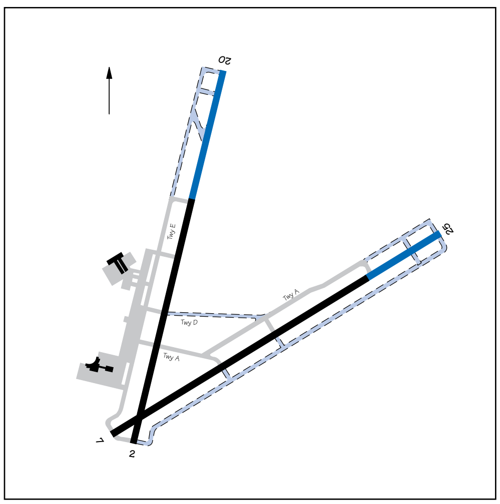

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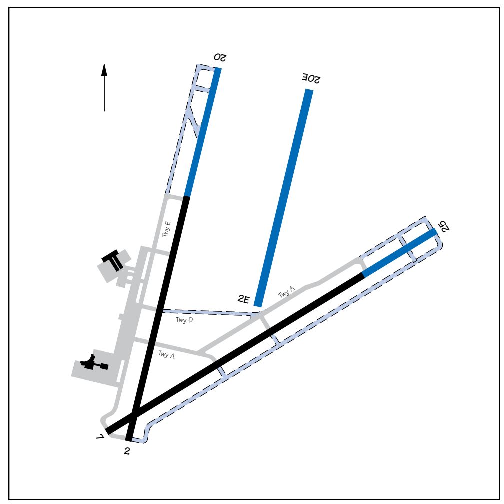

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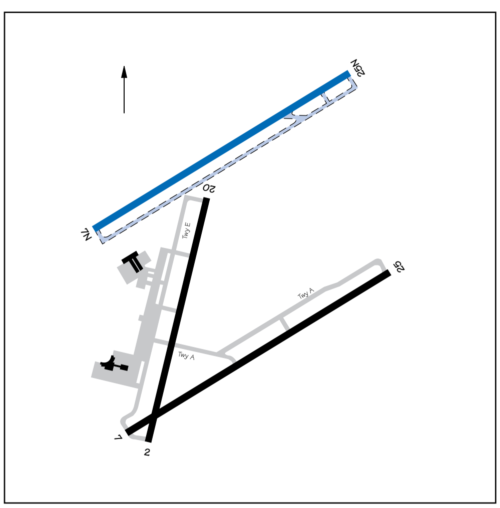
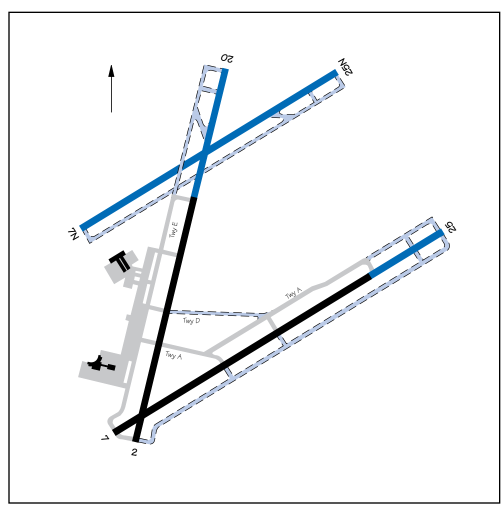


Package F&C



Section 3

Summary of Technical Studies

Overview

The Eastern Virginia Airport Capacity Design Team evaluated the efficiency of the existing runway/taxiway system and the proposed future configurations at each of the three airports—Richmond, Norfolk, and Newport News/Williamsburg. A brief description of the computer model and methodology used can be found in Appendix B. The potential benefits of various improvements were determined by examining airfield demand, airfield capacity, and average aircraft delays.

The EVA Capacity 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:

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

Aircraft delay was 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 use of the same facilities. The major factors influencing aircraft delays are:

- Weather.
- Airfield physical characteristics.
- Air traffic control procedures.
- Aircraft operational characteristics.
- Airfield and ATC system demand.

Air traffic demand levels were derived from *Official Airline Guide* and historical data and from Capacity Team and other forecasts. Daily operations corresponding to an average busy day in the peak month were used for each of the forecast periods. The Capacity Team used the Runway Delay Simulation Model (RDSIM) 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 provide a basis for comparing the benefits of the proposed changes. The benefits associated with various runway use strategies were also identified. The cost of a particular improvement was measured against its annual delay savings. This comparison indicates which improvement will be the most effective. For expected increases in demand, a combination of improvements can be implemented to allow airfield capacity to increase while aircraft delays are minimized.

Certain standard inputs were used to reflect the operating environment at each airport. Details can be found in the data packages produced by the FAA Technical Center during the course of the study. A brief summary of the data follows.

Airfield weather conditions, runway utilization under these conditions, and baseline runway configurations for each airport are detailed in Figures 22 through 24 for Richmond International Airport, Figures 25 through 27 for Norfolk International Airport, and Figures 28 through 30 for Newport News/Williamsburg International Airport.

Figure 31 shows the characteristics of the aircraft fleet at the three EVA air carrier airports.

Figure 32 shows the average-day, peak-month arrival and departure demand levels for each of the three EVA airports for the three annual activity levels used in the study, Baseline, Future 1, and Future 2.

Figures 33 through 35 break down the annual demand characteristics for each airport for Baseline and Future 1 activity levels. Each of the three EVA airports has a distinct mix of aircraft types and operations and a unique hourly count of operations.

At Future 2 activity levels, the EVA Region is likely to be served by a "connecting hub" airport. Figure 36 shows the breakdown of aircraft types and operations. Since the region will probably support only one connecting hub, all three airports have been given the same mix of aircraft types and operations and the same hourly count.

A fleet mix cost was developed for each airport at each demand level, which can be seen in Figure 37. These weighted-average direct operating costs represent the costs for operating the aircraft and include such items as fuel, maintenance, depreciation, leases, insurance, and flight crew salaries, but they do not consider cabin crew salaries, ticketing, ground equipment, landing fees, lost passenger time, disruption to airline schedules, or any other intangible factors. Cost information for air carrier aircraft was obtained from AVMARK, Inc. *Quarterly Aircraft Operating Costs and Statistics*. Operating costs for non-scheduled aircraft were derived using data provided by FAA's Statistical and Forecast Branch, APO-110.

Figure 22. Airfield Weather—Richmond International Airport

Ceiling/Visibility		Occurrence
VFR 1	2,500 ft. and above/3 mi and above	71.8%
VFR 2	1,000 ft. to 2,500/3 mi and above	13.9%
IFR 1	300 to 1,000 ft./0.75 to 3 mi	14.3%
	Total	100.0%

Note: RIC has 240 hours of IFR 2. IFR 2 was not simulated. The VFR and IFR 1 percentages were normalized so they would sum to 100%.

