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TECHNICAL MEMORANDUM NO. 3 — FACILITY REQUIREMENTS

MASTER PLAN UPDATE
PORTLAND INTERNATIONAL AIRPORT

Prepared for
Port of Portland
Portland, Oregon

December 2008

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Chicago • Cincinnati • Dallas • London • New Delhi • Ottawa • San Francisco • Washington, D.C.

CONTENTS

1. INTRODUCTION AND SUMMARY 1-1

1.1 Planning Activity Levels 1-1
1.2 Summary of Requirements 1-2
1.3 Process 1-8
1.4 Sustainability 1-8

2. AIRFIELD CAPACITY AND AIRCRAFT DELAY 2-1

2.1 Background 2-3
2.1.1 Existing Airfield Layout 2-3
2.1.2 Current Constraints on Airfield Capacity 2-4
2.1.3 Wind Coverage of Runway Use Configurations 2-5
2.1.4 Operational Weather Category Descriptors 2-7
2.1.5 Runway Uses and Weather Conditions – Historical 2-7

2.2 FAA Benchmark Capacities 2-8
2.2.1 FAA Benchmark Capacities – VMC 2-10
2.2.2 FAA Benchmark Capacities – MVMC and IMC 2-11
2.2.3 Effect of Weather on Capacity Benchmarks 2-12
2.2.4 FAA Benchmark Capacities with Planned Technological Improvements 2-13
2.2.5 FAA Airport Arrival Rates and Airport Departure Rates – 2007 2-13

2.3 Estimates of Annual Service Volume 2-14

2.4 Comparison of Hourly Demand with Hourly Capacity 2-17

2.5 Aircraft Delays 2-18
2.5.1 Comparison of Previous FAA Aircraft Delay Estimates 2-18
2.5.2 Aircraft Delay Estimates Using ASV Methodology 2-20

2.6 Potential Effects of Future ATC and Aircraft Navigation Technology 2-22
2.6.1 NextGen's Key Capabilities and Core Technologies 2-22
2.6.2 Multiple RNP Approach Procedures 2-24
2.6.3 RNP Parallel Approach Transition 2-25
2.6.4 Potential Benefits of RNAV Standard Instrument Departures (SIDS) 2-26

2.7 Conclusions and Recommendations 2-28

CONTENTS *(continued)*

3. PASSENGER TERMINAL 3-1

3.1 Background 3-1
3.2 Aircraft Gates and Parking 3-5
3.3 Airline Check-In 3-8
3.4 Passenger Security Screening 3-10
3.5 Holdrooms 3-13
3.6 Checked Baggage Security Screening 3-17
3.7 Outbound Baggage Makeup 3-18
3.8 Inbound Baggage Handling 3-19
3.9 Domestic Baggage Claim 3-19
3.10 Federal Inspection Services Facilities 3-22
3.11 Concessions 3-25

4. GROUND TRANSPORTATION AND PARKING 4-1

4.1 Key Assumptions Affecting Ground Transportation and Parking Requirements 4-1

4.2 Access Roadways and Intersections 4-2
4.2.1 Baseline Conditions 4-4
4.2.2 Methodology 4-8
4.2.3 Future Intersection Facility Requirements 4-10
4.2.4 Future Roadway Facility Requirements 4-15

4.3 Terminal Area Roadways 4-16
4.3.1 Level-of-Service Goal 4-17
4.3.2 Assessment of Future Activity and Requirements 4-18

4.4 Curbside Roadways 4-18
4.4.1 Level-of-Service Goal 4-18
4.4.2 Enplaning Level Requirements 4-22
4.4.3 Deplaning Level Requirements 4-25

4.5 Commercial Vehicle Facilities 4-28
4.5.1 Level-of-Service Goal 4-28
4.5.2 Passenger Loading Requirements 4-28
4.5.3 Transportation Providers Hold Lot 4-29

4.6 Public Transit 4-30

CONTENTS *(continued)*

4.7 Public Parking ... 4-31
4.7.1 Level-of-Service Goal ... 4-31
4.7.2 Assessment of Future Activity and Requirements ... 4-31
4.7.3 Cell Phone Lot ... 4-32

4.8 Employee Parking ... 4-32
4.8.1 Level-of-Service Goal ... 4-34
4.8.2 Assessment of Future Activity and Requirements ... 4-34

4.9 Rental Cars ... 4-34

4.10 Pedestrian/Bicycle Facilities ... 4-38

4.11 Other Key Intersections On or Near the Airport ... 4-38
4.11.1 Baseline Conditions ... 4-38
4.11.2 Methodology ... 4-40
4.11.3 Future Intersection Facility Requirements ... 4-41
4.11.4 Future Off-Airport Intersection Facility Requirements ... 4-42

5. AIR CARGO ... 5-1

5.1 Processing and Warehouse Space ... 5-2
5.2 Ramp Area ... 5-9
5.3 Landside Area ... 5-9
5.4 Cargo Land Area Summary ... 5-10

6. GENERAL AVIATION ... 6-1

6.1 Background ... 6-1
6.2 Current Situation ... 6-2

6.3 Approach to Determining GA Requirements ... 6-3
6.3.1 Potential General Aviation Minimum Commercial Aeronautical Activity Standards ... 6-3
6.3.2 Fixed Base Operator Facilities at Other Airports ... 6-4
6.3.3 Requirements for Future General Aviation Facilities ... 6-5

7. MILITARY ... 7-1

CONTENTS *(continued)*

8. AIRLINE SUPPORT 8-1

8.1 Airline Maintenance and Support 8-1
8.2 Deicing Facilities and Glycol Storage 8-2
8.3 Fuel Storage 8-4
8.4 Flight Kitchen 8-8
8.5 Triturator 8-9

9. AIRPORT SUPPORT 9-1

9.1 Aircraft Rescue and Fire Fighting Facilities 9-1
9.2 FAA Facilities 9-2
9.3 Airport Maintenance Facilities 9-3
9.4 Airport Administration 9-3

9.5 Central Utility Plant 9-4
9.5.1 CUP Heating 9-4
9.5.2 CUP Cooling 9-5
9.5.3 CUP Emergency Power 9-6

10. SECURITY 10-1

10.1 Background and Summary 10-1

10.2 Passenger Security Screening 10-1
10.2.1 Baseline 10-1
10.2.2 Major Regulatory Changes Expected 10-2
10.2.3 Required Planning 10-4

10.3 Checked Baggage Screening 10-4
10.3.1 Baseline 10-4
10.3.2 Major Regulatory Changes Expected 10-4
10.3.3 Required Planning 10-5

10.4 Access Control and Credentials 10-6
10.4.1 Baseline 10-6
10.4.2 Major Regulatory Changes Expected 10-6
10.4.3 Risk Mitigation and Required Planning 10-7

10.5 Air Cargo 10-8
10.5.1 Baseline 10-8
10.5.2 Major Regulatory Changes Expected 10-8
10.5.3 Required Planning 10-9

CONTENTS *(continued)*

10.6 General Aviation 10-10
10.6.1 Baseline 10-10
10.6.2 Major Regulatory Changes Expected 10-10
10.6.3 Required Planning 10-11

10.7 Other 10-11

11. UTILITIES AND PAVEMENT 11-1

11.1 Utilities 11-1
11.1.1 Water 11-1
11.1.2 Wastewater/Sewer 11-1
11.1.3 Natural Gas System 11-1
11.1.4 Electrical System 11-2

11.2 Pavement 11-5

TABLES

1-1 Aviation Demand Forecasts 1-1

1-2 Facilities Requirements Summary 1-4

2-1 Runway Use and Weather Conditions 2-8

2-2 Summary of FAA 2004 Capacity Benchmarks 2-9

2-3 Airport Arrival Rates and Airport Departure Rates 2-14

2-4 Summary of Previous Estimates of Annual Airfield Capacity 2-16

2-5 Estimates of Average Annual Aircraft Delay Corresponding to Forecast Demand Levels 2-21

3-1 Summary of Passenger Terminal Facilities Requirements 3-2

3-2 Holdroom Areas Required by Aircraft Type 3-15

3-3 Holdroom Areas Provided 3-16

4-1 Historical Airline Passenger Mode Choice Data 4-2

4-2 LOS Criteria for Signalized and Unsignalized Intersections 4-5

4-3 Summary of Existing (2007) Afternoon Peak Period Operating Conditions at Key Study Area Intersections 4-6

4-4 Summary of Capacity and Requirements Analysis NE 82nd Avenue/NE Airport Way 4-11

4-5 Summary of Capacity and Requirements Analysis Mt. Hood Interchange Area 4-12

4-6 Summary of Capacity and Requirements Analysis NE Airport Way/I-205 Interchange Area 4-14

4-7 Summary of Capacity and Requirements Analysis NE 82nd Avenue/NE Alderwood Road Intersection 4-15

4-8 Summary of Weaving Operational Analysis NE Airport Way, Eastbound and Westbound 4-16

4-9 Level of Service Assumptions Terminal Area Roadways 4-17

TABLES *(continued)*

4-10 Terminal Area Roadway Requirements 4-19

4-11 Level of Service Assumptions, Curbside Loading and Unloading Areas 4-20

4-12 Level of Service Assumptions, Curbside Travel Lanes 4-22

4-13 Enplaning Level Curbside Unloading Area Requirements 4-24

4-14 Enplaning Level Curbside Travel Lane Requirements 4-25

4-15 Deplaning Level Curbside Loading Area Requirements 4-27

4-16 Deplaning Level Curbside Travel Lane Requirements 4-27

4-17 Commercial Vehicle Area 4-29

4-18 Transportation Providers Hold Lot Requirements 4-30

4-19 Public Parking Requirements 4-33

4-20 Employee Parking Requirements 4-34

4-21 Rental Car Facilities Requirements 4-36

4-22 Reconciliation of Rental Car Requirements with Previous Estimates by CH2M HILL and the John F. Brown Company 4-37

4-23 Summary of Existing (2007) Afternoon Peak Hour Operating Conditions at Other Study Area Intersections 4-40

4-24 Summary of Capacity and Requirements Analysis NE Alderwood Road/NE Cornfoot Road Intersection 4-41

4-25 Summary of Capacity and Requirements Analysis NE Airtrans Way/NE Cornfoot Road Intersection 4-42

5-1 Total Air Cargo Forecast 5-2

5-2 Air Cargo Building Sizes and Utilization Rates 5-4

5-3 Peer Airport Cargo Building Utilization Rates 5-6

5-4 Cargo Processing and Warehouse Space Facility Requirements 5-8

TABLES *(continued)*

5-5 Cargo Ramp Requirements 5-9

5-6 Cargo Landside Requirements 5-10

5-7 Cargo Land Area Requirements 5-10

6-1 FBO Area Comparison........ 6-4

8-1 Airline Maintenance and Support Facility and Ramp Areas........ 8-1

8-2 Historical Fuel and Aircraft Operations Data........ 8-5

8-3 Projected ADPM Airline Jet Fuel Demand and Gross Storage Required to Provide 3-, 5-, 7-, and 10-Day Reserves 8-6

8-4 Projected Fuel Farm Storage Requirements........ 8-8

9-1 ARFF Index Classifications........ 9-1

11-1 Electrical Load Allowances for Estimating Power Requirements Associated with Facilities Expansion 11-3

11-2 Electrical Load Allowances for Estimating Power Requirements for Additional Aircraft Gates 11-4

11-3 Electrical Load Allowances for Estimating Power Requirements Associated with Central Utility Plant Expansion........ 11-4

FIGURES

1-1 Capacity Assessment of Selected Passenger and Cargo Facilities 1-3

1-2 Vision and Values 1-9

2-1 Existing Airfield Layout 2-3

2-2 Major Runway Use Configurations at Portland International Airport 2-6

2-3 FAA Capacity Benchmark for Portland International Airport in VMC 2-10

2-4 FAA Capacity Benchmarks for Portland International Airport in MVMC and IMC 2-11

2-5 Ranges of 2004 Airport Capacity Benchmarks for Top 35 U.S. Airports 2-12

2-6 Estimates of ASV Using Capacities from Previous FAA Capacity Studies 2-17

2-7 Rolling Hourly Counts of Aviation Activity from Anoms Data, August 10, 2007 2-18

2-8 Summary of Aircraft Delay Curves from Previous FAA Capacity Enhancement Plans and Estimates Using ASV Methodology 2-19

2-9 Aircraft Delay Curves from FAA AC 150/5060-5, Airport Capacity and Delay 2-20

2-10 Comparison of RNAV and RNP Flight Procedures with Current Flight Procedures 2-23

2-11 Potential Reduction in Required Spacing for Conducting Simultaneous Independent Instrument Landings 2-25

2-12 Simultaneous RNP Parallel Approach Transition and ILS Procedures 2-26

2-13 Radar Flight Tracks Before and After RNAV Standard Instrument Departures 2-27

FIGURES *(continued)*

3-1 Sensitivity of Aircraft Gates Required to Productivity in Daily Turns Per Gate 3-7

3-2 Queuing and Circulation Areas Assumed for Requirements Analysis...... 3-11

3-3 Baggage and Circulation Areas Assumed for Requirements Analysis..... 3-21

4-1 Terminal Access Intersections and Roadways 4-3

4-2 Daily Vehicle Volume Profile: NE Airport Way, West of Interstate 205, Typical Busy Day in 2007........ 4-7

4-3 Daily Vehicle Volume Profile: NE 82nd Avenue, South of NE Airport Way, Typical Busy Day in 2007........ 4-8

4-4 Roadway Link Locations........ 4-21

4-5 Other Study Area Intersections........ 4-39

5-1 Cargo Areas........ 5-3

5-2 Cargo Warehouse Area vs. Cargo Volume at Select North American Airports........ 5-5

5-3 Planned Peer Airport Cargo Building Utilization Rates 5-7

8-1 PDX Deicing System........ 8-2

8-2 Proposed Deicing System Enhancements........ 8-3

8-3 Projected Jet Fuel Storage Requirements 8-7

10-1 Illustration of Checkpoint Evolution Concept........ 10-3

1. INTRODUCTION AND SUMMARY

This Technical Memorandum summarizes the facilities and associated land areas required to accommodate future aviation demand at the Airport, as presented in *Technical Memorandum No. 2 – Aviation Demand Forecasts,* dated September 2008. Facility requirements were developed for the airfield (runways, taxiways, and navigational aids), the passenger terminal complex, ground transportation and parking, air cargo, general aviation, military, airline support, Airport support and administration, security, and utilities, building maintenance, and pavements.

1.1 Planning Activity Levels

Recognizing the uncertainties associated with long-range aviation demand forecasting, five planning activity levels (PALs) were identified to represent future levels of activity at which key Airport improvements will be necessary. Because, for any number of reasons, activity levels could occur at different periods from those anticipated when the forecasts were prepared, the use of PALs allows for facilities planning that is realistically tied to milestone activity levels as they occur, rather than arbitrary years. PAL 1, PAL 2, PAL 3, PAL 4, and PAL 5 correspond to the 50th percentile aviation demand forecasts for 2012, 2017, 2022, 2027, and 2035, respectively. The aviation demand associated with each PAL is summarized in Table 1-1.

Table 1-1

AVIATION DEMAND FORECASTS

Portland International Airport

		Aviation Demand Forecasts *(a)*				
	Actual 2007	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
Enplaned passengers (thousands)	7,332	7,489	8,992	10,312	11,825	13,393
Total air cargo (thousands of short tons) *(b)*	280	322	414	496	594	732
Aircraft operations						
Passenger airline	191,554	180,400	207,000	228,000	250,600	275,000
All-cargo airline	33,324	37,980	41,240	44,840	48,760	52,320
General aviation	27,623	26,100	28,200	29,500	30,900	32,500
Military	3,707	6,000	6,000	6,000	6,000	6,000
Other *(c)*	8,310	8,000	9,100	10,100	11,100	12,000
Total Airport aircraft operations	264,518	258,480	291,540	318,440	347,360	377,820

(a) Forecasts are shown for PALs and their corresponding years.
(b) A short ton equals 2,000 pounds.
(c) Includes nonscheduled and empty flights.

Sources: Actual 2007 demand from Port of Portland records. Forecast demand from Jacobs Consultancy, *Technical Memorandum No. 2 – Aviation Demand Forecasts*, September 2008.

1.2 Summary of Requirements

The most significant findings of the analyses to determine facilities requirements for the planning period (i.e., through 2035) were that (1) a third parallel runway will not be required during the planning period, and (2) terminal and ground access requirements can continue to be satisfied within the existing terminal envelope. Continued Airport development within the planning period will be required; however, it will not be necessary to implement a new Airport development concept (e.g., the centralized or decentralized development concept) as envisioned at the conclusion of the 2000 Master Plan.

The capacities of the Airport's key functional areas are summarized on Figure 1-1, which can be interpreted as follows:

- The bars represent major Airport elements; the length of the bars indicates capacity.
- Capacity for all Airport elements except the cargo ramp and cargo warehouse (the two bottom bars) should be read relative to the scale at the top of the figure—total annual passengers (in millions).
- Capacity for the cargo ramp and cargo warehouse should be read relative to the scale at the bottom of the figure—total annual air cargo tons (thousands).
- Both capacity scales are indexed to the timeframes and corresponding PALs envisioned by the forecasts, shown by the dotted vertical lines.

Some of the capacities of the elements shown on Figure 1-1 are necessarily based on a number of simplifying assumptions (e.g., the bars labeled "access roadways" represent a number of intersections and roadway segments). The detailed requirements are summarized in Table 1-2 for all functional elements of the Airport that were assessed and are discussed in Sections 2 through 11 of this Technical Memorandum.

As shown in Table 1-2, some Airport facilities (e.g., gates) provide sufficient capacity to accommodate forecast demand throughout the planning period. However, a number of facilities will need to be modified or expanded during the planning period to accommodate forecast demand at the desired level of service.

Figure 1-1
CAPACITY ASSESSMENT OF SELECTED PASSENGER AND CARGO FACILITIES

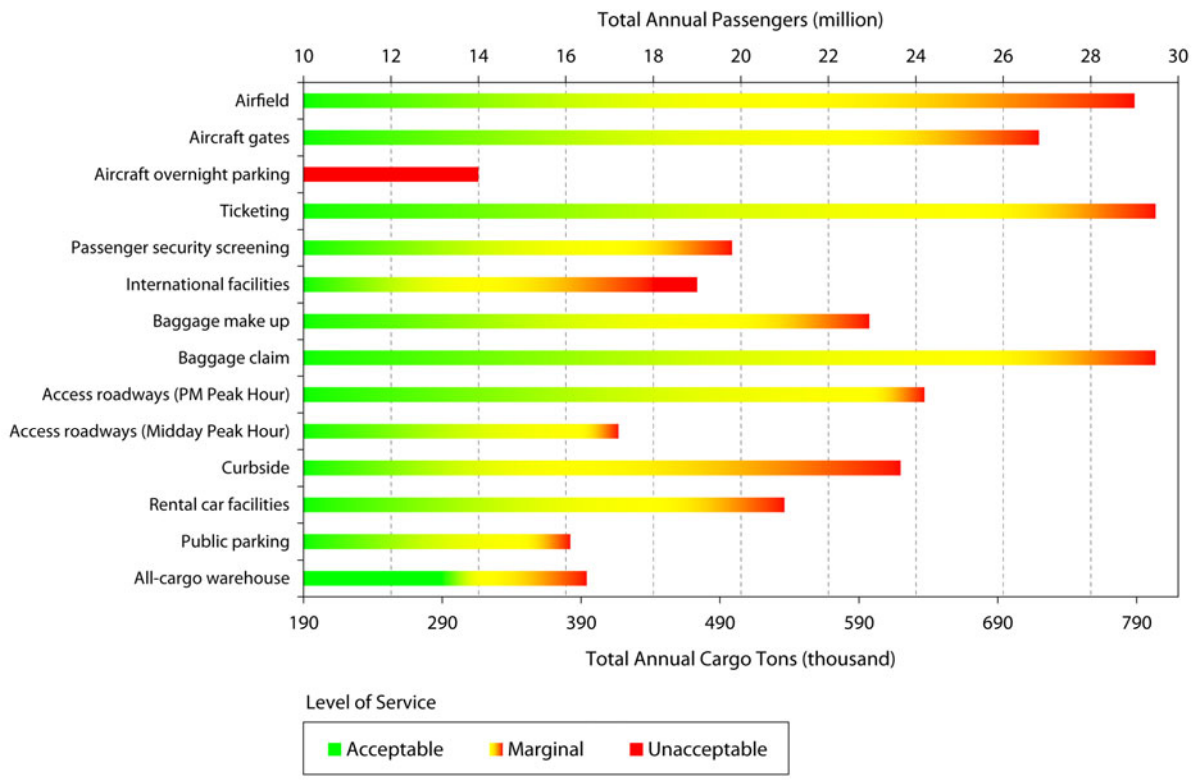


Table 1-2
FACILITIES REQUIREMENTS SUMMARY
Master Plan Update
Portland International Airport

Functional Element	Existing	Estimated total requirements					Estimated surplus (deficiency) compared with existing					Period-over-period (i.e., incremental) requirement				
		PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
BASIS FOR REQUIREMENTS (DEMAND FORECASTS)																
Total annual passengers (millions)	14.7	15.0	18.0	20.6	23.7	26.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cargo in belly of psngr acft (thousands of short tons)		36	40	46	52	62										
Cargo in all-cargo acft (thousands of short tons)	280	288	374	450	542	670	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Aircraft operations (thousands)	265	258	292	318	347	378	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
AIRFIELD																
Number of runways		2 parallels plus crosswind	2 parallels plus crosswind	2 parallels plus crosswind	2 parallels plus crosswind	2 parallels plus crosswind	-	-	-	-	-	-	-	-	-	-
Critical aircraft		B-747-400 (ARC D-V)	B-747-400 (ARC D-V)	B-747-400 (ARC D-V)	B-747-400 (ARC D-V)	B-747-400 (ARC D-V)	-	-	-	-	-	-	-	-	-	-
Runway length (feet)																
Runway 10L-28R		9,827	9,827	9,827	9,827	9,827	-	-	-	-	-	-	-	-	-	-
Runway 10R-28L		11,000	11,000	11,000	11,000	11,000	-	-	-	-	-	-	-	-	-	-
Runway 3-21		6,000	6,000	6,000	6,000	6,000	-	-	-	-	-	-	-	-	-	-
Instrument approach capability		CAT III	CAT III	CAT III	CAT III	CAT III	-	-	-	-	-	-	-	-	-	-
PASSENGER TERMINAL COMPLEX																
Aircraft gates and parking																
Domestic gates																
Widebody	3	1	2	2	3	2	2	1	1	-	1	-	-	-	-	-
Narrowbody - ADG IV (e.g., B-757-300)	22	1	8	10	3	4	21	14	12	19	18	-	-	-	-	-
Narrowbody - ADG III (e.g., B-737-800)	15	34	29	27	33	32	(19)	(14)	(12)	(18)	(17)	-	-	-	-	-
Regional jet / turboprop	21	19	19	19	21	21	2	2	2	-	-	-	-	-	-	-
Total domestic gates	61	55	58	58	60	59	6	3	3	1	2	-	-	-	-	-
FIS gates																
Widebody	5	3	4	4	5	6	2	1	1	-	(1)	-	-	-	-	-
Narrowbody - ADG IV (e.g., B-757-300)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Narrowbody - ADG III (e.g., B-737-800)	1	2	3	2	3	2	(1)	(2)	(1)	(2)	(1)	-	-	-	-	-
Regional jet / turboprop	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total FIS gates	6	5	7	6	8	8	1	(1)		(2)	(2)	-	-	-	-	-
Total domestic + FIS gates																
Widebody	8	4	6	6	8	8	4	2	2	-	-	-	-	-	-	-
Narrowbody - ADG IV (e.g., B-757-300)	22	1	8	10	3	4	21	14	12	19	18	-	-	-	-	-
Narrowbody - ADG III (e.g., B-737-800)	16	36	32	29	36	34	(20)	(16)	(13)	(20)	(18)	-	-	-	-	-
Regional jet / turboprop	21	19	19	19	21	21	2	2	2	-	-	-	-	-	-	-
Total domestic + FIS gates	67	60	65	64	68	67	7	2	3	(1)	-	-	-	-	-	-
Remote / RON parking																
Widebody	3	-	-	-	-	3	3	3	3	3	-	-	-	-	-	-
Narrowbody - ADG IV (e.g., B-757-300)	5	4	1	2	-	3	1	4	3	5	2	-	-	-	-	-
Narrowbody - ADG III (e.g., B-737-800)	-	7	12	15	25	24	(7)	(12)	(15)	(25)	(24)	-	-	-	-	-
Regional jet / turboprop	-	1	1	1	-	1	(1)	(1)	(1)	-	(1)	-	-	-	-	-
Total Remote / RON parking	8	12	14	18	25	31	(4)	(6)	(10)	(17)	(23)	4	2	4	7	6
Holdrooms (area in square feet)																
Concourse A	6,004	9,953	9,953	11,076	10,417	10,766	(3,949)	(3,949)	(5,072)	(4,413)	(4,762)	3,949	-	1,123	-	-
Concourse B	4,701	4,182	4,308	4,308	2,914	2,633	519	393	393	1,787	2,068	-	-	-	-	-
Concourse C	40,267	24,407	29,316	28,464	30,748	31,629	15,860	10,951	11,803	9,519	8,638	-	-	-	-	-
Concourse D	26,117	27,341	31,930	34,321	37,129	36,838	(1,224)	(5,813)	(8,204)	(11,012)	(10,721)	1,224	4,589	2,391	2,808	-
Concourse E	11,212	10,611	9,914	9,759	8,868	8,984	601	1,298	1,453	2,344	2,228	-	-	-	-	-
Total holdroom area	88,301	76,494	85,421	87,928	90,076	90,850	11,807	2,880	373	(1,775)	(2,549)	-	-	-	1,775	774

Table 1-2
FACILITIES REQUIREMENTS SUMMARY
Master Plan Update
Portland International Airport

Functional Element	Existing	Estimated total requirements					Estimated surplus (deficiency) compared with existing					Period-over-period (i.e., incremental) requirement				
		PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
BASIS FOR REQUIREMENTS (DEMAND FORECASTS)																
Total annual passengers (millions)	14.7	15.0	18.0	20.6	23.7	26.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cargo in belly of psngr acft (thousands of short tons)		36	40	46	52	62										
Cargo in all-cargo acft (thousands of short tons)	280	288	374	450	542	670	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Aircraft operations (thousands)	265	258	292	318	347	378	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Airline Check-in																
Number of processors																
Agent counters	87	50	57	64	64	68	37	30	23	23	19	-	-	-	-	-
Kiosks w/bag check	56	36	42	49	47	52	20	14	7	9	4	-	-	-	-	-
Kiosks w/out bag check	23	24	23	25	28	32	(1)	-	(2)	(5)	(9)	1	-	1	3	4
Curbside	24	24	24	24	24	24	-	-	-	-	-	-	-	-	-	-
Total	190	134	146	162	163	176	56	44	28	27	14	-	-	-	-	-
Lobby queue area (square feet)												-	-	-	-	-
@ IATA level of service B	13,565	11,296	12,944	14,528	14,832	16,704	2,269	621	(963)	(1,267)	(3,139)	-	-	963	304	1,872
@ IATA level of service C	13,565	9,884	11,326	12,712	12,978	14,616	3,681	2,239	853	587	(1,051)					
Passenger Security Screening																
Number of screening lanes																
South	8	8	9	9	10	13	-	(1)	(1)	(2)	(5)	-	1	-	1	3
North	8	6	6	7	8	8	2	2	1	-	-	-	-	-	-	-
Total	16	14	15	16	18	21	2	1	-	(2)	(5)	-	-	-	2	3
Queue area (square feet)																
Document check																
@ IATA level of service B																
South	1,660	1,170	3,458	3,692	3,536	4,602	490	(1,798)	(2,032)	(1,876)	(2,942)	-	1,798	234	-	910
North	1,504	1,118	2,301	2,301	2,470	2,704	386	(797)	(797)	(966)	(1,200)	-	797	-	169	234
Total	3,164	2,288	5,759	5,993	6,006	7,306	876	(2,595)	(2,829)	(2,842)	(4,142)	-	2,595	234	13	1,300
@ IATA level of service C																
South	1,660	990	2,926	3,124	2,992	3,894	670	(1,266)	(1,464)	(1,332)	(2,234)	-	1,266	198	-	770
North	1,504	946	1,947	1,947	2,090	2,288	558	(443)	(443)	(586)	(784)	-	443	-	143	198
Total	3,164	1,936	4,873	5,071	5,082	6,182	1,228	(1,709)	(1,907)	(1,918)	(3,018)	-	1,709	198	11	1,100
Primary queue																
@ IATA level of service B																
South	2,003	2,860	3,367	4,082	4,082	4,953	(857)	(1,364)	(2,079)	(2,079)	(2,950)	857	507	715	-	871
North	2,044	2,223	2,288	2,483	2,951	3,250	(179)	(244)	(439)	(907)	(1,206)	179	65	195	468	299
Total	4,047	5,083	5,655	6,565	7,033	8,203	(1,036)	(1,608)	(2,518)	(2,986)	(4,156)	1,036	572	910	468	1,170
@ IATA level of service C																
South	2,003	2,420	2,849	3,454	3,454	4,191	(417)	(846)	(1,451)	(1,451)	(2,188)	417	429	605	-	737
North	2,044	1,881	1,936	2,101	2,497	2,750	163	108	(57)	(453)	(706)	-	-	57	396	253
Total	4,047	4,301	4,785	5,555	5,951	6,941	(254)	(738)	(1,508)	(1,904)	(2,894)	254	484	770	396	990
Baggage Security Screening																
Number of primary EDS machines																
South	4	3	3	3	3	3	1	1	1	1	1	-	-	-	-	-
North	4	2	2	2	2	3	2	2	2	2	1	-	-	-	-	-
Total	8	5	5	5	5	6	3	3	3	3	2	-	-	-	-	-
Outbound Baggage Makeup																
Number of cart staging positions																
South	78	65	72	79	86	95	13	6	(1)	(8)	(17)	-	-	1	7	9
North	85	56	69	71	89	90	29	16	14	(4)	(5)	-	-	-	4	1
Total	163	121	141	150	175	185	42	22	13	(12)	(22)	-	-	-	12	10
Inbound Baggage Handling																
Total offload frontage (linear feet)	439	328	379	425	462	490	111	60	14	(23)	(51)	-	-	-	23	29
Baggage Claim -- Domestic																
Total presentation frontage (linear feet)	1,653	1,094	1,262	1,417	1,539	1,635	559	391	236	114	18	-	-	-	-	-
Total area for claiming baggage (square feet)	32,812	16,529	19,067	21,411	23,250	24,702	16,283	13,745	11,401	9,562	8,110	-	-	-	-	-

Table 1-2
FACILITIES REQUIREMENTS SUMMARY
Master Plan Update
Portland International Airport

Functional Element	Existing	Estimated total requirements					Estimated surplus (deficiency) compared with existing					Period-over-period (i.e., incremental) requirement				
		PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
BASIS FOR REQUIREMENTS (DEMAND FORECASTS)																
Total annual passengers (millions)	14.7	15.0	18.0	20.6	23.7	26.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cargo in belly of psngr acft (thousands of short tons)		36	40	46	52	62										
Cargo in all-cargo acft (thousands of short tons)	280	288	374	450	542	670	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Aircraft operations (thousands)	265	258	292	318	347	378	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
FIS Facilities																
Primary processing																
Number of primary screening modules	6	5	7	7	7	7	1	(1)	(1)	(1)	(1)	-	1	-	-	-
Primary queuing area (square feet)	5,037	4,313	6,038	6,038	6,038	6,038	724	(1,001)	(1,001)	(1,001)	(1,001)	-	1,001	-	-	-
Baggage Claim																
Per device																
Presentation frontage (linear feet)	145	210	210	210	210	210	(65)	(65)	(65)	(65)	(65)	65	-	-	-	-
Retrieval & peripheral area (square feet)	2,525	2,972	2,972	2,972	2,972	2,972	(447)	(447)	(447)	(447)	(447)	447	-	-	-	-
Total																
Number of devices	2	2	3	3	3	3	-	(1)	(1)	(1)	(1)	-	1	-	-	-
Presentation frontage (linear feet)	290	420	630	630	630	630	(130)	(340)	(340)	(340)	(340)	130	210	-	-	-
Retrieval & peripheral area (square feet)	5,800	5,945	8,917	8,917	8,917	8,917	(145)	(3,117)	(3,117)	(3,117)	(3,117)	145	2,972	-	-	-
Secondary processing																
Queuing area (square feet)	460	565	791	791	791	791	(105)	(331)	(331)	(331)	(331)	105	226	-	-	-
Referral waiting area (square feet)	1,015	275	400	400	400	400	740	615	615	615	615	-	-	-	-	-
Exam podiums w/ belts (units)	4	-	-	-	-	-	4	4	4	4	4	-	-	-	-	-
X-ray workstations (units)	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
Baggage security screening																
Number of primary EDS machines	1	3	4	4	4	4	(2)	(3)	(3)	(3)	(3)	2	1	-	-	-
Passenger security screening																
Number of screening lanes	4	2	2	2	2	2	2	2	2	2	2	-	-	-	-	-
GROUND TRANSPORTATION AND PARKING																
Public parking (spaces)																
Close-in parking	7,380	5,120	6,540	7,760	9,000	10,540	2,260	840	(380)	(1,620)	(3,160)	-	-	-	-	-
Remote parking	7,788	8,260	10,540	12,510	14,510	17,000	(472)	(2,752)	(4,722)	(6,722)	(9,212)	-	-	-	-	-
Subtotal	15,168	13,380	17,080	20,270	23,510	27,540	1,788	(1,912)	(5,102)	(8,342)	(12,372)	-	1,912	3,190	3,240	4,030
Holiday / overflow	-	650	840	990	1,150	1,350	(650)	(840)	(990)	(1,150)	(1,350)	-	-	-	-	-
Requirements currently accommodated off-Airport	1,300	1,400	1,800	2,100	2,500	2,900	(100)	(500)	(800)	(1,200)	(1,600)	-	-	-	-	-
Total, including holiday/overflow and off-Airport	16,468	15,430	19,720	23,360	27,160	31,790	2,826	(5,164)	(11,994)	(19,034)	(27,694)	-	-	-	-	-
Employee parking (spaces)	2,544	1,900	2,200	2,500	2,800	3,100	644	344	44	(256)	(556)	-	-	-	256	300
Curbside loading & unloading (linear feet)																
Enplaning curbside	929	720	840	960	1,080	1,200	209	89	(31)	(151)	(271)	-	-	31	120	120
Deplaning curbside	500	440	520	600	650	730	60	(20)	(100)	(150)	(230)	-	20	80	50	80
Subtotal	1,429	1,160	1,360	1,560	1,730	1,930	269	69	(131)	(301)	(501)	-	-	131	170	200
Curbside roadway (lanes)																
Enplaning curbside	4	4	4	4	5	6	-	-	-	(1)	(2)	-	-	-	1	1
Deplaning curbside	4	4	4	5	5	5	-	-	(1)	(1)	(1)	-	-	1	-	-
Commercial vehicle facilities																
Loading area (linear feet)	1,245	770	840	890	970	1,070	475	405	355	275	175	-	-	-	-	-
Hold / staging facility (acres)	0.8	0.9	1.0	1.2	1.4	1.6	(0.0)	(0.2)	(0.3)	(0.5)	(0.7)	0.0	0.2	0.2	0.2	0.2
Rental car facilities																
Ready / return parking (spaces)	1,481	910	1,090	1,250	2,390	2,700	571	391	231	(909)	(1,219)	-	-	-	909	310
Service facilities (acres)	2.4	6.9	7.9	10.5	8.5	9.6	(4.5)	(5.5)	(8.1)	(6.1)	(7.2)	4.5	1.0	2.6	0.0	1.1
Roadways																
NE Airport Way, westbound (link ID A--Fig 4-4)	3	3	3	4	4	4	-	-	(1)	(1)	(1)	-	-	1	-	-
NE Airport Way, eastbound (link ID B--Fig 4-4)	3	3	3	3	4	4	-	-	-	(1)	(1)	-	-	-	1	-
Parking entrance (link ID C--Fig 4-4)	1	1	1	1	2	2	-	-	-	(1)	(1)	-	-	-	1	-
Enplaning level approach (link ID D--Fig 4-4)	2	2	2	3	3	3	-	-	(1)	(1)	(1)	-	-	1	-	-
Deplaning level approach (link ID E--Fig 4-4)	3	3	3	3	3	3	-	-	-	-	-	-	-	-	-	-
Enplaning level departure (link ID F--Fig 4-4)	1	2	2	2	3	3	(1)	(1)	(1)	(2)	(2)	1	-	-	1	-
Deplaning level departure (link ID G--Fig 4-4)	2	2	2	2	3	3	-	-	-	(1)	(1)	-	-	-	1	-
Parking exit (link ID H--Fig 4-4)	1	1	1	1	2	2	-	-	-	(1)	(1)	-	-	-	1	-
Terminal exit (link ID I--Fig 4-4)	2	3	3	3	4	4	(1)	(1)	(1)	(2)	(2)	1	-	-	1	-
Return-to-terminal road (link ID J--Fig 4-4)	1	1	1	1	2	2	-	-	-	(1)	(1)	-	-	-	1	-
Terminal area exit (link ID K--Fig 4-4)	2	2	3	3	4	4	-	(1)	(1)	(2)	(2)	-	1	-	1	-

Table 1-2

FACILITIES REQUIREMENTS SUMMARY

Master Plan Update

Portland International Airport

Functional Element	Existing	Estimated total requirements					Estimated surplus (deficiency) compared with existing					Period-over-period (i.e., incremental) requirement				
		PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
BASIS FOR REQUIREMENTS (DEMAND FORECASTS)																
Total annual passengers (millions)	14.7	15.0	18.0	20.6	23.7	26.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cargo in belly of psngr acft (thousands of short tons)		36	40	46	52	62										
Cargo in all-cargo acft (thousands of short tons)	280	288	374	450	542	670	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Aircraft operations (thousands)	265	258	292	318	347	378	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Key intersections																
NE 82nd Ave/NE Airport Way		-	grade separated interchange	-	-	-	-	**grade separated interchange**		-	-	-	grade separated interchange		-	-
Mt. Hood interchange area (3 intersections)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NE Airport Way/I-205 interchange																
I-205 Southbound		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I-205 Northbound		e'bound to n'bound solution	-	-	-	-	**e'bound to n'bound solution**	-	-	-	-	e'bound to n'bound solution	-	-	-	-
NE 82nd Avenue/NE Alderwood Road		-	-	-	-	e'bound rt turn pocket	-	-	-	-	**e'bound rt turn pocket**	-	-	-	-	e'bound rt turn pocket
NE Alderwood Road/NE Cornfoot Road		-	-	n'bound lt turn pocket	-	-	-	-	**n'bound lt turn pocket**	-	-	-	-	n'bound lt turn pocket	-	-
NE Airtrans Way/NE Cornfoot Road		signalized intersection	-	-	-	-	**signalized intersection**	-	-	-	-	signalized intersection	-	-	-	-
NE Columbia Boulevard/NE 82nd Avenue (2 intersections)												-				
NE Killingsworth St./I-205 interchange area (2 intersections)												-				
AIR CARGO																
Belly Cargo																
Warehouse space (square feet)	236,000	54,000	60,000	69,000	78,000	93,000	182,000	176,000	167,000	158,000	143,000	-	-	-	-	-
Ramp (square yards)	67,000	4,000	4,000	5,000	6,000	7,000	63,000	63,000	62,000	61,000	60,000	-	-	-	-	-
Landside area (square feet)	-	54,000	60,000	69,000	78,000	93,000	-	-	-	-	-	-	-	-	-	-
Total area (acres)	-	3	4	4	5	6	-	-	-	-	-	-	-	-	-	-
All Cargo																
Warehouse space (square feet)	392,000	432,000	561,000	675,000	813,000	1,005,000	**(40,000)**	**(169,000)**	**(283,000)**	**(421,000)**	**(613,000)**	40,000	129,000	114,000	138,000	192,000
Ramp (square yards)	189,000	240,000	312,000	375,000	452,000	558,000	**(51,000)**	**(123,000)**	**(186,000)**	**(263,000)**	**(369,000)**	51,000	72,000	63,000	77,000	106,000
Landside area (square feet)	-	432,000	561,000	675,000	813,000	1,005,000	**(432,000)**	**(561,000)**	**(675,000)**	**(813,000)**	**(1,005,000)**	432,000	129,000	114,000	138,000	192,000
Total area (acres)		69	90	108	131	161	-	-	-	-	-	-	-	-	-	-
GENERAL AVIATION																
Total area (acres)	30	40 - 50	40 - 50	40 - 50	40 - 50	40 - 50	10 - 20	10 - 20	10 - 20	10 - 20	10 - 20	10 - 20	10 - 20	-	-	-
MILITARY																
Total area (acres)	246	246	246	246	246	246	-	-	-	-	-	-	-	-	-	-
AIRLINE SUPPORT																
Fuel storage																
Quantity (millions of gallons)	3,360	3,109	3,534	3,884	4,262	4,660	251	**(174)**	**(524)**	**(902)**	**(1,300)**	-	174	350	378	398
Land area (acres)	4	3.7	4.2	4.6	5.1	5.5	**0**	**(0)**	**(1)**	**(1)**	**(2)**	0.0	0.2	0.4	0.5	0.4
Airline maintenance and support (square feet)	339	339	339	339	339	339	-	-		-	-					
In-flight catering facilities (acres)	6.5	6.5	6.5	6.5	6.5	6.5	-	-		-	-					
AIRPORT SUPPORT																
Aircraft rescue and fire fighting (acres)	5.8	9	9	9	9	9	**(3)**	**(3)**	**(3)**	**(3)**	**(3)**	3	-	-	-	-
Airport maintenance (acres)	12.2	14.4	14.4	14.4	14.4	14.4	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	2	-	-	-	-

ADG = Airplane design group
ARC = Airplane reference code
CAT = Category
EDS = Explosives detection system
FIS = Federal Inspection Services
IATA = International Air Transport Association
n/a = Not applicable
RON = Remain overnight

a. Passenger terminal complex requirements were determined based primarily on simulation modeling using flight schedules for 2008, 2017, 2022, 2027 and 2035. A flight schedule was not developed for 2012 because the activity is forecast so be very similar to activity in 2008. Accordingly, requirements for the passenger terminal complex in 2012 were assumed to equal the requirements for 2008.