Figure 23. Runway Utilization—Richmond International Airport

	VFR 1	VFR 2	IFR 1	Total
North Flow	48.3%	9.4%	10.1%	67.8%
South Flow	23.5%	4.5%	4.2%	32.2%
Total	71.8%	13.9%	14.3%	100.0%

Figure 24. Runway Configurations—Current Airport Richmond International Airport

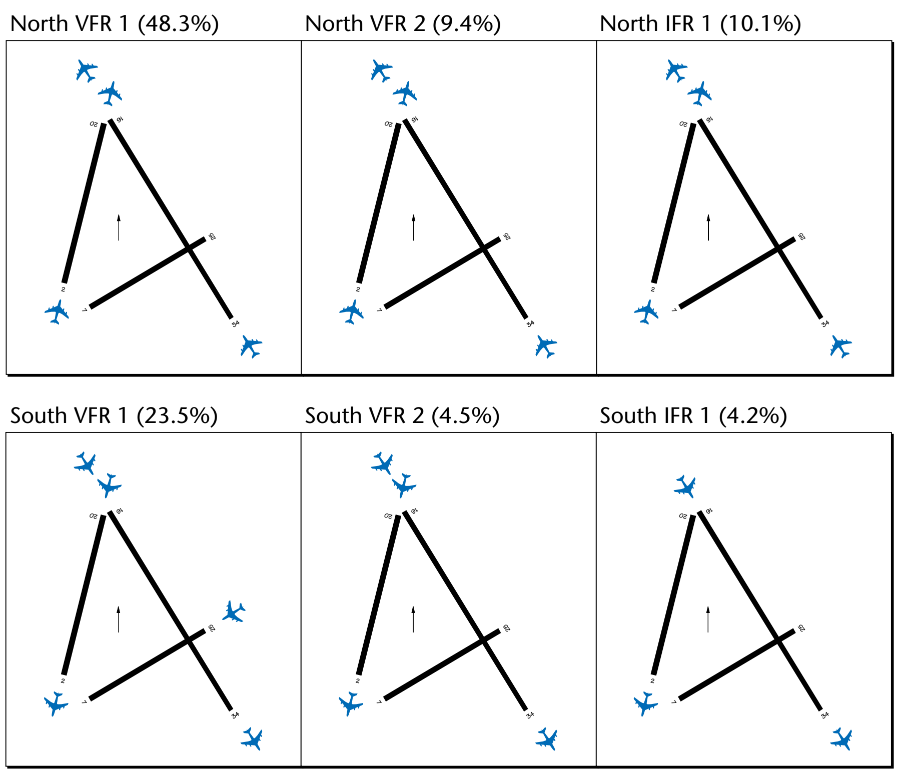


Figure 25. Airfield Weather—Norfolk International Airport

Ceiling/Visibility		Occurrence
VFR 1	2,100 ft. and above/3 mi and above	89.0%
VFR 2	1,000 ft. to 2,100/3 mi and above	(see note)
IFR 1	300 to 1,000 ft./0.75 to 3 mi	11.0%
	Total	100.0%

Note: ORF has 96 hours of VFR 2 per year and 175 hours of IFR 2/IFR 3. VFR 2 and IFR 2/IFR 3 were not simulated. The VFR 1 and IFR 1 percentages were normalized so they would sum to 100%.

Figure 26. Runway Utilization—Norfolk International Airport

	VFR 1	IFR 1	Total
Northeast Flow	45.0%	6.0%	51.0%
Southwest Flow	44.0%	5.0%	49.0%
Total	89.0%	11.0%	100.0%

Figure 27. Runway Configurations—Current Airport Norfolk International Airport

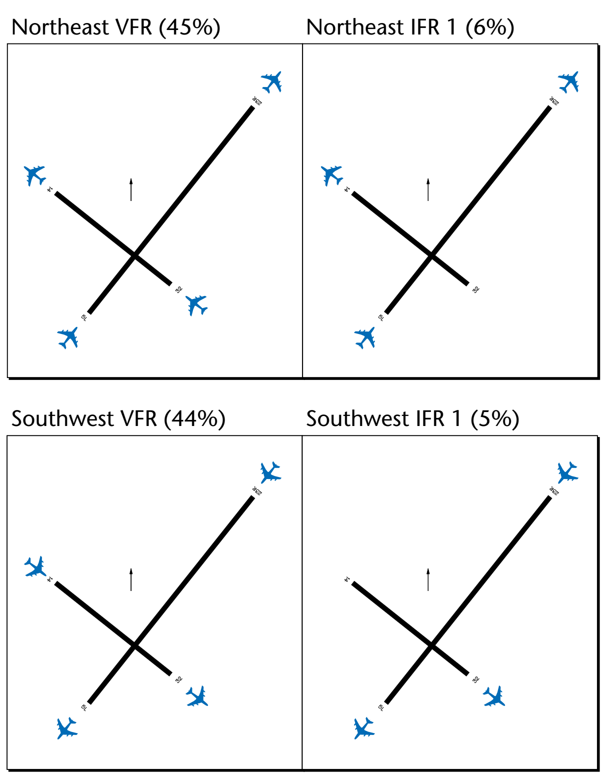


Figure 28. Airfield Weather
Newport News/Williamsburg International Airport

	Ceiling/Visibility	Occurrence
VFR 1	1,700 ft. and above/3 mi and above	89.0%
VFR 2	1,000 ft. to 1,700/3 mi and above	(see note)
IFR 1	240 to 1,000 ft./2,400 ft. RVR to 3 mi (Rwy 7) 460 to 1,000 ft./1 to 3 mi (Rwy 25 back-course)	11.0%
	Total	100.0%

Note: PHF has 96 hours of VFR 2 per year and 175 hours of IFR 2/IFR 3. VFR 2 and IFR 2/IFR 3 were not simulated. The VFR 1 and IFR 1 percentages were normalized so they would sum to 100%.

Figure 29. Runway Utilization (Northeast Flow Preferred)
Newport News/Williamsburg International Airport

	VFR 1	IFR 1	Total
Northeast Flow	58.0%	9.0%	67.0%
Southwest Flow	31.0%	2.0%	33.0%
Total	89.0%	11.0%	100.0%

Figure 30. Runway Configurations—Current Airport (Northeast Flow Preferred)
Newport News/Williamsburg International Airport

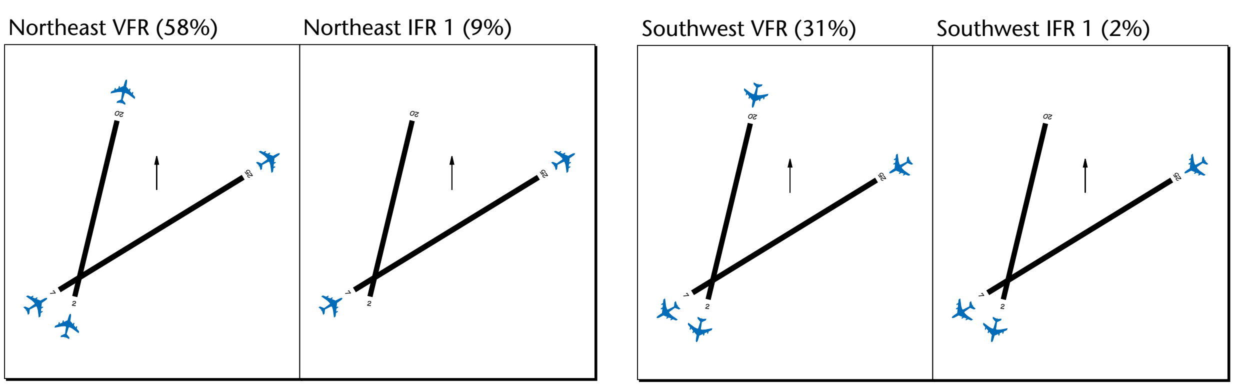
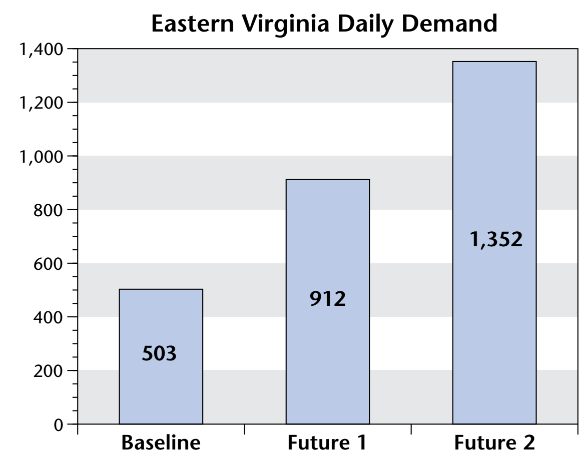