Sources: Jacobs Consultancy, DKS Associates, and HNTB Corporation; October 2008.

1.3 Process

The process of developing facility requirements involved not only the consultant team, but also Port staff, City staff, the airlines, the planning subcommittee, and the Planning Advisory Group (PAG).

- At the beginning of preparing the requirements element of the Master Plan Update, focus groups, consisting of Port and City staff, were formed for every functional element of the Airport to be analyzed. The consultant team met with each focus group to discuss the scope and proposed approach for the analyses and to learn about particular issues. These meetings occurred the week of June 9, 2008.

- The focus groups, City staff, the airlines, and the planning subcommittee were briefed on the preliminary results of the requirements analysis and provided comments to the consultant team the week of September 8, 2008. The PAG was briefed and provided comments to the consultant team the week of September 15, 2008.

- Written descriptions of the analyses, results, and conclusions related to requirements for each functional area of the Airport were distributed to the focus groups in September and October 2008. Follow-up meetings and telephone conferences were held with the focus groups to receive verbal comments on the written descriptions; Port planning staff provided written comments.

- The planning subcommittee was briefed on the final results of the requirements analyses and provided comments the week of October 6, 2008. The PAG was briefed and provided comments the week of October 20, 2008.

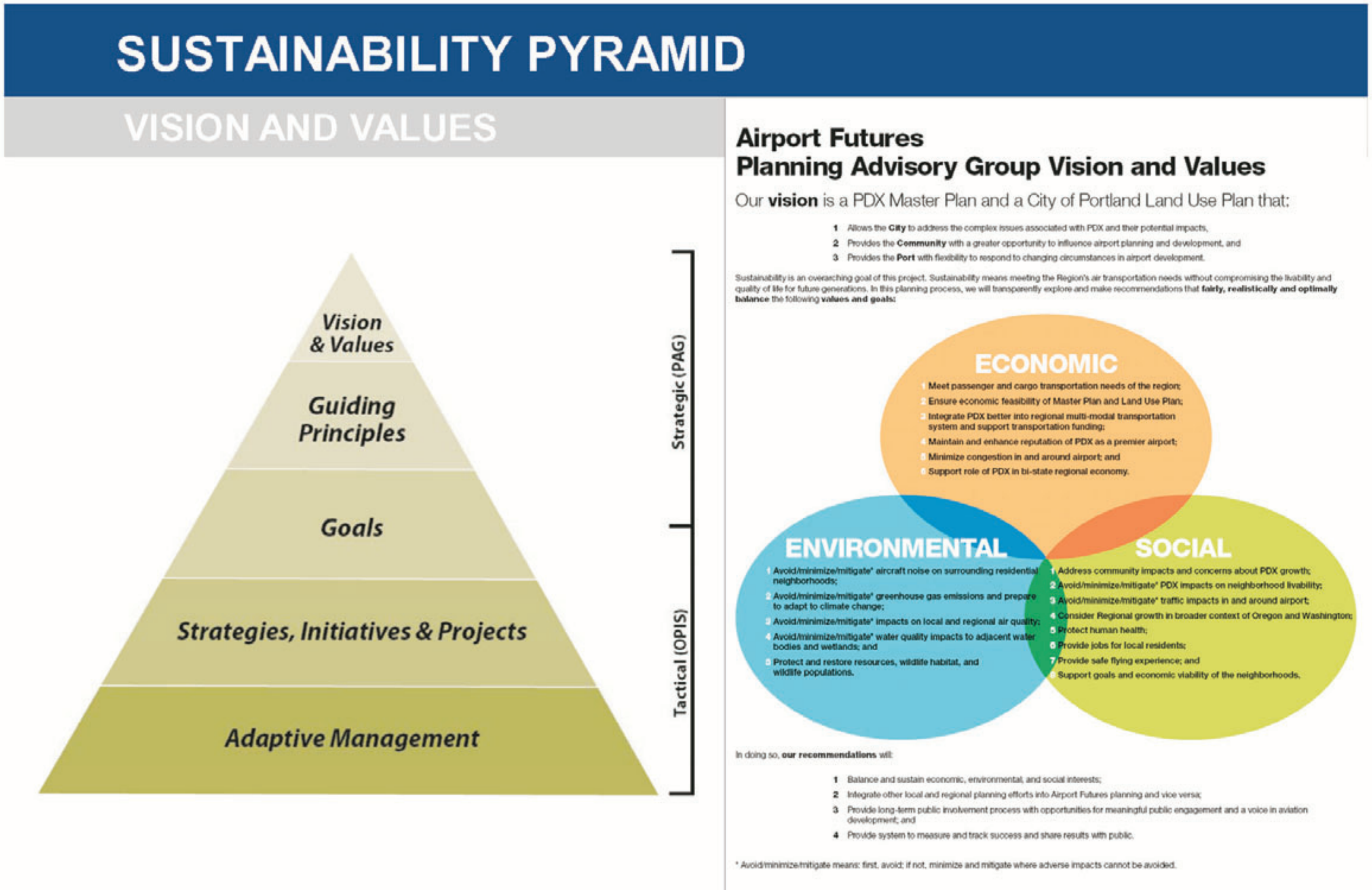
Many valuable comments were received from the focus groups and, to the extent possible, those comments are reflected in the analyses and results reported in this Technical Memorandum. To the extent that some issues raised are outside the scope of the Master Plan Update, every attempt was made to record the issues so that they may be addressed in subsequent studies as appropriate.

1.4 Sustainability

Consistent with our commitment to Airport Futures' Vision and Values, shown on Figure 1-2, the planning team has carefully considered sustainability in determining the facility requirements for each functional area of the Airport. The application of new technologies, changes in passenger behavior, and changes in the airline industry are among the many uncertain factors that will influence the capacity, design, use, and reuse of the Airport's facilities in the future. While the impact of these factors cannot be known with certainty, we embrace the notion, discussed at numerous PAG and PAG

Figure 1-2

VISION AND VALUES



Source: Port of Portland.

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Subcommittee meetings, that future changes have the potential to significantly increase the utilization of existing facilities and the efficiency of operations, thus extending the life of Airport facilities and ultimately postponing the development of new facilities.

The facility requirements presented in this Technical Memorandum are based on aviation demand forecasts that were highly influenced by a collaborative discussion of sustainability. That discussion was directly reflected in the forecast process by choosing a probabilistic rather than traditional approach to forecasting and by carefully considering the potential impact of future oil prices and future carbon emissions costs. While the probabilistic forecasts of passengers, cargo, and aircraft operations define a wide range of potential future demand, it is important to understand that the facility requirements are based on the 50th percentile forecasts recommended by PAG.

We have devoted significant effort to identifying pending technological innovations or procedural changes that promise significant capacity increases. An example is the future air traffic control system and navigation technologies being studied by the FAA. Although these technologies will require major investments by the FAA and airlines and the timing is uncertain, it is believed that they can provide significant capacity increases for the existing airfield and also may enable the development of new noise abatement departure procedures. In other functional areas of the Airport, such as aircraft gates, we were able assume a 40 percent increase in gate utilization based on current industry trends (e.g., common use facilities) and input from airline representatives. The result of increased gate utilization, when combined with the continued trend toward larger aircraft, is a significant reduction in the number of gates required to meet future demand. Similar opportunities to utilize emerging technologies and creative approaches to planning and operations—to extend the life of existing facilities—are described throughout this Technical Memorandum.

In some areas, such as ground transportation and parking, we have taken a more conservative approach to assessing facility requirements by modeling needs based on today's use characteristics. Explained in greater detail in Section 4, we assumed no significant changes in passenger mode choice and that the demand for all travel modes will increase in direct proportion to growth in passenger activity. We acknowledge that mode choices may change as passengers adapt to changes in the regional transportation system (e.g., new or expanded mode choices, changes in pricing, and the elimination of services) and that such changes could have the effect of reducing demand for parking, terminal curb or access roadways. Our approach is intended to simplify our assessment of ground transportation needs and provide a valid baseline for considering alternative approaches to meeting forecast demand. In later studies, we will be able to test the sensitivity of facilities required to specific ground transportation assumptions such as a reduced level of service (LOS) standard, reduced pick-up/drop-off capability, elimination of at-grade pedestrian crossings of the terminal roadway, reduced parking supply or changes in the use of the terminal roadway system.

2. AIRFIELD CAPACITY AND AIRCRAFT DELAY

The capacity of the existing airfield and airspace system was assessed to determine if and when additional airfield capacity improvements will be required to meet aviation demand forecast through the planning period (2035). These assessments were primarily based on reports prepared for or by the Federal Aviation Administration (FAA) and the Port of Portland, as follows:

- **October 1996**: Federal Aviation Administration, *Portland International Airport Capacity Enhancement Plan (CEP)*
- **March 1997**: P&D Aviation, *Technical Memorandum 4, Airport Facility Requirements* (prepared for the Port based on the October 1996 CEP)
- **October 2001**: Federal Aviation Administration, *Portland International Airport Capacity Enhancement Plan*
- **September 2004**: Federal Aviation Administration, *Airport Capacity Benchmark Report 2004*
- **October 2004**: Federal Aviation Administration, *Airport Capacity Enhancement Plan, Phase II Terminal Option Study*

Jacobs Consultancy has reviewed these reports and determined the following:

- The studies were conducted using different models. The CEP described in the October 1996 report was prepared using the FAA's Airport and Airspace Simulation Model (SIMMOD). The study reported on in March 1997 was based on data from the October 1996 study. The CEPs reported on in October 2001 and October 2004 were conducted using the FAA's Airfield Delay Simulation Model (ADSIM). The benchmarking effort reported in the *Airport Capacity Benchmark Report 2004* was conducted using the FAA Airfield Capacity Model (ACM).
- Some results from the studies are inconsistent; no explanations for the inconsistencies were presented; the inconsistencies are assumed to have resulted from the use of different models.
- The most current report, from October 2004 (*Airport Capacity Enhancement Plan, Phase II Terminal Option Study*), does not contain an estimate of annual capacity for the airfield, which is essential for assessing when additional capacity enhancement improvements will be required. Instead, the report presents hourly arrival and departure capacities for different weather conditions.

Our approach to estimating the annual capacity of the airfield was based on the hourly capacities for the Airport contained in *Airport Capacity Benchmark Report 2004* and the FAA's annual service volume (ASV) methodology documented in FAA Advisory Circular (AC) 150/5060-5, *Airport Capacity and Delay*. The information necessary to understand this approach and its validity is presented below, along with the results of the analyses and our conclusions. The information is organized in seven subsections, as follows:

- **Background** – Summarizes the existing layout of the airfield and its capacity constraints, explains how the runways are used in different wind conditions, and defines different weather categories in terms of ceiling and visibility conditions that govern how FAA air traffic controllers manage aircraft landings and takeoffs at the Airport.

- **FAA Benchmark Capacities** – Summarizes the hourly capacities presented in the September 2004 report; these capacities, along with assumptions related to runway use and the occurrence of different weather conditions, are key inputs to the ASV methodology used to estimate the current annual capacity of the Airport's airfield.

- **Estimates of Annual Service Volume** – Explains that ASV is one measure of annual capacity, defines ASV and how it is calculated, describes the FAA's ASV methodology for estimating aircraft delays, and compares the ASV with annual airfield capacity estimates from the previous studies.

- **Comparison of Hourly Demand with Hourly Capacity** – Summarizes the relationship between current hourly operations and hourly runway capacity.

- **Aircraft Delays** – Explains the aircraft delay curve, which is a fundamental assessment tool in airfield modeling; compares the delay curves developed in the previous studies with a delay curve developed by Jacobs Consultancy using the ASV method and hourly capacity estimates from the September 2004 report; and demonstrates that the delay curve developed by Jacobs Consultancy is consistent with the delay curve developed by the FAA in the 2001 CEP and, therefore, is a rational basis for further analyses, conclusions, and recommendations.

- **Potential Effects of Future Air Traffic Control (ATC) and Aircraft Navigation Technology** – Introduces the key capabilities, core technologies, and potential benefits of the next generation (NextGen) air transportation system envisioned by the FAA.

- **Conclusions and Recommendations** – Summarizes the conclusions and recommendations of this airfield and airspace capacity assessment regarding the need for additional airfield capacity improvements at the Airport to meet aviation demand forecast through 2035.

2.1 Background

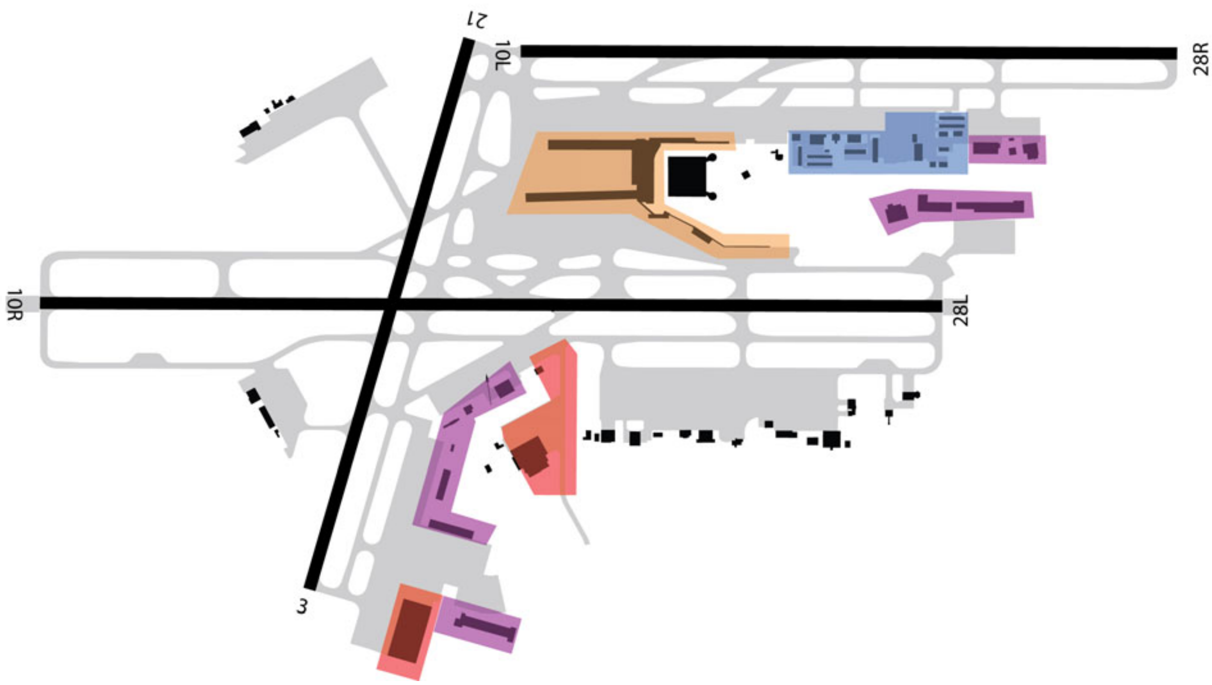
2.1.1 Existing Airfield Layout

Portland International Airport has three runways:

- Runway 10L-28R (8,000 feet long), also referred to as the north parallel runway (extensions to Runway 10L-28R currently being designed will result in a total runway length of 9,827 feet; the runway will be extended 1,290 feet to the west and 537 feet to the east)
- Runway 10R-28L (11,000 feet long), also referred to as the south parallel runway
- Runway 3-21 (7,000 feet long), also referred to as the crosswind runway (as part of the project to extend Runway 10L-28R, Runway 3-21 will be shortened to 6,020 feet by removing the northernmost 980 feet of runway pavement)

Figure 2-1

EXISTING AIRFIELD LAYOUT
Portland International Airport



2.1.2 Current Constraints on Airfield Capacity

The airfield capacity at Portland International Airport is limited by the following two major constraints:

1. The 3,100-foot spacing between the two parallel runways does not permit simultaneous independent instrument approaches.

2. The existing noise-abatement departure procedures require departures from both parallel runways to fly over a common fix in both east flow (Runways 10R and 10L) and west flow (Runways 28L and 28R).

The first major capacity constraint could be solved by either (1) waiting to see if certain future navigation and ATC technologies would enable simultaneous independent judgment approaches to parallel runways spaced as close as 3,100 feet apart, or (2) increasing the spacing between the parallel runways to 3,400 feet (which would require a precision runway monitor [PRM]) or 4,300 feet. Later in Section 2.6 of this Technical Memorandum, future navigation and ATC technologies and their prospects for providing such capability are discussed.

The existing departure capacity constraints limit the ability of controllers to conduct simultaneous independent departures on the parallel runways, even though there is sufficient spacing between the two parallel runways (2,500 feet is required) for conducting such operations. The existing procedures do not allow controllers to provide the 15-degree divergent headings between jet aircraft after takeoff that are required for conducting independent departures. Without such divergent departure headings, the Airport is limited to essentially a single stream of departures by jet aircraft. This departure capacity constraint is partially mitigated because controllers can provide divergent headings by non-jet departures. The previous analyses of airfield capacity and aircraft delay by the FAA and others have taken into account these dependent departure procedures.

As discussed later in Section 2.6.1 of this Technical Memorandum, these departure capacity constraints might be mitigated by available Runway Area Navigation (RNAV) technology, which is already in use at the Airport. Such procedures could enable the development of new and effective noise-abatement flight procedures in the future.

The parallel runways are separated by 3,100 feet. Under today's air traffic control rules, the minimum required spacing between parallel runways for independent approaches in all weather conditions is 4,300 feet. With a PRM, independent approaches could be conducted to parallel runways as close as 3,400 feet.

However, the spacing of 3,100 feet between the parallel runways does exceed the minimum spacing of 2,500 feet required for the following three instrument procedures:

1. Parallel dependent (staggered) instrument landing system (ILS) approaches where controllers provide a minimum of 1.5 nautical mile separation diagonally between successive aircraft on the parallel runways.

2. Independent instrument departures provided that 15-degree divergent departure headings can be conducted. As previously mentioned, such divergent headings are currently available at PDX only for turboprop aircraft departures (i.e., not for jet aircraft) because of noise abatement procedures that require all departures from the parallel runways to fly over a common point in each direction of flow.

3. Independent instrument arrivals and departures (i.e., arrivals on one parallel runway are independent of departures on the other parallel runway, and vice versa) provided that the departure course diverges immediately by at least 30 degrees from the missed approach course until separation is applied (which is the case at the Airport).

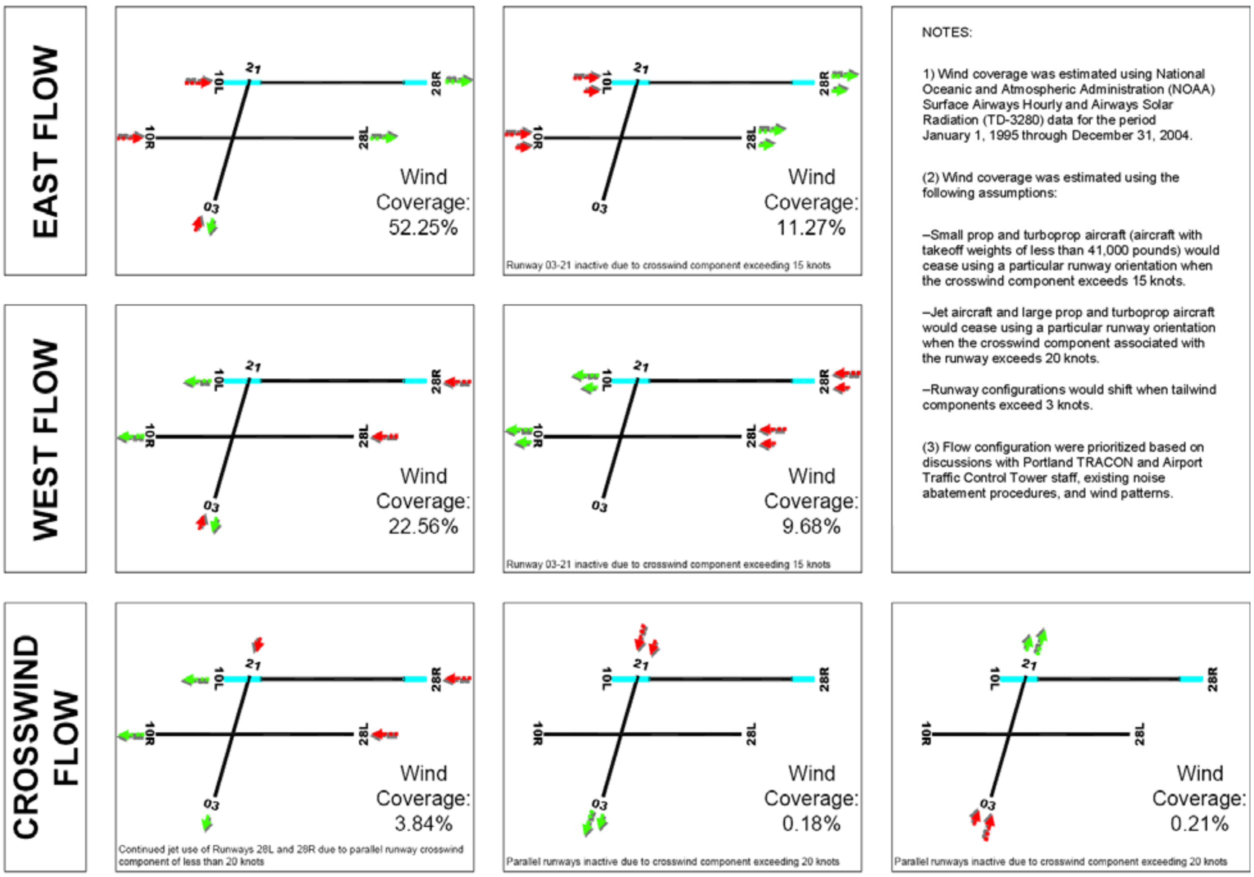
This latter independence between arrivals and departures at the Airport is important because it gives controllers more flexibility to assign arrivals and departures to the runway that is closest to the aircraft gate. At today's traffic levels, such flexibility is manageable, and controllers are able to minimize aircraft taxiing times by crossing over arriving aircraft in the air, rather than on the ground. In addition, because independent departures are currently not feasible at the Airport, controllers are able to assign departures to the runway closest to their gates without significant operational penalties. However, as aviation activity levels increase in the future, and airfield capacity constraints become a more significant issue, there will be increased pressure to separate arrivals and departures in the airspace according to their origin or destination (i.e., assigning aircraft from/to the north to the north parallel runway and aircraft from/to the south to the south parallel runway), thereby reducing crossovers in the air during peak activity periods.

2.1.3 Wind Coverage of Runway Use Configurations

There are three major runway use configurations for aircraft arrivals and departures at the Airport—east flow, west flow, and crosswind flow—as illustrated on Figure 2-2 below. East flow involves the use of Runways 10L and 10R, with occasional use of Runways 3 and 21 by light aircraft. For noise abatement purposes, east flow is the preferred calm-wind runway-use configuration. West flow involves the use of Runways 28L and 28R, coupled with occasional use of Runways 3 and 21 by light aircraft. Crosswind flow—which is in effect when wind conditions preclude the use of the Airport's parallel runway system by smaller, lighter aircraft—involves the use of Runways 21, 28R, and 28L.

Figure 2-2

MAJOR RUNWAY USE CONFIGURATIONS AT PORTLAND INTERNATIONAL AIRPORT



Source: Leigh Fisher Associates, *Runway 10L-28R Extension Feasibility Study, Portland International Airport*, August 2006.

Jacobs Consultancy summarized the runway use criteria in *Runway 10L-28R Extension Feasibility Study*, August 2006 as follows:

- East flow is the preferred calm wind runway use configuration.
- The Airport transitions to crosswind flow when the crosswind component to the Runway 10 or 28 systems approaches or exceeds 15 knots. Gusting crosswinds and reported wind shear can result in controllers switching to crosswind flow at lower reported crosswind speeds.
- Small, light propeller aircraft approaching or departing from the south cargo area may request clearance to land on or take off from Runway 3, winds

permitting. Such crosswind runway use is generally permitted if the crosswind component on Runway 3-21 does not exceed 12 knots and the tailwind component does not exceed 3 knots.

- The small, light propeller aircraft that land on Runway 3 when the parallel runway system is in use generally exit the runway south of Runway 10L-28R. However, these arrivals are no longer permitted to conduct land and hold short operations (LAHSO).

2.1.4 Operational Weather Category Descriptors

In previous studies, different terminology was used to describe operational weather categories. Good weather conditions are variously described as optimum weather, visual flight rules (VFR) conditions, and visual meteorological conditions (VMC). At the other extreme, poor weather conditions are variously described as instrument flight rules (IFR) conditions and instrument meteorological conditions (IMC). Between these two extremes are marginal conditions usually described as marginal visual meteorological conditions (MVMC). Wherever possible in this Technical Memorandum, the descriptors VMC, MVMC, and IMC are used.

2.1.5 Runway Uses and Weather Conditions – Historical

For capacity evaluation purposes, the foregoing runway use configurations must also be further categorized according to different operational weather categories as defined by cloud ceiling and visibility. In its previous CEPs for the Airport, the FAA identified five operational weather categories, as follows (see Table 2-1):

- ***Visual Meteorological Conditions—VMC (referred to as VFR 1 in Table 2-1).*** When the ceiling is at least 3,500 feet above the ground and visibility at least 10 miles, controllers can conduct independent visual approaches to the parallel runways.

- ***Marginal Visual Meteorological Conditions—MVMC (referred to as VFR 2 in Table 2-1).*** When the ceiling is less than 3,500 feet above the ground but at least 2,000 feet, and visibility is less than 10 miles but at least 5 miles, controllers can conduct parallel dependent (staggered) ILS approaches to the parallel runways with a diagonal separation as low as 1.5 nautical miles.

- ***Instrument Meteorological Conditions—IMC (referred to as IFR 1, IFR 2, and IFR 3 in Table 2-1).*** These three IFR categories represent ILS Categories I, II, and III, respectively. Only Runway 10R (east flow) has Category II and III ILS approach capability. In the IFR 2 and IFR 3 weather categories, the Airport is limited to a single instrument arrival stream.

The frequencies of occurrence of these five weather categories are summarized in Table 2-1.

Table 2-1

RUNWAY USE AND WEATHER CONDITIONS
Portland International Airport

Weather	VFR1	VFR2	IFR1	IFR2	IFR3	
Minima	Visual	<VIS and ≥IFR	CAT I	CAT II	CAT III	All weather
Ceiling (feet above MSL)	3,500	2,000	200	100		
Visibility	10 miles	5 miles	0.5 mile	0.25 mile	0.125 mile	
East flow (10L/10R)	34.7%	9.1%	7.7%	0.6%	1.1%	53.2%
West flow (28L/28R)	38.4	4.9	3.5	0.0	0.0	46.8
Total	73.1%	14.0%	11.2%	0.6%	1.1%	100.0%

MSL = mean sea level

Sources: October 1996 and October 2001 FAA Capacity Enhancement Plans for the Airport based on historical data tabulated from 10 years of Surface Airways Hourly Data (TD-1440) for January 1, 1979, through December 31, 1988, from the National Climatic Data Center, Asheville, North Carolina.

2.2 FAA Benchmark Capacities

The FAA prepared Airport Capacity Benchmark Reports in 2001 and 2004. Below is a summary of the findings for the Airport from the FAA's *Airport Capacity Benchmark Report 2004*:

- Capacity benchmarks are defined as the maximum number of flights that can be routinely handled at an airport in an hour for the most commonly used runway configuration in each specified weather condition.

- The capacity benchmark for Portland International Airport today is 116-120 flights per hour (arrivals and departures) in VMC.

- The benchmark rate decreases in MVMC conditions to 79-80 flights per hour, and in IFR conditions to 77-80 flights per hour, for the most commonly used runway configurations in these conditions. Throughput may be lower when ceiling and visibility are low, or when IFR operations at nearby airports affect operations at Portland International Airport.

- Most departures from both parallel runways at the Airport are limited to a single departure corridor (stream) for noise abatement. It was assumed in estimating the future benchmark that this noise abatement procedure was in effect. By limiting departure headings, this procedure reduces the maximum departure throughput.

Table 2-2 below, which was taken from the FAA *Airport Capacity Benchmark Report 2004*, summarizes the capacity benchmarks for the Airport in VMC, MVMC, and IMC. In addition, Table 2-2 shows the FAA's estimates of the percentage occurrence of each of these weather conditions. Also shown in the table are estimates of benchmark capacities with planned improvements, which consist primarily of technological improvements discussed in Section 2.6**.**

Table 2-2

SUMMARY OF FAA 2004 CAPACITY BENCHMARKS
Portland International Airport

Weather	*Scenario*	*Configuration*	*Procedures*	*Benchmark Rate (per hour)*
Optimum Rate	**Today**	Arrivals on Runways 28R, 28L Departures on 28R, 28L *Frequency of Use: insufficient data*	Visual approaches, visual separation Restricted departure headings for noise abatement	**116-120**
Ceiling and visibility above minima for visual approaches (3500 ft ceiling and 8 mi visibility)	**New runway**	Not applicable		Not applicable
Occurrence: 75%	**Planned improvements (2013)**	Same		**116**
Marginal Rate	**Today**	Arrivals on Runways 10R, 10L Departures on 10R, 10L *Frequency of Use: insufficient data*	Dependent instrument approaches, radar separation Simultaneous departures, restricted departure headings for noise abatement	**79-80**
Below visual approach minima but better than instrument conditions	**New runway**	Not applicable		Not applicable
Occurrence: 21%	**Planned improvements (2013)**	Same	Paired approaches, visual separation; same departure procedures	**109**
IFR Rate	**Today**	Arrivals on Runways 10R, 10L Departures on 10R, 10L *Frequency of Use: insufficient data*	Dependent instrument approaches, radar separation Simultaneous departures, restricted departure headings for noise abatement	**77-80**
Instrument conditions (ceiling < 1000 ft or visibility < 3.0 miles)	**New runway**	Not applicable		Not applicable
Occurrence: 4%	**Planned improvements (2013)**	Same		**77**

Note: Data on frequency of occurrence of weather and runway configuration usage are based on FAA Aviation System Performance Metrics data for January 2000 to July 2002 (excluding 11-14 September 2001), 7 AM to 10 PM local time.

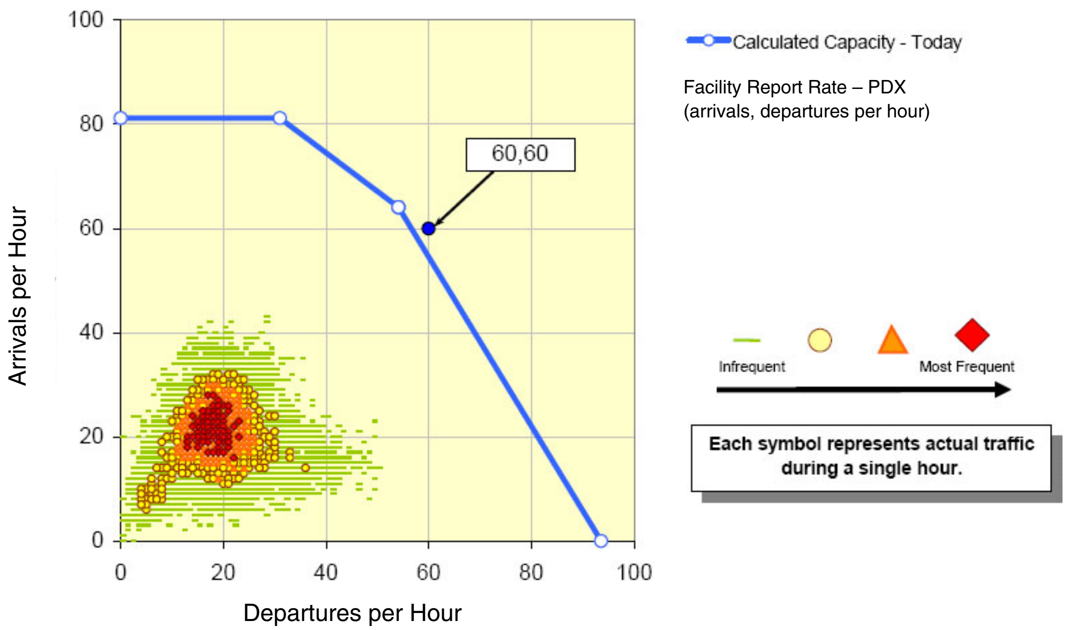
Source: Federal Aviation Administration, *Airport Capacity Benchmark Report 2004*, September 2004.

2.2.1 FAA Benchmark Capacities – VMC

Estimates of hourly runway capacity for different combinations of arrivals and departures are presented on Figures 2-3 and 2-4, taken from the FAA's *Airport Capacity Benchmark Report 2004*. The segmented linear function plotted on each figure, known as a Pareto frontier, illustrates the trade-offs between arrival capacity and departure capacity. The maximum hourly arrival capacity is the point at which the Pareto frontier intercepts the vertical axis; the maximum hourly departure capacity is the point at which the Pareto frontier intercepts the horizontal axis. The shape of the Pareto frontier between those two endpoints is an indication of the dependence between arrival capacity and departure capacity. A rectangular shape would indicate that arrival capacity and departure capacity are independent. The sloping lines reflect a trade-off between arrival and departure capacity typical of an airfield configuration where mixed operations (both arrivals and departures) occur on the runways.

Figure 2-3

FAA CAPACITY BENCHMARK FOR PORTLAND INTERNATIONAL AIRPORT IN VMC



Source: Federal Aviation Administration, *Airport Capacity Benchmark Report 2004,* September 2004.