Figure 31. Aircraft Fleet Characteristics

Aircraft Class	Aircraft Types	Approach Speed (knots) VFR/IFR
Class 4	Small single-engine props under 12,500 lbs.	90
Class 3	Small twin-engine props under 12,500 lbs.	115
Class 2	Large aircraft between 12,500 and 300,000 lbs.	130
Class 1	Heavy aircraft over 300,000 lbs.	140

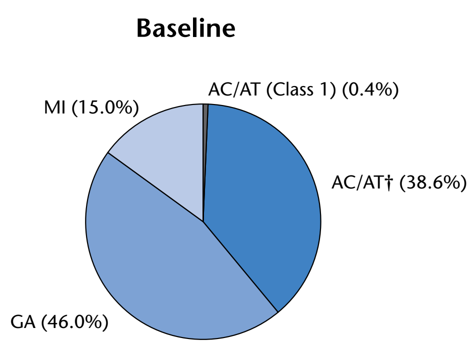
Figure 32. Eastern Virginia Airfield Demand Levels

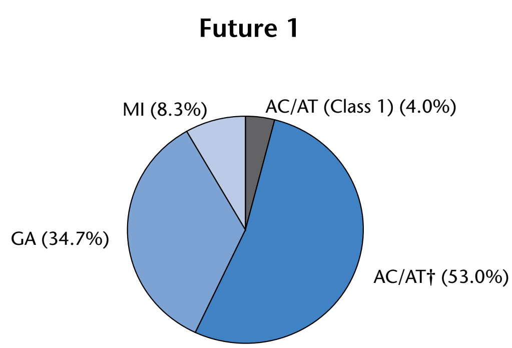


24-Hour Day, Average Day		
	Annual	Peak Month
Baseline	160,000	503
Future 1	290,000	912
Future 2	430,000	1,352

Figure 33. Demand Characteristics Richmond International Airport

Demand (Annual Ops)	Air Carrier/ Air Taxi Class 1		Air Carrier/ Air Taxi Class 2/3/4		General Aviation Class 2/3/4		Non-Military Subtotal		Military Class 2/3/4		Total Activity
Baseline	636	0.4%	61,764	38.6%	73,600	46.0%	136,000	85.0%	24,000	15.0%	160,000
Future 1	11,650	4.0%	153,796	53.0%	100,554	34.7%	266,000	91.7%	24,000	8.3%	290,000

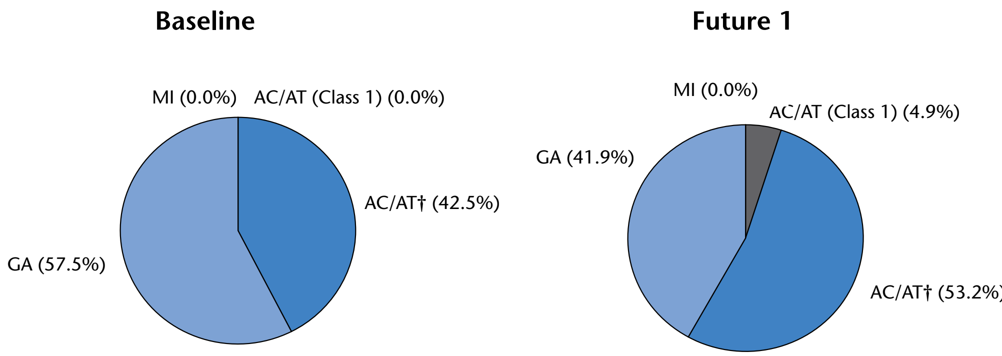




† - Includes Classes 2, 3, & 4

Figure 34. Demand Characteristics Norfolk International Airport

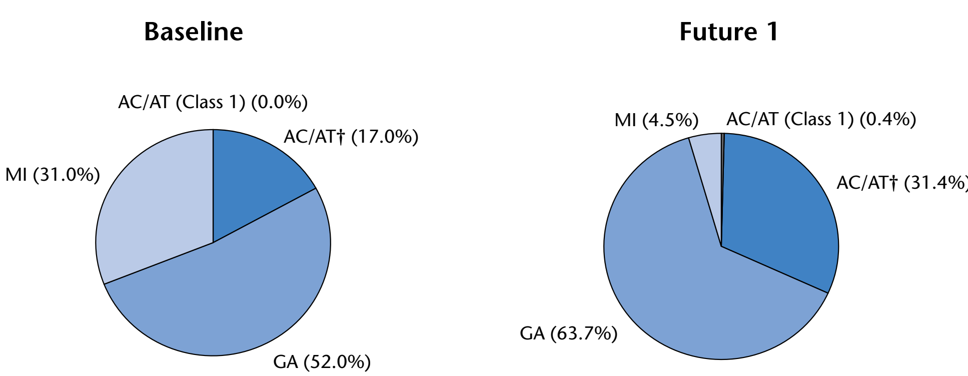
Demand (Annual Ops)	Air Carrier/ Air Taxi Class 1		Air Carrier/ Air Taxi Class 2/3/4		General Aviation Class 2/3/4		Non-Military Subtotal		Military Class 2/3/4		Total Activity
Baseline	0	0.0%	68,000	42.5%	92,000	57.5%	160,000	100%	0	0.0%	160,000
Future 1	14,210	4.9%	154,280	53.2%	121,510	41.9%	290,000	100%	0	0.0%	290,000



† - Includes Classes 2, 3, & 4

Figure 35. Demand Characteristics Newport News/Williamsburg International Airport

Demand (Annual Ops)	Air Carrier/ Air Taxi Class 1		Air Carrier/ Air Taxi Class 2/3/4		General Aviation Class 2/3/4		Non-Military Subtotal		Military Class 2/3/4		Total Activity
Baseline	0	0.0%	27,200	17.0%	83,200	52.0%	110,400	69.0%	49,600	31.0%	160,000
Future 1	1,272	0.4%	90,902	31.4%	184,626	63.7%	276,800	95.5%	13,200	4.5%	290,000



† - Includes Classes 2, 3, & 4

Figure 36. Hub Demand Characteristics—Annual Distribution of Traffic Type of Operations and Fleet Mix

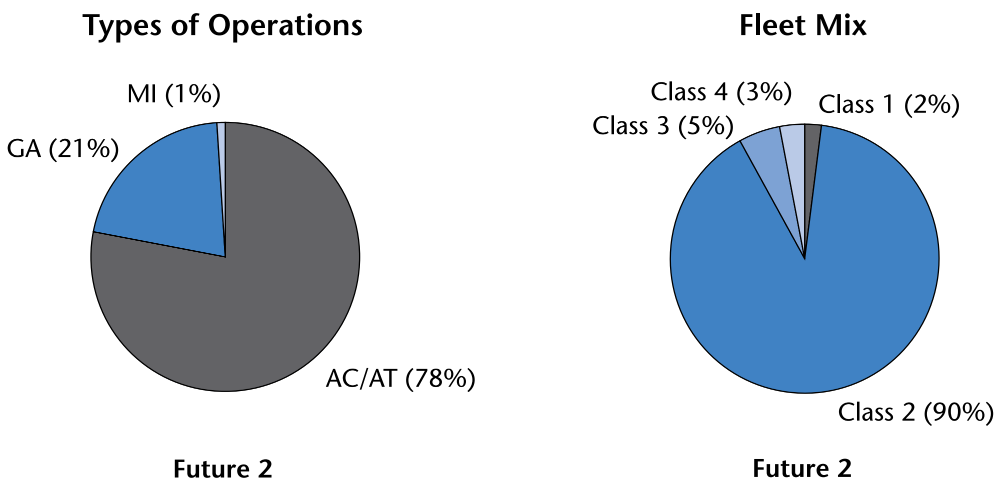


Figure 37. Fleet Mix Direct Operating Costs

	Direct Operating Cost Per Hour		
	Baseline	**Future 1**	**Future 2**
Richmond (RIC)	$934	$1,304	$1,328
Norfolk (ORF)	$782	$1,122	$1,328
Newport News/Williamsburg (PHF)	$450	$450	$1,328

Section 4

Summary of Results

Richmond International Airport

Figure 38 presents the airport capacity curves for Richmond International Airport. These curves were developed for the north and south flow runway configurations, under instrument flight rules (IFR) and visual flight rules (VFR), with a 50/50 split of arrivals and departures. These curves are based on the assumption that arrival and departure demands are randomly distributed within the hour. Other patterns of demand can alter the demand/delay relationship.

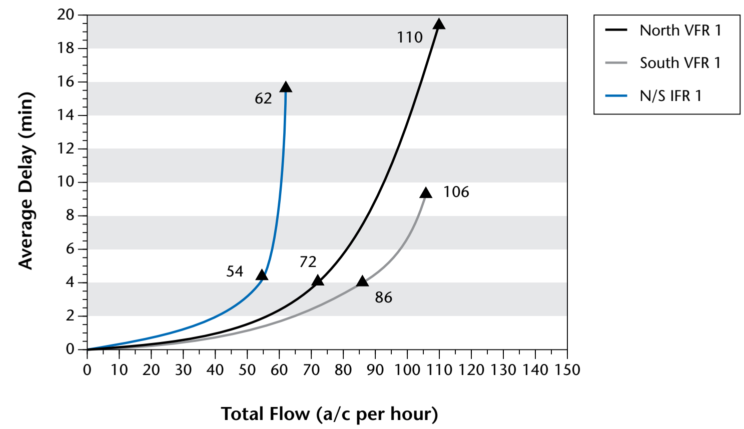
The curves in Figure 38 illustrate the relationship between airfield capacity, stated in the number of operations per hour, and the average delay per aircraft. They show that, as the number of aircraft operations per hour increases, the average delay per operation increases exponentially.

Figure 39 illustrates the hourly profile of daily demand for the Baseline activity level of 160,000 aircraft operations per year. It also includes the profile of daily operations for the Future 1 activity level of 290,000 aircraft operations per year and the Future 2 activity level of 430,000 operations per year.

Comparing the information in Figures 38 and 39 shows that:

- Aircraft delays will begin to escalate rapidly under IFR as hourly demand exceeds 54 operations per hour, and,
- While hourly demand does not exceed 54 operations at Baseline demand levels, 54 operations per hour is frequently exceeded at the demand levels forecast for Future 1 and Future 2.

Figure 38. Airport Capacity Curves—Hourly Flow Rate Versus Average Delay Richmond International Airport



Note: North VFR1 curve shows capacity achieved by substituting a departure for an arrival.

Figure 39. Profile of Daily Demand—Hourly Distribution Richmond International Airport

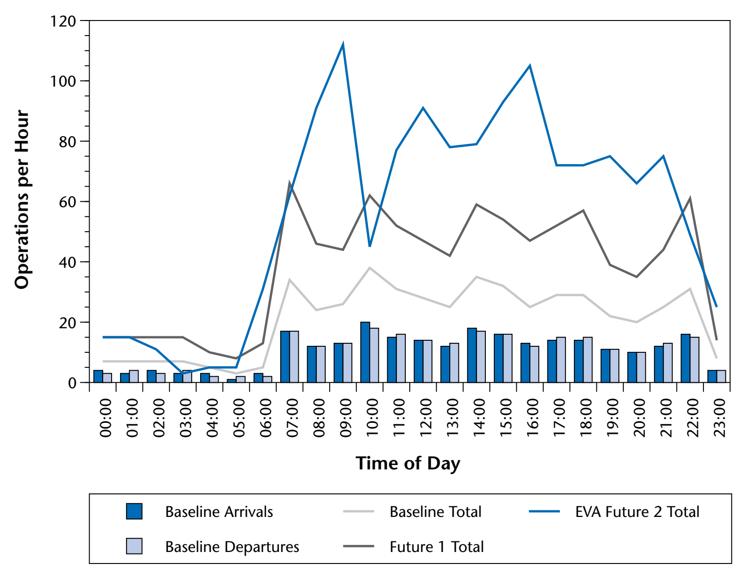


Figure 40 demonstrates the impact of delays at Richmond International Airport. The chart shows how delay will continue to grow at a substantial rate as demand increases if there are no improvements made in airfield capacity, i.e., the Do Nothing scenario.

The chart also shows the savings in delay costs as shown in the table below.

Figure 41 illustrates the average delay in minutes per aircraft operation for these same alternatives. Under the Do Nothing alternative, if there are no improvements made in airfield capacity, the average delay per operation of 0.4 minutes at the Baseline level of activity will increase to 1.5 minutes per operation by Future 1 and 20.7 minutes per operation by Future 2.

	Annual Delay Costs	
	Hours	Millions of 1992 $
Baseline	957	$0.9
Future 1	7,192	$9.4
Future 2	148,414	$197.1

	Annual Delay Savings			
	Future 1		Future 2	
Improvement Packages	Hours	1992 $ M	Hours	1992 $ M
• Improve exits and taxiways to allow full use of Runway 34 for arrivals	†	†	754	$1.0
• Extend three existing runways and improve exits and taxiways	1,616	$2.1	46,600	$61.9
• Build Runway 2R/20L; extend Runways 16/34 and 2/20; and improve exits and taxiways	2,254*	$2.9*	119,924	$159.3
• Build Runway 7R/25L; extend Runways 7/25, 16/34, and 2/20; and improve exits and taxiways	2,254*	$2.9*	124,415	$165.2
• Build Runway 16L/34R; extend Runways 16/34 and 2/20, and improve exits and taxiways	2,254*	$2.9*	124,899	$165.9

† Improvement packages were not simulated at this activity level.
* Estimated annual delay savings for a parallel runway at Future 1.