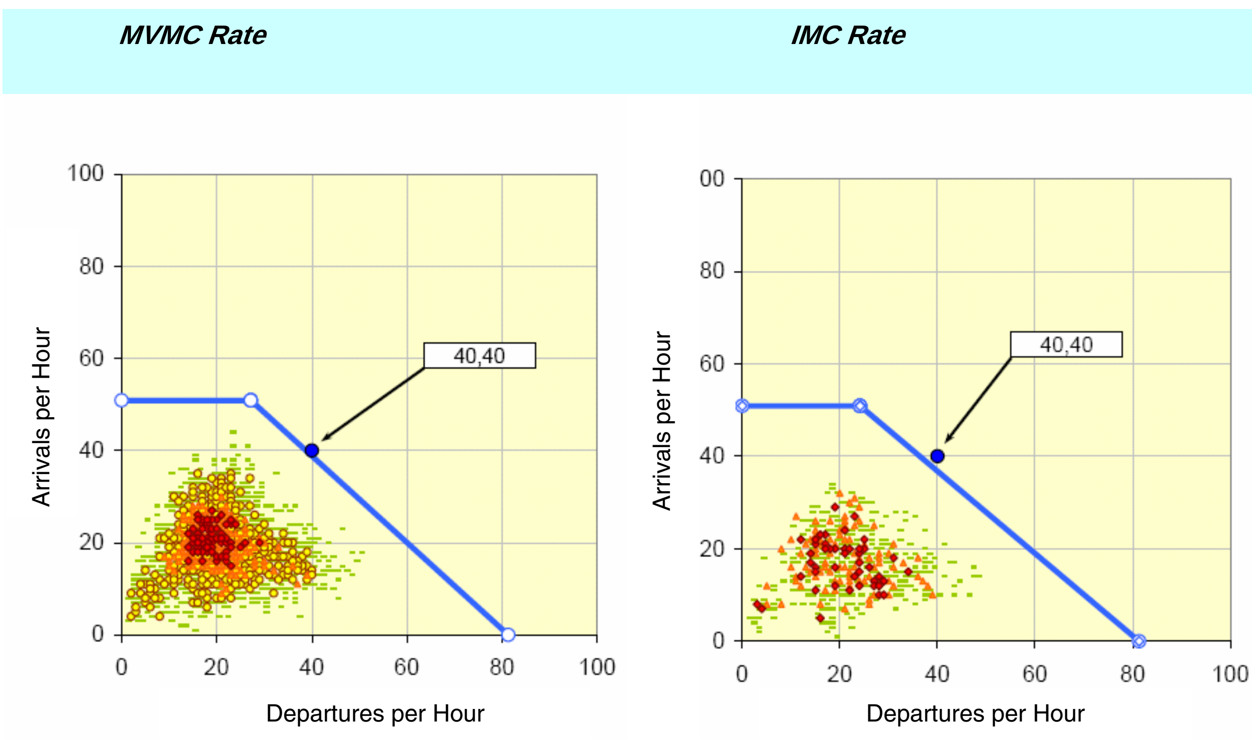
As shown on Figure 2-3, for the optimum rate in VMC, the estimated "balanced" capacity benchmark (50% arrivals and 50% departures) for the Airport is 60 arrivals and 60 departures, for a total of 120 hourly aircraft operations. Figure 3 also includes actual plotted data points showing historical hourly arrival and departure rates, which were obtained from the FAA Aviation System Performance Metrics (ASPM) database for January 2000 to July 2002, 7 a.m. to 10 p.m. local time (excluding September 11-14, 2001). Facility reported rates were provided by ATC personnel at the Airport. As shown, these actual hourly arrival and departure rates are considerably lower than the estimated hourly runway capacities illustrated by the Pareto frontier.

2.2.2 FAA Benchmark Capacities – MVMC and IMC

The capacity benchmarks for the Airport in MVMC and IMC are illustrated on Figure 2-4. As shown, the arrival and departure capacities are lower and more dependent than they are in VMC.

Figure 2-4

FAA CAPACITY BENCHMARKS FOR PORTLAND INTERNATIONAL AIRPORT IN MVMC AND IMC



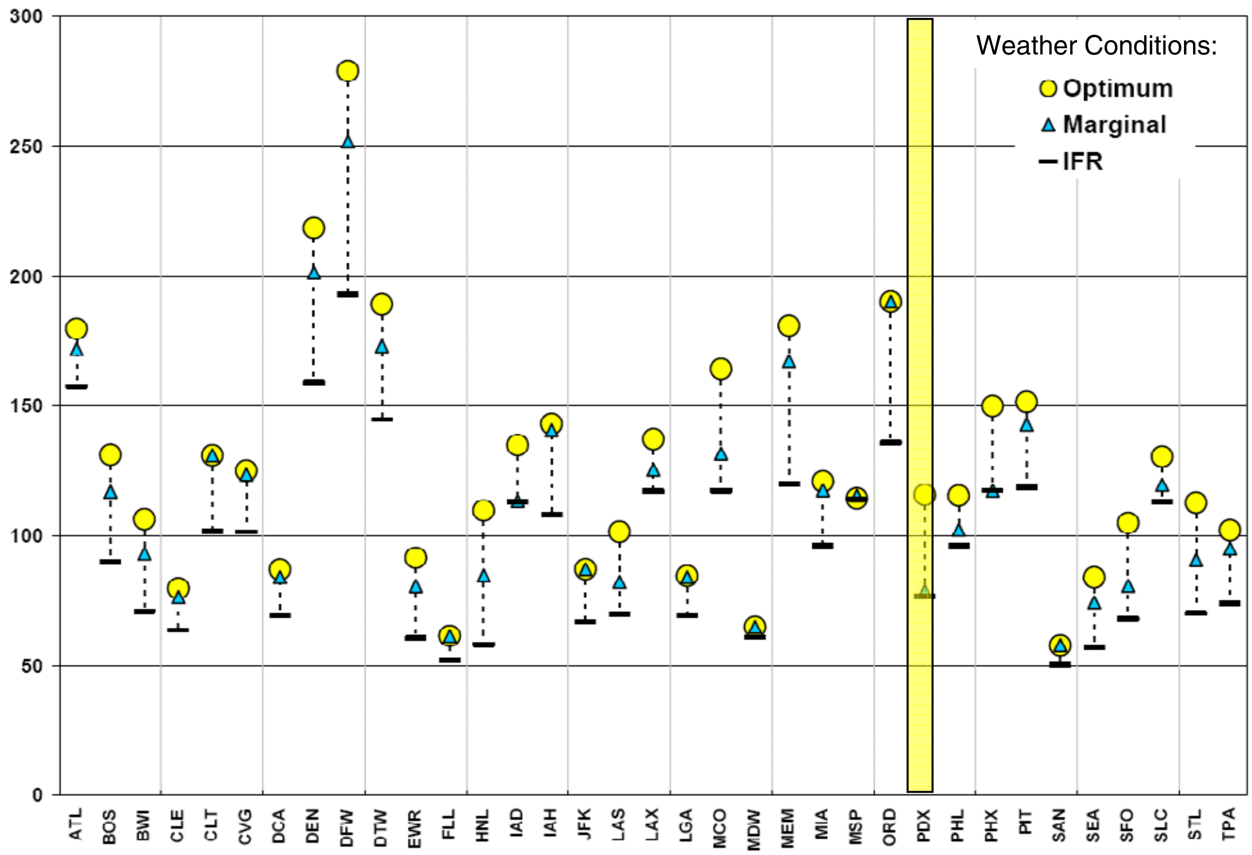
Source: Federal Aviation Administration, *Airport Capacity Benchmark Report 2004,* September 2004.

2.2.3 *Effect of Weather on Capacity Benchmarks*

The effect of weather on hourly runway capacity varies widely among airports. Figure 2-5 below, also taken from the FAA *Airport Capacity Benchmark Report 2004*, illustrates this point. The vertical lines shown for each airport represent a range of capacities between VMC (labeled “Optimum” on Figure 2-5) and IMC (labeled “IFR” on Figure 2-5). The range of 77-120 hourly operations indicated on Figure 2-5 for Portland International Airport (see yellow highlighted box) is typical of many airports with dependent parallel runways. The airports with the widest capacity ranges are Dallas/Fort Worth, Denver, and Chicago O'Hare international airports, which have complex, multiple-runway airfields. The airports with the narrowest capacity ranges are typically characterized by either a single runway operation, such as San Diego International Airport, or those in locations that are not very sensitive to changes in weather conditions.

Figure 2-5

RANGES OF 2004 AIRPORT CAPACITY BENCHMARKS FOR TOP 35 U.S. AIRPORTS



Source: Federal Aviation Administration, *Airport Capacity Benchmark Report 2004*, September 2004.

2.2.4 FAA Benchmark Capacities with Planned Technological Improvements

The FAA *Airport Capacity Benchmark Report 2004* also estimated that planned technological improvements would increase the benchmark rate at the Airport by as much as 38% in MVMC conditions. This additional benefit derives from Required Navigation Performance (RNP) and Cockpit Display of Traffic Information (CDTI) Enhanced Flight Rules (CEFR), which will allow suitably equipped aircraft to maintain visual separations in MVMC conditions. This additional benefit also assumes that RNP Parallel Approach Transition (RPAT) procedures would allow paired approaches to the parallel runways. These potential RPAT procedures are described in more detail in Section 2.6.3.

2.2.5 FAA Airport Arrival Rates and Airport Departure Rates – 2007

Air traffic controllers specify airport arrival rates (AARs) and airport departure rates (ADRs) for purposes of anticipating the need for coordinating traffic flows with other air traffic control facilities. The AARs and ADRs are intended to represent current and anticipated constraints resulting from runway use and weather conditions that can be coordinated in time to avoid overloading individual air traffic control facilities. They also provide a useful comparison for the foregoing hourly runway capacity estimates.

In Table 2-3 below, which was obtained from the FAA Aviation System Performance Metrics database, the FAA provides information on the distribution of facility provided rates for the AARs and ADRs. Note that the total (AAR plus ADR) hourly numbers in Table 2-3 agree closely with the FAA's 2004 "capacity benchmark" for the Airport of 120 total aircraft operations per hour, as shown on Figure 2-3.

Table 2-3

AIRPORT ARRIVAL RATES AND AIRPORT DEPARTURE RATES
Portland International Airport

AAR/ADR Calculator : Summary (Hourly Source)

From 01/2000 To 12/2007 : 'PDX'

Airport Efficiency Traffic Count :	2020994	Conditions To Vector For Visual Approach	
OPSNET Operations :	2206725	Ceiling :	3500
Percent Of Operations :	91	Visibility :	8

Actual Efficiency Counts

	Time Periods	Max	99th	95th	75th	Min	Median	Average
Departure	43830	56	42	33	23	0	19	19
Arrival	43830	49	36	31	24	0	19	19
Total Operations	43830	73	61	55	45	0	39	39

Facility Provided Rates

	Time Periods	Max	99th	95th	75th	Min	Median	Average
ADR	43830	60	60	60	60	8	42	46
AAR	43830	60	60	60	60	8	40	44
Total (ADR+AAR)	43830	120	120	120	120	16	80	91

Source: Federal Aviation Administration, Aviation System Performance Metrics database.

2.3 Estimates of Annual Service Volume

Jacobs Consultancy prepared a range of estimates of annual service volume for the Airport, as defined in FAA AC 150/5060-5, *Airport Capacity and Delay.* In that Advisory Circular, ASV is defined as the point at which further increases in demand will result in disproportionate increases in average aircraft delay. As such, ASV is not a hard upper limit on annual aircraft operations and is not tied to any particular aircraft delay level. Aircraft operations levels can be as much as 15% to 20% higher than ASV before aircraft delays become excessive, depending on aircraft mix, operational complexity, and peaking patterns.

Annual service volume is calculated using a formula in FAA AC 150/5060-5, which essentially extrapolates the various hourly runway capacities for specific runway uses and weather conditions to an annual capacity using the percent occurrence of those runway uses and weather conditions and weighting factors prescribed in the Advisory Circular. Moreover, in AC 150/5060-5, ASV is the basis for estimating average annual aircraft delay using a ratio of total annual operations to ASV, as demonstrated in Section 2.5.2.

Jacobs Consultancy calculated ASV based on the hourly runway capacity estimates from the (1) 1996 *Capacity Enhancement Plan*, (2) the 2001 *Capacity Enhancement Plan*, and (3) the *Airport Capacity Benchmark Report 2004*, as shown in Table 2-4.

In its 1996 and 2001 CEPs, the FAA used aircraft delay curves to estimate annual capacities as the annual operations levels that correspond to an average annual aircraft delay of 10 minutes per operation. These aircraft delay curves are discussed later in Section 2.5.1 and are reproduced on Figure 2-8. The annual aircraft operation levels corresponding to an average aircraft delay of 10 minutes per operation are shown in the second column of Table 2-4.

Therefore, ASV is not just a measure of annual capacity; it also provides a standard industry method for estimating aircraft delays that is widely used in the United States for airport master planning and system planning studies. We have used this ASV method to estimate existing and future aircraft delays at the Airport, as discussed in Section 2.5.2 of this Technical Memorandum.

Table 2-4

SUMMARY OF PREVIOUS ESTIMATES OF ANNUAL AIRFIELD CAPACITY
Portland International Airport

Source	Annual Capacity (Operations) at Average Delay of 10 minutes/ operation	Hourly VMC Capacity		Hourly MVMC Capacity		Hourly IMC Capacity		Annual Service Volume (ASV) *	2007 Operations	2007 Operations as % of ASV
		Capacity	% of Time	Capacity	% of Time	Capacity	% of Time			
1996 FAA Capacity Enhancement Plan	412,000	112	74.4%	80	14.2%	62	11.4%	376,000	264,518	70.4%
2001 FAA Capacity Enhancement Plan	510,000	120	74.4%	96	14.2%	80	11.4%	461,000	264,518	57.4%
2004 FAA Airport Capacity Benchmark Report	Not Applicable	120	75.0%	80	21.0%	80	4.0%	425,000	264,518	62.2%

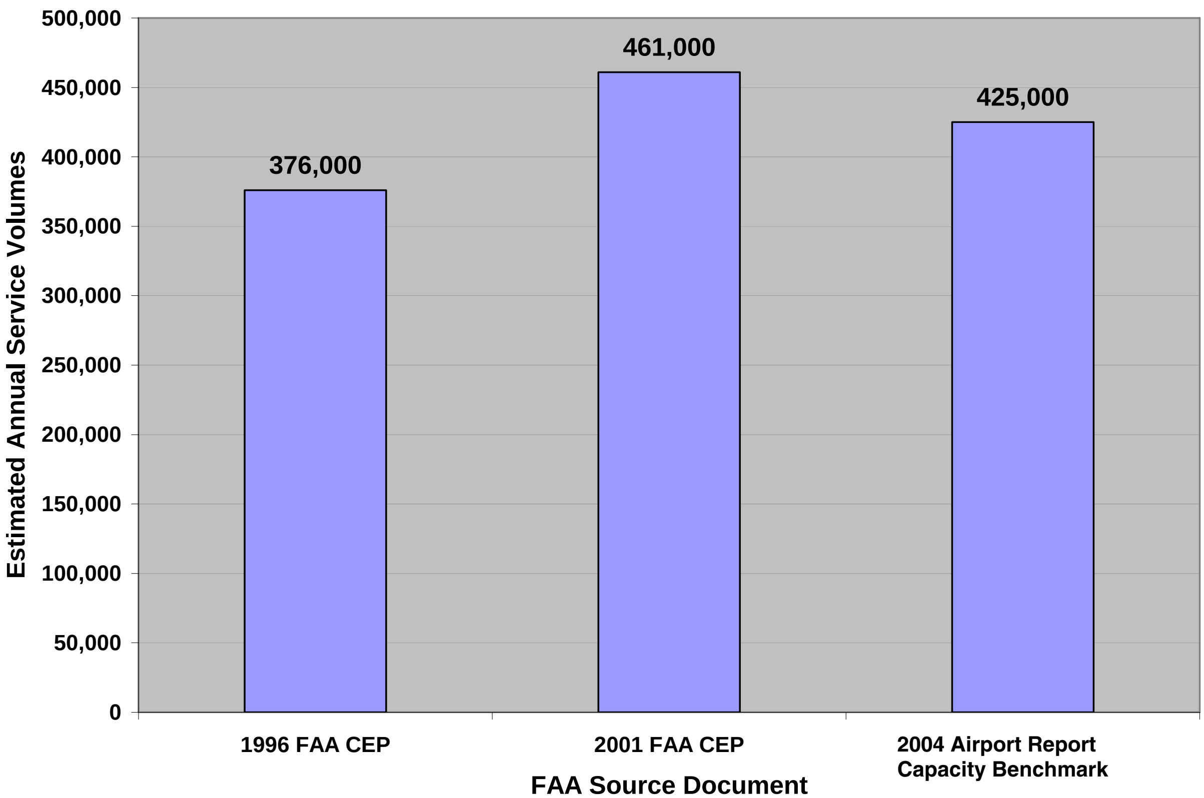
*Preliminary estimates by Jacobs Consultancy using methods in FAA AC 150/5060-5, *Airport Capacity and Delay*. Aircraft operations levels can be as much as 15% to 20% higher than ASV before aircraft delays become excessive.

Source: Jacobs Consultancy based on review of previous FAA and Master Plan reports, August 2008.

Figure 2-6 below shows a graphical comparison of the various ASVs.

Figure 2-6

ESTIMATES OF ASV USING CAPACITIES FROM PREVIOUS FAA CAPACITY STUDIES



Source: Jacobs Consultancy, August 2008.

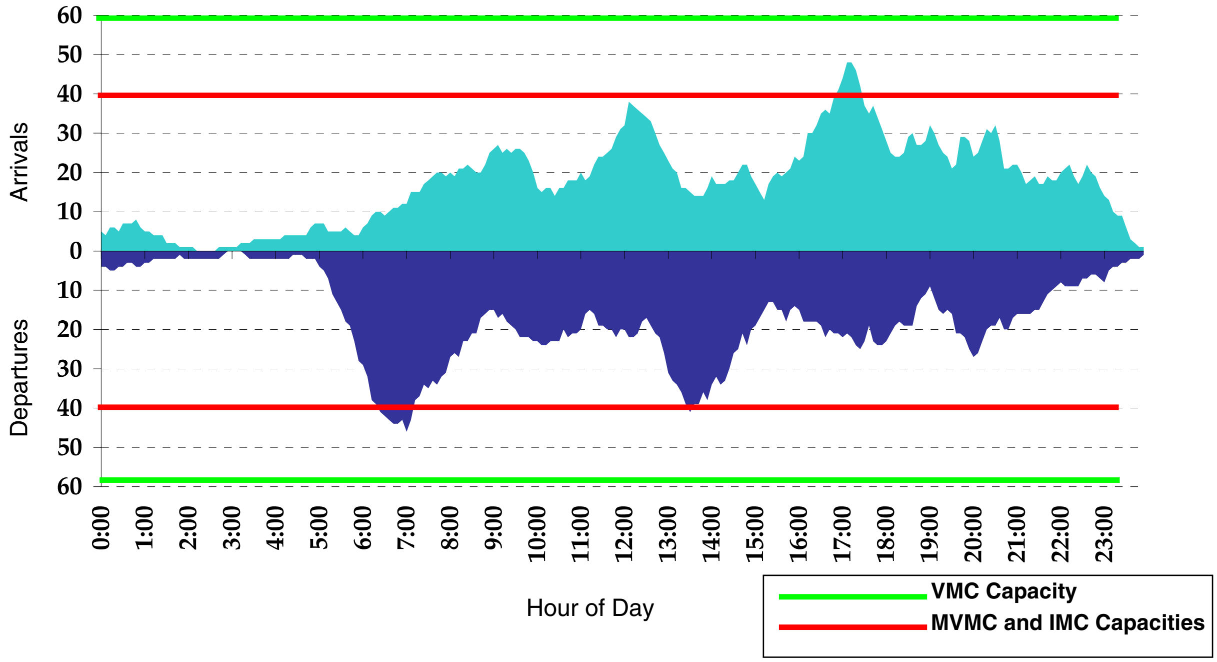
On the basis of a review of the foregoing results, Jacobs Consultancy recommends adopting the FAA 2004 baseline capacity estimates, as shown in Table 2-2, and the corresponding estimate of ASV of 425,000 operations for purposes of evaluating future airfield requirements and estimating the delay reduction benefits of proposed airfield improvements.

2.4 Comparison of Hourly Demand with Hourly Capacity

For purposes of comparing hourly demand with hourly runway capacity, Figure 2-7 shows a chart of rolling hourly counts of arrivals and departures every 6 minutes (taken from the Port's Airport Noise and Operations Monitoring System [ANOMS] data), with arrivals plotted above the horizontal axis and departures plotted below the horizontal axis. This chart shows detailed peaking within the hour, which can easily be compared with hourly runway capacities, which are shown as green (VMC capacity) and red (MVMC and IMC capacities) horizontal lines on Figure 2-7.

Figure 2-7

ROLLING HOURLY COUNTS OF AVIATION ACTIVITY FROM ANOMS DATA, AUGUST 10, 2007



Source: Jacobs Consultancy, August 2008.

Note that the peak arrivals exceed the MVMC and IMC capacities in the afternoon peak hour, but are well below the VMC capacity. MVMC and IMV occur a total of about 27% of the time, as noted in Table 2-1. Similarly, peak departures exceed the MVMC and IMC capacities during two of the peak hours, but are well below the VMC capacity. Therefore, as indicated on Figure 2-7, for these conditions, delays are expected to be low in VMC and moderate in MVMC and IMC.

2.5 Aircraft Delays

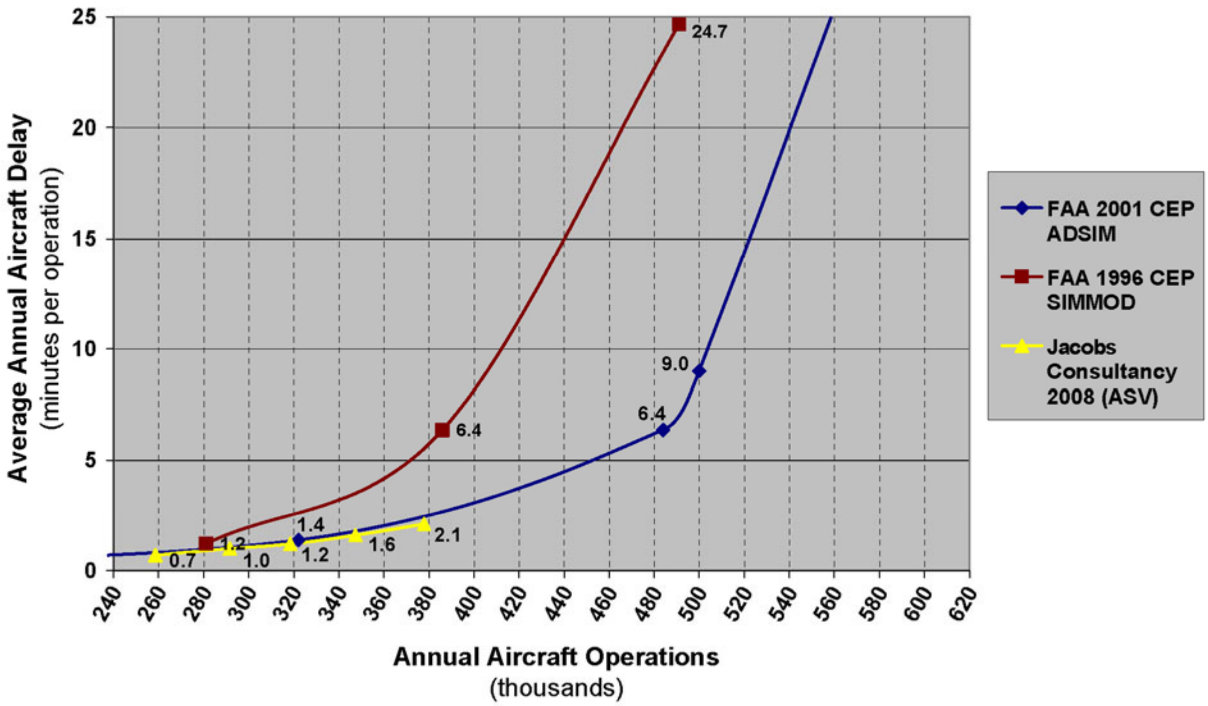
2.5.1 Comparison of Previous FAA Aircraft Delay Estimates

Jacobs Consultancy reviewed the previous FAA aircraft delay curves from the 1996 FAA *Capacity Enhancement Plan*, the 2000 *Master Plan Update*, and the 2001 FAA *Capacity Enhancement Plan*. To simplify the discussion, please note that the delay curves used in the 2000 *Master Plan Update* are the same as those in the 1996 FAA *Capacity Enhancement Plan*.

The aircraft delay curves from the 1996 and 2001 FAA Capacity Enhancement Plans differ significantly, as can be seen on Figure 2-8 where they are plotted on the same chart.

Figure 2-8

SUMMARY OF AIRCRAFT DELAY CURVES FROM PREVIOUS FAA CAPACITY ENHANCEMENT PLANS AND ESTIMATES USING ASV METHODOLOGY



Sources: FAA and Jacobs Consultancy.

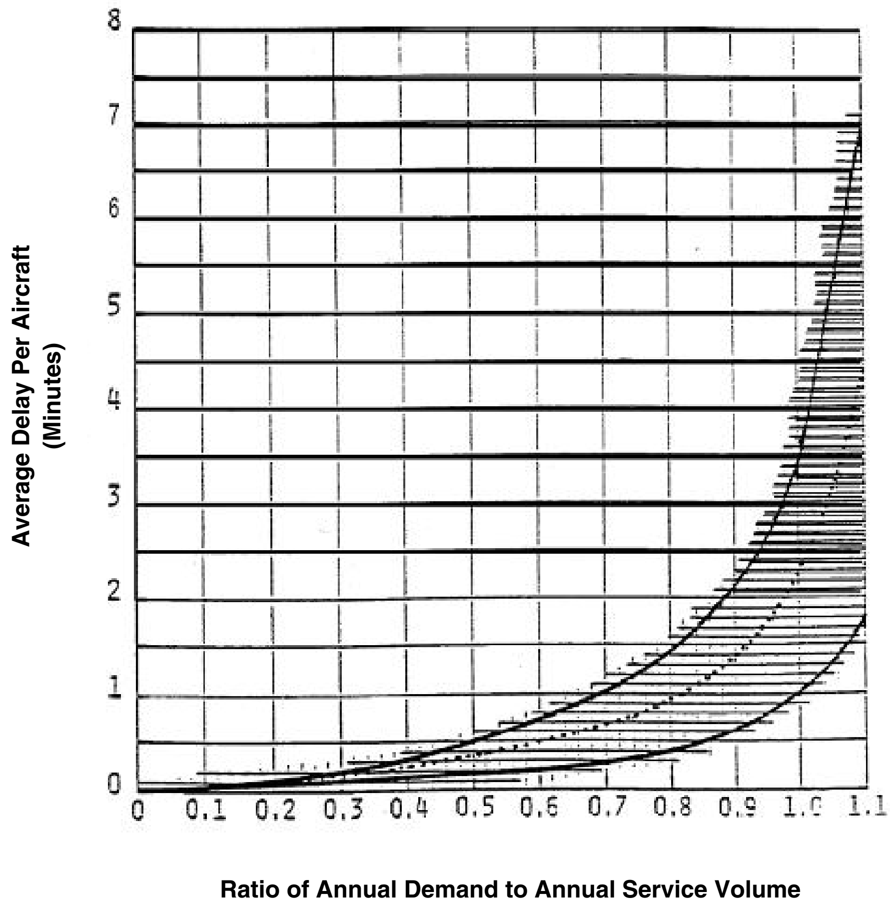
Note that, on Figure 2-8, the corresponding demand levels differ by nearly 100,000 annual operations (386,000 annual operations versus 484,000 annual operations) at the same level of annual aircraft delay (e.g., 6.4 minutes per operation). Similarly, for the same demand level, the more recent 2001 estimates of average annual aircraft delay developed using ADSIM are considerably lower than the 1996 estimates developed using SIMMOD. It is not clear why these delay estimates differ so widely. Different simulation models often yield different results.

2.5.2 *Aircraft Delays Estimated Using ASV Methodology*

To help reconcile these differences, Jacobs Consultancy estimated average annual aircraft delays based on the ASV methodology described in FAA AC 150/5060-5, *Airport Capacity and Delay*. This methodology enables the user to estimate average annual aircraft delays based on the relationship between average annual aircraft delay and the ratio of annual demand to ASV, as shown on Figure 2-9.

Figure 2-9

AIRCRAFT DELAY CURVES FROM FAA AC 150/5060-5, AIRPORT CAPACITY AND DELAY



The aircraft delay curves illustrated on Figure 2-9 represent a range of possible annual aircraft delays estimated by the FAA on the basis of extensive experimentation using ADSIM over a wide range of conditions and runway use configurations.

For purposes of this airfield requirements analysis, Jacobs Consultancy estimated average annual aircraft delays using the upper end of the range (which is intended to be used for major air carrier airports) of FAA delay curves shown on Figure 2-9, along with the assumed ASV of 425,000 operations and the forecast annual aircraft operations developed by Jacobs Consultancy as part of this Master Plan Update.

The estimated average annual aircraft delays are shown in Table 2-5 and on Figure 2-8 (presented earlier) as the yellow plotted curve, which more or less coincides with the aircraft delay curve developed for the 2001 FAA *Capacity Enhancement Plan* using ADSIM. Therefore, for the purposes of future evaluation, we recommend using the ASV methodology, which closely agrees with the aircraft delay curves prepared for the 2001 FAA *Capacity Enhancement Plan*.

Table 2-5

ESTIMATES OF AVERAGE ANNUAL AIRCRAFT DELAY CORRESPONDING TO FORECAST DEMAND LEVELS

PAL (Forecast Year)	Annual Operations	Ratio of Annual Operations to 2007 ASV (425,000)	Average Annual Delay (minutes per operation)
PAL 1 (2012)	258,480	61%	0.7
PAL 2 (2017)	291,540	69%	1.0
PAL 3 (2022)	318,440	75%	1.2
PAL 4 (2027)	347,360	82%	1.6
PAL 5 (2035)	377,820	89%	2.1

Source: Jacobs Consultancy using ASV methodology in FAA AC 150/5060-5, *Airport Capacity and Delay*, and forecast demand in Jacobs Consultancy, *Technical Memorandum No. 2 — Aviation Demand Forecasts,* September 2008.

Both the foregoing estimates of aircraft delays and actual data on aircraft delays indicate that the current and estimated delay levels at the Airport will remain low, even for PAL 5 (2035) activity of 377,820 annual aircraft operations, for which the average annual aircraft delay is estimated at about 2.1 minutes per operation, as shown in Table 2-5. Therefore, the existing airfield at the Airport appears to have adequate capacity to accommodate demand forecast through PAL 5 (2035) with low aircraft delays.

The FAA previously estimated an upper limit of about 500,000 annual aircraft operations at the Airport most likely based on its 2001 aircraft delay curve, as presented on Figure 2-8, which shows that an average annual delay of about 10 minutes per aircraft operation would be reached at an annual aircraft operations level of slightly over 500,000. As further corroboration of this estimate, note that the ratio of 500,000 annual operations to the ASV estimate of 425,000 operations is about 1.2, which would imply an average annual delay of about 10 minutes per operation according to the upper delay curve presented on Figure 2-9. Therefore, at today's capacity levels, the estimated upper limit of 500,000 annual aircraft operations at the Airport appears to be reasonable.

2.6 Potential Effects of Future ATC and Aircraft Navigation Technology

2.6.1 NextGen's Key Capabilities and Core Technologies

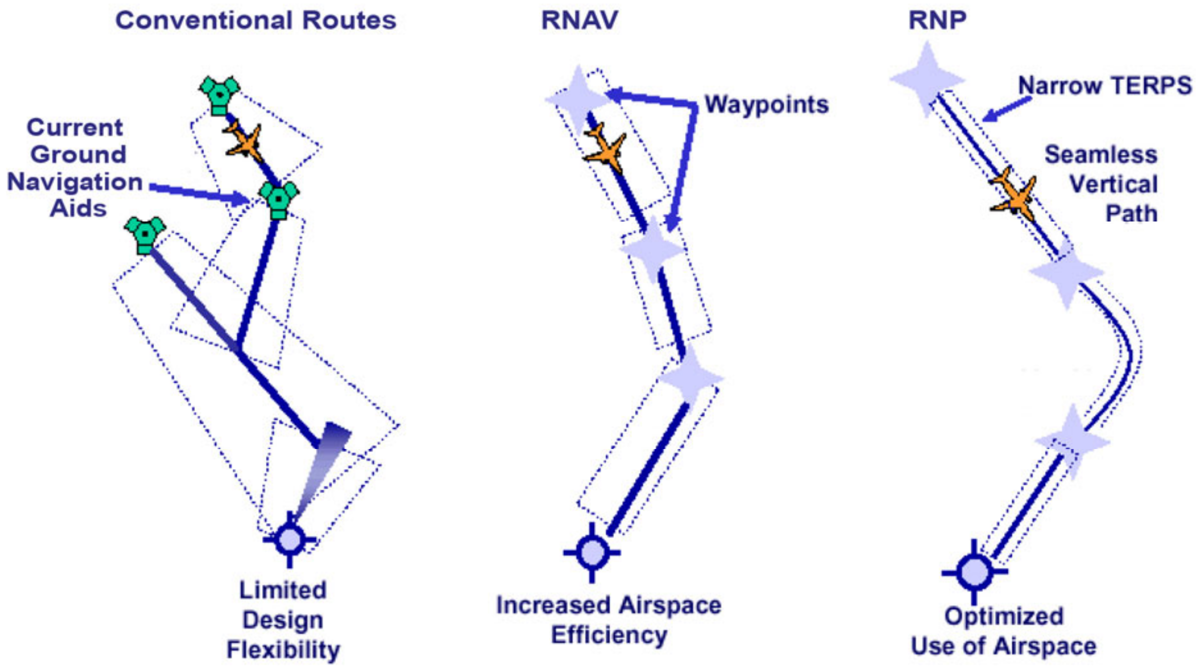
The FAA Joint Planning and Development Office (JPDO) prepared a plan for future ATC and navigation technologies called the "Next Generation Air Transportation System" (NextGen).* These global positioning system (GPS)-based technologies are expected to provide significant airport capacity increases by enabling more precise aircraft navigation and surveillance, thereby reducing the required spacing between simultaneous movements and separations between aircraft. These technologies will require major investments on the part of both the FAA and the airlines, and their timing is uncertain.

Table 2-2 presents expected increases in runway capacity with these new technologies (improvements). The NextGen technologies are expected to improve both VFR and IFR capacities and reduce airspace capacity constraints. The bases of these technologies are the concepts of RNAV and RNP. These concepts can best be understood by contrasting them with today's aircraft navigation procedures. As shown on Figure 2-10, today's aircraft navigation procedures involve flying zigzag courses between ground-based navigation aids, and all pilots must generally follow the same routes from navigational aid to navigational aid. RNAV is a method of navigation that permits flying on any desired flight path, independent of ground-based navigational aid location.

*Federal Aviation Administration, *NextGen Implementation Plan,* June 2008.

Figure 2-10

COMPARISON OF RNAV AND RNP FLIGHT PROCEDURES WITH CURRENT FLIGHT PROCEDURES



Source: Federal Aviation Administration, *Roadmap for Performance–Based Navigation, Evolution for Area Navigation (RNAV) and Required Navigation Performance (RNP) Capabilities 2006-2025,* July 2006.

Currently, RNAV (GPS) instrument approach procedures are in place to Runways 10L, 10R, 28R, and 28L, which essentially are overlay procedures that mimic the ILS approaches to those runways.

RNP is a statement of navigation performance accuracy necessary for operation within a defined airspace. Essentially, RNP is RNAV with on-board navigation monitoring and alerting. RNP-capable aircraft are equipped with dual flight management system computers that can monitor actual navigation performance and alert the pilot when the RNP operational requirement cannot be met.

RNAV and RNP flight procedures are conducted from waypoint to waypoint, and are completely independent of ground-based navigational aids, as shown by the second and third diagrams on Figure 2-10. These pilot-defined flight paths can save significant route mileage and travel time both in the en route and terminal area airspace, and can be defined to follow more precisely desired noise-abatement flight corridors.

Alaska Airlines and Horizon Air currently use RNP procedures to Runways 28R and 28L at the Airport. Horizon Air has been using RNP procedures at the Airport since September 2007 on its Bombardier Q400 Dash 8s. In particular, the special Alaska/Horizon RNAV RNP approach to Runway 28R follows the Columbia River on a path similar to the charted Mill visual approach procedure to reduce noise impacts on neighborhoods.