Figure 40. Annual Delay Costs—Capacity Enhancement Alternatives Richmond International Airport

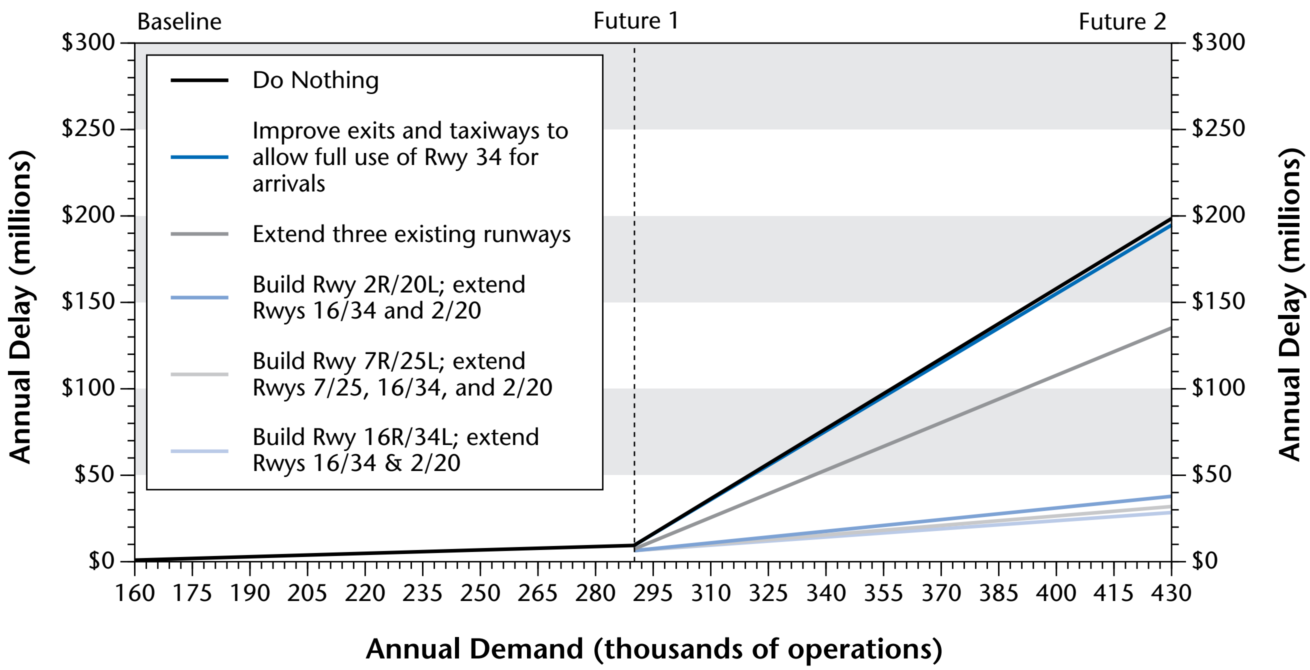
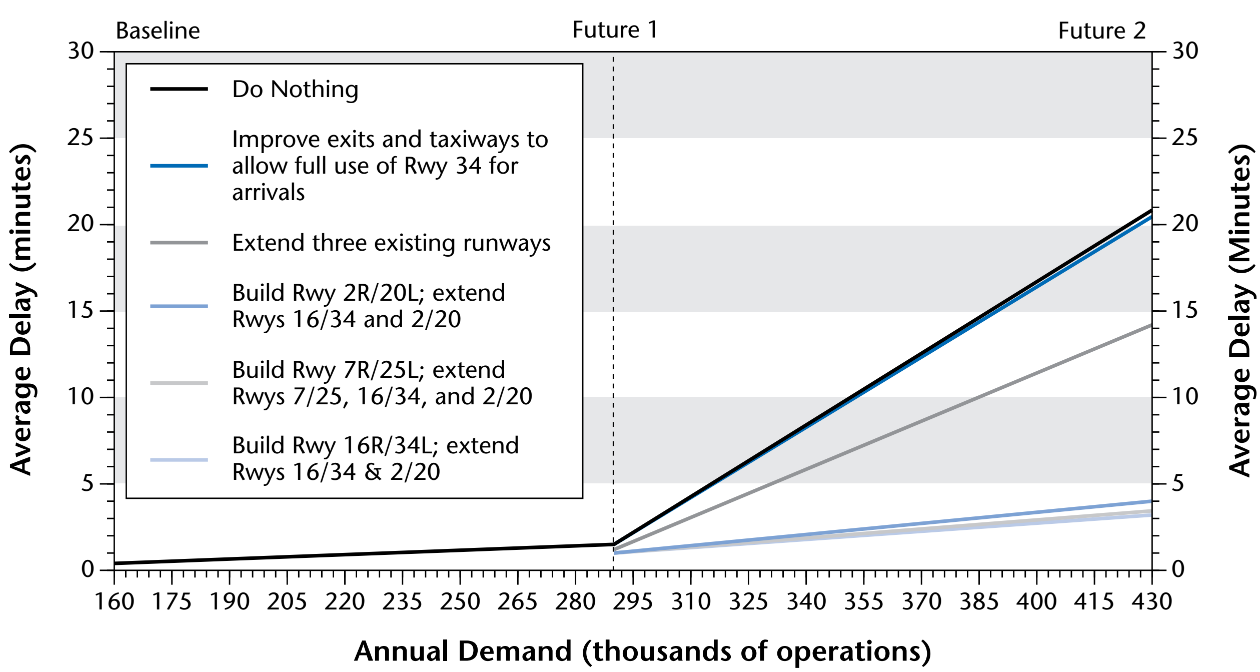


Figure 41. Average Delays—Capacity Enhancement Alternatives Richmond International Airport



Norfolk International Airport

Figure 42 presents the airport capacity curves for Norfolk International Airport. These curves were developed for the southwest flow runway configuration, under IFR and VFR, with a 50/50 split of arrivals and departures. These curves are based on the assumption that arrival and departure demands are randomly distributed within the hour. Other patterns of demand can alter the demand/delay relationship.

The curves in Figure 42 illustrate the relationship between airfield capacity, stated in the number of operations per hour, and the average delay per aircraft. They show that, as the number of aircraft operations per hour increases, the average delay per operation increases exponentially.

Figure 43 illustrates the hourly profile of daily demand for the Baseline activity level of 160,000 aircraft operations per year. It also includes the profile of daily operations for the Future 1 activity level of 290,000 aircraft operations per year and the Future 2 activity level of 430,000 operations per year.

Comparing the information in Figures 42 and 43 shows that:

- Aircraft delays will begin to escalate rapidly under IFR as hourly demand exceeds 54 operations per hour, and,
- While hourly demand does not exceed 54 operations at Baseline demand levels, 54 operations per hour is frequently exceeded at the demand levels forecast for Future 1 and Future 2.

Figure 42. Airport Capacity Curves—Hourly Flow Rate Versus Average Delay Norfolk International Airport

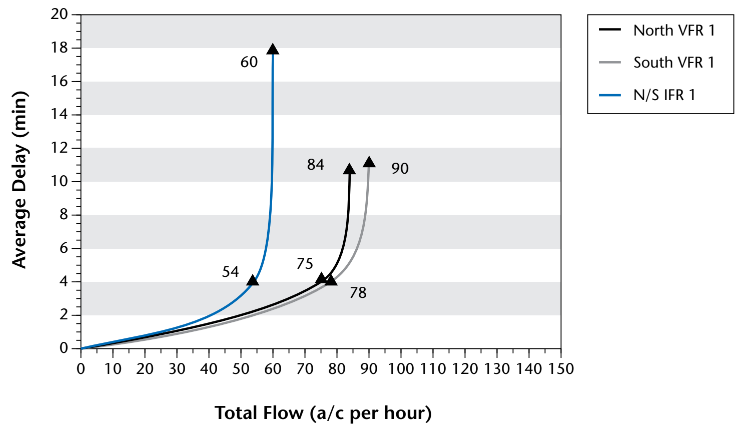


Figure 43. Profile of Daily Demand—Hourly Distribution Norfolk International Airport