2.6.2 Multiple RNP Approach Procedures

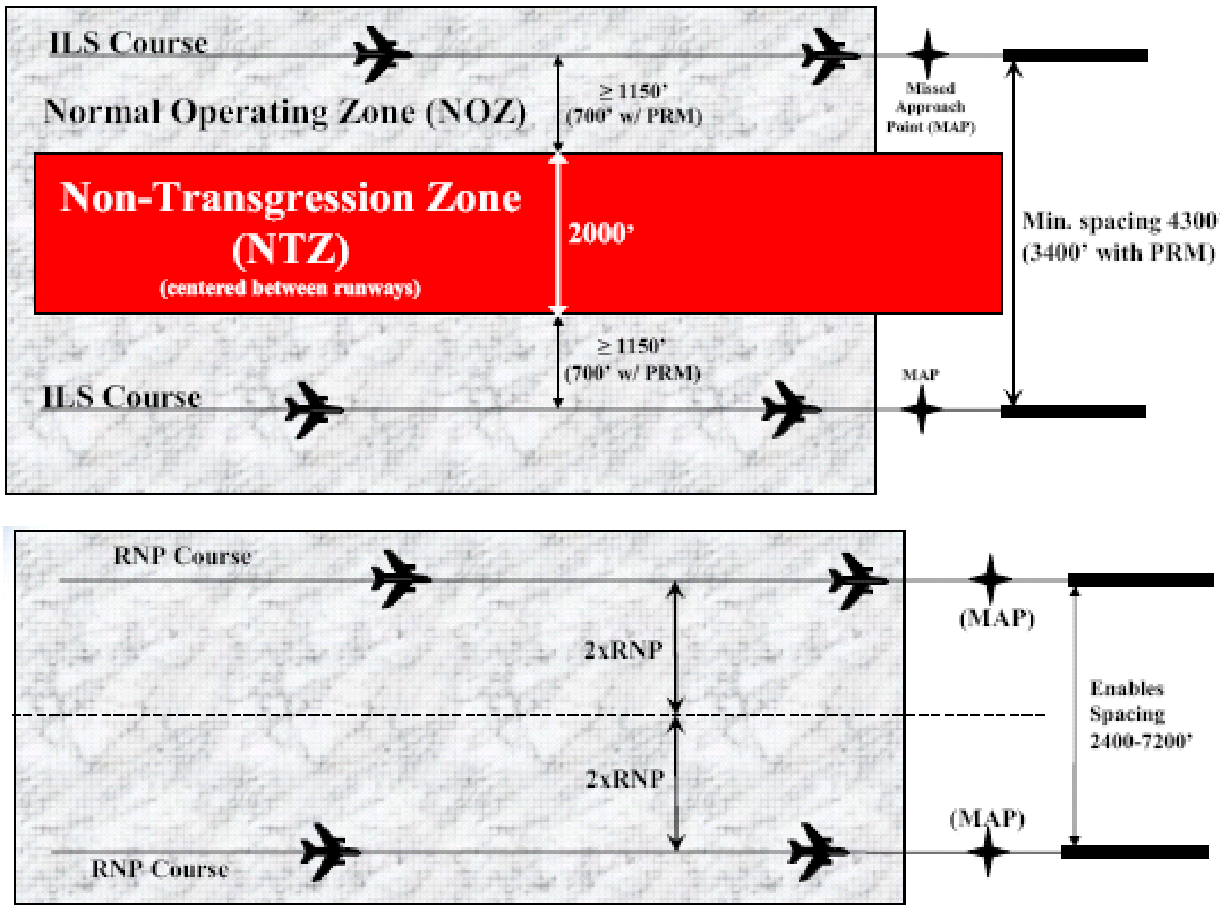
RNP approaches are characterized by their precision or "RNP value." For example, an RNP procedure may be specified to have an RNP value of 0.3 nautical mile, which means that an aircraft capable of flying such an approach is virtually assured of remaining within a "containment area" that is plus or minus 2-RNP wide (i.e., plus or minus 0.6 nautical mile). Therefore, RNP approaches may provide the basis for development of new simultaneous independent instrument approach procedures to more closely spaced parallel runways, such as those at Portland International Airport.

For example, the top portion of Figure 2-11 illustrates the existing requirements for conducting simultaneous independent instrument approaches, which entail protection of a no-transgression zone between the runways. With today's technology and air navigation precision, the required spacing for conducting such approaches is 4,300 feet.

The lower portion of Figure 2-11 illustrates a potential concept for conducting simultaneous independent approaches by RNP-equipped aircraft, where the required spacing between parallel approaches would be defined as 4 times RNP. Such spacing would ensure safe aircraft separation and would replace the concept of having a no-transgression zone between the parallel runways, monitored by air traffic controllers.

Figure 2-11

POTENTIAL REDUCTION IN REQUIRED SPACING FOR CONDUCTING SIMULTANEOUS INDEPENDENT INSTRUMENT LANDINGS



Source: Federal Aviation Administration, *Roadmap for Performance–Based Navigation, Evolution for Area Navigation (RNAV) and Required Navigation Performance (RNP) Capabilities 2006-2025,* July 2006.

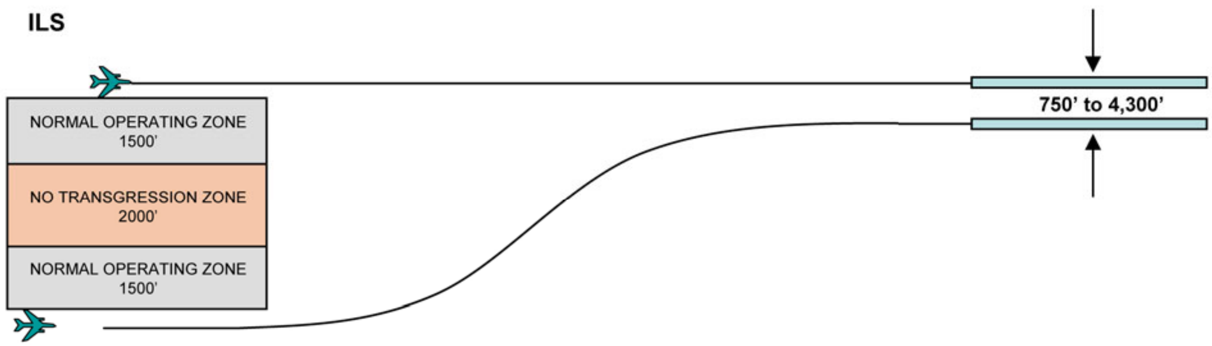
If such procedures were conducted by aircraft equipped to fly with an RNP value of 0.1 nautical mile or better, the spacing between parallel runways could be reduced to about 2,430 feet (4 x 0.1 x 6,076 feet per nautical mile), a decrease from the current 4,300 feet with today's ILS technology and procedures.

2.6.3 RNP Parallel Approach Transition

Another procedure enabled by RNP approaches is a side-step procedure similar to the Simultaneous Offset Instrument Approach (SOIA) procedure developed for Lambert/St. Louis international Airport and San Francisco International Airport. This RPAT procedure is illustrated below on Figure 2-12. This procedure is specifically mentioned as a potential capacity enhancement for the Airport in the FAA's *Airport Capacity Benchmark Report 2004*.

Figure 2-12

SIMULTANEOUS RNP PARALLEL APPROACH TRANSITION AND ILS PROCEDURES



Potentially applicable with 2,100-foot cloud ceilings and 3-5 mile visibility

Source: Federal Aviation Administration, *Roadmap for Performance–Based Navigation, Evolution for Area Navigation (RNAV) and Required Navigation Performance (RNP) Capabilities 2006-2025,* July 2006.

The FAA has estimated that the foregoing RPAT procedure could provide a capacity increase of up to 60% over a single approach procedure; by comparison, an independent approach procedure would provide a capacity increase of up to 100% over a single approach procedure.

2.6.4 Potential Benefits of RNAV Standard Instrument Departures (SIDS)

The greater precision and navigation possible with RNAV and RNP approach and departure procedures were previously mentioned. RNAV flight procedures have been widely implemented at many airports for both arrivals and departures. One of the major benefits of RNAV procedures is that they are flown without the need for radar vectors and the associated voice communication between pilots and controllers.

RNAV flight procedures have been implemented at Dallas/Fort Worth and Hartsfield-Jackson Atlanta international airports, and their benefits have been quantified and documented. These RNAV flight procedures are illustrated on Figure 2-13. The reduced dispersion of flight tracks enabled by the RNAV flight procedures is evident from the actual radar flight tracks shown on Figure 2-13.

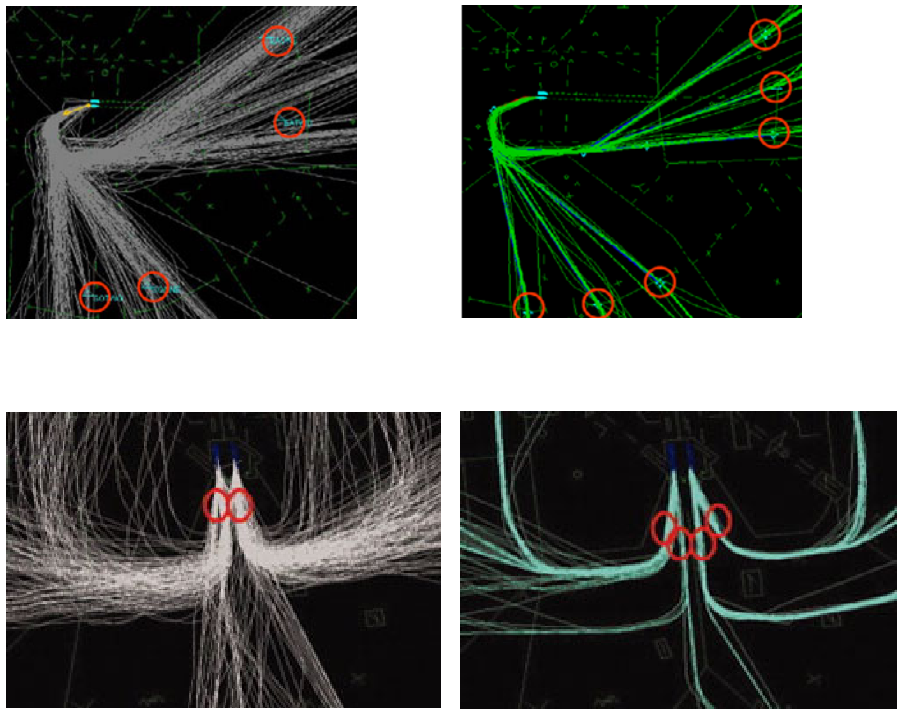
Figure 2-13

RADAR FLIGHT TRACKS BEFORE AND AFTER RNAV STANDARD INSTRUMENT DEPARTURES

Before | After

Hartsfield-Jackson Atlanta International Airport

Dallas/Fort Worth International Airport



Source: RNAV/RNP Program Update, Federal Aviation Administration

The benefits from the standard instrument departure (SID) procedures shown on Figure 2-13 were documented and widely accepted by both pilots and air traffic controllers. Before the implementation of the RNAV SIDs at Dallas/Fort Worth International Airport and Hartsfield-Jackson Atlanta International Airport (left-hand pictures on Figure 2-13), departures were radar vectored, significant dispersion in flight tracks occurred, and there were limited exit points from the terminal area airspace. After implementation of the RNAV SIDs (right-hand pictures on Figure 2-13), pilots flew RNAV flight tracks on departure (i.e., they were not radar vectored), flight track dispersion was reduced, pilots were able to fly more efficient vertical profiles, there were additional exit points available from the terminal area airspace, and voice transmissions were reduced 30% to 50%.

Such flight procedures are available today and do not require future technologies or changes in flight procedures; they only require that aircraft be equipped to fly the RNAV SIDs. Therefore, such RNAV departure procedures might provide the tools necessary for ultimately developing new noise abatement departure procedures at the Airport that will enable pilots to fly very precise, nondivergent departure paths from the parallel runways (e.g., both flying straight out on runway heading) with such operations being conducted simultaneously and independently.

2.7 Conclusions and Recommendations

1. Previous FAA estimates of hourly runway capacities and average aircraft delays, as documented in its 1996 and 2001 Capacity Enhancement Plans, vary widely and were estimated using different simulation models. The reasons for these differences are not clear. Moreover, the demand levels assumed in those plans were much higher than those forecast for 2035 (PAL 5) in this Master Plan Update.

2. The more recent estimates of hourly runway capacities contained in the FAA's 2001 *Capacity Enhancement Plan* and the 2004 *Airport Capacity Benchmark Report 2004* also differ from one another. The 2004 capacity benchmarks were intended to update the 2001 capacity benchmarks. Therefore, it is recommended that the 2004 FAA baseline capacities be used, along with Jacobs Consultancy's corresponding ASV estimate of 425,000 aircraft operations for future evaluations of airfield requirements and for estimating the delay-reduction benefits of proposed airfield capacity improvements at the Airport. The delay estimates produced using this ASV estimate agree reasonably well with the delay estimates presented in the 2001 FAA *Capacity Enhancement Plan*.

3. In this Technical Memorandum, we have used ASV as defined in FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*. As defined in this Advisory Circular, ASV is the point at which further increases in demand will result in disproportionate increases in average aircraft delay. As such, ASV is not a hard upper limit on annual aircraft operations and is not tied to any particular aircraft delay level.

4. The FAA previously estimated an upper limit of about 500,000 annual aircraft operations at the Airport, a level that the 2008 Master Plan Update forecasts indicate would not be reached until well beyond 2035. This FAA estimate was based on an aircraft delay curve in the 2001 FAA *Capacity Enhancement Plan*, which showed that an average annual delay of about 10 minutes per operation would be reached at an annual operations level of 500,000 (that aircraft delay curve is reproduced on Figure 2-8 of this Technical Memorandum). As further corroboration of this estimate, note that the ratio of 500,000 annual operations to the ASV estimate of 425,000 annual operations is about 1.2, which would imply an average annual delay of about 10 minutes per operation according to the delay curves on Figure 2-9 of this Technical Memorandum. Therefore, at today's capacity levels, the upper limit of 500,000 annual aircraft operations appears to be reasonable.

5. Both estimated aircraft delays and actual data on aircraft delays indicate that delay levels at the Airport will remain low even for the level of aircraft operations forecast throughout the planning period (i.e., PAL 5, or 2035). Therefore, there does not appear to be an immediate need for significant capacity enhancements at the Airport, such as a new runway or a more widely spaced parallel runway. Nevertheless, the FAA recommends initiating planning related to capacity enhancements when annual operations reach 60% of ASV (425,000). The 2007 annual operations level (264,518) at the Airport exceeds 60% of the Airport's ASV; therefore, the Port should continue to plan for capacity enhancements in this Master Plan Update.

6. The spacing between the parallel runways currently limits the area available for passenger terminal development and associated apron-edge taxiways and taxilanes.

7. The airfield appears to have an adequate supporting taxiway system for aircraft circulation and queuing of departures and arrivals. At current traffic levels, controllers have the flexibility to minimize aircraft taxiing distances by assigning arrivals and departures to the runway closest to the aircraft gates. However, as traffic increases in the future, this flexibility may be reduced, particularly in peak demand periods. Therefore, average aircraft taxiing times are likely to increase as traffic increases in the future. Accordingly, in the future, the taxiway system should be modified to facilitate the movement of taxiing aircraft between the north and south parallel runways.

8. The FAA has estimated potential increases in future hourly runway capacity with the JPDO NextGen technology improvements for the Airport and the other top 35 U.S. airports. However, the timing of these capacity improvements is uncertain because of the major investments that would be required on the part of both the FAA and the airlines. Although it is reasonable to assume that progress will be made on these future technologies by the time the annual operations level at the Airport reaches 378,000 (at PAL 5 or about 2035), we recommend not relying on those capacity increases until the timing of future technology is better understood.

9. The existing spacing of 3,100 feet between the parallel runways may be sufficient to permit simultaneous independent approaches in all weather conditions in the future with greatly increased navigation and surveillance accuracy made possible by RNAV and RNP flight procedures. The major investments required for enabling such approaches would be borne by the airlines in the form of equipping their aircraft with the required onboard GPS-based navigation technology. This enhanced navigation technology may also enable the implementation of independent noise-abatement departure procedures from the parallel runways at the Airport without requiring divergent flight paths.

3. PASSENGER TERMINAL

3.1 Background

The passenger terminal requirements assessment focused on the key functional elements listed below.

- Aircraft gates and parking
- Airline check-in
- Passenger security screening
- Holdrooms
- Checked baggage security screening
- Outbound baggage makeup
- Inbound baggage handling
- Domestic baggage claim
- Federal Inspection Services (FIS) facilities
- Concessions

With the exception of concession facilities, facility requirements were assessed by analyzing design-day flight schedules developed as part of the Master Plan Update forecasts (planning schedules). The planning schedules represent scheduled airline activity occurring on an average day during the peak month (August). The development of the planning schedules, including an assessment of seasonal fluctuations in activity, is discussed in Section 5.9 in *Technical Memorandum No. 2 – Aviation Demand Forecasts, Master Plan Update, Portland International Airport* (Jacobs Consultancy, September 2008). Schedules analyzed as part of the requirements analysis included an actual base year (i.e., 2008) schedule and schedules for forecast years 2017 (PAL 2), 2022 (PAL 3), 2027 (PAL 4), and 2035 (PAL 5). A planning schedule for 2012 (PAL 1) was not developed because the forecast demand for 2012 is similar to the activity in the base year. Results of the requirements analyses are summarized in Table 3-1. Detailed discussion of each functional element is provided in the sections that follow. As explained later in this section, requirements for concessions were assessed in light of the Port's current planning objectives and philosophy.

In developing requirements for functional elements of the passenger terminal other than concessions, different modeling and analysis tools were used, as appropriate. Aircraft gate and parking requirements were assessed using Jacobs Consultancy's proprietary Gate Model. Airline check-in and passenger security screening requirements were assessed using Comprehensive Airport Simulation Technology, a high-performance fast time simulation system developed by Airport Research Center GmbH and licensed to Jacobs Consultancy. Other elements were assessed using spreadsheet-based tools that were developed by Jacobs Consultancy and have been used over many years.

Table 3-1

SUMMARY OF PASSENGER TERMINAL FACILITIES REQUIREMENTS
Master Plan Update
Portland International Airport

Functional Element	Existing	Estimated requirements						Estimated surplus (deficiency)					
		2008	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035	2008	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
BASIS FOR REQUIREMENTS (DEMAND FORECASTS)													
Total annual passengers (millions)	14.7	-	15.0	18.0	20.6	23.7	26.8	n/a	n/a	n/a	n/a	n/a	n/a
Total air cargo (thousands of short tons)	280	-	322	414	496	594	732	n/a	n/a	n/a	n/a	n/a	n/a
Aircraft operations (thousands)	265	-	258	292	318	347	378	n/a	n/a	n/a	n/a	n/a	n/a
Aircraft gates and parking													
Domestic gates													
Widebody	3	1	1	2	2	3	2	2	2	1	1	-	1
Narrowbody - ADG IV (e.g., B-757-300)	22	1	1	8	10	3	4	21	21	14	12	19	18
Narrowbody - ADG III (e.g., B-737-800)	15	34	34	29	27	33	32	**(19)**	**(19)**	**(14)**	**(12)**	**(18)**	**(17)**
Regional jet / turboprop	21	19	19	19	19	21	21	2	2	2	2	-	-
Total domestic gates	61	55	55	58	58	60	59	6	6	3	3	1	2
FIS gates													
Widebody	5	3	3	4	4	5	6	2	2	1	1	-	**(1)**
Narrowbody - ADG IV (e.g., B-757-300)	-	-	-	-	-	-	-	-	-	-	-	-	-
Narrowbody - ADG III (e.g., B-737-800)	1	2	2	3	2	3	2	**(1)**	**(1)**	**(2)**	**(1)**	**(2)**	**(1)**
Regional jet / turboprop	-	-	-	-	-	-	-	-	-	-	-	-	-
Total FIS gates	6	5	5	7	6	8	8	1	1	**(1)**		**(2)**	**(2)**
Total domestic + FIS gates													
Widebody	8	4	4	6	6	8	8	4	4	2	2	-	-
Narrowbody - ADG IV (e.g., B-757-300)	22	1	1	8	10	3	4	21	21	14	12	19	18
Narrowbody - ADG III (e.g., B-737-800)	16	36	36	32	29	36	34	**(20)**	**(20)**	**(16)**	**(13)**	**(20)**	**(18)**
Regional jet / turboprop	21	19	19	19	19	21	21	2	2	2	2	-	-
Total domestic + FIS gates	67	60	60	65	64	68	67	7	7	2	3	**(1)**	-
Remote / RON parking													
Widebody	3	-	-	-	-	-	3	3	3	3	3	3	-
Narrowbody - ADG IV (e.g., B-757-300)	5	4	4	1	2	-	3	1	1	4	3	5	2
Narrowbody - ADG III (e.g., B-737-800)	-	7	7	12	15	25	24	**(7)**	**(7)**	**(12)**	**(15)**	**(25)**	**(24)**
Regional jet / turboprop	-	1	1	1	1	-	1	**(1)**	**(1)**	**(1)**	**(1)**	-	**(1)**
Total Remote / RON parking	8	12	12	14	18	25	31	**(4)**	**(4)**	**(6)**	**(10)**	**(17)**	**(23)**
Holdrooms (area in square feet)													
Concourse A	6,004	9,953	9,953	9,953	11,076	10,417	10,766	**(3,949)**	**(3,949)**	**(3,949)**	**(5,072)**	**(4,413)**	**(4,762)**
Concourse B	4,701	4,182	4,182	4,308	4,308	2,914	2,633	519	519	393	393	1,787	2,068
Concourse C	40,267	24,407	24,407	29,316	28,464	30,748	31,629	15,860	15,860	10,951	11,803	9,519	8,638
Concourse D	26,117	27,341	27,341	31,930	34,321	37,129	36,838	**(1,224)**	**(1,224)**	**(5,813)**	**(8,204)**	**(11,012)**	**(10,721)**
Concourse E	11,212	10,611	10,611	9,914	9,759	8,868	8,984	601	601	1,298	1,453	2,344	2,228
Total holdroom area	88,301	76,494	76,494	85,421	87,928	90,076	90,850	11,807	11,807	2,880	373	**(1,775)**	**(2,549)**

Table 3-1 *(page 2 of 3)*
SUMMARY OF PASSENGER TERMINAL FACILITIES REQUIREMENTS
Master Plan Update
Portland International Airport

		Estimated requirements						Estimated surplus (deficiency)					
Functional Element	**Existing**	**2008**	**PAL 1 2012**	**PAL 2 2017**	**PAL 3 2022**	**PAL 4 2027**	**PAL 5 2035**	**2008**	**PAL 1 2012**	**PAL 2 2017**	**PAL 3 2022**	**PAL 4 2027**	**PAL 5 2035**
Airline Check-in													
Number of processors													
Agent counters	87	50	50	57	64	64	68	37	37	30	23	23	19
Kiosks w/bag check	56	36	36	42	49	47	52	20	20	14	7	9	4
Kiosks w/out bag check	23	24	24	23	25	28	32	**(1)**	**(1)**	-	**(2)**	**(5)**	**(9)**
Curbside	24	24	24	24	24	24	24	-	-	-	-	-	-
Total	190	134	134	146	162	163	176	56	56	44	28	27	14
Lobby queue area (square feet)													
@ IATA level of service B	13,565	11,296	11,296	12,944	14,528	14,832	16,704	2,269	2,269	621	**(963)**	**(1,267)**	**(3,139)**
@ IATA level of service C	13,565	9,884	9,884	11,326	12,712	12,978	14,616	3,681	3,681	2,239	853	587	**(1,051)**
Passenger Security Screening													
Number of screening lanes													
South	8	8	8	9	9	10	13	-	-	**(1)**	**(1)**	**(2)**	**(5)**
North	8	6	6	6	7	8	8	2	2	2	1	-	-
Total	16	14	14	15	16	18	21	2	2	1	-	**(2)**	**(5)**
Queue area (square feet)													
Document check													
@ IATA level of service B													
South	1,660	1,170	1,170	3,458	3,692	3,536	4,602	490	490	**(1,798)**	**(2,032)**	**(1,876)**	**(2,942)**
North	1,504	1,118	1,118	2,301	2,301	2,470	2,704	386	386	**(797)**	**(797)**	**(966)**	**(1,200)**
Total	3,164	2,288	2,288	5,759	5,993	6,006	7,306	876	876	**(2,595)**	**(2,829)**	**(2,842)**	**(4,142)**
@ IATA level of service C													
South	1,660	990	990	2,926	3,124	2,992	3,894	670	670	**(1,266)**	**(1,464)**	**(1,332)**	**(2,234)**
North	1,504	946	946	1,947	1,947	2,090	2,288	558	558	**(443)**	**(443)**	**(586)**	**(784)**
Total	3,164	1,936	1,936	4,873	5,071	5,082	6,182	1,228	1,228	**(1,709)**	**(1,907)**	**(1,918)**	**(3,018)**
Primary queue													
@ IATA level of service B													
South	2,003	2,860	2,860	3,367	4,082	4,082	4,953	**(857)**	**(857)**	**(1,364)**	**(2,079)**	**(2,079)**	**(2,950)**
North	2,044	2,223	2,223	2,288	2,483	2,951	3,250	**(179)**	**(179)**	**(244)**	**(439)**	**(907)**	**(1,206)**
Total	4,047	5,083	5,083	5,655	6,565	7,033	8,203	**(1,036)**	**(1,036)**	**(1,608)**	**(2,518)**	**(2,986)**	**(4,156)**
@ IATA level of service C													
South	2,003	2,420	2,420	2,849	3,454	3,454	4,191	**(417)**	**(417)**	**(846)**	**(1,451)**	**(1,451)**	**(2,188)**
North	2,044	1,881	1,881	1,936	2,101	2,497	2,750	163	163	108	**(57)**	**(453)**	**(706)**
Total	4,047	4,301	4,301	4,785	5,555	5,951	6,941	**(254)**	**(254)**	**(738)**	**(1,508)**	**(1,904)**	**(2,894)**
Baggage Security Screening													
Number of primary EDS machines													
South	4	3	3	3	3	3	3	1	1	1	1	1	1
North	4	2	2	2	2	2	3	2	2	2	2	2	1
Total	8	5	5	5	5	5	6	3	3	3	3	3	2

Table 3-1 *(page 3 of 3)*
SUMMARY OF PASSENGER TERMINAL FACILITIES REQUIREMENTS
Master Plan Update
Portland International Airport

Functional Element	Existing	Estimated requirements 2008	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035	Estimated surplus (deficiency) 2008	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
Outbound Baggage Makeup													
Number of cart staging positions													
South	78	65	65	72	79	86	95	13	13	6	**(1)**	**(8)**	**(17)**
North	85	56	56	69	71	89	90	29	29	16	14	**(4)**	**(5)**
Total	163	121	121	141	150	175	185	42	42	22	13	**(12)**	**(22)**
Inbound Baggage Handling													
Total offload frontage (linear feet)	439	328	328	379	425	462	490	111	111	60	14	**(23)**	**(51)**
Baggage Claim -- Domestic													
Total presentation frontage (linear feet)	1,653	1,094	1,094	1,262	1,417	1,539	1,635	559	559	391	236	114	18
Total area for claiming baggage (square feet)	32,812	16,529	16,529	19,067	21,411	23,250	24,702	16,283	16,283	13,745	11,401	9,562	8,110
FIS Facilities													
Primary processing													
Number of primary screening modules	6	5	5	7	7	7	7	1	1	**(1)**	**(1)**	**(1)**	**(1)**
Primary queuing area (square feet)	5,037	4,313	4,313	6,038	6,038	6,038	6,038	724	724	**(1,001)**	**(1,001)**	**(1,001)**	**(1,001)**
Baggage Claim													
Per device													
Presentation frontage (linear feet)	145	210	210	210	210	210	210	**(65)**	**(65)**	**(65)**	**(65)**	**(65)**	**(65)**
Retrieval & peripheral area (square feet)	2,525	2,972	2,972	2,972	2,972	2,972	2,972	**(447)**	**(447)**	**(447)**	**(447)**	**(447)**	**(447)**
Total													
Number of devices	2	2	2	3	3	3	3	**-**	**-**	**(1)**	**(1)**	**(1)**	**(1)**
Presentation frontage (linear feet)	290	420	420	630	630	630	630	**(130)**	**(130)**	**(340)**	**(340)**	**(340)**	**(340)**
Retrieval & peripheral area (square feet)	5,800	5,945	5,945	8,917	8,917	8,917	8,917	**(145)**	**(145)**	**(3,117)**	**(3,117)**	**(3,117)**	**(3,117)**
Secondary processing													
Queuing area (square feet)	460	565	565	791	791	791	791	**(105)**	**(105)**	**(331)**	**(331)**	**(331)**	**(331)**
Referral waiting area (square feet)	1,015	275	275	400	400	400	400	740	740	615	615	615	615
Exam podiums w/ belts (units)	4	-	-	-	-	-	-	4	4	4	4	4	4
X-ray workstations (units)	1	1	1	1	1	1	1	**-**	**-**	**-**	**-**	**-**	**-**
Baggage security screening													
Number of primary EDS machines	1	3	3	4	4	4	4	**(2)**	**(2)**	**(3)**	**(3)**	**(3)**	**(3)**
Passenger security screening													
Number of screening lanes	4	2	2	2	2	2	2	2	2	2	2	2	2

ADG = Airplane design group
CAT = Category
EDS = Explosives detection system
FIS = Federal Inspection Services
IATA = International Air Transport Association
n/a = Not applicable
RON = Remain overnight

a. Passenger terminal complex requirements were determined based primarily on simulation modeling using flight schedules for 2008, 2017, 2022, 2027 and 2035. A flight schedule was not developed for 2012 because the activity is forecast so be very similar to activity in 2008. Accordingly, requirements for the passenger terminal complex in 2012 were assumed to equal the requirements for 2008.

Source: Jacobs Consultancy, October 2008.

Data sources for key assumptions used throughout these analyses are noted below:

- Airline-specific load factors were based on actual monthly averages for August 2007 obtained from the U.S. Department of Transportation (DOT) T100 database.

- Airline-specific percentages of passengers originating or terminating at the Airport were based on actual third quarter 2007 averages obtained from the U.S. DOT OD1B database.

- Earliness distributions and percentage splits for originating passengers' first point-of-contact in the terminal were based on surveys conducted by Jacobs Consultancy in August 2008, and data contained in a report prepared for the Transportation Security Administration (TSA), *Architectural and Engineering Design, In-Line Baggage Screening Improvements, 100% TSA Design Report*, PGAL, June 2008 (TSA Design Report).

3.2 Aircraft Gates and Parking

The requirements analysis for this functional element focused on identifying the number of gates and remote aircraft parking positions required to accommodate passenger airline activity in each planning schedule. For purposes of this analysis, a gate is any aircraft parking position used by airlines for loading and unloading passengers, and a remote parking position is any aircraft parking position used only for staging idle aircraft. Remote parking is generally used by aircraft that remain overnight (RON). Gate and remote parking requirements were assessed using Jacobs Consultancy's Gate Model. The Gate Model is a planning tool used to allocate flights to gates and remote parking positions based on:

- **Physical constraints,** which include geometric constraints that limit the size and types of aircraft that can park at each position, and any physical dependencies that may exist between adjacent positions.

- **Policies and priorities,** which include rules that govern how gates are to be allocated among various airline users. For example, provisions of the Port's Airport use and lease agreements may grant exclusive or preferential use of specific gates to a particular airline.

- **Operational parameters,** which include assumptions regarding the amount of time typically required for gating and towing operations and buffer time. Buffer times are minimum planning allowances between successive gate occupancies that take into account both schedule variations and the time required for maneuvering aircraft in and out of the gate.

Gate Model runs were conducted to test the ability of the existing gate layout to accommodate each planning schedule. During each run, the model attempts to assign each flight in the schedule to an existing gate. When flights cannot be assigned to an existing gate, the model generates new gates as required to accommodate all flights in the schedule. The model is also used to identify any surplus gate positions. Flights will not be assigned to gates that are not needed to accommodate the airline schedule, or to gates that are not usable by the aircraft fleet.

The existing terminal apron provides 67 independent gate positions. Of these, 6 are FIS gates that can accommodate international arrivals, and 61 are used exclusively for domestic operations. Except for the 14 commuter gates at Concourse A and 7 commuter gates at Concourse E, all gates are equipped with loading bridges. Existing remote/RON positions relatively close to the terminal and suitable for staging passenger airline aircraft are located on the Northeast Ramp and the Southeast Ramp. Currently, there are approximately eight usable positions in these areas.

A summary of gate and remote aircraft parking requirements is presented in Table 3-1. Key findings of the analysis are summarized as follows:

- The available capacity of the existing terminal gates can absorb much of the increased demand associated with the future planning schedules. Most of the surplus gate capacity is located on Concourse C.

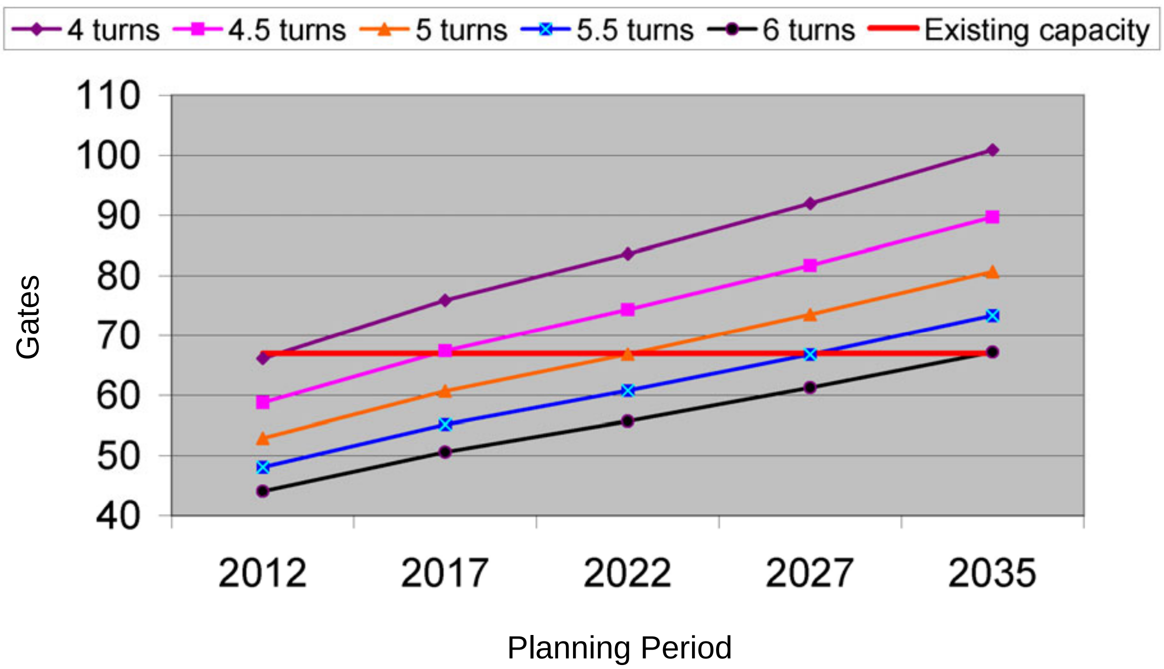
- Increased demand can also be accommodated by increasing gate use, i.e., the number of daily turns per gate. The results of the analysis indicted that gate use could be increased from the current 4.3 daily turns per gate to 6.0 turns per gate by PAL 5 (2035). The increased gate use required to avoid constructing new gates can be achieved gradually over time. As indicated on Figure 3-1, no increase over the current gate use is needed by PAL 1 (2012); thereafter, an increase of only one-half turn per planning activity level (i.e., 4.5, 5, 5.5, and 6 daily turns per gate by PAL 2 (2017), PAL 3 (2022), PAL 4 (2027), and PAL 5 (2035), respectively) is necessary.

- To achieve higher gate use, additional gate sharing, common-use gates and remote parking positions will be required. Additional remote parking would allow individual gates to accommodate multiple originating aircraft (i.e., aircraft that depart in the morning after overnighting at the Airport). As many as 31 remote aircraft parking positions will be needed by PAL 5 (2035).

- One additional narrowbody FIS gate (7 total FIS gates) will be needed by PAL 2 (2017). One additional FIS gate (8 total FIS gates) will be required by PAL 5 (2035).

Figure 3-1

SENSITIVITY OF AIRCRAFT GATES REQUIRED TO PRODUCTIVITY IN DAILY TURNS PER GATE



Key assumptions used in the analysis of gate and remote aircraft parking requirements are summarized below:

- Airline gate allocations were based on current leases. If an airline's flights could not be accommodated at its leased gates, then flights were assigned to the nearest Port gate on the same concourse. Domestic flights on Concourse D were allowed to use FIS gates when/if those gates are not needed for an international flight.

- Operational parameters:

Sector/aircraft class	Gate operation (minutes) Arrival	Departure	Turn	Buffer
Domestic widebody	50	50	70	20-25
Domestic narrowbody—Airplane Design Group (ADG) IV	40-50	40-50	50	20-25
Domestic narrowbody ADG III	20-40	20-40	40	20-25
Domestic regional jet/turboprop	20-30	20-30	40	20-25
International widebody	50	50	110	20-25
International narrowbody ADG III	30	30	60	20-25

Two management issues beyond the scope of this Master Plan Update should be addressed in follow-on studies. The first issue relates to managing the gates as gate use increases from 4.3 daily turns per gate to 6.0 daily turns per gate—an increase of 40%. The second issue is the potential effect of increased gate use on the operation and storage of aircraft ground support equipment (several potential solutions to this issue have been suggested, including the creation of a designated ground support equipment storage area).

3.3 Airline Check-In

The requirements analysis for this functional element focused on identifying the number of check-in processors (for the purposes of this analysis, a processor is a facility, such as a ticket counter or electronic kiosk, where a function related to ticketing or baggage check-in is accomplished) required and the square footage required for queuing in the ticket lobby. These requirements were developed using Comprehensive Airport Simulation Technology.

Comprehensive Airport Simulation Technology was set up to solve for the number of processors that would be required to meet an assumed level-of-service standard (i.e., maximum wait time in queue) and to determine the maximum passenger queue that would result if the indicated number of processors were available. The maximum passenger queues were then converted to square footage requirements based on the International Air Transport Association (IATA) level-of-service standards.

In conducting the analysis, requirements were developed for each airline in the planning schedules. Aggregate results (i.e., the sum of all individual airline requirements) are presented in Table 3-1. Table 3-1 also presents aggregate totals for the existing number of processors and lobby queue area based on the following:

- The existing total number of check-in processors includes 18 unused agent counter positions located in the south lobby area.

- The existing total lobby queue area of approximately 13,500 square feet is the estimated area that will be available for queuing when TSA baggage screening equipment and operations are removed from the ticket lobby when the in-line baggage screening system is fully installed and operational.

As shown in Table 3-1, the requirements analysis indicated that the existing number of check-in processors and queuing area provided in the ticket lobby are sufficient to accommodate forecast demand throughout the planning period. Also, it was determined that the area provided for passenger circulation in the ticketing lobby is sufficient.

It was assumed that allocation of check-in facilities among different airline users will be managed to address potential imbalances that may arise. Managing this allocation will be easier once the new in-line baggage screening system now under construction is operational. Currently, the Port's ability to reallocate airline check-in counters is limited by the fact that these facilities are served by baggage take-away belts that are tied to specific makeup devices in the lower level baggage handling area. Baggage sortation capabilities provided by the new in-line screening system will largely eliminate this constraint. The new in-line system will consist of two zones, north and south, and bags checked at any counter within a zone can be routed to any makeup device in the same zone. This increased operational flexibility will make common-use check-in facilities, such as those currently provided in the south lobby for international airlines, a more viable option for accommodating the terminal's domestic airline tenants. The primary benefit of common-use, with respect to domestic check-in facilities, would be greater ease and flexibility in making periodic reallocations to ensure efficient and well-balanced use of the facilities.