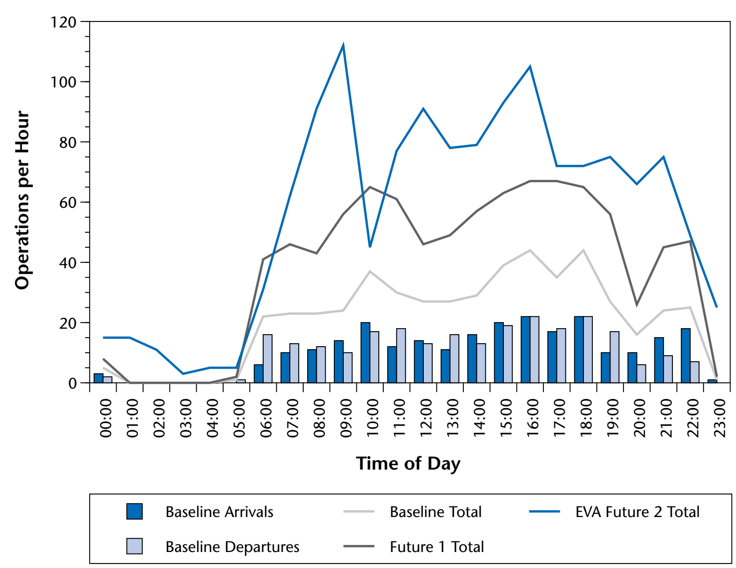


Figure 44 demonstrates the impact of delays at Norfolk International Airport. The chart shows how delay will continue to grow at a substantial rate as demand increases if there are no improvements made in airfield capacity, i.e., the Do Nothing scenario.

The chart also shows the savings in delay costs as shown in the table below.

Figure 45 illustrates the average delay in minutes per aircraft operation for these same alternatives. Under the Do Nothing alternative, if there are no improvements made in airfield capacity, the average delay per operation of 0.4 minutes at the Baseline level of activity will increase to 2.0 minutes per operation by Future 1 and 19.5 minutes per operation by Future 2.

	Annual Delay Costs	
	Hours	Millions of 1992 $
Baseline	1,082	$0.8
Future 1	9,846	$11.0
Future 2	140,040	$186.0

	Annual Delay Savings			
	Future 1		Future 2	
Improvement Packages	Hours	1992 $ M	Hours	1992 $ M
• Extend Runway 14/32 to 5,700 ft.	346	$0.4	3,072	$4.1
• Build Runway 5R/23L and use 2.5 nm spacing	3,319	$3.7	57,286	$76.1
• Build Runway 5R/23L; extend Runway 14/32 to 5,700 ft.; and use 2.5 nm spacing	3,215	$3.6	56,624	$75.2

Figure 44. Annual Delay Costs—Capacity Enhancement Alternatives Norfolk International Airport

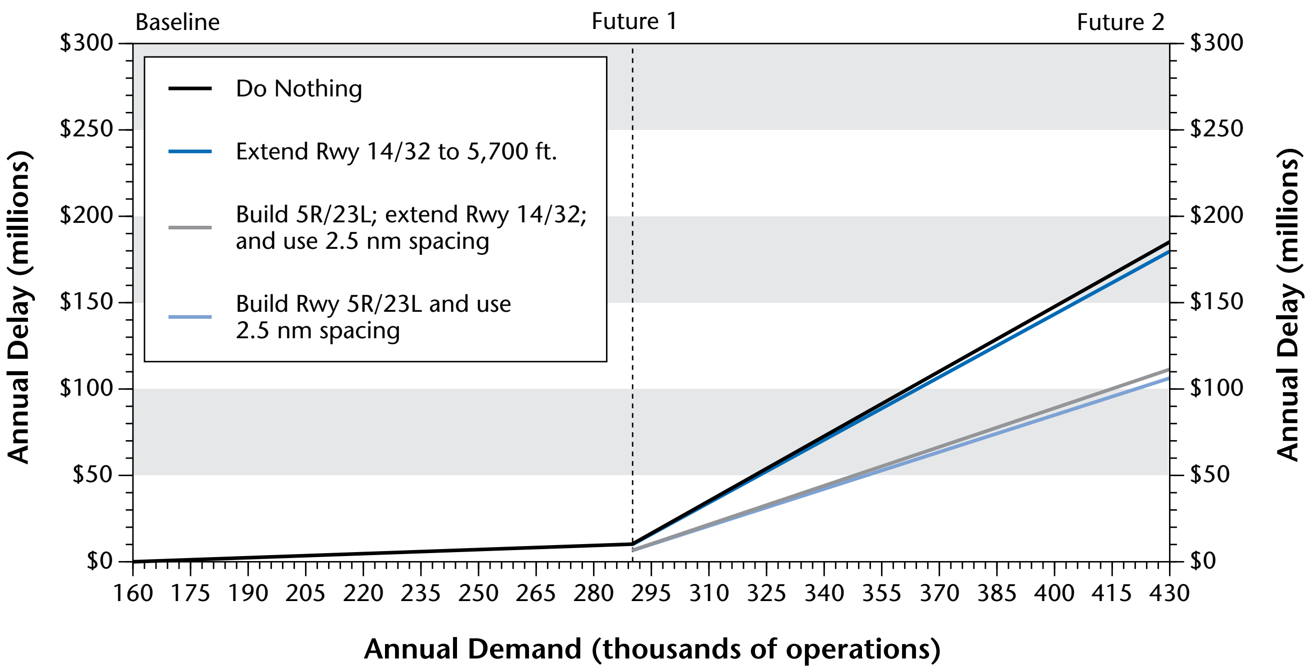
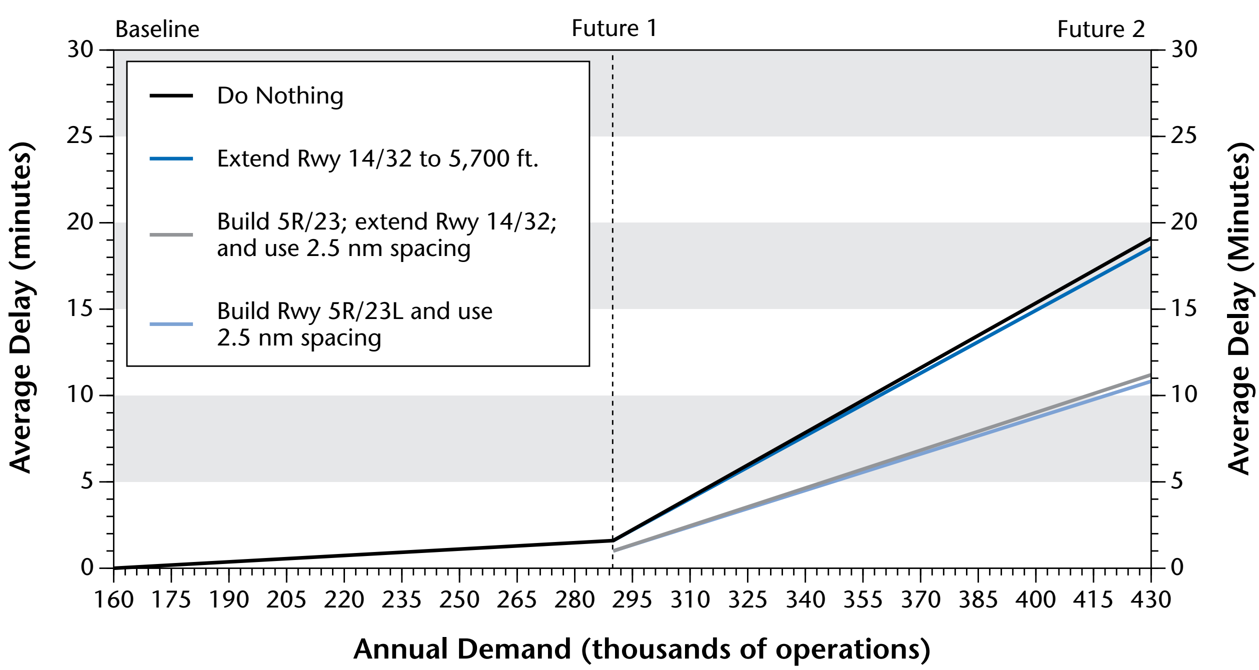