Key assumptions used in developing these results are summarized below:

- A maximum queue time of 10 minutes was assumed as the level-of-service standard for all airlines.

- Average transaction time by type of processor:

Type of processor	Average transaction time (minutes per passenger)*
Agent counter	2.0 to 10.0
Kiosk with baggage check	1.9 to 2.9
Kiosk without baggage check	1.3
Curbside	1.8 to 3.5

*Transaction times were determined by field survey and varied by airline; values shown are the ranges for all airlines.

- Passenger check-in splits by type of processor:

Type of processor	Percent of originating passengers using*
Agent counter	18% to 31%
Kiosk with baggage check	30% to 43%
Kiosk without baggage check	20% to 25%
Curbside	2% to 3%
Online/no checked bags**	14% to 24%

*Varied by airline; values are the range for all airlines.
**Passengers who bypass check-in and proceed directly to security screening.

- IATA space standards for check-in queue:

Level of service*	Square feet per passenger
B	16
C	14

*With few carts and one or two pieces of luggage per passenger.

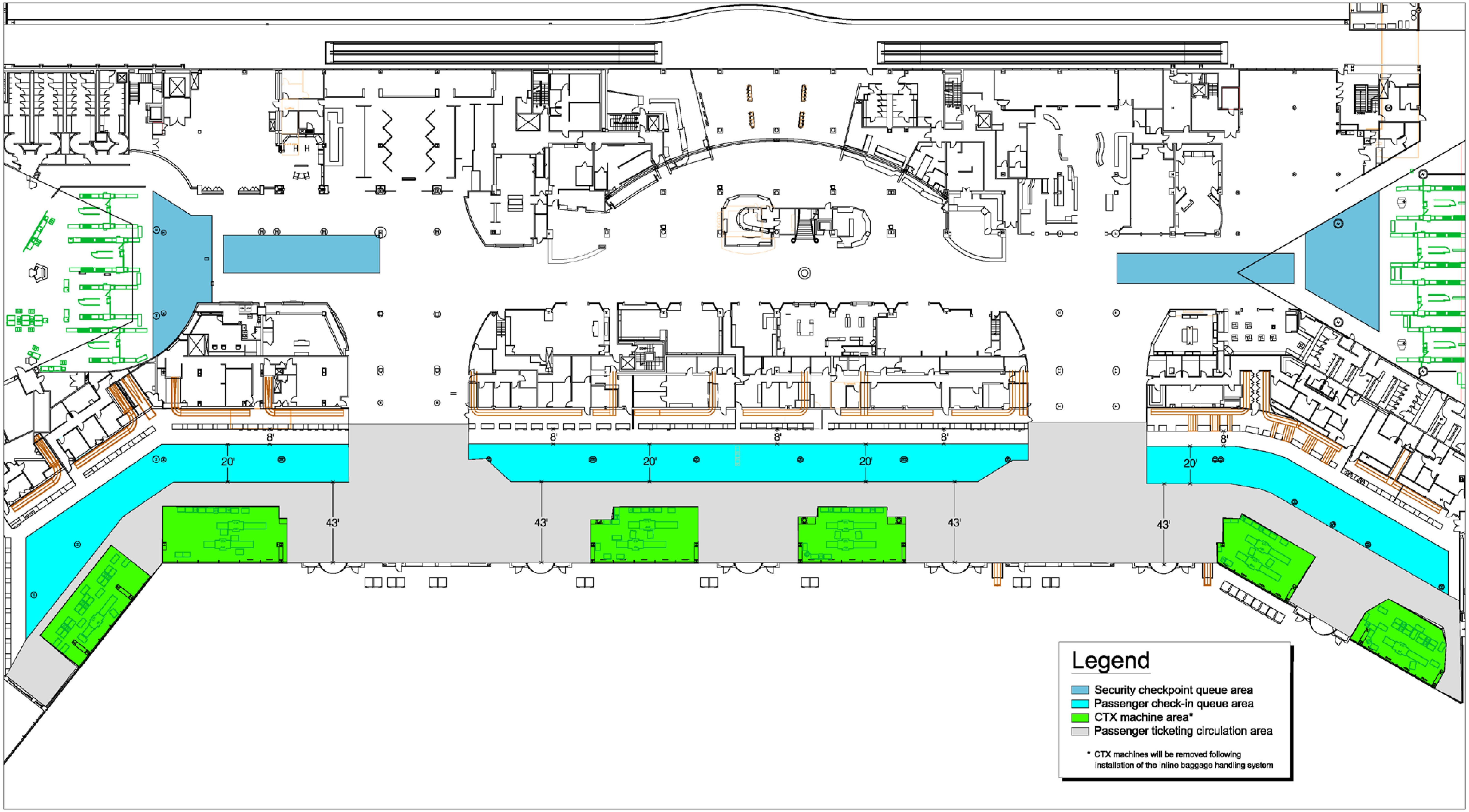
- The depth of the queuing area in front of the ticket counters is approximately 20 feet and the depth remaining for circulation is approximately 43 feet; these dimensions are shown on Figure 3-2.

3.4 Passenger Security Screening

The requirements analysis for passenger security screening checkpoints focused on identifying the number of checkpoint lanes required and the area required for both document check queuing and primary queuing. These requirements are for checkpoints in the main terminal that serve originating passengers and employees. Requirements for checkpoints to serve transferring international passengers are included in Section 3.10, “Federal Inspection Services Facilities.”

These requirements were developed using the same Comprehensive Airport Simulation Technology model runs described above for airline check-in requirements. Integrated modeling of check-in and passenger security screening functions allowed the capture of the metering effect that the check-in process has on passenger flows to downstream security screening checkpoints.

Comprehensive Airport Simulation Technology was set up to solve for the number of lanes required to meet an assumed level-of-service standard (i.e., maximum wait time in queue) and to determine the maximum passenger accumulation in the document check queues and primary queues that would result if the indicated number of lanes were available. The maximum number of passenger queues was then converted to square footage requirements based on IATA level-of-service space standards.



AIRPORT FUTURES
CHARTING A COURSE FOR PDX

Figure 3-2

Queuing and Circulation Areas Assumed for Requirements Analysis

Master Plan Update
Portland International Airport

Source: Jacobs Consultancy, 2008

December 2008

The existing terminal has two security screening checkpoints, a north checkpoint serving Concourses D and E and a south checkpoint serving Concourses A, B, and C. Each checkpoint has eight screening lanes. The lanes are fed from a dedicated primary queue area located immediately upstream and equipped with stanchions. Documents are checked at stations located at the entrance to the primary queue. During peak periods, passenger queues form in front of the document check stations in the adjacent public circulation space.

Results of the requirements analysis indicate that an additional checkpoint lane will be needed by 2017 and as many as five additional checkpoint lanes may be needed by 2035. As shown in Table 3-1, the additional capacity will be required at the south checkpoint, which accommodates a greater passenger volume than the north checkpoint. Increases in the space available for queuing will be required on both the north side and the south side. These results were determined assuming that future screening will continue to be performed at separate north and south checkpoints and that the current airline concourse allocations will be similar to today's allocations.

It is recommended that the Port examine checkpoint options that incorporate new TSA technologies and processes that are expected to be adopted in the near future, once the specific details of the new technologies are available.

Key assumptions used in developing these results are described below:

- A maximum queue time of 10 minutes is the level-of-service target for both primary queuing and document check queues, assuming a maximum combined wait time of 20 minutes during the peak period.

- The average throughput per checkpoint lane would be 175 passengers per hour.

- The average throughput per document check position would be 480 passengers per hour.

- Throughput rates for future years would remain at current levels. The TSA has indicated that new technologies and processes will be implemented at security checkpoints in the near future. Space requirements per checkpoint lane may increase by as much as 20%. Throughput rates per lane are also expected to increase; however, specific details have not been released.

- IATA space standards for security inspection queues (the TSA does not dictate level of service standards for security queues; therefore, a range of IATA standards has been assumed):

Level of service	Square feet per passenger
B	13
C	11

- The checkpoints serve originating passengers and employees. Employees were assumed to account for approximately 9% of total flow volume. This assumption was developed by comparing actual TSA-provided magnetometer counts from August 2008 with originating passenger estimates for the same period.

3.5 Holdrooms

The requirements analysis for the holdrooms focused on identifying the total holdroom area required for each gate based on the largest aircraft using the gate. These requirements were based on the gate modeling results discussed in Section 3.2. For each Gate Model run, the maximum-seat aircraft that was assigned to a gate was recorded and used as the basis for determining the required holdroom area using the following formula:

Holdroom area required = $S * LF * [(P_{seat} * A_{seat}) + (P_{stand} * A_{stand})] * P_{max}$

Where the values and descriptions of the variable are as follows:

Variable	Value	Description
S	Varies	Number of seats on the largest aircraft using the gate
LF	85%	Aircraft load factor
P_{seat}	80%	Percent of holdroom occupants seated
A_{seat}	18 square feet	Area required per seated occupant
P_{stand}	20%	Percent of holdroom occupants standing
A_{stand}	13 square feet	Area required per standing occupant
P_{max}	67%	Percent of flight's passenger load accumulated in the holdroom 10 minutes prior to boarding

Results of the holdroom requirements analysis, aggregated by concourse, are summarized in Table 3-1. Holdroom areas required, by aircraft type and holdroom areas provided are summarized in Tables 3-2 and 3-3, respectively. Key findings are summarized as follows:

- **Concourses B, C, and E.** Overall holdroom space on these concourses will be sufficient throughout the planning period, except for the commuter holdroom serving Gates E6 through E13. A shift to smaller aircraft in the future planning schedules for the airlines using the jet gates on Concourses B (e.g., more aircraft similar to the 124 seat B-737-700 and fewer aircraft similar to the 144 seat B-737-400) and E (e.g., more aircraft similar to the 138 seat A-320 and fewer aircraft similar to the 182 seat B-757-200) will result in an increasing surplus of holdroom space on these concourses. The existing surplus on Concourse C will diminish as the gates are more efficiently used, but the aircraft anticipated to use these gates would generally have smaller capacity than the existing holdrooms were designed to accommodate, so an overall space surplus will remain. The lower level holdroom on Concourse E that serves commuter aircraft at Gates E6 through E13 is currently deficient and will remain so in the future. To the extent that the number of commuter aircraft served from this holdroom increases, or the size of the aircraft served from this holdroom increases, the level of service provided will deteriorate.

- **Concourse A.** Holdroom space on Concourse A is currently deficient and will become more deficient in the future as larger capacity aircraft (e.g. the CRJ-900) anticipated in the planning schedules come into service. However, this deficiency is somewhat mitigated by adjacent concession spaces that provide passengers with alternative seating areas.

- **Concourse D.** Holdroom space on Concourse D is currently somewhat deficient and will become more deficient in the future. The current deficiency is caused by the larger capacity aircraft that typically use Concourse D gates. The increasing deficiency in the outer planning years shown in Table 3-1 is the result of increasing international operations that were assumed to be accommodated on this concourse. It was assumed that required new FIS gates identified in the gate modeling effort would be located on Concourse D and additional holdroom space for these new gates is included in the Concourse D holdroom requirements.

Table 3-2

HOLDROOM AREAS REQUIRED BY AIRCRAFT TYPE

Aircraft	Typical seats	Holdroom area *(a)* (sq. ft.)
EMB-120	30	290
ERJ-145	50	
CRJ-700	70	678
DH-8-400	74	716
CRJ-900	90	871
B-737-700	124	1,326
A-319	136	1,317
A-320	138	1,336
B-737-400	144	1,394
B-737-800	157	1,520
B-737-900	167	1,617
B-757-200	182	1,762
B-757-300	224	2,169
A-330-200	243	2,353
B-767-300	264	2,556
B-787-8	290	2,808

(a) Holdroom area required was estimated based on the methodology described in Section 3.5 Holdrooms.

Table 3-3

HOLDROOM AREAS PROVIDED

Concourse	Gate	Holdroom area (a) (sq. ft.)	Concourse	Gate	Holdroom area (a) (sq. ft.)
A	1	851	C	6	1,674
A	2	851	C	5	1,782
A	3	851	C	4	1,979
A	4	314	C	3	1,650
A	5	14	C	2	1,979
A	6	314	C	1	1,650
A	7	314	D	1	1,916
A	8	314	D	2	2,132
A	9	314	D	3	1,995
A	10	314	D	4	2,132
A	11	314	D	5	2,034
A	12	314	D	6	1,754
A	13	314	D	7	2,369
A	14	314	D	8	1,754
B	1	1,567	D	9	2,369
B	2	1,567	D	10	1,265
B	3	1,567	D	11	955
C	23	1,636	D	12	1,185
C	22	1,450	D	13	1,175
C	21	1,477	D	14	2,367
C	20	1,477	D	15	715
C	19	1,833	E	1	2,199
C	18	1,837	E	2	2,306
C	17	1,655	E	3	1,355
C	16	1,658	E	4	1,780
C	15	1,655	E	5	1,952
C	14	1,671	E	6	231
C	13	1,643	E	7	231
C	12	1,905	E	8	231
C	11	1,907	E	9	231
C	10	1,951	E	10	231
C	9	2,000	E	11	231
C	8	1,951	E	12	231
C	7	1,847			

(a) Holdroom areas listed represent the areas available for passenger standing and seating; i.e., they do not include the areas necessary for ticket podiums or walkways to and from the loading bridge door.

3.6 Checked Baggage Security Screening

The requirements analysis for this functional element focused on identifying the number of primary explosives detection system (EDS) machines that would be needed to accommodate the design-hour flow of originating baggage associated with each planning schedule. It was assumed that security screening of international recheck baggage would continue to be handled separately at the FIS facilities. Requirements for international recheck baggage security screening are included in the later discussion of FIS facilities requirements.

The Port is currently implementing major improvements to provide an automated checked baggage sortation and security screening system on the terminal's lower level. The design provides for two separate screening zones serving the north and south halves of the terminal. Each screening zone will be equipped with four Analogic XLB 1100 machines for primary screening.

Requirements for checked baggage security screening were assessed using Jacobs Consultancy's Flow Model. The Flow Model was used to generate design-day baggage flows for the north and south screening zones for each planning schedule. In developing these flows, airline-zone allocations were based on those described in the TSA design Report. EDS machine requirements for each zone were estimated based on the zone's projected peak-hour baggage flow, and a machine throughput equivalent to that of an Analogic XLB 1100.

Results of the requirements analysis are presented in Table 3-1. The analysis indicated that the new automated checked baggage sortation and security screening system design will provide sufficient capacity through PAL 5 (2035).

Key assumptions used in this analysis include the following:

- Airline-zone allocations were based on those described in the TSA Design Report.
- The throughput of one Analogic XLB 1100 would be 1,200 bags per hour.
- The number of checked bags per domestic passenger would be 0.80.
- The number of checked bags per international passenger would be 1.20.
- Consistent with TSA policy, to ensure system reliability, each zone would require an additional (i.e., redundant) machine beyond the total number of machines required to accommodate design-hour demand.

3.7 Outbound Baggage Makeup

The requirements analysis for this functional element focused on identifying the maximum number of baggage carts that would need to be staged simultaneously at the baggage makeup carousels.

The existing baggage makeup areas are located on the lower level of the main terminal. Several of these makeup areas are being modified and/or relocated as part of the in-line baggage system project currently under construction. Based on drawings in the TSA Design Report, when this project is completed, 11 separate makeup carousels will be provided—6 on the south side and 5 on the north side. All devices will be oval-shaped carousels. The maximum number of carts that could be simultaneously staged at each device was estimated by analyzing drawings in the TSA Design Report. In estimating these maximums, it was assumed that carts would be staged perpendicular to the device edge, as space allows, without encroaching into the circulation lanes.

Each planning schedule's list of departing flights was analyzed to develop a profile of cart staging requirements at each makeup area at 10-minute intervals throughout the day. In developing these profiles, airlines were allocated to individual makeup areas based on information in the TSA Design Report.

For each area, the peak count in the profile was used to determine the maximum number of carts that would need to be simultaneously staged at that area. The individual peaks were summed to provide aggregate counts for areas on the south and north sides. These aggregate counts are presented in Table 3-1.

As shown in Table 3-1, it was estimated that deficiencies in cart staging capacity would occur in PAL 4 (2027) (12 positions) and PAL 5 (2035) (22 positions). It is possible that deficiencies such as these could be addressed by operational measures, such as limiting the number of carts per flight that are staged simultaneously, which would require more frequent cart rotation between the makeup areas and locations on the terminal apron.

Key assumptions used in the analysis are listed below:

- The number of makeup carousels, their cart staging capacities, and airline allocations, were based on information contained in the TSA Design Report.
- Cart staging for a flight would begin 2 hours before scheduled departure time and end 15 minutes before scheduled departure time.
- The average capacity of one baggage cart would be 40 bags.

- The average number of checked bags per domestic passenger would be 0.80 (this number could decrease with implementation of checked baggage fees; if so, demand in the outbound baggage makeup area would be reduced, offsetting the minor deficiencies in cart staging positions noted above).

- The average number of checked bags per international passenger would be 1.20 (this number could decrease with implementation of checked baggage fees; if so, demand in the outbound baggage makeup area would be reduced, offsetting the minor deficiencies in cart staging positions noted above).

3.8 Inbound Baggage Handling

The requirements analysis for this functional element focused on identifying the linear footage of belt required for offloading inbound baggage by airline baggage handlers.

The existing baggage claim devices are direct feed devices. Therefore, a section of frontage of each device is exposed to the public (i.e., presentation frontage) and a nonpublic section is exposed to baggage handlers (i.e., offload frontage).

Requirements for this functional element were estimated based on a planning ratio of 0.30 foot of offload frontage for every foot of presentation frontage. Presentation frontage requirements are discussed in the following section. For reference, the average ratio of offload frontage to presentation frontage for the existing claim devices is approximately 0.27. Results of the requirements analysis are presented in Table 3-1; as shown, based on the 0.30 planning ratio, minor deficiencies could occur in PAL 4 (2027) and PAL 5 (2035).

3.9 Domestic Baggage Claim

The requirements analysis for this functional element focused on identifying the linear footage of claim device presentation frontage required for passengers claiming bags, and the required circulation area for passengers and visitors in the baggage claim area.

The existing domestic baggage claim facilities are located on the lower level of the terminal and include nine separate baggage claim areas. Each area is equipped with a flat bed/direct feed baggage claim device. The devices are configured in a variety of ‘T’, ‘L’, and ‘U’ shapes of different sizes. The devices are common-use, but airlines typically operate from a preferred device.

The requirements analysis involved developing estimates of passenger flows to each baggage claim area for each planning schedule. In developing these area-specific passenger flows, device allocations were based on current airline preferences and assignments. The frontage and area required at each area was calculated based on the peak-hour passenger flow for the airlines allocated to that area. The individual requirements for each area were summed to provide aggregate totals for the terminal. These aggregate totals are presented in Table 3-1.

As shown in Table 3-1, the analysis indicated that the existing domestic baggage claim facilities would provide sufficient capacity through PAL 5 (2035).

Key assumptions used in the analysis include the following:

- Percentage of terminating passengers that would claim bags at domestic baggage claim:

Domestic	60%
International*	50%

- Claim device allocation begins:

Domestic flights	10 minutes after scheduled arrival time
International flights**	35 minutes after scheduled arrival time

- The number of meeters/greeters per passenger at baggage claim would be 0.33.

- The area required in the baggage claim area would be 18.0 square feet per occupant (IATA level-of-service C for baggage claim)

- The frontage required for queuing at the claim device edge would be 2.0 linear feet per passenger.

- The share of passengers claiming baggage and actively queuing at the edge of the device would be 75%. It was assumed that for every four passengers in the baggage claim area, three would be actively queuing at the device edge and one would be waiting in the peripheral area.

- The average dwell time per passenger at baggage claim would be 20 minutes.

- The active claim area and length of baggage belt available (i.e., frontage) at each of the nine baggage claim devices are shown on Figure 3-3.

*100% of international passengers claim bags at the FIS facilities, located on level 1 of Concourse D. Upon exiting the FIS facilities, approximately 50% of passengers carry their bags with them on a shuttle to the main terminal, and 50% deposit their bags on a belt for transport to a domestic bag claim device where they are reclaimed a second time at the main terminal.

**Assuming a lag time to account for the fact that international passengers must first claim their baggage within the FIS facilities, exit the FIS facilities, and recheck their baggage before it can be transported to a domestic claim device located in the main terminal.

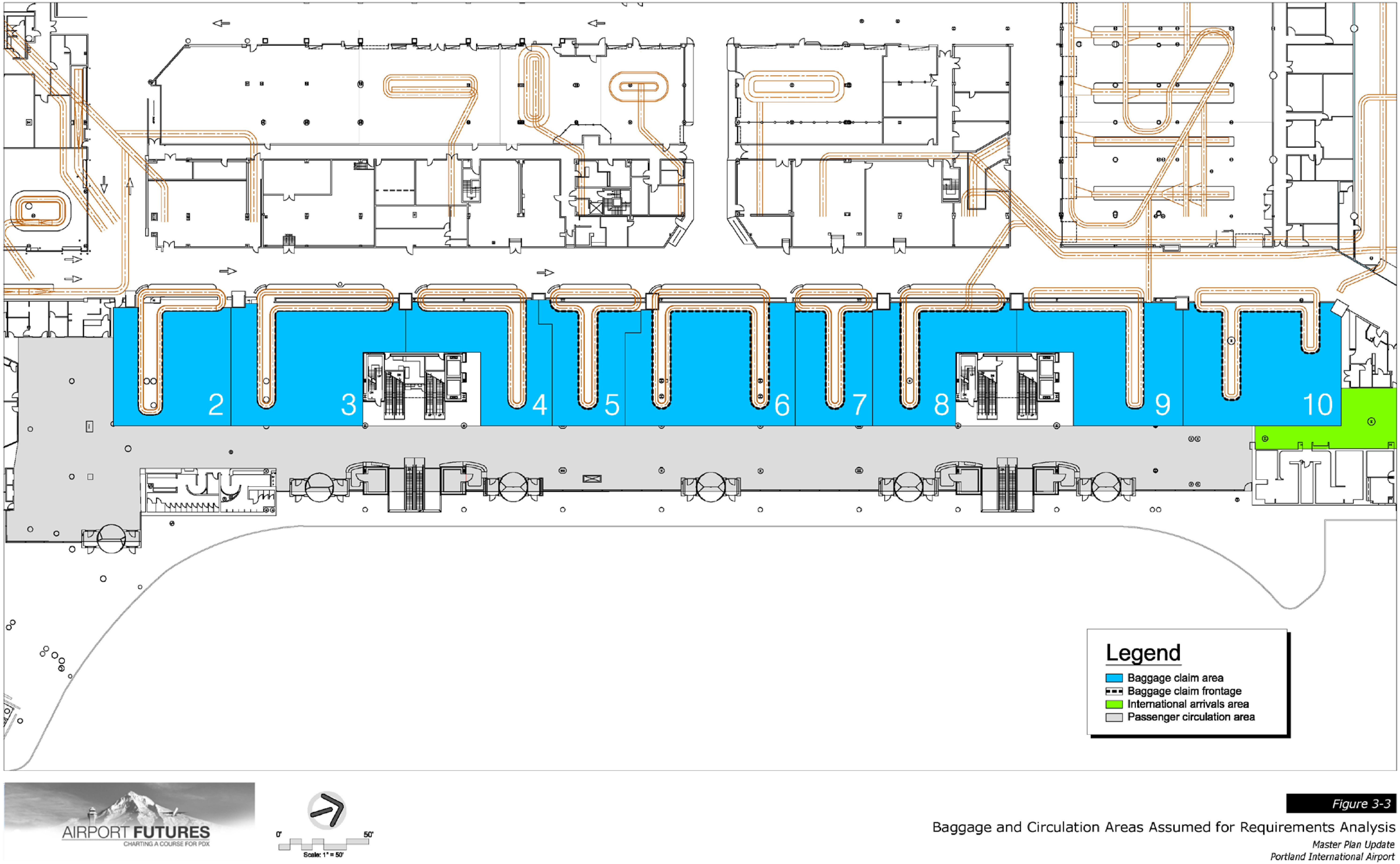


Figure 3-3

Baggage and Circulation Areas Assumed for Requirements Analysis

Master Plan Update
Portland International Airport

Source: Jacobs Consultancy, 2008

Several issues beyond the scope of this Master Plan Update should be addressed in follow-on studies. These issues include the following:

- Managing meeters and greeters awaiting the arrival of international passengers
- Managing the needs (e.g., temporary check-in desks) of tour groups
- The potential need for additional or expanded baggage storage areas or baggage offices
- The effect on circulation of the flight information display screens located on level 1 at the bottom of the escalators

The locations of the international arrivals area and general circulation space on level 1 of the terminal are shown on Figure 3-3.

3.10 Federal Inspection Services Facilities

The FIS facilities provide a number of passenger and baggage processing functions for arriving international flights. The requirements analysis for FIS facilities focused on key functional components whose requirements are directly driven by passenger and baggage flow volumes and that account for a significant percentage of the total space requirements of the FIS facilities. Guidelines for these and other elements of the FIS are provided in the U.S. Customs and Border Protection's (CBP) August 2006 edition of *Airport Technical Design Standards, Passenger Processing Facilities*. The following key functional components described in the CBP design standards were addressed as part of the FIS facilities requirements analysis.

- **Primary Processing**. All arriving international passengers must be examined and screened by CBP officers at the primary processing area to determine nationality and/or admissibility to the United States. The requirements analysis for primary processing focused on identifying the number of processing booths and the amount of queuing area required for this function.
- **Baggage Claim**. After primary processing, passengers with checked baggage proceed to the international baggage claim area within the FIS facilities. Typically, all arriving international passengers have checked baggage to be reclaimed. The requirements analysis for international baggage claim focused on identifying the number of devices required and the amount of presentation frontage and peripheral/retrieval area required for each device.

- **Secondary Processing**. The CBP identifies a subset of arriving international passengers as requiring additional processing and examination. These passengers, along with any baggage they have reclaimed, are directed or escorted to the CBP secondary processing area located downstream from baggage claim. The following component elements of secondary processing were addressed in the requirements analysis:

  – ***Secondary Queue Area.*** All passengers directed to secondary processing by a CBP officer must queue up, with their baggage, in front of a triage podium. At the triage podium, a CBP officer examines the passenger and determines whether further inspection is required. Passengers requiring further inspection are designated as "referral passengers."

  – ***Referral Passenger Waiting Area***. Referral passengers and their baggage are provided with a waiting area located upstream of the secondary exam stations.

  – ***Secondary Exam Stations***. At these stations, CBP officers conduct more extensive inspections of passenger documents and baggage. There are two standard types of secondary exam stations: a larger station that includes an x-ray machine, and a slightly smaller station without an x-ray machine. Each station accommodates two CBP officers.

- **Security Screening**. Arriving international passengers and baggage that are transferring to another flight after exiting the FIS facilities are subject to the same security screening processes as originating passengers and baggage. The requirements analysis focused on identifying the number of passenger security screening checkpoint lanes and the number of primary EDS machines for baggage screening that would be required.

The existing FIS facilities are located at the end of Concourse D on the lower level. Currently, six gates provide access to the FIS facilities by means of a sterile corridor, stairs, and elevators. These gates can also be used for domestic flights. Doors within the sterile corridor can be closed to isolate arriving international passenger flows from nonsterile passenger flows. Based on observation and discussion with Port staff, the following issues were noted with respect to the existing FIS facilities prior to conducting the requirements analysis:

- The queue area available for primary processing is technically compliant with CBP design guidelines. However, the existing stairs and escalators feed this area from the side, reducing the effective area that can be used for queuing. The Port has developed options for relocating the circulation core to allow the queue area to be fed from the back.

- There are two baggage claim devices at the FIS facilities. This number is sufficient to handle two simultaneous arrivals, which is the current peak requirement. However, the devices are undersized for the size of aircraft they serve. The peripheral and retrieval areas around the devices are similarly undersized. In addition, the devices are spaced with about 27 feet from edge to edge, leaving little room for a circulation zone between the devices.

- Terminating passengers exiting the FIS facilities travel to the main terminal/landside via a shuttle bus with a drop-off point near Gate D1. The shuttle bus allows terminating passengers to avoid the walking distance and processing through TSA passenger security screening that would otherwise be necessary. Passengers have the option of carrying their baggage with them on the shuttle bus. Alternatively, baggage can be placed on a belt in the FIS facilities where it is picked up by airline baggage handlers and conveyed to a domestic baggage claim device in the main terminal. The Port has examined a scheme for providing a dedicated pedestrian corridor between the FIS facilities and the main terminal at the lower level of Concourse D to replace the shuttle bus.

Key assumptions used in FIS requirements analysis include the following:

- 46% of peak-hour international passengers would be transferring to another flight.

- Each primary processing module provides a throughput of 100 passengers per hour and requires 862 square feet of queuing area.*

- 5% of passengers would be directed to secondary processing; 50% of these passengers would be referred to an exam station.* The required queuing area for secondary processing and the exam station would be 25.0 square feet per passenger.

Results of the requirements analysis are presented in Table 3-1. Key findings of the analysis are summarized below.

- **The existing baggage claim devices and areas are undersized**. The largest aircraft served by the devices today is the A340-300 with 247 seats. The existing devices provide 145 linear feet of presentation frontage. The estimated frontage per device that would provide an acceptable level-of-service for this size aircraft is 210 linear feet. Similarly, 2,970 square feet for the retrieval and

*Source: U.S. Customs and Border Protection, Airport Technical Design Standards, Passenger Processing Facilities, August 2006.

peripheral area for each device should be provided versus the existing 2,520 square feet.

- **By PAL 2 (2017) one additional primary processing module and queuing area and a third baggage claim device will be required**. Based on the planning schedules, beginning in PAL 2 (2017) and continuing through PAL 5 (2035), the international arrivals peak-hour will include three widebody aircraft, which is one more than the current peak. This roughly translates to a 50% increase in peak-hour passengers, which will require one additional primary processing module and additional queue space plus a third baggage claim device.

- **The amount of secondary queuing space is currently deficient**. The deficiency will increase with the addition of a third widebody arrival in the peak hour.

- **The referral waiting area and secondary exam stations will be sufficient throughout the planning period**.

- **The number of EDS machines currently provided for screening international recheck baggage is deficient**. One Reveal CTX-80 machine is provided; it is estimated that three machines of this type are currently required.

- **There is a surplus number of security lanes currently provided for screening international transfer passengers**. Four lanes are currently provided; it is estimated that two lanes will be sufficient throughout the planning period.

3.11 Concessions

Portland International Airport is one of a few airports in North America that have been developed with a significantly higher than average amount of concessions space per passenger. These few airports generate sales per passenger that significantly exceed the average and are recognized in the industry as having very successful concessions programs.

An analysis of concessions requirements is outside the scope of this master plan update. However, it is acknowledged that the concessions program is central to the Port's goal of maintaining and enhancing the Airport's reputation as one of the nation's premier airports. The concession program at the Airport is unique; its requirements have evolved with the program's development and therefore cannot be characterized solely on the basis of square footage. Instead, the requirements are based on a range of considerations including layout, function, product spacing, circulation and visibility.

While Concourse C has been identified as having an ideal mix of concessions space relative to other concourse functions, it is recognized that a number of constraints (e.g., apron depth, existing structures, passenger circulation and changes in airline space needs and layout) may limit the ability to create this ideal situation on other concourses.

Gate utilization and passenger processing have a direct relationship to concessions requirements. Therefore, as the Airport evolves, the concessions program requirements should be refined through further careful study. Furthermore, future concessions development and redevelopment should be considered during the design of any new or modified terminal facilities (e.g., modifications to correct existing circulation and holdroom deficiencies in Concourses A, B and E).

4. GROUND TRANSPORTATION AND PARKING

Ground transportation and parking requirements at Portland International Airport are primarily based on (a) the assessment of 2008 peak period activity, as described in Section 5.3 of *Technical Memorandum No. 1 – Inventory of Existing Conditions* and (b) the projected need for each type of ground transportation facility to accommodate forecast peak period activity, as presented in *Technical Memorandum No. 2 – Aviation Demand Forecasts*, at an acceptable level-of-service. The definition of "acceptable level-of-service" for each facility type is provided in the appropriate subsections below. For all facilities, the existing Airport configuration was assumed in determining future requirements. If alternative configurations (e.g., two independent terminal areas, more than one principal access route) are considered during the alternatives development and analysis process, certain requirements may need to be modified to reflect the new configuration.

4.1 Key Assumptions Affecting Ground Transportation and Parking Requirements

In general, ground transportation and parking facilities requirements are based on (a) the level of activity to be accommodated, (b) the level-of-service goal for that activity, and (c) functional requirements for specific modes or vehicle types. For almost all travel modes, the level of activity was assumed to increase in direct proportion to growth in annual passenger activity at the Airport. While demand for ground transportation and parking facilities is closely tied to the hourly and daily airline flight schedules, the aviation demand forecasts and flight schedules show no major changes to the existing monthly, daily, and hourly distribution of passenger activity.

The other key assumption governing future facility requirements is the various access modes (also known as "mode choice") assumed for future years. Historical mode choice data are summarized in Table 4-1. It is possible that, during the planning period of this Master Plan Update, these mode choices may change as passengers adapt to changes in the regional transportation system (e.g., the introduction of new modes or elimination of existing modes serving the Airport, vehicle operating costs, transit coverage and schedules, changes in regional freeway congestion). However, the mode choice data presented in Table 4-1 represents the share of total *annual* originating and terminating passengers using each mode in the years shown. As requirements for ground transportation facilities are typically driven by peak hour or daily demands, they may not be proportionally affected by changes in the annual mode choice distribution.

For purposes of determining the ground transportation and parking facilities requirements at the Airport through PAL 5 (2035), it was assumed that mode choices from 2006 were appropriate and that future changes in passenger mode choice and the resulting changes in requirements would be explored through sensitivity testing during the alternatives analysis.

Table 4-1

HISTORICAL AIRLINE PASSENGER MODE CHOICE DATA
Portland International Airport

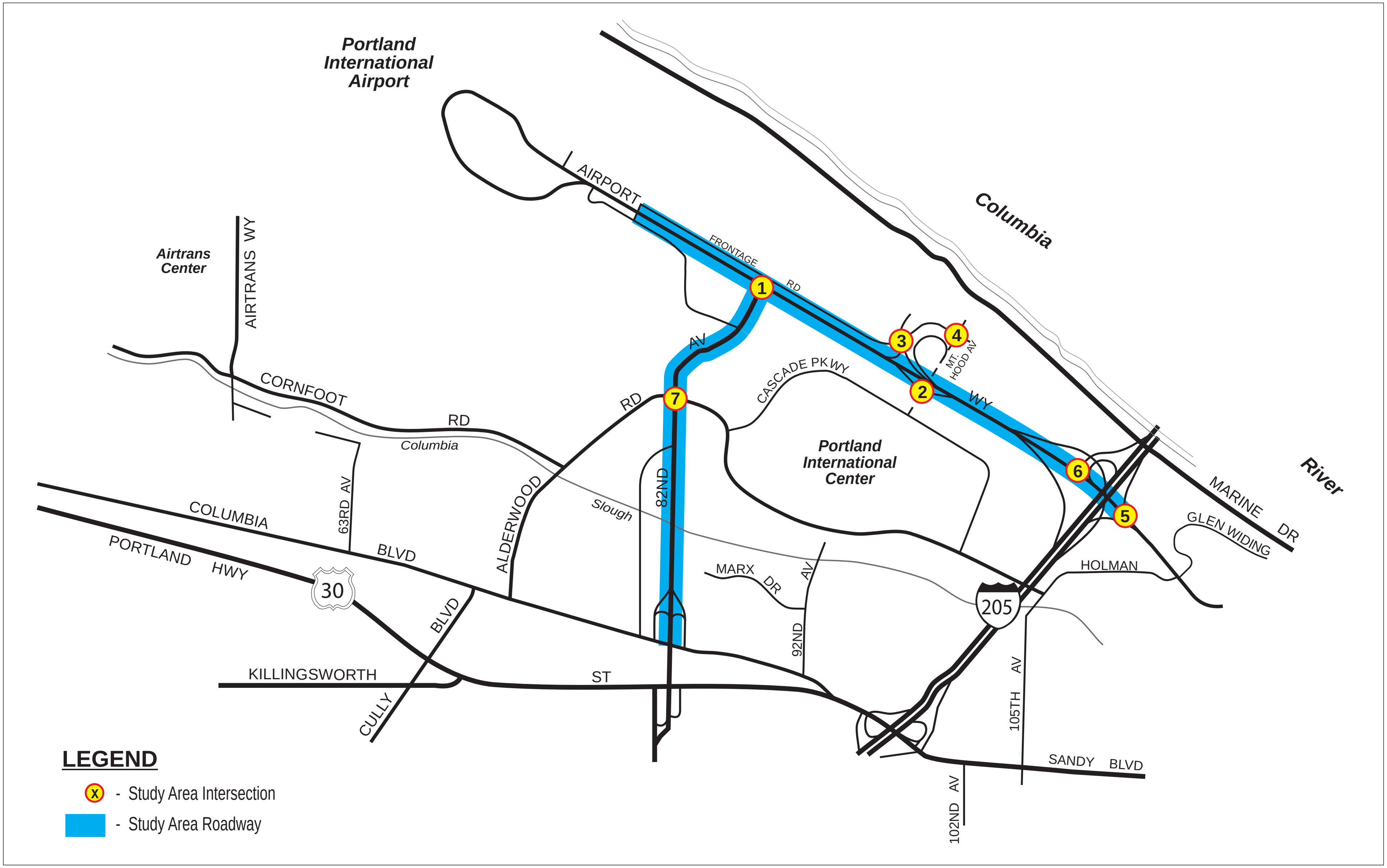
Mode	1997/1998	2001	2003	2006
Private vehicle – picked up or dropped off *(a)*	66% *(b)*	54% *(b)*	61% *(b)*	41%
Private vehicle – parked for duration of trip				17
Rental car	15	19	20	19
Taxicab/limousine	4	4	4	6
Shuttles *(c)*	11	15	9	12
Tri-Met (MAX light rail transit after 2001)	1	5	6	5
Other	3	3	--	--

(a) Includes vehicles parked in the Airport's parking facilities for short durations (less than 2 hours).
(b) Passenger survey data prior to 2006 do not distinguish between vehicles parked for the duration of an airline trip versus those parked while picking up or dropping off passengers.
(c) Includes shared-ride (door-to-door) vans, buses, and courtesy vehicles operated by hotels and motels.

Source: Port of Portland, Research and Marketing Department.

4.2 Access Roadways and Intersections

This section focuses on key terminal access intersections and roadways and their ability to accommodate motor vehicle traffic to and from the Airport in the future. Other key intersections on or near the Airport are discussed in Section 4.11. The facilities discussed in this section (and shown on Figure 4-1) include seven intersections and two major roadways, NE Airport Way (from approximately NE 82nd Avenue to Interstate 205) and NE 82nd Avenue (from approximately NE Airport Way to NE Columbia Boulevard). These intersections and roadways were evaluated to determine their ability to accommodate the demand forecast for PAL 1 (2012), PAL 2 (2017), PAL 3 (2022), PAL 4 (2027), and PAL 5 (2035) and to determine when a facility may become deficient and the potential capacity improvements that may be required.



PDX610 Fig4-1.ai

MAP NOT TO SCALE

Figure 4-1

Terminal Access Intersections and Roadways

Master Plan Update
Portland International Airport

Source: Port of Portland

December 2008

4.2.1 Baseline Conditions

Baseline conditions for the seven intersections and two roadways are discussed below.

Intersections

The study area intersections were analyzed to identify their current performance, and to compare that performance against adopted intersection operational standards based on delay and capacity. The Oregon Department of Transportation (ODOT) adopted standards for highway mobility as part of its *1999 Oregon Highway Plan** (as amended January 2006), requiring operation at or below a volume-to-capacity (V/C) ratio of 0.99 during each of the busiest two consecutive hours of weekday traffic. The City of Portland requires intersections to operate at a level-of-service (LOS) D or better for signalized intersections, and LOS E or better at unsignalized intersections, as determined by the amount of delay experienced during the design hour. The Port of Portland also applies the City of Portland's mobility standards to Port-owned roadways.

Volume-to-capacity ratios are comparisons of the actual motor vehicle volumes using the intersection (or a particular movement) to the maximum volume that could be served. For example, if the calculated V/C ratio at an intersection is 0.85 during the afternoon peak hour, approximately 85% of the available capacity at that intersection is being used. It is expected that V/C ratios for existing conditions would be at or below 1.0 during the peak hour. When an intersection approaches a 1.0 ratio, that intersection is very heavily used and typically will become very congested Intersections with V/C ratios over 1.0 typically have long vehicle delays and queues that do not clear in one signal cycle. This congestion can lead to other delays and queuing upstream of the intersection.

Instead of using a V/C ratio to measure the level of mobility (or available capacity) at an intersection, the City of Portland uses a level-of-service performance standard based on the average delay experienced by vehicles at the intersection.

Levels-of-service A, B, and C indicate conditions in which traffic moves without significant delays during periods of peak hour demand. LOS D and E are progressively worse peak hour operating conditions. LOS F represents long delays and vehicle queues and is commonly considered to be a "failing" condition. Table 4-2 presents the range of average per-vehicle delays (in seconds) corresponding with each LOS.

*Oregon Department of Transportation, *1999 Oregon Highway Plan*, originally adopted March 18, 1999; including amendments through January 2006.

Table 4-2

LOS CRITERIA FOR SIGNALIZED AND UNSIGNALIZED INTERSECTIONS

	Control Delay per Vehicle (seconds)	
LOS	Signalized	Unsignalized
A	≤ 10	≤ 10
B	> 10-20	> 10-15
C	> 20-35	> 15-25
D	> 35-55	> 25-35
E	> 55-80	> 35-50
F	≥ 80	≥ 50

Source: Transportation Research Board, National Research Council, *Highway Capacity Manual*, December 2000.

Traffic patterns at the study area intersections are influenced by both terminal-related traffic and non-terminal related traffic (i.e., local area commute or “background” traffic). Terminal-related traffic typically is greatest during the midday peak period between 11:00 a.m. and 2:00 p.m. whereas local area traffic typically is greatest during the afternoon peak period between 4:00 p.m. and 6:00 p.m. Depending on the share of total traffic accounted for by terminal-related traffic, peak period activity at an intersection could occur during the midday peak period or during the afternoon peak period. Accordingly, traffic was forecast for both the afternoon and midday peak periods for all planning periods; requirements were based on the peak period.

Table 4-3 summarizes the baseline operating conditions at the study area intersections shown on Figure 4-1.

Table 4-3

SUMMARY OF EXISTING (2007) AFTERNOON PEAK PERIOD OPERATING CONDITIONS AT KEY STUDY AREA INTERSECTIONS

	Intersection	Delay (seconds)	LOS	V/C	Operational standard
1	NE Airport Way/NE 82nd Avenue	11.9	B	0.62	D
2	NE Mt. Hood Avenue/NE Airport Way eastbound	5.5	A	0.45	D
3	NE Mt. Hood Avenue/NE Frontage Road	6.5	A	0.23	D
4	NE Frontage Road/NE Airport Way westbound	15.7	C	0.13	E
5	NE Airport Way/I-205 northbound on ramp	28.8	C	0.96	0.99
6	NE Airport Way/I-205 southbound off ramp	14.3	B	0.58	0.99
7	NE 82nd Avenue/NE Alderwood Road	52.9	D	0.59	D

Note: Peak period traffic occurs between 4:00 p.m. and 6:00 p.m. at all study area intersections except NE 82nd Avenue/NE Airport Way where the peak period traffic occurs between 11:00 a.m. and 2:00 p.m.

Delay = Average intersection delay in seconds (calculated using 2000 *Highway Capacity Manual* methodology)
LOS = Level of service (calculated using 2000 *Highway Capacity Manual* methodology)
V/C = Volume-to-capacity ratio (calculated using 2000 *Highway Capacity Manual* methodology)

Source: DKS Associates, September 2008, based on traffic counts provided by the Port of Portland and Oregon Department of Transportation. Data collected on multiple days throughout 2007 were combined and adjusted to represent the 30th busiest hour of the year.

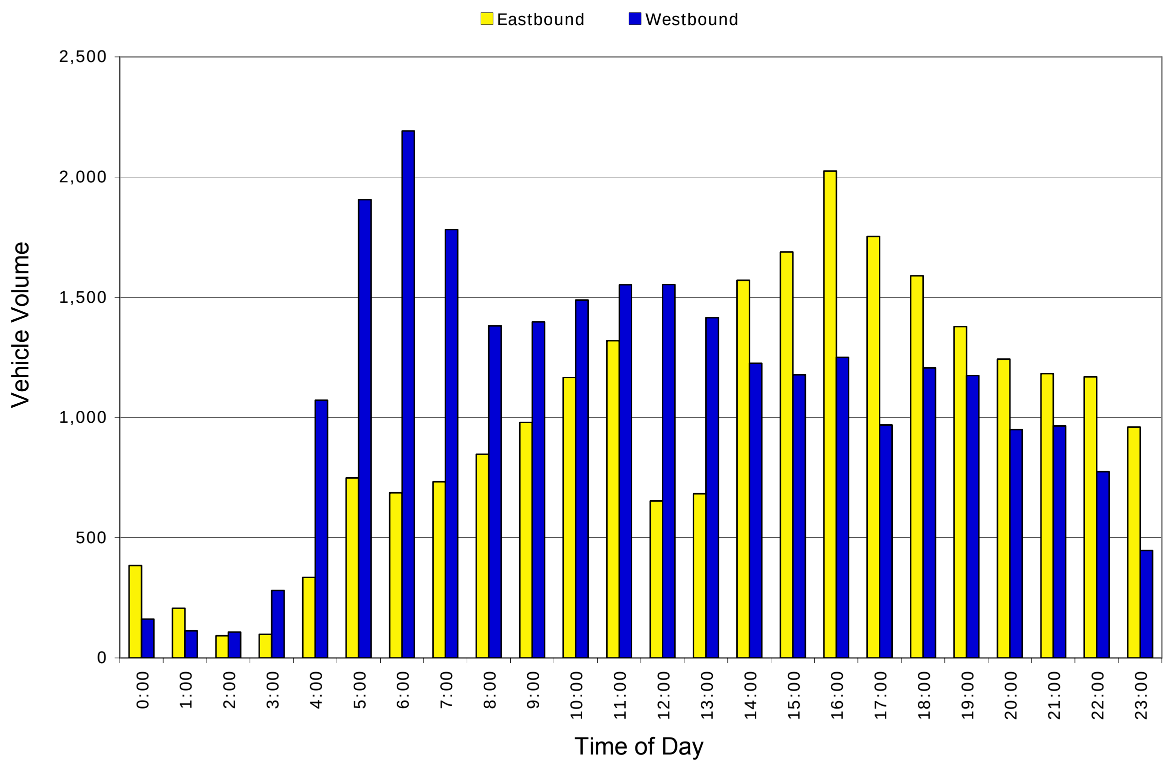
As shown in Table 4-3, existing operations at these intersections meet the governing operational standards. In addition, the intersection of NE Airport Way/Interstate 205 northbound is approaching the V/C mobility standard, primarily due to eastbound left turns and westbound right turns accessing the interstate. During severe conditions, queuing along NE Airport Way (resulting from I-205 northbound ramp congestion preventing the eastbound left and westbound right turns) has been observed to extend to NE 82nd Avenue to the west and to 122nd Avenue to the east (over 7,000 feet and 4,000 feet, respectively). As results of the delay analysis present the average delay experienced by all traffic at an intersection, delay for specific movements, such as the two turns onto I-205, could be worse than for the intersection as a whole.

Roadways

For the two major access roadways, traffic counts were conducted to establish a 24-hour volume profile. These data, presented on Figures 4-2 and 4-3, were used to determine the variations in motor vehicle volumes accessing the terminal along the key approach roadways throughout the day.

Figure 4-2

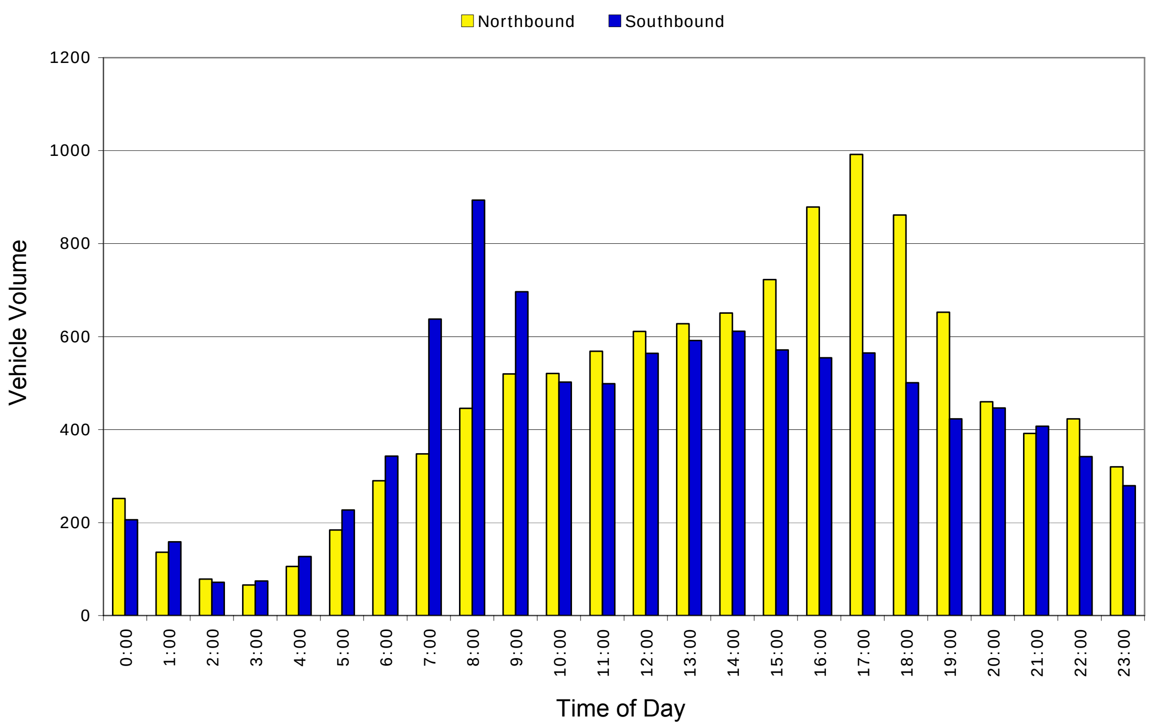
DAILY VEHICLE VOLUME PROFILE: NE AIRPORT WAY, WEST OF INTERSTATE 205, TYPICAL BUSY DAY IN 2007



Note: Vehicle volumes were measured on NE Airport Way between NE Mount Hood Avenue and NE 82nd Avenue.

Figure 4-3

DAILY VEHICLE VOLUME PROFILE: NE 82ND AVENUE, SOUTH OF NE AIRPORT WAY, TYPICAL BUSY DAY IN 2007



Note: Vehicle volumes were measured on NE 82nd Avenue between Air Cargo Road and NE Alderwood Road.

Both of these roadways exhibit typical "commuter" traffic patterns with peak directional flows in both the morning and afternoon peak periods. In this case, NE Airport Way has a westbound (toward the terminal) peak in the morning, and then an eastbound (toward Interstate 205) peak in the afternoon. Conversely, NE 82nd Avenue has a southbound (away from the terminal) peak in the morning and a northbound (toward Interstate 205) peak in the late afternoon. This pattern is most likely due to regional trips (not Airport terminal trips) accessing Interstate 205 via NE Airport Way and NE 82nd Avenue.

4.2.2 Methodology

Metro, the regional planning agency, maintains a travel demand model for the Portland metropolitan area that includes land uses for both the base year as defined by Metro (2005) and future year (2035). These land uses are grouped into smaller focused areas called transportation analysis zones that are usually bordered by natural or manmade obstructions, such as rivers, freeways, topographical features, railroads, and other obstructions. The land uses generate motor vehicle trips that access the roadway network and traverse the network through intersections to their final destinations. This regional travel demand model was used as the basis for determining future traffic forecasts at study area intersections.

The methodology for projecting future traffic along the roadways and at the signalized (and unsignalized) intersections incorporated existing motor vehicle volumes, base case travel demand model vehicle volumes, and future travel demand model vehicle volumes. This methodology minimized the effects of model error by adding the incremental growth projected by the travel demand model (modeled 2035 vehicle volumes minus the modeled vehicle volumes for existing base year 2005 conditions) to the base year motor vehicle volumes. Therefore, intersection approach and departure volumes used in the LOS calculations have been adjusted and may not exactly match raw model volumes produced by the regional travel demand model. After developing the 2035 vehicle volumes, volumes for the interim assessment years (2012, 2017, 2022, and 2027) were established by interpolating between the 2005 and 2035 volumes.

Future traffic includes not only Airport area growth, but also background regional growth. Background growth (non-Airport area) was estimated using the Metro travel demand model for 2005 and 2035. The 2035 forecast growth in traffic (subtracting Airport-area uses) was compared to the existing 2005 model (subtracting Airport-area uses) to determine background traffic growth at the key intersections. This growth was then reflected in the traffic analysis for each intersection.

The capacity of the study area intersections was analyzed using the traffic analysis software Synchro, which uses the methodology in the 2000 *Highway Capacity Manual*.* In addition to this methodology, existing morning and afternoon peak hour motor vehicle volumes (collected in 2007) were adjusted to represent the 30th-busiest vehicle hour of the year.

To reflect intermediate analysis years between 2005 and the end of the planning period for this Master Plan Update (2035), a straightlining methodology was used, which prorates the volumes from the end of the planning period back to the base year on a per year basis. Therefore, incremental growth occurs on all motor vehicle movements at an intersection based on the per year growth in activity. This methodology was used for all study area intersections with the exception of NE 82nd Avenue/NE Airport Way because of the proximity to the terminal and the fact that passenger activity (which directly relates to motor vehicle activity) does not increase uniformly over the planning period. Therefore, the growth in motor vehicle activity to/from the terminal through this intersection was assumed to increase at the same rate as the forecast for airline passengers.

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*Transportation Research Board, National Research Council, *Highway Capacity Manual,* Washington, D.C., December 2000.

When evaluating the future study area constraints relating to facility requirements, the controlling bottlenecks in the area that drive potential capacity improvements are typically the signalized (or unsignalized) intersections, and not typically the roadways themselves. However, the roadways were analyzed for their ability to accommodate motor vehicles transitioning from one travel path to another (also known as weaving) particularly between I-205 and the Mt. Hood interchange along NE Airport Way.

4.2.3 Future Intersection Facility Requirements

The following summarizes the results of the capacity and requirements analysis for the terminal access intersections and roadways. Capacity constraints were identified if (a) an intersection does not meet a jurisdictional mobility standard for either delay (i.e., LOS) or volume-to-capacity or (b) the V/C ratio for a critical movement at the intersection exceeds 1.0 during the afternoon peak hours. For identified capacity constraints, recommendations are provided to mitigate the deficiency. The levels of service represented on the following tables reflect conditions assuming implementation of the recommended action.

NE 82nd Avenue/NE Airport Way (Figure 4-1, Intersection 1)

This signalized intersection delineates the point at which motor vehicles enter or exit the terminal area roadway system. When severe congestion occurs, vehicle access to and from the terminal is not reliable. Currently, NE Airport Way has three eastbound and three westbound travel lanes that traverse through the signal at this intersection. In addition, the TriMet MAX light rail system operates on the south side of this intersection with 15-minute headways, which affect the westbound left turn, the northbound approach, and the eastbound right turn. The limiting factor at this intersection is the eastbound through traffic because it must stop more frequently than the westbound traffic. Eastbound traffic stops for the westbound traffic turning left as well as northbound traffic while the westbound traffic only stops for the northbound left turning movement.

An additional through travel lane is currently under construction in each direction along NE Airport Way through this intersection, which will result in a total of six travel lanes (three lanes in each direction). This construction is scheduled for completion by the end of 2008.

Unlike intersections typically experiencing commute traffic patterns, a midday peak period occurs at this intersection (between 11:00 a.m. and 2:00 p.m.), with more eastbound/westbound traffic than during the afternoon peak period (occurring between 4:00 p.m. and 6:00 p.m.). This peaking activity occurs because terminal-related traffic, which peaks during the midday, accounts for a large share of the traffic using the intersection. For this reason, traffic during all intervening planning periods was forecast for both the afternoon and midday peak periods. (No other study area intersections share this characteristic because the background traffic—traffic not associated with the terminal—at other intersections peaks during the 4:00 p.m. to 6:00 p.m. period, increasing traffic levels above those experienced during the midday peak.) Table 4-4 summarizes the operations at this intersection for future planning years.

Table 4-4

SUMMARY OF CAPACITY AND REQUIREMENTS ANALYSIS
NE 82ND AVENUE/NE AIRPORT WAY

PAL (Forecast Year)	LOS *(a)*	V/C	Facility Requirements
Afternoon Peak Period (4 p.m. - 6 p.m.)			
PAL 1 (2012) *(b)*	B	0.74	No additional requirements
PAL 2 (2017) *(c)*	C	0.84	Implement grade-separated interchange
PAL 3 (2022) *(c)*	C	0.87	No additional requirements
PAL 4 (2027) *(c)*	C	0.91	No additional requirements
PAL 5 (2035) *(c)*	D	0.96	No additional requirements
Midday Peak Period (11 a.m. - 2 p.m.)			
PAL 1 (2012) *(b)*	D	0.91	No additional requirements
PAL 2 (2017) *(c)*	C	0.82	Implement grade-separated interchange
PAL 3 (2022) *(c)*	C	0.85	No additional requirements
PAL 4 (2027) *(c)*	C	0.88	No additional requirements
PAL 5 (2035) *(c)*	D	0.93	No additional requirements

Note: Level-of-service standard is LOS D. V/C standard is 0.99.

LOS = Level of service
V/C = Volume-to-capacity ratio

(a) Assuming implementation of projects to meet facility requirements.
(b) Assuming three lanes in both eastbound/westbound directions on NE Airport Way.
(c) Assuming diamond–configured grade-separated interchange (due to midday peak initially).

Source: DKS Associates, September 2008.

Based on the analysis summarized in Table 4-4, the intersection of NE 82nd Avenue/ NE Airport Way becomes capacity constrained during the midday peak hour before the afternoon peak hour, and is forecast to need additional capacity at PAL 2 (2017). One potential improvement in the Regional Transportation Plan, on the list of projects that are “Financially Constrained”, is a grade-separated interchange at this location. This interchange would provide for unimpeded travel eastbound and westbound on NE Airport Way while northbound/southbound traffic on NE 82nd Avenue would use the signalized interchange ramps. With this configuration, the higher midday traffic on NE Airport Way would not affect the signalized operations of the interchange and the two signals would operate at LOS D (or better) and V/C 0.96 (or better) by PAL 5 (2035), meeting both the City of Portland and the Port of Portland mobility standards.

Mt. Hood Interchange Area (Figure 4-1, Intersections 2, 3, and 4)

This area consists of three intersections (one signal controlled, one unsignalized, and one roundabout). The interchange is the primary access point for both the Portland International Center (PIC) and the economy parking lots (Blue and Red). This analysis did not include changes in vehicle volumes that could result from any significant addition to the economy parking lots or changes in surrounding land uses along the frontage road, but the future retail and office land use buildout of the PIC area was considered. Table 4-5 summarizes the results of the capacity and requirements analysis for this area.

Table 4-5

SUMMARY OF CAPACITY AND REQUIREMENTS ANALYSIS
MT. HOOD INTERCHANGE AREA

PAL (Forecast Year)	LOS	V/C	Facility Requirements
Mt. Hood Avenue/NE Airport Way eastbound (signal control) (Figure 4-1, Intersection 2)			
PAL 1 (2012)	A	0.76	No improvement necessary
PAL 2 (2017)	A	0.78	No improvement necessary
PAL 3 (2022)	A	0.81	No improvement necessary
PAL 4 (2027)	A	0.83	No improvement necessary
PAL 5 (2035)	B	0.95	No improvement necessary
NE Frontage Road/NE Airport Way westbound (unsignalized) (Figure 4-1, Intersection 3)			
PAL 1 (2012)	C	0.15	No improvement necessary
PAL 2 (2017)	C	0.16	No improvement necessary
PAL 3 (2022)	C	0.17	No improvement necessary
PAL 4 (2027)	C	0.19	No improvement necessary
PAL 5 (2035)	C	0.21	No improvement necessary
NE Frontage Road/Mt. Hood Avenue (roundabout) (Figure 4-1, Intersection 4)			
PAL 1 (2012)	A	0.25	No improvement necessary
PAL 2 (2017)	A	0.26	No improvement necessary
PAL 3 (2022)	A	0.27	No improvement necessary
PAL 4 (2027)	A	0.29	No improvement necessary
PAL 5 (2035)	B	0.32	No improvement necessary

Note: Level-of-service standard is LOS D. V/C standard is 0.99.

LOS = Level of service
V/C = Volume-to-capacity ratio

Source: DKS Associates, September 2008.

As shown in Table 4-5, these intersections have available capacity to accommodate future traffic demand. However, a significant increase in economy parking capacity could result in hourly traffic volumes exceeding the capacity of one or more of these intersections. As a sensitivity test for motor vehicle operations, net new motor vehicle trips associated with the potential expansion of the economy parking lots were added to the interchange area to determine potential facility requirements. This sensitivity test was conducted using existing ratios for current parking supply and trips generated during the afternoon peak period. The analysis indicates available capacity at the roundabout and the unsignalized intersection to accommodate expected growth in parking supply (up to 10,000 new stalls by PAL 4 (2035); however, the signalized intersection would not meet operational standards (LOS D) with this potential expansion. Improvements to accommodate this level of parking expansion could include an additional southbound left turn lane at this intersection. This additional left turn could affect the width of the overpass of NE Airport Way. It does appear that, by 2027, the intersection could accommodate future expansion of economy lots' parking supply (approximately 6,800 net new parking stalls).

NE Airport Way/I-205 Interchange Area (Figure 4-1, Intersections 5 and 6)

This area consists of two signalized intersections and provides access to and from NE Airport Way and Interstate 205. As previously mentioned, capacity constraints exist at times with the eastbound left turn and the westbound right turn to access Interstate 205 northbound.

For PAL 1 (2012) and beyond, an additional southbound off-ramp right turn pocket was assumed at this intersection. This improvement is currently being constructed and is expected to be operational by early 2009. Table 4-6 summarizes the results of the capacity and requirements analysis for this area.

The volume-to-capacity ratios shown in Table 4-6 indicate that only the northbound intersection would have a capacity constraint in the future. The northbound access would be constrained by the combined eastbound left turns and westbound right turns from NE Airport Way by PAL 1 (2012).

Previous studies indicated two additional requirements at the interchange. The first is the need for an additional southbound right turn from the I-205 off ramp to westbound NE Airport Way. The second is the need to relocate the eastbound to northbound I-205 access. ODOT is currently conducting a study to determine and evaluate alternatives associated with relocating this movement via a flyover, loop-ramp, or some other means. Addressing the eastbound left turning movement at this intersection would allow for adequate intersection operations during the afternoon peak period through PAL 5 (2035).

Table 4-6

SUMMARY OF CAPACITY AND REQUIREMENTS ANALYSIS
NE AIRPORT WAY/I-205 INTERCHANGE AREA

PAL (Forecast Year)	LOS	V/C	Facility Requirements
NE Airport Way/Interstate 205 southbound intersection (Figure 4-1, Intersection 6) *(a)*			
PAL 1 (2012)	B	0.64	No improvement necessary
PAL 2 (2017)	C	0.69	No improvement necessary
PAL 3 (2022)	C	0.75	No improvement necessary
PAL 4 (2027)	D	0.81	No improvement necessary
PAL 5 (2035)	C	0.92	No improvement necessary
NE Airport Way/Interstate 205 northbound (Figure 4-1, Intersection 5) *(b)*			
PAL 1 (2012)	A	0.54	The eastbound left turn movement requires improvement to provide for adequate operations
PAL 2 (2017)	A	0.61	The eastbound left turn movement requires improvement to provide for adequate operations
PAL 3 (2022)	A	0.65	The eastbound left turn movement requires improvement to provide for adequate operations
PAL 4 (2027)	A	0.69	The eastbound left turn movement requires improvement to provide for adequate operations
PAL 5 (2035)	A	0.76	The eastbound left turn movement requires improvement to provide for adequate operations

Note: Level-of-service standard is LOS D. V/C standard is 0.99.

LOS = Level of service
V/C = Volume-to-capacity ratio

(a) Assuming second southbound right turn.
(b) Assuming improvements for eastbound to northbound movement that would remove it from signalized operations.

Source: DKS Associates, September 2008.

NE 82nd Avenue Intersection/NE Alderwood Road (Figure 4-1, Intersection 7)

Similar to the Mt. Hood interchange signalized intersection, this intersection is a major access point to and from the PIC, as well as being located on a key roadway providing access to the terminal area.

This intersection includes improvements from the conditions that are currently being planned or constructed and would be in place by PAL 1 (2012). These improvements include modifying the eastbound approach geometry to include two left turn lanes, one through lane, and a separate right turn pocket (i.e., a limited-length lane that allows automobiles to wait for a turning opportunity without blocking through traffic). The westbound approach geometry would be similar with dual left turn lanes, one through lane, and a separate right turn pocket. The southbound approach would include a left turn lane, two through lanes, and a separate right turn pocket. Table 4-7 summarizes the results of the capacity and requirements analysis for this intersection with these improvements in place for the various planning years.

Table 4-7

SUMMARY OF CAPACITY AND REQUIREMENTS ANALYSIS
NE 82ND AVENUE/NE ALDERWOOD ROAD INTERSECTION

PAL (Forecast Year)	LOS *(a)*	V/C	Facility Requirements
PAL 1 (2012)	C	0.61	No additional requirements
PAL 2 (2017)	D	0.70	No additional requirements
PAL 3 (2022)	D	0.81	No additional requirements
PAL 4 (2027)	D	0.91	No additional requirements
PAL 5 (2035)	D	0.97	Adjust signal timing to increase cycle length

Note: Level-of-service standard is LOS D. V/C standard is 0.99.

LOS = Level of service
V/C = Volume-to-capacity ratio

(a) Assuming implementation of projects to meet facility requirements.

Source: DKS Associates, September 2008.

By PAL 5 (2035), the signal cycle length would need to be lengthened to accommodate slightly longer phases to serve additional demand. This longer cycle length would allow the intersection to meet the mobility standard for delay and maintain a V/C ratio below 1.0.

4.2.4 Future Roadway Facility Requirements

As noted above, NE Airport Way and NE 82nd Avenue are the two major roadways providing access to and from the terminal area. In addition to capacity constraints created by intersections along those roadways, the roadways were evaluated to determine whether or not weaving movements affect roadway capacity. It was concluded that no significant weaving activity occurs on NE 82nd Avenue, but that weaving movements on NE Airport Way between the Mt. Hood interchange and Interstate 205 could affect roadway operations. For NE Airway Way between NE 82nd Avenue and the Mt. Hood interchange, it was determined that conditions at the intersections would have a larger impact on roadway level of service than would weaving activity on NE Airport Way.

Table 4-8 summarizes the results of the capacity and requirements analysis for the eastbound and westbound weaving movements on the section of NE Airport Way between the Mt. Hood interchange and I-205. The eastbound weaving area on NE Airport Way may also be influenced by the eastbound left turn leading to the I-205 northbound on-ramp. Capacity constraints for this turning movement result in queues that extend into the weaving area. Because the eastbound left turn deficiency is addressed as part of a separate analysis, the weaving operations on NE Airport Way were evaluated independent of the surrounding intersections.

Table 4-8

SUMMARY OF WEAVING OPERATIONAL ANALYSIS
NE AIRPORT WAY, EASTBOUND AND WESTBOUND

PAL (Forecast Year)	LOS	Speed	Facility Requirements
Eastbound – Mt. Hood Avenue to I-205			
PAL 1 (2012)	B	36mph	No improvement necessary
PAL 2 (2017)	C	35mph	No improvement necessary
PAL 3 (2022)	D	34mph	No improvement necessary
PAL 4 (2027)	D	33mph	No improvement necessary
PAL 5 (2035)	E	32mph	May explore opportunity to braid ramps
Westbound – I-205 to Mt. Hood Avenue			
2007	A	38mph	No improvement necessary
PAL 1 (2012)	B	37mph	No improvement necessary
PAL 2 (2017)	B	36mph	No improvement necessary
PAL 3 (2022)	B	35mph	No improvement necessary
PAL 4 (2027)	B	34mph	No improvement necessary
PAL 5 (2035)	C	33mph	No improvement necessary

Note: Level-of-service standard is LOS D.

LOS = Level of service (based on average speed on roadway)
mph = Miles per hour

Source: DKS Associates, September 2008.

As shown in Table 4-8, improvements may be necessary by PAL 5 (2035) to meet the mobility standards for eastbound weaving operations. These improvements may include improved operations at the NE Airport Way/Interstate 205 interchange, which, as noted earlier in the discussion of this interchange, is the subject of an ongoing study of potential interchange improvements intended to address existing and future deficiencies at the signalized intersections.

4.3 Terminal Area Roadways

This section focuses on key terminal area roadways and the number of lanes needed to accommodate future peak period vehicle volumes at an acceptable level of service. The roadway links evaluated include:

- NE Airport Way, west of NE 82nd Avenue
- P-1 access road
- Approach to enplaning level curbside
- Approach to deplaning level curbside

- Departure from enplaning level curbside
- Departure from deplaning level curbside
- Parking exit roadway (east of the exit plaza)
- Terminal exit roadway
- Return-to-terminal roadway
- Terminal area exit roadway

4.3.1 Level-of-Service Goal

For terminal area roadways, requirements are based on the desired LOS during the design hour for each roadway. The LOS is based on a ratio of the volume of vehicles using the roadway during the design hour versus the assumed capacity of the roadway. Table 4-9 presents the levels of service that correspond to the range of values typically observed for that ratio.

Table 4-9

LEVEL OF SERVICE ASSUMPTIONS
TERMINAL AREA ROADWAYS

Level of Service	Ratio of Hourly Volume versus Capacity
A	0 to 0.25
B	0.25 to 0.40
C	0.40 to 0.60
D	0.60 to 0.80
E	0.80 to 1.00
F	Greater than 1.00

Source: Jacobs Consultancy, September 2008, based on information presented in Transportation Research Board, National Research Council, *Highway Capacity Manual*, December 2000, Exhibit 21-2.

For master planning purposes, roadway facility requirements are established to meet the anticipated design-hour demand at LOS C. While this LOS may be higher than the standard used for roadways and other transportation facilities not located on an airport (such as those discussed in Section 4.2), it is justified by:

- The high proportion of unfamiliar drivers that typically use on-airport roadways and curbsides.

- The consequences of delays and congestion typically associated with LOS D, E, and F. Under LOS D, E, or F conditions, drivers typically experience slower travel speeds that may result in queues. When these conditions occur on roads predominantly used by commuters, drivers may risk being a few minutes late to work. Under these conditions on an airport, passengers may risk missing flights or baggage check-in cut-off times.

- The significantly reduced tolerance for delay, once drivers are at the Airport.

4.3.2 Assessment of Future Activity and Requirements

Design hour volumes were established for each key roadway link based on data collected in August 2007 (see *Technical Memorandum No. 1—Inventory of Existing Conditions*). These volumes were assumed to increase in proportion to the growth in annual numbers of passengers. Future volumes were then compared with the assumed lane capacity for each roadway to identify the number of lanes required to provide LOS C. Table 4-10 presents the requirements for the roadway links, which are identified on Figure 4-4.

4.4 Curbside Roadways

The terminal curbside is a two-level configuration, with enplaning passengers dropped off on the upper roadway outside the ticketing lobbies and deplaning passengers picked up on the lower roadway outside baggage claim. The upper-level roadway consists of two separate four-lane roadways while the lower-level roadway consists of a four-lane roadway for private vehicles and three separate roadways for commercial vehicles. Requirements for the commercial vehicle roadways and curbsides on the deplaning level are discussed in Section 4.5, "Commercial Vehicle Facilities."

4.4.1 Level-of-Service Goal

For curbside roadways, facility requirements were developed for (a) the length of curb needed to accommodate vehicles loading or unloading passengers at the curb and (b) the number of lanes required to carry traffic past the vehicles that are loading or unloading. For both components, requirements are based on a goal to provide facilities that meet the anticipated design hour demand at an acceptable level of service. For the length of curb, the LOS is based on a ratio of the combined length of vehicles that would be parked simultaneously during the design hour versus the available length of curbside. Table 4-11 presents the levels of service that correspond to the range of values typically observed for that ratio. As shown, LOS B through F correspond to situations where the length of parked vehicles exceeds the length of available curb. In such cases, some vehicles are double (or triple) parked as they load or unload passengers. At most airports, double parking is considered acceptable during busy periods and, therefore, curbside roadways where double parking occurs may still operate at an acceptable level of service (such as LOS C).