Figure 45. Average Delays—Capacity Enhancement Alternatives Norfolk International Airport



Newport News/Williamsburg International Airport

Figure 46 presents the airport capacity curves for Newport News/Williamsburg International Airport. These curves were developed for the north and south flow runway configurations, under IFR and VFR, with a 50/50 split of arrivals and departures. These curves are based on the assumption that arrival and departure demands are randomly distributed within the hour. Other patterns of demand can alter the demand/delay relationship.

The curves in Figure 46 illustrate the relationship between airfield capacity, stated in the number of operations per hour, and the average delay per aircraft. They show that, as the number of aircraft operations per hour increases, the average delay per operation increases exponentially.

Figure 47 illustrates the hourly profile of daily demand for the Baseline activity level of 160,000 aircraft operations per year. It also includes the profile of daily operations for the Future 1 activity level of 290,000 aircraft operations per year and the Future 2 activity level of 430,000 operations per year.

Comparing the information in Figures 46 and 47 shows that:

- Aircraft delays will begin to escalate rapidly under IFR as hourly demand exceeds 50 operations per hour, and,
- While hourly demand exceeds 50 operations only during the peak hours of the day at Baseline demand levels, 50 operations per hour is frequently exceeded at the demand levels forecast for Future 1 and Future 2.

Figure 46. Airport Capacity Curves—Hourly Flow Rate Versus Average Delay Newport News/Williamsburg International Airport

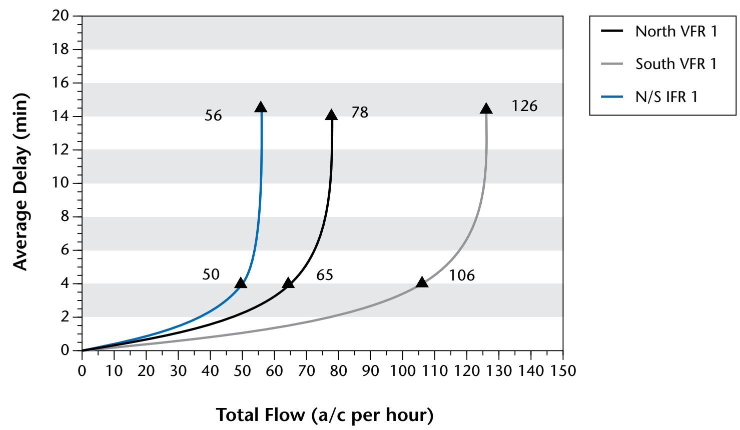


Figure 47. Profile of Daily Demand—Hourly Distribution Newport News/Williamsburg International Airport

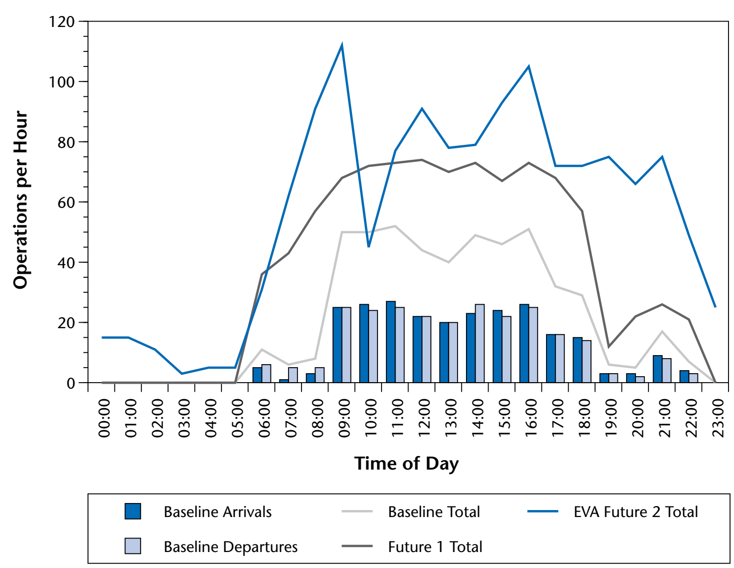


Figure 48 demonstrates the impact of delays at Newport News/Williamsburg International Airport. The chart shows how delay will continue to grow at a substantial rate as demand increases if there are no improvements made in airfield capacity, i.e., the Do Nothing scenario.

The chart also shows the savings in delay costs as shown in the table below.

Figure 49 illustrates the average delay in minutes per aircraft operation for these same alternatives. Under the Do Nothing alternative, if there are no improvements made in airfield capacity, the average delay per operation of 0.8 minutes at the Baseline level of activity will increase to 3.9 minutes per operation by Future 1 and 27.4 minutes per operation by Future 2.

	Annual Delay Costs	
	Hours	Millions of 1992 $
Baseline	2,019	$0.9
Future 1	19,001	$8.6
Future 2	196,127	$260.5

Improvement Packages	Annual Delay Savings Future 1 Hours	Future 1 1992 $ M	Future 2 Hours	Future 2 1992 $ M
• Improve taxiway system to allow full use of Runway 2 for small GA departures	2,108	$0.9	24,928	$33.1
• Operate with southwest flow preferred in VFR 1	7,842	$3.5	34,252	$45.5
• Extend Runways 2/20 and 7/25 to at least 10,000 ft. with southwest flow preferred in VFR 1	8,755	$3.9	73,278	$97.3
• Build 8,000 ft. north parallel Runway 7N/25N and extend Runways 2/20 and 7/25 to at least 10,000 ft.	†	†	173,826	$230.8

† Improvement packages were not simulated at this activity level.

Figure 48. Annual Delay Costs—Capacity Enhancement Alternatives Newport News/Williamsburg International Airport

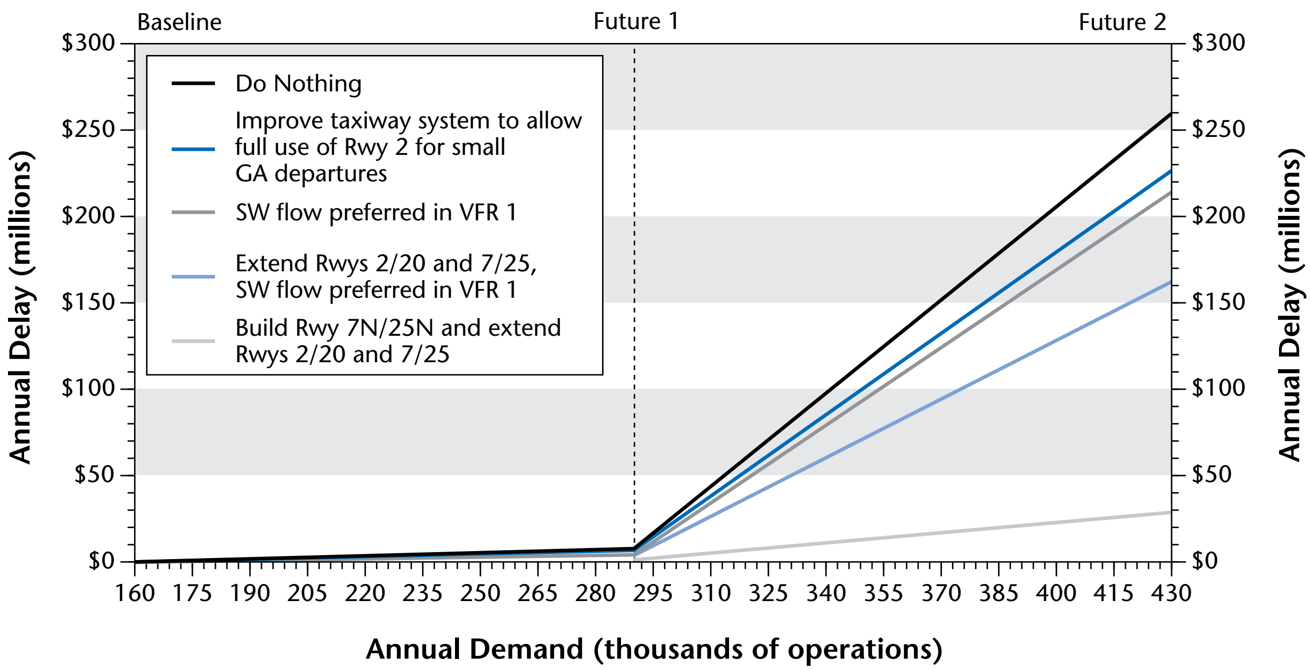
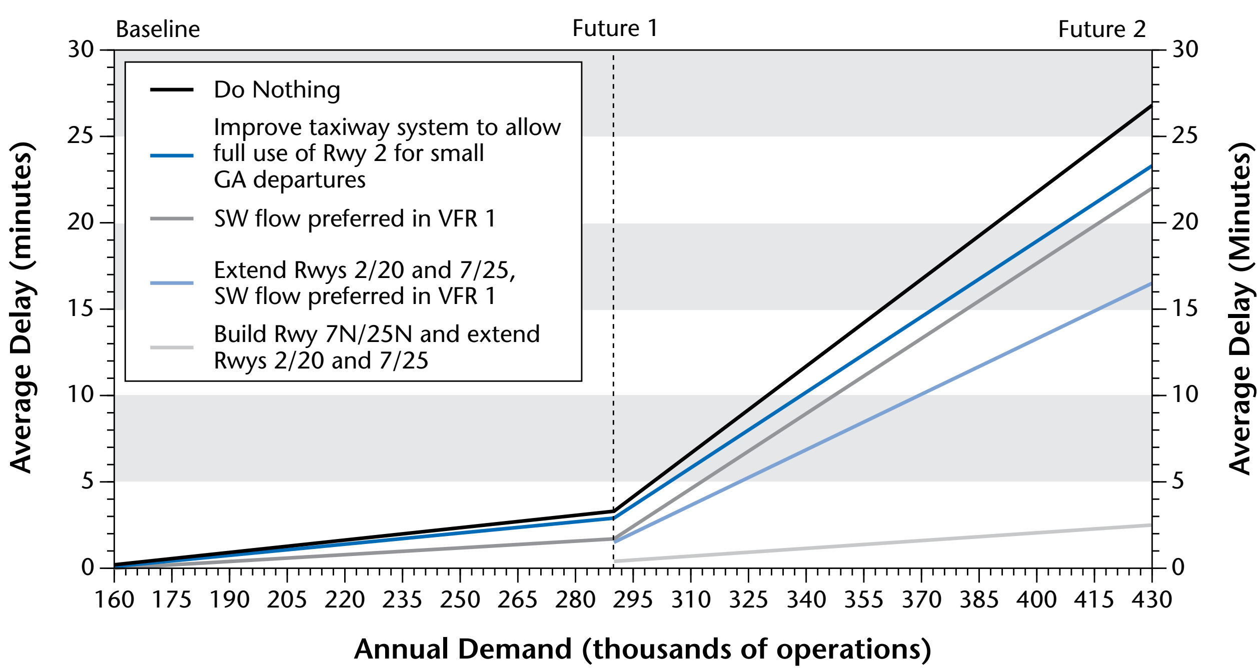


Figure 49. Average Delays—Capacity Enhancement Alternatives Newport News/Williamsburg International Airport



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Appendix A

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APPENDIX B

COMPUTER MODEL AND METHODOLOGY

Computer Model

The EVA Capacity 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.

Runway Delay Simulation Model (RDSIM)

RDSIM is a short version of the Airfield Delay Simulation Model (ADSIM). ADSIM is a fast-time, discrete event model that 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.

RDSIM, on the other hand, simulates only the runways and runway exits. There are two versions of the model. The first version ignores the taxiway and gate complexes for a user-specified daily traffic demand and is used to calculate daily demand statistics. In this mode, the model replicates each experiment forty times, using Monte Carlo sampling techniques to introduce system variability, which occurs on a daily basis in actual airport operations. The results are averaged to produce output statistics. The second version also simulates the runway and runway exits only, but it creates its own demand using randomly assigned arrival and departure times. The demand created is based upon user-specified parameters. This form of the model is suitable for capacity analysis.

For this study, RDSIM was calibrated against field data collected at RIC, ORF, and PHF to ensure that the model was site specific. For a given demand, the model calculated the hourly flow rate and average delay per aircraft during the full period of airport operations. Using the same aircraft mix, simulation analysts simulated different demand levels for each run to generate demand versus delay relationships.

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, the FAA used different airfield configurations 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, simulation analysts developed traffic demands based on the *Official Airline Guide*, historical data, and various forecasts. Aircraft volume, mix and peaking characteristics were developed for three activity levels (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 case.

APPENDIX C

LIST OF ABBREVIATIONS

ADSIM	Airfield Delay Simulation Model
AFB	Air Force Base
ALP	Airport Layout Plan
ALSF-II	Approach Light System with Sequenced Flashers and CAT II modification
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASC	Office of System Capacity and Requirements, FAA
ATC	Air Traffic Control
ATCT	Airport Traffic Control Tower
CAT	Category—of instrument landing system
CLL	Centerline Lights
CPDC	Crater Planning District Commission
CRDA	Converging Runway Display Aid
DCIA	Dependent Converging Instrument Approaches
EVA	Eastern Virginia
FAA	Federal Aviation Administration
FACSFAC	Fleet Area Control and Surveillance Facility
HIRL	High Intensity Runway Lights
HRPDC	Hampton Roads Planning District Commission
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IM	Inner Marker
IMC	Instrument Meteorological Conditions
LFI	Langley AFB
MALSR	Medium Intensity Approach Light System with Runway Alignment Indicator
MI	Miles
NAS	Naval Air Station
NGU	NAS Norfolk
NM	Nautical miles
NTU	NAS Oceana
OM	Outer Marker
ORF	Norfolk International Airport
PDC	Planning District Commission
PHF	Newport News/Williamsburg International Airport
PRM	Precision Runway Monitor
RDSIM	Runway Delay Simulation Model
RIC	Richmond International Airport
RRPDC	Richmond Regional Planning District Commission
RVR	Runway Visual Range
RWY	Runway
SCIA	Simultaneous Converging Instrument Approaches
TDZ	Touchdown Zone
TERPS	Terminal Instrument Procedures
VACAPES	Virginia Capes
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions

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