Table 4-10

TERMINAL AREA ROADWAY REQUIREMENTS
Portland International Airport

PAL (Forecast Year)	Link Identifier *(a)*	Description	Existing Lanes	Lane Capacity *(b)*	Total Capacity	Design Hour Volume	Volume/ Capacity Ratio	Additional Lanes Required to Accommodate Demand at LOS C
2007	A	NE Airport Way West, westbound	2	1,290	2,580	1,670	0.65	1
	B	NE Airport Way West, eastbound	2	1,290	2,580	1,630	0.63	1
	C	Parking entrance	1	1,130	1,130	440	0.39	0
	D	Enplaning level approach	2	1,070	2,140	970	0.45	0
	E	Deplaning level approach	3	1,130	3,390	880	0.26	0
	F	Enplaning level departure	1	1,150	1,150	970	0.84	1
	G	Deplaning level departure	2	1,210	2,420	970	0.40	0
	H	Parking exit roadway	1	1,210	1,210	430	0.36	0
	I	Terminal exit	2	1,290	2,580	1,460	0.57	1
	J	Return-to-terminal road	1	1,210	1,210	490	0.40	0
	K	Terminal area exit	2	1,290	2,580	1,520	0.59	0
PAL 1	A	NE Airport Way West, westbound *(c)*	3	1,290	3,870	1,710	0.44	0
(2012)	B	NE Airport Way West, eastbound *(c)*	3	1,290	3,870	1,660	0.43	0
	C	Parking entrance	1	1,130	1,130	450	0.40	0
	D	Enplaning level approach	2	1,070	2,140	990	0.46	0
	E	Deplaning level approach	3	1,130	3,390	890	0.26	0
	F	Enplaning level departure	1	1,150	1,150	990	0.86	1
	G	Deplaning level departure	2	1,210	2,420	990	0.41	0
	H	Parking exit roadway	1	1,210	1,210	440	0.36	0
	I	Terminal exit	2	1,290	2,580	1,490	0.58	1
	J	Return-to-terminal road	1	1,210	1,210	500	0.41	0
	K	Terminal area exit	2	1,290	2,580	1,550	0.60	0
PAL 2	A	NE Airport Way West, westbound *(c)*	3	1,290	3,870	2,050	0.53	0
(2017)	B	NE Airport Way West, eastbound *(c)*	3	1,290	3,870	2,000	0.52	0
	C	Parking entrance	1	1,130	1,130	540	0.48	0
	D	Enplaning level approach	2	1,070	2,140	1,190	0.56	0
	E	Deplaning level approach	3	1,130	3,390	1,070	0.32	0
	F	Enplaning level departure	1	1,150	1,150	1,190	1.03	1
	G	Deplaning level departure	2	1,210	2,420	1,190	0.49	0
	H	Parking exit roadway	1	1,210	1,210	530	0.44	0
	I	Terminal exit	2	1,290	2,580	1,790	0.69	1
	J	Return-to-terminal road	1	1,210	1,210	600	0.50	0
	K	Terminal area exit	2	1,290	2,580	1,860	0.72	1
PAL 3	A	NE Airport Way West, westbound *(c)*	3	1,290	3,870	2,350	0.61	1
(2022)	B	NE Airport Way West, eastbound *(c)*	3	1,290	3,870	2,290	0.59	0
	C	Parking entrance	1	1,130	1,130	620	0.55	0
	D	Enplaning level approach	2	1,070	2,140	1,360	0.64	1
	E	Deplaning level approach	3	1,130	3,390	1,230	0.36	0
	F	Enplaning level departure	1	1,150	1,150	1,360	1.18	1
	G	Deplaning level departure	2	1,210	2,420	1,360	0.56	0
	H	Parking exit roadway	1	1,210	1,210	600	0.50	0
	I	Terminal exit	2	1,290	2,580	2,050	0.79	1
	J	Return-to-terminal road	1	1,210	1,210	690	0.57	0
	K	Terminal area exit	2	1,290	2,580	2,140	0.83	1
PAL 4	A	NE Airport Way West, westbound *(c)*	3	1,290	3,870	2,690	0.70	1
(2027)	B	NE Airport Way West, eastbound *(c)*	3	1,290	3,870	2,630	0.68	1
	C	Parking entrance	1	1,130	1,130	710	0.63	1
	D	Enplaning level approach	2	1,070	2,140	1,560	0.73	1
	E	Deplaning level approach	3	1,130	3,390	1,410	0.42	0
	F	Enplaning level departure	1	1,150	1,150	1,560	1.36	2
	G	Deplaning level departure	2	1,210	2,420	1,560	0.64	1
	H	Parking exit roadway	1	1,210	1,210	690	0.57	1
	I	Terminal exit	2	1,290	2,580	2,350	0.91	2
	J	Return-to-terminal road	1	1,210	1,210	790	0.65	1
	K	Terminal area exit	2	1,290	2,580	2,450	0.95	2

Table 4-10 *(page 2 of 2)*
TERMINAL AREA ROADWAY REQUIREMENTS
Portland International Airport

PAL (Forecast Year)	Link Identifier *(a)*	Description	Existing Lanes	Lane Capacity *(b)*	Total Capacity	Design Hour Volume	Volume/ Capacity Ratio	Additional Lanes Required to Accommodate Demand at LOS C
PAL 5	A	NE Airport Way West, westbound *(c)*	3	1,290	3,870	3,050	0.79	1
(2035)	B	NE Airport Way West, eastbound *(c)*	3	1,290	3,870	2,980	0.77	1
	C	Parking entrance	1	1,130	1,130	800	0.71	1
	D	Enplaning level approach	2	1,070	2,140	1,770	0.83	1
	E	Deplaning level approach	3	1,130	3,390	1,600	0.47	0
	F	Enplaning level departure	1	1,150	1,150	1,770	1.54	2
	G	Deplaning level departure	2	1,210	2,420	1,770	0.73	1
	H	Parking exit roadway	1	1,210	1,210	790	0.65	1
	I	Terminal exit	2	1,290	2,580	2,670	1.03	2
	J	Return-to-terminal road	1	1,210	1,210	900	0.74	1
	K	Terminal area exit	2	1,290	2,580	2,780	1.08	2

(a) See Figure 4-4.
(b) Lane capacity is based on Transportation Research Board, National Research Council, *Highway Capacity Manual*, December 2000, Exhibit 21-3. Capacities reflect assumed free-flow speed and adjustments for driver population, heavy vehicles, and lateral clearances.
(c) Assuming completion of third lane on NE Airport Way, both eastbound and westbound.

Source: Jacobs Consultancy, September 2008.

Table 4-11

LEVEL OF SERVICE ASSUMPTIONS
CURBSIDE LOADING AND UNLOADING AREAS

Level of Service	Ratio of Length of Parked Vehicles versus Available Length of Curbside *(a)*
A	0 to 0.9
B	0.9 to 1.1
C	1.1 to 1.3
D	1.3 to 1.7
E	1.7 to 2.0
F	Greater than 2.0

(a) Values are for curbside roadways providing two parking lanes and at least two travel lanes.

Source: Transportation Research Board, *Special Report 215: Measuring Airport Landside Capacity*, 1987, Figure 11-2.

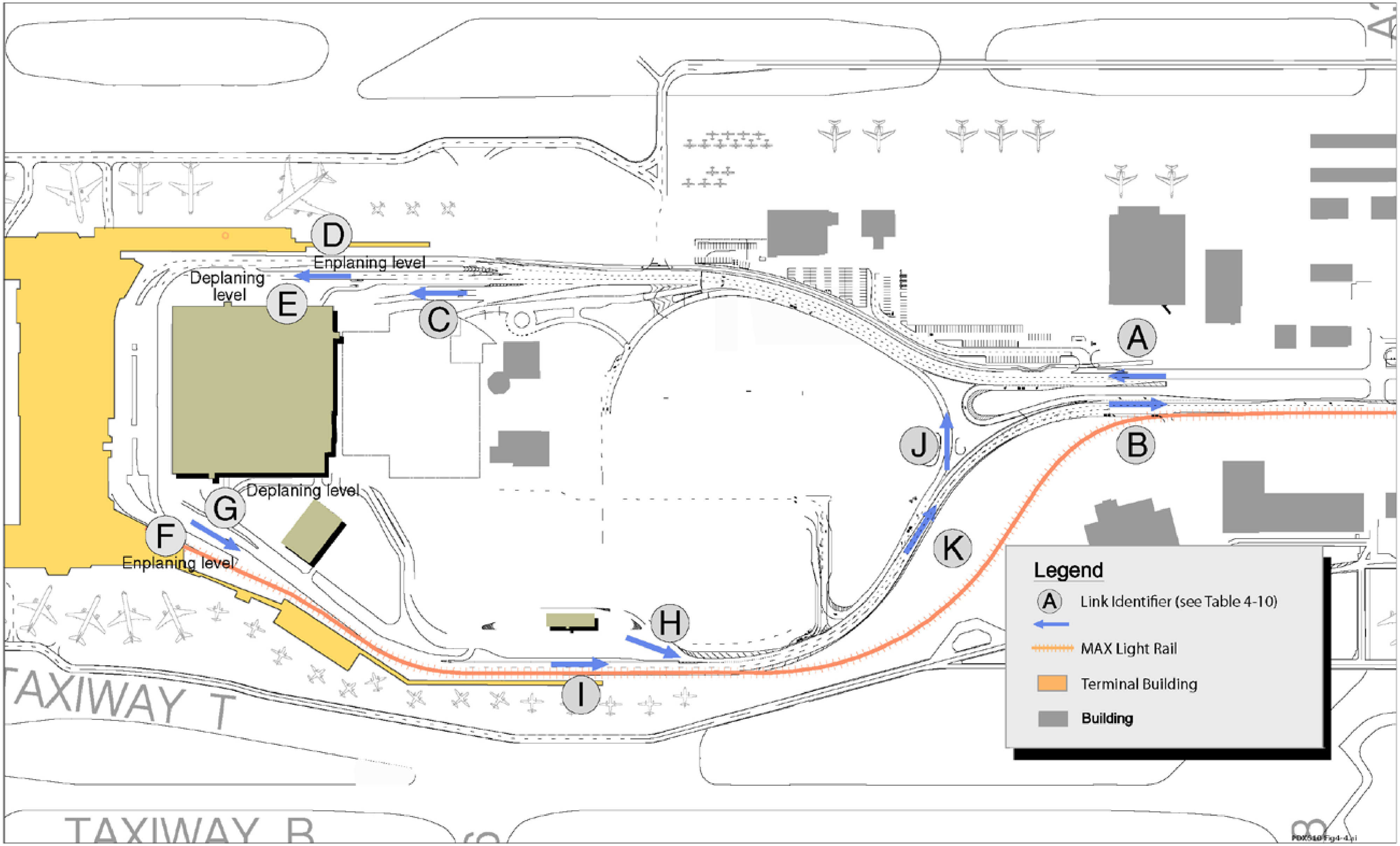


Figure 4-4

Roadway Link Locations

Master Plan Update
Portland International Airport

Source: Port of Portland.

December 2008

For the travel lanes on the curbside roadway, the level of service is based on a ratio of the hourly volume of vehicles using the roadway (including vehicles that may or may not be loading or unloading) versus the assumed capacity of the roadway. Table 4-12 presents the levels of service that correspond to the range of values typically observed for that ratio.

Table 4-12

LEVEL OF SERVICE ASSUMPTIONS
CURBSIDE TRAVEL LANES

Level of Service	Volume/ Capacity Ratio
A	0 to 0.25
B	0.25 to 0.40
C	0.40 to 0.60
D	0.60 to 0.80
E	0.80 to 1.00
F	Greater than 1.00

Source: Jacobs Consultancy, September 2008, based on information presented in Transportation Research Board, National Research Council, *Highway Capacity Manual*, December 2000, Exhibit 21-2.

As described earlier in Section 4.3, "Terminal Area Roadways", for master planning purposes, facility requirements were established to meet the anticipated design-hour demand at LOS C. In addition to the reasons presented above, this higher standard is justified by the fact that, on curbside roadways under LOS D, E, or F conditions, drivers may have difficulty finding available loading or unloading spaces near their desired destination (e.g., a particular doorway, curbside check-in position, or pre-arranged meeting point). On the Airport's deplaning level, these conditions can result in queues that block access to commercial vehicle loading areas, rental car facilities, and the P-1 parking garage.

4.4.2 Enplaning Level Requirements

On the enplaning level roadway, the inner roadway is used by private vehicles and the outer roadway is predominantly used by commercial vehicles (the outer roadway also serves valet parking customers). Data from field observations were used to determine (a) a vehicle fleet mix, indicating the relative proportions of different vehicle modes (private vehicles, taxicabs, etc) within the design hour; (b) vehicle dwell times by mode; and (c) the amount of time that pedestrians using crosswalks connecting to the outer curbside restrict the free flow of vehicular traffic on the inner curbside roadway. Using these data, requirements for the enplaning level curbsides were determined based on the following assumptions and guidelines:

- Requirements were based on projected "design hour" traffic volumes, which are based on 2007 enplaning level traffic volumes, as described in *Technical Memorandum No. 1 – Inventory of Existing Conditions*. It was assumed that design-hour volumes will increase in direct proportion to the forecast growth in average day peak month originating passengers.

- Private vehicles will continue to use the inner roadway and commercial vehicles will continue to use the outer roadway.

- Vehicular fleet mix, dwell times, and stand requirements (the length of curb required for a vehicle to stop and unload passengers and baggage) will remain consistent throughout the planning period.

- Pedestrian activity crossing the inner lanes and, therefore the amount of time the inner roadway would be obstructed by pedestrian activity will increase in direct proportion to the volume of vehicles using the outer curbside.

- The curbsides will meet the unloading vehicle demand 95% of the time during the design hour, based on a Poisson distribution of average demand at a V/C ratio of 1.3 or lower.

- Curbside dwell time policies will continue to be actively and visibly enforced.

Table 4-13 presents the requirements for the enplaning level curbside unloading area and Table 4-14 presents the requirements for the enplaning level curbside travel lanes. As shown, the existing inner and outer roadway lengths available for unloading would accommodate the requirements until PAL 3 (2022). The inner roadway travel lanes, however, would require an additional lane by PAL 4 (2027). This requirement could be addressed by reducing the outer roadway area reserved for non-curbside functions and encouraging drivers to use the outer roadway for passenger unloading.

Table 4-13

ENPLANING LEVEL CURBSIDE UNLOADING AREA REQUIREMENTS

PAL (Forecast Year)	Curbside Roadway *(a)*	Peak Hour Volume (vph)	Curb Length (feet) Required	Curb Length (feet) Available	Volume/ Capacity Ratio	Level of Service	Curbside Length Required to Accommodate Volume at LOS C (feet)
2007 *(b)*	Inner	645	575	564	1.02	B	445
	Outer	325	365	345	1.05	B	280
PAL 1 (2012)	Inner	660	575	564	1.02	B	445
	Outer	330	365	345	1.05	B	280
PAL 2 (2017)	Inner	790	675	564	1.20	C	520
	Outer	395	420	345	1.21	C	320
PAL 3 (2022)	Inner	910	775	564	1.38	D	595
	Outer	455	475	345	1.38	D	365
PAL 4 (2027)	Inner	1,040	875	564	1.55	D	675
	Outer	520	530	345	1.54	D	410
PAL 5 (2035)	Inner	1,180	975	564	1.73	E	750
	Outer	590	585	345	1.70	D	450

vph = Vehicles per hour

(a) Inner lanes serve private vehicles. Outer lanes are reserved for commercial vehicles.
(b) Reflects peak 2007 volumes (which occurred during August) applied to improvements completed in October 2007.

Source: Jacobs Consultancy, September 2008.

Table 4-14

ENPLANING LEVEL CURBSIDE TRAVEL LANE REQUIREMENTS

PAL (Forecast Year)	Curbside Roadway *(a)*	Peak Hour Volume (vph)	Existing Number of Total Lanes	Adjusted Capacity (vph) *(a)*	Volume/ Capacity Ratio	Level of Service	Additional Lanes Required to Meet LOS C *(b)*
2007 *(c)*	Inner	645	4	2,065	0.31	B	0
	Outer	325	4	2,790	0.12	A	0
PAL 1 (2012)	Inner	660	4	2,050	0.32	B	0
	Outer	330	4	2,100	0.12	A	0
PAL 2 (2017)	Inner	790	4	1,840	0.43	C	0
	Outer	395	4	2,680	0.15	A	0
PAL 3 (2022)	Inner	910	4	1,435	0.63	D	0
	Outer	455	4	2,220	0.20	A	0
PAL 4 (2027)	Inner	1,040	4	1,330	0.78	D	1 *(d)*
	Outer	520	4	2,220	0.23	A	0
PAL 5 (2035)	Inner	1,180	4	1,000	1.18	F	2 *(e)*
	Outer	590	4	2,220	0.27	B	0

vph = Vehicles per hour

(a) Reflects the capacity of existing lanes, with reductions due to crosswalks and curbside activity in adjacent lanes.
(b) Assuming that the curbside unloading area is operating at LOS C or better.
(c) Reflects peak 2007 volumes (which occurred during August) applied to improvements completed in October 2007.
(d) Could be reduced to zero if a portion of drivers on the inner roadway is encouraged to use the outer roadway.
(e) Could be reduced to zero or one additional lane if a portion of drivers on the inner roadway is encouraged to use the outer roadway.

Source: Jacobs Consultancy, September 2008.

4.4.3 Deplaning Level Requirements

On the deplaning level roadway, the innermost curbside roadway is used exclusively by private vehicles. The other curbside roadways are used by commercial vehicles and are discussed in Section 4.5. Data from field observations were used to determine average vehicle dwell times and the amount of time that pedestrians using crosswalks connecting to the commercial vehicle curbsides and P-1 parking garage restrict the free flow of vehicular traffic on the inner curbside roadway. Using these data, requirements for the deplaning level curbsides were determined based on the following assumptions and guidelines:

- Requirements were based on projected "design hour" traffic volumes, which are based on 2007 deplaning level traffic volumes, as described in *Technical Memorandum No. 1 – Inventory of Existing Conditions*. It was assumed that design-hour volumes will increase in direct proportion to the forecast growth in average day peak month originating passengers.

- Dwell times and stand requirements (the length of curb required for a vehicle to stop and unload passengers and baggage) will remain consistent throughout the planning period.

- Curbside dwell time policies will continue to be actively and visibly enforced.

- During busy periods, traffic enforcement staff will continue to assemble pedestrians into 'platoons' that cross the inner roadway as a group, thereby minimizing the amount of time the roadway is obstructed by pedestrians. As activity increases in the commercial vehicle area and P-1 parking garage, it was assumed that the number of pedestrians in each platoon will increase, but that the amount of time the roadway is obstructed will not.

- The curbsides will meet loading vehicle demand 95% of the time during the design hour, based on a Poisson distribution of average demand, at a V/C ratio of 1.3 or lower.

Table 4-15 presents the requirements for the deplaning level curbside loading area and Table 4-16 presents the requirements for the deplaning level curbside travel lanes. As shown, the existing area available for loading would accommodate the projected requirements until PAL 2 (2017). The roadway travel lanes would require an additional lane by PAL 3 (2022).

Table 4-15

DEPLANING LEVEL CURBSIDE LOADING AREA REQUIREMENTS

PAL (Forecast Year)	Peak Hour Volume (vph)	Curb Length (feet)		Volume/ Capacity Ratio	Level of Service	Curbside Length Required to Accommodate Demand at LOS C (feet)
		Required	Available			
2007	640	575	500	1.15	C	440
PAL 1 (2012)	650	575	500	1.15	C	440
PAL 2 (2017)	785	675	500	1.35	D	520
PAL 3 (2022)	900	775	500	1.55	D	595
PAL 4 (2027)	1,030	850	500	1.70	E	655
PAL 5 (2035)	1,165	950	500	1.90	E	730

vph = Vehicles per hour

Source: Jacobs Consultancy, September 2008.

Table 4-16

DEPLANING LEVEL CURBSIDE TRAVEL LANE REQUIREMENTS

PAL (Forecast Year)	Peak Hour Volume (vph)	Existing Number of Total Lanes	Adjusted Capacity (vph) *(a)*	Volume/ Capacity Ratio	Level of Service	Additional Lanes Required to Meet LOS C *(b)*
2007	640	4	1,715	0.37	B	0
PAL 1 (2012)	650	4	1,715	0.38	B	0
PAL 2 (2017)	785	4	1,420	0.55	C	0
PAL 3 (2022)	900	4	1,420	0.63	D	1
PAL 4 (2027)	1,030	4	1,150	0.90	E	1
PAL 5 (2035)	1,165	4	1,150	1.01	F	1

vph = Vehicles per hour

(a) Reflects the capacity of existing lanes, with reductions due to crosswalks and curbside activity in adjacent lanes.
(b) Assuming curbside loading area operates at LOS C or better.

Source: Jacobs Consultancy, September 2008.

4.5 Commercial Vehicle Facilities

Commercial vehicle facilities consist of three curbside roadways used for passenger loading on the deplaning level and the Transportation Providers Hold Lot.

4.5.1 Level-of-Service Goal

For commercial vehicle loading areas, facility requirements were developed for the length of curb needed to accommodate vehicles loading passengers. To assist patrons in locating their desired transportation mode, specific curb areas within the commercial vehicle loading area are allocated to each mode. These requirements are based on a goal to provide facilities that meet the anticipated design-hour demand for each mode without requiring vehicles to double park. Therefore, requirements for each mode equal the combined length of vehicles parked simultaneously during the design hour.

4.5.2 Passenger Loading Requirements

For some modes (e.g., courtesy vehicles, pre-arranged limousines, charter buses), the curb length required is directly related to the number of trips made by vehicles in each mode during the design hour. For on-demand modes (taxicabs and on-demand limousines), the curb length required is related to the number of trips made by mode vehicles during the design hour, and also reflects the ability of support facilities, such as the Transportation Providers Hold Lot and close-by feeder queues, to deliver on-demand vehicles to curbside so that vehicles are always available as passengers arrive at the curbside. For on-Airport public and employee parking shuttles, the required curb length is related to the number of distinct facilities being served by the shuttles. For all modes, especially those with low volumes, a minimum amount of curb length is required regardless of the level of demand.

To develop requirements, data from field observations were used to determine typical vehicle dwell times and typical vehicle mix. Using these data, requirements for the commercial vehicle area were determined based on the following assumptions and guidelines:

- Requirements were based on projected "design hour" traffic volumes, which are based on 2007 commercial vehicle area traffic volumes, as described in *Technical Memorandum No. 1 – Inventory of Existing Conditions*. It was assumed that design-hour volumes will increase in direct proportion to the forecast growth in average day peak month originating passengers.

- Dwell times and stand requirements (the length of curb required for a vehicle to stop and unload passengers and baggage) will remain consistent throughout the planning period.

- Curbsides will meet the loading vehicle demand 95% of the time during the design hour, based on a Poisson distribution of the average demand, at a V/C of 1.0 or lower.

Requirements for travel lanes were not analyzed because of the low design-hour total volume of commercial vehicles and the availability of three separate roadways to carry the traffic.

Table 4-17 presents requirements for the commercial vehicle area. As shown, the total capacity of the three roadways would be sufficient to meet requirements through PAL 5 (2035). However, areas allocated for individual modes may need to be adjusted to meet mode-specific requirements.

Table 4-17

COMMERCIAL VEHICLE AREA

	Curbside requirements (feet)												
PAL (Forecast Year)	Taxicabs	Pre-arranged limousines	On-demand executive sedans	Door-to-door vans	Long-haul vans	Courtesy vehicles *(a)*	Airport public parking shuttles *(b)*	Airport employee parking shuttles *(b)*	Charter bus/TriMet bus bridge	Other *(c)*	Total demand	Existing total capacity (feet)	Additional curb required to meet demand (feet)
2007	100	100	25	50	30	210	135	45	45	30	770	1,285	0
PAL 1 (2012)	100	100	25	50	30	210	135	45	45	30	770		0
PAL 2 (2017)	120	120	25	50	30	240	135	45	45	30	840		0
PAL 3 (2022)	120	140	25	50	30	270	135	45	45	30	890		0
PAL 4 (2027)	140	140	25	50	30	330	135	45	45	30	970		0
PAL 5 (2035)	160	160	25	75	30	360	135	45	45	30	1,065		0

(a) Includes vehicles operated by hotels, motels, off-Airport parking, and off-Airport rental car operators.
(b) Assuming one bus stop per distinct parking facility.
(c) Includes Airport vehicles and police vehicles.

Source: Jacobs Consultancy, September 2008.

4.5.3 Transportation Providers Hold Lot

Currently, commercial vehicle operators waiting for dispatch to the commercial vehicle loading area park in the Transportation Providers Hold Lot, located east of the Airport traffic control tower. This area is approximately 37,000 square feet and accommodates taxicabs, door-to-door vans, long-haul vans, other scheduled vehicles, and charter buses waiting to be dispatched to curbside. Port staff indicated that this area is adequately sized for existing demand. Assuming that the required area is directly related to the annual originating/terminating passenger activity at the Airport, requirements for the Transportation Providers Hold Lot are as shown in Table 4-18.

Table 4-18

TRANSPORTATION PROVIDERS HOLD LOT REQUIREMENTS

PAL (Forecast Year)	Required Area (square feet)	Existing Area (square feet)	Additional Area Needed to Meet Requirements (square feet)
2007	37,000	37,000	0
PAL 1 (2012)	38,000		1,000
PAL 2 (2017)	45,000		8,000
PAL 3 (2022)	52,000		15,000
PAL 4 (2027)	60,000		23,000
PAL 5 (2035)	68,000		31,000

Source: Jacobs Consultancy, September 2008.

It was assumed that the functions accommodated in the Transportation Providers Hold Lot will be provided in one consolidated location within a short drive (i.e., less than 5 minutes) of the commercial vehicle loading area. If a hold area is developed for a specific mode, or if the area is located further away, total requirements would increase.

4.6 Public Transit

Requirements for public transit facilities at the Airport are predominantly driven by (a) the number of individual services and/or routes serving the Airport and (b) the functional requirements of the service. Currently, only one service, TriMet's MAX light-rail transit system, provides service at the Airport. As demand for the service increases, it was assumed that more passengers would board each train and/or TriMet would increase the frequency of trains serving the Airport.

Future requirements for this service are predominantly functional and include the following:

- A MAX station would continue to be provided within a short walking distance of the terminal building.

- For periods when the MAX light-rail system is unable to serve the Airport because of a service disruption, a bus stop would be provided near the MAX station to accommodate buses, providing a 'bus bridge' for the MAX service.

- Changes to the existing alignment and station location should incorporate TriMet's design requirements for right-of-way width, track separation, double tracking, horizontal and vertical curve radii, grade, and vertical clearance.

Although no other systems currently serve the Airport, in the event that a new transit operator (i.e., C-Tran, based in Clark County, Washington) begins service at the Airport (C-Tran currently provides service to the Parkrose Transit Center, where passengers can transfer to MAX), the Port will attempt to accommodate the vehicle within the commercial vehicle loading area on the deplaning level.

4.7 Public Parking

Public parking is currently provided in the P-1 parking garage, the Long-Term Lot, the Economy Lots, and in privately operated off-Airport parking lots. In 2010, the P-2 parking garage will also available.

4.7.1 Level-of-Service Goal

In general, the public parking requirements presented here are based on projected peak occupancy of close-in and remote parking facilities during a design day, which is based on the 30th-highest occupancy observed during 2007. In determining the requirements for remote facilities, such as the existing Economy Lot, 10% additional spaces were assumed as a circulation allowance, recognizing a patron's inability to locate the last available spaces in a busy, large parking facility.

In determining requirements for close-in facilities, which consist of the P-1 parking garage, the Long-Term Lot, and the P-2 parking garage, a 5% circulation allowance was assumed. This reduced allowance reflects the availability of the single-space guidance system (which is currently available in P-1 and may be available in P-2), in which indicator lights at the end of each aisle and over each parking space are used to direct patrons to available spaces.

4.7.2 Assessment of Future Activity and Requirements

Future public parking requirements are presented for a design day, which is based on the 30th-highest observed peak occupancy during 2007 and was used to identify requirements for permanent parking facilities. Requirements are also presented for holiday/overflow parking, which is based on the highest observed peak occupancy in 2007 and was used to identify requirements for temporary or multi-use facilities that would only be needed during the busiest days of the year. To estimate the total demand for Airport-related public parking, future off-Airport demand is presented as well. In the event that off-Airport operators are unable to maintain their existing share of the parking market or if the Port elects to increase the share of parking accommodated on-Airport, parking requirements may increase to accommodate a share of the off-Airport demand.

Since 2003, public parking demand at the Airport has grown at a faster rate than the growth in the number of originating passengers—a consistent trend at airports nationwide. Recognizing that (a) this trend may or may not continue in the future and (b) external factors, such as use of public transit, may affect future parking requirements, parking requirements are shown for three growth rates:

- A “low” growth rate, at which parking demand increases at the same rate as originating passengers.
- A “high” growth rate, at which parking demand increases faster than originating passengers, similar to growth observed since 2004.
- A “medium” growth rate, at which parking demand increases slightly faster than originating passengers, but not as fast as the “high” growth rate.

Table 4-19 presents the public parking requirements. As shown, under all growth scenarios, additional capacity would be required by PAL 2 (2017).

4.7.3 Cell Phone Lot

Currently, the Port provides a 30-space cell phone lot at the Airport where drivers unwilling to use the public parking garage may park for a limited period of time (e.g., 30 minutes or less) while awaiting a call from the arriving passenger(s). It was assumed that demand for such a lot will continue through the planning period, but no quantitative requirement has been prepared. Rather, it is recommended that, for future years, a cell phone lot site be identified that meets the following functional requirements:

- Easily accessible from the major Airport access route.
- Sufficiently distant from the terminal so that drivers are discouraged from walking into the terminal to meet passengers.
- Easy access to the roadway leading to the terminal building.

4.8 Employee Parking

Employee parking is provided on Airport property in the Portland International Center off Alderwood Road and in the North Employee Lot located near the Transportation Providers Hold Lot.

Table 4-19

PUBLIC PARKING REQUIREMENTS

PAL (Forecast Year)	Average Annual Growth Rate	Design Day *(a)* Close-in Facilities *(b)*	Design Day *(a)* Remote Facilities *(c)*	Total	Holiday/ Overflow *(d)*	Off-Airport Demand *(e)*	Grand Total	Capacity *(f)*	Additional Spaces to Meet Requirements
Low Parking Demand Growth Rate (assuming that parking grows at same rate as the base enplaned passenger forecast)									
2007	--	4,750	7,660	12,410	610	1,300	14,320	12,964	1,356
PAL 1 (2012)	0.4%	4,860	7,830	12,690	620	1,330	14,640	16,198	0
PAL 2 (2017)	3.7%	5,830	9,400	15,230	750	1,590	17,570	16,198	1,372
PAL 3 (2022)	2.8%	6,690	10,780	17,470	860	1,830	20,160	16,198	3,962
PAL 4 (2027)	2.8%	7,670	12,360	20,030	980	2,100	23,110	16,198	6,912
PAL 5 (2035)	1.6%	8,680	14,000	22,680	1,110	2,270	26,060	16,198	9,862
Medium Parking Demand Growth Rate									
2007	--	4,750	7,660	12,410	610	1,300	14,320	12,964	1,356
PAL 1 (2012)	1.5%	5,120	8,260	13,380	650	1,400	15,430	16,198	0
PAL 2 (2017)	5.0%	6,540	10,540	17,080	840	1,790	19,710	16,198	3,512
PAL 3 (2022)	3.5%	7,760	12,510	20,270	990	2,120	23,380	16,198	7,182
PAL 4 (2027)	3.0%	9,000	14,510	23,510	1,150	2,460	27,120	16,198	10,922
PAL 5 (2035)	2.0%	10,540	17,000	27,540	1,350	2,880	31,770	16,198	15,572
High Parking Demand Growth Rate									
2007	--	4,750	7,660	12,410	610	1,300	14,320	12,964	1,356
PAL 1 (2012)	3.0%	5,510	8,880	14,390	700	1,510	16,600	16,198	402
PAL 2 (2017)	6.0%	7,370	11,890	19,260	940	2,020	22,220	16,198	6,022
PAL 3 (2022)	4.5%	9,190	14,820	24,010	1,180	2,510	27,700	16,198	11,502
PAL 4 (2027)	4.0%	11,180	18,030	29,210	1,430	3,060	33,700	16,198	17,502
PAL 5 (2035)	3.0%	14,160	22,830	36,990	1,810	3,870	42,670	16,198	26,472

(a) Based on 30th-highest occupancy observed in 2007.
(b) Includes 5% circulation allowance.
(c) Includes 10% circulation allowance.
(d) Based on highest occupancy observed in 2007. Includes no circulation allowance.
(e) Based on estimated busy-day occupancy in 2007.
(f) Assuming completion of the P-2 garage by 2012, which will add 3,000 public parking spaces and replaces the spaces lost in the P-1 garage and the Long-Term Lot during construction.

Source: Jacobs Consultancy, September 2008.

4.8.1 Level-of-Service Goal

In general, the employee parking requirements presented here are based on projected combined peak occupancy of both employee parking facilities during a "design day", which is based on the 30th-highest occupancy observed during 2007. For planning purposes, 10% additional spaces were assumed as a circulation allowance, recognizing a patron's inability to locate the last available spaces in a busy, large parking facility.

4.8.2 Assessment of Future Activity and Requirements

For future years, employee parking requirements were assumed to increase at a blended rate of the growth in annual enplaned passengers and the growth in total aircraft operations. Table 4-20 presents the employee parking requirements.

Table 4-20

EMPLOYEE PARKING REQUIREMENTS

PAL (Forecast Year)	Average Annual Growth: Enplaned Passengers	Average Annual Growth: Airport Operations	Average Annual Growth: Blended Rate	Requirements (spaces)	Existing Capacity (spaces)	Additional Spaces Needed to Meet Requirements
2007	--	--	--	1,900	2,544	0
PAL 1 (2012)	0.4%	-0.5%	0.0%	1,900		0
PAL 2 (2017)	3.7%	2.4%	3.1%	2,200		0
PAL 3 (2022)	2.8%	1.8%	2.3%	2,500		0
PAL 4 (2027)	2.8%	1.8%	2.3%	2,800		256
PAL 5 (2035)	1.6%	1.1%	1.3%	3,100		556

Source: Jacobs Consultancy, September 2008.

4.9 Rental Cars

In 2007, alternative plans and strategies for providing rental car facilities near the terminal for as long as possible were identified in the CH2M-Hill report *Assessment of Alternative Plans for Accommodation of Rental Car Operations through 23 Million Passengers*, February 23, 2007 (the 2007 Rental Car Report). Multiple operating configurations and assumptions were examined and it was concluded that:

- So long as rental cars are allowed to operate from the terminal area, the Port should maintain its current goal of accommodating 80% of the rental car market in on-Airport facilities.

- Through a series of incremental improvements (e.g., adding a car wash), rental cars could continue to operate in the terminal area until the Airport is serving approximately 21 million annual passengers (expected to occur around 2022).

The requirements presented below are based on facility needs identified in the 2007 Rental Car Report, under the following assumptions:

- Through PAL 3 (2022), 80% of the rental car market would be accommodated in on-Airport facilities.
- For PAL 4 (2027) and beyond, the facilities needed to accommodate 100% of the rental car market would be provided.
- Through PAL 3 (2022), requirements reflect an operating condition that minimizes the number of ready / return stalls (which must be within walking distance of the terminal), but increases the number of vehicle storage stalls (which do not have to be within walking distance of the terminal). This condition reflects the Port's desire to maintain ready/return facilities within the footprint of the existing P-1 parking garage for as long as possible. This configuration would increase staffing costs for the rental car companies because they would have to shuttle cars between storage and ready/return stalls during peak rental and return periods.
- For PAL 4 (2027) and beyond, requirements reflect a balanced configuration that reduces the staffing costs for rental car companies by providing sufficient ready/return stalls (and, in turn, fewer storage stalls) to meet the needs of a 2.0- to 2.5-hour rental or return peak period.

Table 4-21 presents future rental requirements for the following elements:

- **Ready/return area** where customers pick up and return their vehicles. The portion of the area used for ready vehicles versus return vehicles varies throughout the day.
- **Storage area** near the ready/return area where rental car companies can store vehicles (parked nose-to-tail) for quick transport to or from the ready/return area.
- **Customer building/office** area where customers conduct transactions with rental car company representatives. Area also includes back office and support space for the rental car companies, as well as lobby and circulation space for customers.

- **Service center** (also known as the quick turnaround area, or QTA) where rental car companies refuel and wash returned cars before moving them either to the storage area or to the ready/return area. The area typically consists of car washes, fueling islands, and nose-to-tail stacking stalls for vehicles that are about to be fueled and washed, or have just been fueled and washed.

Table 4-21

RENTAL CAR FACILITIES REQUIREMENTS

PAL (Forecast Year)	Ready/Return Area Spaces *(a)*	Ready/Return Area Acres	Storage Area (acres)	Customer Building/Office Area (acres)	Service Center (acres)	Total Area (acres)	Additional Area Required to Meet Demand (acres) *(b)*
2007	890	7.16	4.06	0.51	2.23	13.96	0
PAL 1 (2012)	910	7.30	4.16	0.52	2.23	14.20	0
PAL 2 (2017)	1,090	8.79	4.64	0.62	2.66	16.71	2.41
PAL 3 (2022)	1,250	10.01	6.75	0.71	3.07	20.54	6.24
PAL 4 (2027)	2,390	18.65	3.26	0.81	4.39	27.67	13.37
PAL 5 (2035)	2,700	21.69	3.69	0.92	4.97	31.28	16.98

Notes: For 2007 through 2022, it was assumed that 80% of the rental car market would be accommodated on-Airport. After 2022, 100% of the rental car market would be accommodated on-Airport

For 2007 through 2022, requirements reflect a goal to minimize the ready/return area. After 2022, requirements reflect a goal to provide “balanced” facilities.

(a) Equivalent public parking spaces.
(b) In addition to the existing 14.30 acres.

Source: Jacobs Consultancy, 2008, from analyses prepared by CH2MHILL and John F. Brown Company, 2006 and 2007.

In addition to the requirements presented here, rental car operators may elect to provide additional area for long-term storage, overflow, and heavy maintenance. These functions, however, are often accommodated off-airport in areas independently leased by the rental car companies and, therefore, are not included in the on-Airport facility requirements.

Data presented in Table 4-22 further reconcile the requirements shown in Tables 1-1 and 4-21 with the requirements estimated by CH2M Hill and the John F. Brown Company in 2006 and 2007.

Table 4-22

RECONCILIATION OF RENTAL CAR REQUIREMENTS WITH PREVIOUS ESTIMATES BY CH2MHILL AND THE JOHN F. BROWN COMPANY

		Requirements by CH2M Hill Assuming 80% Market Share and Inefficient Operations Due to Facilities Constraints *(a)*			Requirements Assuming 100% Market Share and Efficient Operations with No Facilities Constraints		
					By CH2M Hill *(b)*	By Jacobs Consultancy, Based on Estimate by CH2M Hill *(c)*	
Planning activity level (PAL)		PAL 1	PAL 2	PAL 3	not applicable	PAL 4	PAL 5
Forecast year		2012	2017	2022	not applicable	2027	2035
Forecast passenger activity (MAP)		15	18	20.6	23.0	23.7	26.8
Rental Car Operational Areas							
Ready stalls (i.e., parking spaces)		480	580	660	1,500	1,540	1,750
Return stalls (i.e., parking spaces)		600	720	820	1,150	1,180	1,340
Total stalls (spaces)		1,080	1,300		2,650	2,720	3,090
Equivalent ready stalls (as shown in Table 1-1)	*(d)*	910	1,090	1,250	2,300	2,400	2,700
Total operational area (SF)	*(e)*	318,000	383,000	436,000	812,500	834,000	947,500
Storage							
Nose-to-tail stalls		840	1010	1150	690	710	804
Additional stalls required due to inadequate area		52		256			
Total storage area	*(f)*	181,000	202,000	294,000	138,000	141,900	160,740
Building Space							
Customer service lobby		16,070	19290	22070	24,640	25,336	28,700
Rental car company support areas (SF)		6,430	7710	8830	9,860	10,139	11,485
Total building space (SF)		22,500	27,000	30,900	34,500	35,475	40,185
Quick Turn Around (QTA) Facilities							
Fuel positions		31	37	43	60	62	70
Car wash bays		8	9	11	15	15	17
Stacking stalls (nose-to-tail stalls)		240	290	330	460	473	536
Total QTA facilities (SF)		97,200	115,700	133,900	186,000	191,257	216,650
Total storage, building and QTA area (SF)	*(g)*	300,700	344,700	458,800	358,500	368,632	417,575
Total storage, building and QTA area (acres) (as shown in Table 1-1)	*(h)*	6.9	7.9	10.5	8.2	8.5	9.6
Total Rental Car Facility Space (SF)		618,700	727,700	894,800	1,171,000	1,202,632	1,365,075

(a) CH2MHILL and Blunk Demattei Associates, *Update to the Assessment of Alternative Plans for Accommodation of Rental Car Operations Through 23 Million Passengers*, February 23, 2007

(b) John F. Brown Company and CH2MHill, *Assessment of Alternative Plans For Accommodation of Rental Car Operations Through 23 Million Annual Passengers*, February 24, 2006

(c) Estimates are extrapolated from CH2MHill's 23 MAP estimates

(d) Equivalent ready stalls equals the number of ready stalls plus the number of return stalls multiplied by 250/350

(e) Assumes 350 square feet per ready stall and 250 square feet per return stall

(f) Assumes 200 square feet per storage stall

(g) Equals the total area required for storage stalls, building space, and QTA facilities in square feet

(h) Equals the total storage, building and QTA area in square feet divided by 43,560 square feet per acre

4.10 Pedestrian/Bicycle Facilities

Requirements for on-Airport pedestrian and bicycle facilities are predominantly qualitative because activity levels are typically sufficiently low that geometric requirements (e.g., path widths) are based on minimum design standards instead of demand. Requirements for on-Airport pedestrian and bicycle facilities include:

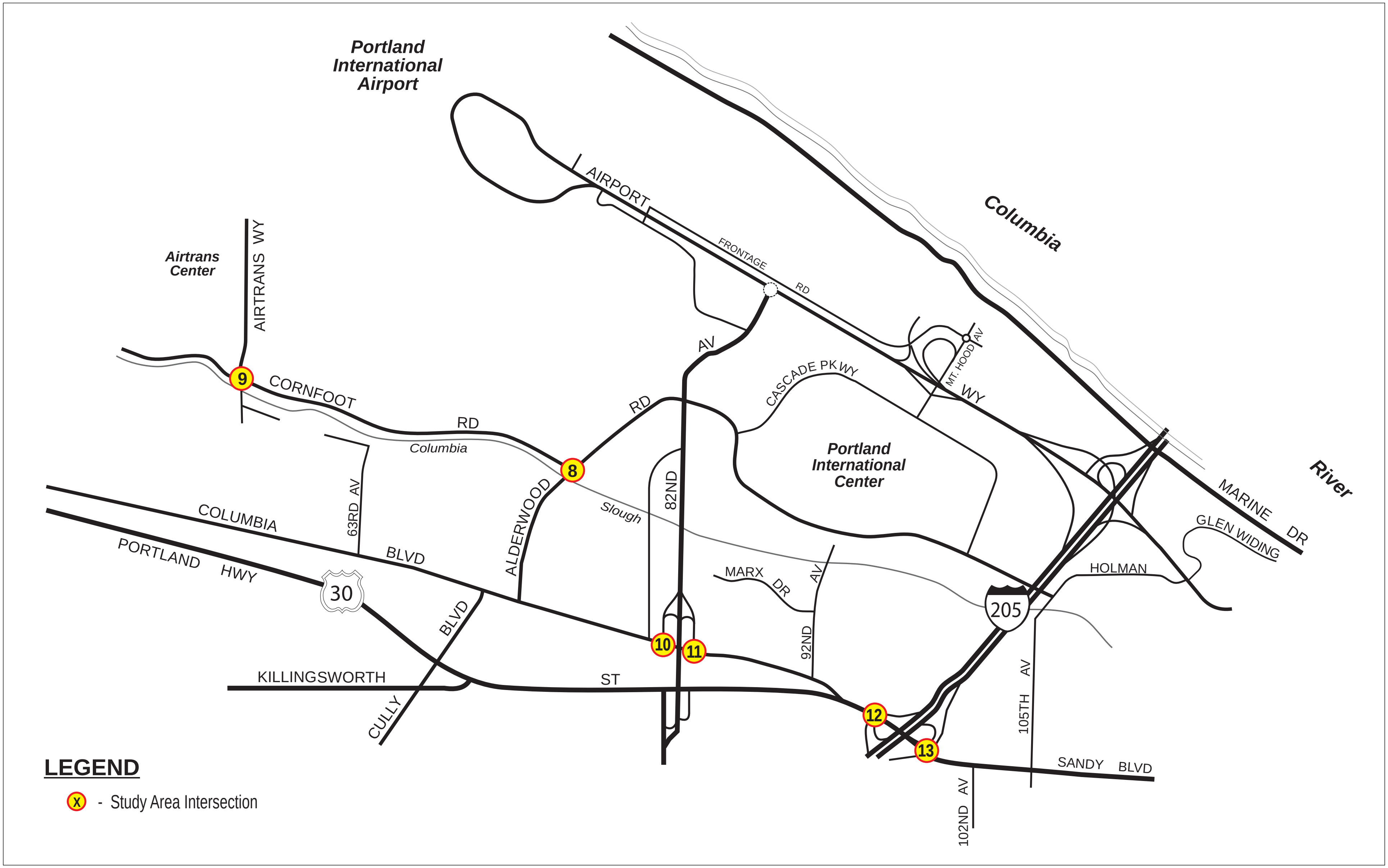
- Identified pedestrian and bicycle paths should connect the regional pedestrian/bicycle network to major on-Airport destinations, including the terminal and major employment centers.
- Nonsecure pedestrian paths should be provided to connect passenger terminal facilities to all close-in public parking facilities.

4.11 Other Key Intersections On or Near the Airport

This section focuses on key on-Airport and off-Airport intersections not on the two major terminal access routes, and their ability to accommodate motor vehicle traffic to and from the Airport in the future. These intersections and roadways provide direct (or adjacent) access to non-terminal-area facilities, such as general aviation, cargo, and military facilities. The facilities analyzed in this section (and shown on Figure 4-5) include six intersections. These intersections were evaluated to assess their ability to accommodate the demand forecast for PAL 1 through PAL 5; to determine when a facility may become deficient; and to determine the potential capacity improvements that may be required.

4.11.1 Baseline Conditions

The six intersections identified on Figure 4-5 were analyzed to identify their current performance and to compare that performance against adopted intersection operational standards based on delay and capacity. The assumed operational standards are identical to those presented in Section 4.2.1 in the discussion of the analysis of the seven intersections on the two main terminal access roadways. Table 4-23 summarizes the baseline operating conditions at these other study area intersections.



PDX610 Fig4-5.ai

AIRPORT FUTURES
CHARTING A COURSE FOR PDX

MAP NOT TO SCALE

Figure 4-5

Other Study Area Intersections

Master Plan Update
Portland International Airport

Source: Port of Portland.

December 2008

Table 4-23

SUMMARY OF EXISTING (2007) AFTERNOON PEAK HOUR OPERATING CONDITIONS AT OTHER STUDY AREA INTERSECTIONS

	Intersection	Delay (seconds)	LOS	V/C	Operational Standard
8	NE Alderwood Road/NE Cornfoot Road	> 80.0	F	1.00	E
9	NE Airtrans Way/NE Cornfoot Road	25.4	D	0.53	D
10	NE Columbia Boulevard/NE 82nd Avenue southbound	> 80.0	F	0.93	E
11	NE Columbia Boulevard/NE 82nd Avenue northbound	21.1	C	0.19	E
12	NE Killingsworth Street/I-205 southbound	42.2	D	1.00	0.99
13	NE Killingsworth Street/I-205 northbound	30.2	C	0.67	0.99

Delay = Average intersection delay in seconds (calculated using 2000 *Highway Capacity Manual* methodology)
LOS = Level of service (calculated using 2000 *Highway Capacity Manual* methodology)
V/C = Volume-to-capacity ratio (calculated using 2000 *Highway Capacity Manual* methodology)
= Does not meet jurisdiction's operational standard

Source: DKS Associates, September 2008, based on counts provided by the Port of Portland and Oregon Department of Transportation. Multiple data collection days were used throughout 2007; however, all counts were adjusted for analysis to represent the 30th busiest hour of the year.

As shown in Table 4-23, existing conditions at three of the evaluated intersections do not meet the governing jurisdiction's operational standards.

4.11.2 Methodology

For the two on-Airport intersections (NE Alderwood Road/NE Cornfoot Road and NE Airtrans Way/NE Cornfoot Road), the methodology used for projecting future year volumes was identical to that used for the analysis of intersections on the two main terminal access roadways (see Section 4.2.2). Capacity constraints were identified if (a) an intersection did not meet a jurisdictional mobility standard for either delay (LOS) or volume-to-capacity or (b) the V/C ratio for a critical movement at the intersection exceeded 1.0 during the afternoon peak hour.

Regarding the four remaining intersections listed in Table 4-23: typically, these intersections serve some users originating from, or destined to, Airport facilities, but they generally do not provide direct access to those facilities or they serve many other regional users. As a result of the limited share of Airport-related traffic at these intersections, detailed year-by-year analysis was not conducted, but the capacity constraints at the intersections were identified to indicate which movements would be expected to limit operations in the future.

4.11.3 Future Intersection Facility Requirements

The following summarizes the results of the capacity and requirements analysis for the other study area intersections.

NE Alderwood Road/NE Cornfoot Road Intersection (Figure 4-5, Intersection 8)

This intersection is used by a portion of Airport traffic traveling to and from the south side of the airfield, as well as a limited portion of traffic traveling to and from the terminal area. This traffic typically consists of air cargo and military users.

It was assumed that a number of improvements will be in place at this intersection by 2012 that will affect traffic operations. By 2012, it was assumed that this intersection will be signalized with separate eastbound left and right turn pockets, and the southbound approach will have a separate right turn pocket. Table 4-24 summarizes the results of the capacity and requirements analysis for this intersection with these improvements in place for the various planning years.

Table 4-24

SUMMARY OF CAPACITY AND REQUIREMENTS ANALYSIS
NE ALDERWOOD ROAD/NE CORNFOOT ROAD INTERSECTION

PAL (Forecast Year)	LOS	V/C	Facility Requirements
PAL 1 (2012)	B	0.78	No additional requirements
PAL 2 (2017)	B	0.85	No additional requirements
PAL 3 (2022)	E	1.11	Add northbound left turn pocket
PAL 4 (2027)*	B	0.84	No additional requirements
PAL 5 (2035)*	C	0.99	No additional requirements

LOS = Level of service
V/C = Volume-to-capacity ratio

*Assuming northbound left turn pocket.

Source: DKS Associates, September 2008.

As shown in Table 4-24, this intersection will require the addition of a separate northbound left turn pocket by PAL 3 (2022) to meet mobility standards. One consequence of widening NE Alderwood Road to accommodate a northbound left turn pocket could be a need to rebuild the existing Columbia Slough overpass located south of this intersection on NE Alderwood Road.

NE Airtrans Way/NE Cornfoot Road Intersection (Figure 4-5, Intersection 9)

This intersection is the primary access point for Airport facilities on the south side, including the AirTrans Cargo Center, Airport and airline support areas, and military facilities. Table 4-25 summarizes the results of the capacity and requirements analysis for this intersection.

Table 4-25

SUMMARY OF CAPACITY AND REQUIREMENTS ANALYSIS
NE AIRTRANS WAY/NE CORNFOOT ROAD INTERSECTION

PAL (Forecast Year)	LOS	V/C	Facility Requirements
PAL 1 (2012)	F	0.88	Signalized intersection
PAL 2 (2017)*	B	0.67	No additional requirements
PAL 3 (2022)*	B	0.76	No additional requirements
PAL 4 (2027)*	B	0.84	No additional requirements
PAL 5 (2035)*	C	0.94	No additional requirements

LOS = Level of service
V/C = Volume-to-capacity ratio

*Assuming signalization

Source: DKS Associates, September 2008.

Based on the results of the capacity and requirements analysis, future growth in the area will require signalization of this intersection by 2012. With signalization, this location will meet mobility standards through 2035.

4.11.4 Future Off-Airport Intersection Facility Requirements

The following summarizes the off-Airport intersection requirements. Typically, some users of these intersections originate from, or are destined to, Airport facilities but these intersections generally do not provide direct access from or to those Airport facilities and have many other regional users. Therefore, detailed year-by-year analysis was not conducted, but capacity constraints at the intersections were identified to indicate which movements would limit operations in the future.

NE Columbia Boulevard/NE 82nd Avenue Interchange Area (Figure 4-5, Intersections 10 and 11)

This area consists of two unsignalized intersections that provide access from NE Columbia Boulevard to NE 82nd Avenue. While not an “on-Airport” facility, this interchange area is a key entry and exit point between NE 82nd Avenue and destinations further east and west. Improvements planned within the interchange area, which will be in place by PAL 1 (2012), would affect the capacity at these intersections in future years. These improvements consist of signalizing the southbound on-/off-ramp. In addition, the southbound ramp will accommodate both left and right turn pockets, and the eastbound approach will have a separate left turn pocket and single through lane. The westbound approach at the signal will include a through lane and a shared through/right lane.

The northbound ramp intersection will have the same eastbound and westbound geometry as the signalized intersection, but will not be signalized and will have a shared southbound approach geometry.

Based on the results of the capacity analysis, the northbound intersection would have capacity constraints at the southbound approach, primarily resulting from delays caused by heavy eastbound and westbound traffic volumes.

While not the responsibility of the Port of Portland, the widening of NE Columbia Boulevard to create a five-lane cross-section would help meet the needs of regional traffic demand in the future. This widening would help to match the existing upstream and downstream five-lane cross section at NE 60th Avenue and approximately NE 87th Avenue.

NE Killingsworth Street/Interstate 205 Interchange Area (Figure 4-5, Intersections 12 and 13)

This interchange area provides secondary regional access to the Airport and surrounding land uses. Within the area, the southbound intersection currently operates near capacity and is constrained during the afternoon peak hour. Capacity is constrained by access to the southbound on-ramp, as well as by heavy volumes eastbound and westbound. The southbound intersection reaches capacity first with the eastbound right turn pocket. The heavy demand for this movement would require some form of free-flow movement to alleviate the capacity constraint. In addition, the southbound off-ramp movement would have capacity constraints later in the planning period and would need some form of capacity improvement to allow for adequate operations.

5. AIR CARGO

This section provides the projected air cargo requirements for Portland International Airport through PAL 5 (2035). Airport-wide facility requirements were determined to accommodate the growth in air cargo tonnage as presented in the forecasts contained in *Technical Memorandum No. 2 – Aviation Demand Forecasts*. Cargo facility requirements are presented for three facility components:

- **Processing and Warehouse Space** – Processing and warehouse space consists of enclosed areas used to store and sort air cargo as well as to provide office and other space to facilitate air cargo operations. Processing and warehouse facilities requirements are presented in square feet.

- **Ramp Area** – Ramp areas are the paved airside areas used for aircraft parking while air cargo is loaded and unloaded. For larger air cargo complexes, ramp area may include a maneuvering area for aircraft to access parking positions as well as storage areas for ground service equipment used to load air cargo onto aircraft, unload air cargo from aircraft, or service aircraft. Ramp area requirements are presented in square yards.

- **Landside Areas** – Air cargo landside areas include vehicle access and circulation from the Airport's primary roadway network, parking for employees and visitors, and truck parking for delivering air cargo to warehousing and sorting facilities and for taking delivery of air cargo from these facilities. An allowance is made for landscaping and other improvements in the total landside area calculation. Landside area requirements are presented in square feet.

These three components encompass the total air cargo facility requirements at the Airport. The total Airport-wide area required is presented in acres for use in developing an Airport land use plan.

Table 5-1 depicts the forecast cargo tonnage at the Airport for PAL 1 through PAL 5. The cargo forecasts are provided for passenger airlines (referred to as belly cargo, as it is transported in the belly of passenger aircraft) and all-cargo airlines. The all-cargo airlines carry approximately 91% of the total cargo volume of 732,000 annual tons forecast at the Airport in PAL 5 (2035).

Table 5-1

TOTAL AIR CARGO FORECAST
(tons, in thousands)

	2007 *(a)*	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
Belly cargo	35	36	40	46	52	62
All-cargo airlines	245	288	374	450	542	670
Total cargo	280	324	414	496	594	732

(a) According to Port records, in 2007, 35,000 tons of belly cargo and 245,000 tons of cargo on the all-cargo airlines, for a total of 280,000 tons of cargo, were processed at the Airport.

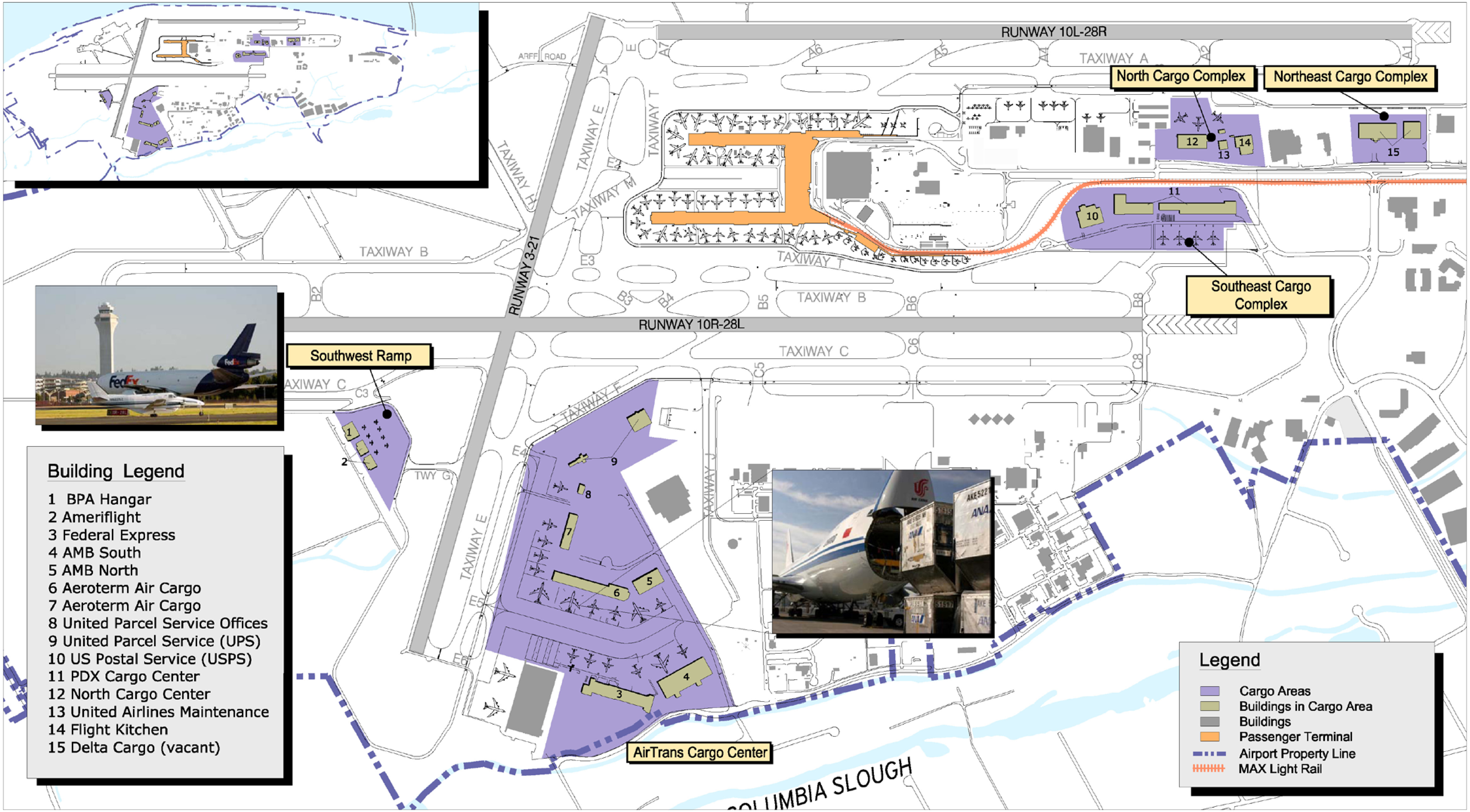
Source: Jacobs Consultancy, *Technical Memorandum No. 2 – Aviation Demand Forecasts,* Master Plan Update, Portland International Airport, September 2008, except as noted.

5.1 Processing and Warehouse Space

Cargo facilities used by the passenger airlines for belly cargo are located in the North Cargo Complex, Northeast Cargo Complex, and the Southeast Cargo Complex. Cargo facilities used by the all-cargo airlines are located in the AirTrans Center. Other cargo facilities are located at the Southwest Ramp. The locations of these facilities are shown on Figure 5-1. The Port of Portland owns all facilities in the North Cargo Complex and the Northeast Cargo Complex, except for the United States Postal Service (USPS) facilities. The USPS facility, located in the Southeast Cargo Complex, is currently used for ground sorting purposes only and, for the purposes of facility requirements, is not considered as a belly cargo or an all-cargo facility. Facilities in the AirTrans Cargo Center and Southwest Ramp are tenant owned and managed.

In 2007, 649,039 square feet of cargo building and office space were provided at the Airport, where 280,323 tons of cargo carried on passenger and all-cargo aircraft were processed. Table 5-2 provides a breakdown of the building areas of the various cargo facilities, the volume of cargo processed at each facility, and the building utilization rate (the square footage of building space per annual ton of cargo processed). All cargo operations at PDX are considered on-airport operations.

The warehouse space at the Airport has a very low utilization rate for the volume of cargo processed relative to other North American airports with similar cargo volumes. Figure 5-2 depicts the cargo warehouse area compared with total tons of cargo processed at select North American airports.



AIRPORT FUTURES
CHARTING A COURSE FOR PDX

0' 1,000'
Scale: 1" = 1,000'

Figure 5-1

Cargo Areas

Master Plan Update
Portland International Airport

Source: Port of Portland Staff

December 2008

Table 5-2

AIR CARGO BUILDING SIZES AND UTILIZATION RATES
Portland International Airport
2007

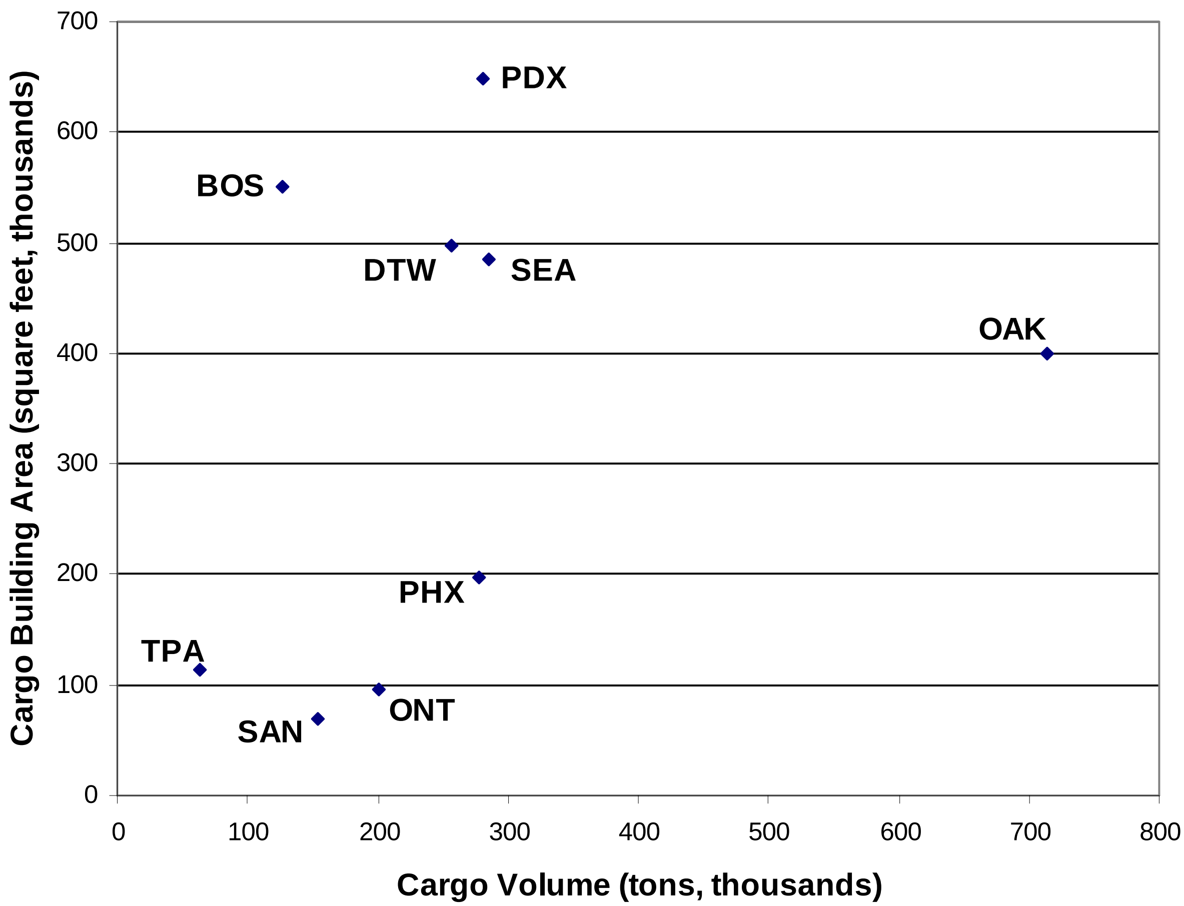
Cargo Complex	Building Area (square feet)	Cargo Processed (tons)	Building Utilization Rate (square feet/ton)
North Cargo Complex (multi-tenant building)	42,000	2,489	16.87
Northeast Cargo Complex (multi-tenant building; former Delta Cargo Complex) *(a)*	63,500	0	--
Southeast Cargo Complex			
U.S. Postal Service*(b)*	114,500	0	--
PDX Cargo Center – East Cargo Complex	77,645	20,158	3.85
PDX Cargo Center - West Cargo Complex	52,612	9,034	5.82
AirTrans Cargo Center			
AMB (2 multi-tenant buildings)	159,500	44,954	3.54
Aeroterm (2 multi-tenant buildings)	91,554	2,170	42.19
FedEx	101,500	127,546	0.80
United Parcel Service (UPS)	10,914	66,415	0.16
Southwest Ramp			
BPA Hangar	20,816	0	--
Ameriflight	28,998	7,557	3.84
TOTAL (excluding U.S. Postal Service facility)	649,039	280,323	2.32

(a) The Northeast Cargo Complex is currently vacant.
(b) The USPS facility serves as a mail sorting facility. The total area for the USPS facility was not considered a part of the total cargo area.

Source: Port of Portland.

Figure 5-2

CARGO WAREHOUSE AREA VS. CARGO VOLUME AT SELECT NORTH AMERICAN AIRPORTS



Sources: HNTB Corporation, September 2008 and *Air Cargo World,* 2007.

The building utilization rate (square feet per annual ton of cargo processed) is the measure typically used to define the capacity of cargo facilities. The average building utilization rate at U.S. airports is between 1.50 and 1.75 square feet per annual cargo ton. The range of adequacy, however, averages between 1.0 square foot and 2.5 square feet per annual cargo ton. A building utilization rate of 1.0 square foot per annual ton generally implies that facilities are well-utilized and some near-term expansion is required. A utilization rate of 2.5 square feet per annual ton implies that facilities are adequately spaced for current activities and may provide additional capacity for growth. Table 5-3 presents the cargo building utilization rates at selected North American airports. PDX has lower utilization of cargo building space than the majority of other airports listed in the table. This low utilization may partly be attributable to inefficient space allocation. For instance, some of the cargo handlers at the Airport have expressed a desire for smaller processing areas, sized less than 10,000 square feet. Other tenants may desire larger facilities. And although the Airport may have available square footage, the space cannot be subdivided to meet the needs of these potential tenants. Thus, a lack of flexibility with the existing facilities limits their usability despite space availability. It is recommended that the Port consider flexible facility designs for future air cargo processing facilities so that a wide range of space needs can be accommodated.

Table 5-3

PEER AIRPORT CARGO BUILDING UTILIZATION RATES

Airport IATA Code *(a)*	Utilization Rate (square feet/ annual ton)	Airport IATA Code *(a)*	Utilization Rate (square feet/ annual ton)
FLL	0.23	BOS	1.67
SJC	0.44	LAS	1.67
SNA	0.46	SEA	1.70
ONT	0.48	IAH	1.77
SAN	0.54	LGA	1.80
DFW	0.56	DTW	1.94
OAK	0.56	JFK	2.31
PHX	0.71	**PDX**	**2.32**
LAX	1.01	PIT	2.42
IAD	1.10	MCO	2.53
ATL	1.20	SLC	2.73
TPA	1.22	BWI	3.26
SFO	1.24	YVR	4.43
EWR	1.32	MSP	5.34
MIA	1.37	CLT	5.58
ORD	1.55	CVG	5.71
DEN	1.66		

(a) International Air Transport Association.

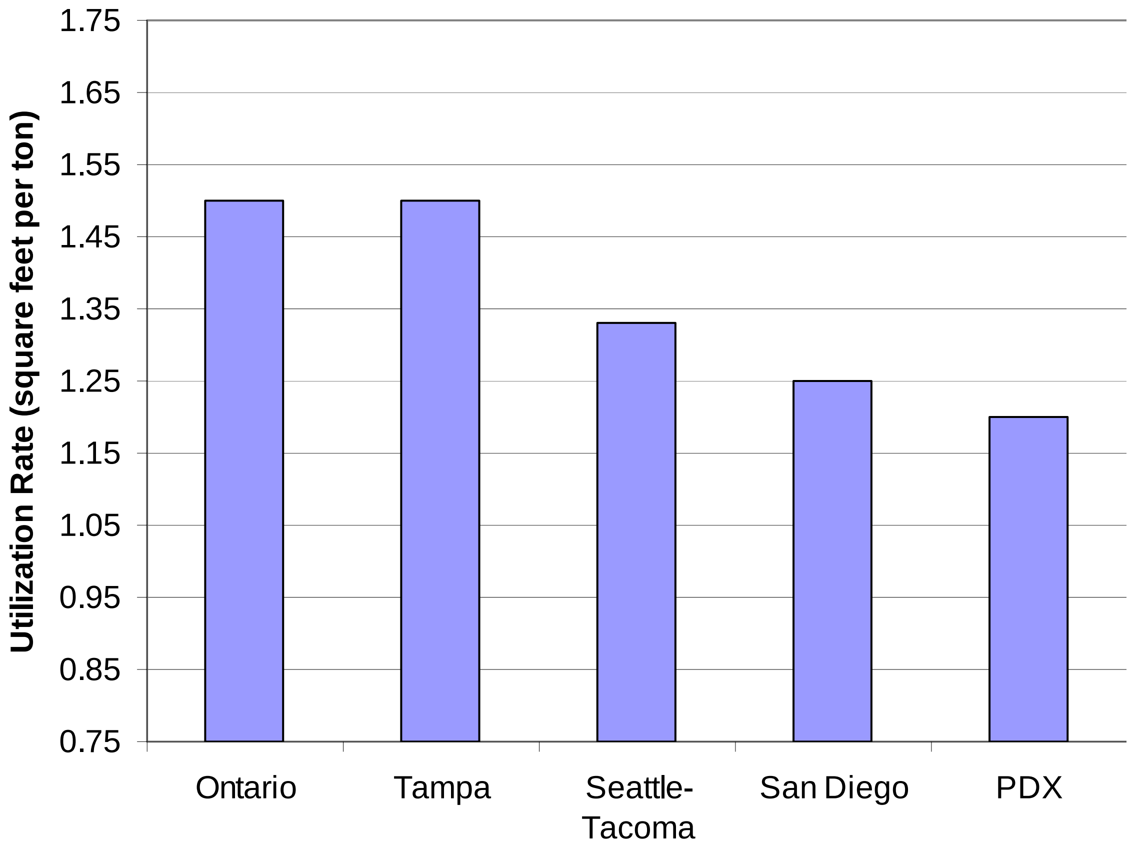
Sources: *Air Cargo World,* 2007 and Airports Council International – North America, 2007.

A range of cargo building utilization rates was assumed for the requirements developed for the 2000 Master Plan. The utilization rates assumed for the Airport in 2000, 2005, 2010, and 2020 requirements were 1.20, 1.14, 1.09, and 1.00 square feet per ton, respectively. The current Airport-wide building utilization rate, however, is approximately 2.32 square feet per annual ton. The planned cargo building utilization rates at selected peer airports (i.e., the utilization rates assumed by planners for cargo facilities at these airports) were examined to establish an appropriate utilization rate for PDX. Figure 5-3 presents these rates for Ontario International Airport (in the

Los Angeles area), Tampa International Airport, Seattle-Tacoma International Airport, San Diego International Airport, and Portland International Airport from the 2000 PDX Master Plan.

Figure 5-3

PLANNED PEER AIRPORT CARGO BUILDING UTILIZATION RATES



Sources: *2008 Ontario International Airport Master Plan,* Los Angeles World Airports, December 2008.
2000 Portland International Airport Master Plan, Port of Portland, September 2000. (A variable utilization rate was used in the 2000 Master Plan, from 1.21 square feet to 1.00 square foot of warehouse and office space per annual ton of cargo processed. An average utilization rate of 1.13 square feet per annual ton was graphed.)
2008 San Diego International Airport Master Plan, San Diego County Regional Airport Authority, May 2008.
2006 Seattle-Tacoma International Airport Regional Air Cargo Strategy, Puget Sound Regional Council, October 2006.
2005 Tampa International Airport Master Plan Update, Hillsborough County Aviation Authority, 2005.

For the purposes of this Master Plan, a 1.50 square feet per annual ton building utilization rate was applied to the cargo forecast to determine future cargo building requirements for both belly cargo and for all-cargo processing facilities. Table 5-4 presents the required total cargo processing and warehouse space at the Airport for the planning activity levels. The PAL 5 requirement for total cargo processing and warehouse space is 1,098,000 square feet. This represents a deficiency of approximately 449,000 square feet. Belly cargo facility space would be sufficient to accommodate forecast cargo activity, but the all-cargo facilities would require additional building space by PAL 3.

Table 5-4

CARGO PROCESSING AND WAREHOUSE SPACE FACILITY REQUIREMENTS
(square feet, in thousands)

	2007*(a)*	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
Belly Cargo Building Area	236	54	60	69	78	93
All-Cargo Building Area	392	432	561	675	813	1,005
Total Building Area	628	486	621	744	891	1,098
Total Building Deficiency	0	0	0	95	242	449

(a) Existing cargo processing and warehouse space.

Source: HNTB Corporation, December 2008.

The building utilization rate suggests that any new construction or renovation of existing cargo processing facilities would incorporate a more sustainable design to accommodate varying tenant requirements with increased efficiency. Although the building utilization rate provides an overview of how efficiently facilities are being used, it does not account for anomalies in the characteristics of a given market that may influence facility efficiency.

It is expected that, prior to PAL 5, the existing cargo facilities would be reconfigured to accommodate multiple tenants in appropriately sized facilities. It is recommended that the Port redevelop the North, Northeast, and Southeast Cargo Complexes into flexible cargo facilities to meet the varying needs of multiple tenants. For example, the former Delta Cargo Complex, also known as the Northeast Cargo Complex, could be redeveloped to accommodate the varying needs of multiple cargo tenants.

5.2 Ramp Area

The Airport currently provides approximately 256,000 square yards of cargo ramp area. Air cargo ramp area requirements vary based on aircraft size and tenant requirements and may be constrained due to available land or the airport layout. The Jacobs Consultancy Team's experience indicates that a planning criterion of 7.5 square feet of ramp per forecast ton of all-cargo airline freight is appropriate to determine cargo aircraft parking ramp space requirements at the Airport. This criterion takes into account aircraft parking and staging areas for freight and support vehicles. Airline belly cargo operations, however, require a minimal amount of ramp area, which is generally used for ground service vehicle loading and storage. For planning purposes, a factor of 1.0 square foot of ramp per forecast ton of belly cargo freight was applied. As shown in Table 5-5, approximately 565,000 square yards of ramp space would be required for PAL 5, resulting in a deficiency of approximately 309,000 square yards. The majority of this long-term expansion relates to all-cargo operations.

Table 5-5

CARGO RAMP REQUIREMENTS
(square yards, in thousands)

	2007 *(a)*	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
Belly Cargo Ramp Area	67	4	4	5	6	7
All-Cargo Ramp Area	189	240	312	375	452	558
Total Ramp Area	256	244	316	380	458	565
Total Ramp Deficiency	0	0	60	124	202	309

(a) Existing cargo ramp.

Source: HNTB Corporation, December 2008.

5.3 Landside Area

Cargo landside areas consist of truck circulation, parking areas for visitors and employees, loading docks, and landscaping. For planning purposes, the cargo landside area approximately equals the required cargo building area (calculated as described in Section 5.1). The required landside area is summarized in Table 5-6. Cargo tenants at the Airport have indicated their desire to have more convenient public landside access for their customers.

Table 5-6

CARGO LANDSIDE REQUIREMENTS
(square feet, in thousands)

	2007	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
Landside Area	--	486	621	744	891	1,098

Source: HNTB Corporation, December 2008.

5.4 Cargo Land Area Summary

The aggregate requirements for cargo operations at the Airport are presented in Table 5-7. In total, approximately 167 acres of land would be needed to support cargo operations at the Airport for PAL 5. Approximately 206 acres of land are currently available for cargo operations.

Table 5-7

CARGO LAND AREA REQUIREMENTS
(square feet in thousands, except as noted)

	2007 *(a)*	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
Cargo Building Area	649	486	621	744	891	1,098
Cargo Ramp Area (square yards)	256	244	316	380	457	565
Cargo Landside Area	--	486	621	744	891	1,098
Cargo Land Area Required (acres)	206	73	94	113	136	167

(a) Existing cargo areas

Source: HNTB Corporation, December 2008.

From a land use perspective, this area would be sufficient to accommodate the forecast cargo tonnage through PAL 5; however, from a facilities perspective, some degree of flexibility would be required to reconfigure and redevelop the existing cargo footprints to more efficiently use facilities and ramp areas.

6. GENERAL AVIATION

This section summarizes general aviation (GA) facility requirements at the Airport. GA activity includes all flight operations by aircraft other than scheduled or charter passenger aircraft and military aircraft. GA covers a range of activity from recreational flights on small single-engine or multi-engine propeller-driven aircraft to operations by larger corporate or business jet aircraft. GA facility requirements are expressed in terms of total land area and were developed considering existing facilities, the GA market, facilities at benchmark airports, activity forecasts, and FAA policy.

6.1 Background

As presented in *Technical Memorandum No. 2 – Aviation Demand Forecasts*, for the median scenario, the total number of GA operations is forecast to increase an average of 0.5% per year from 2007 through 2035, which includes a period of continued decline between 2007 and 2012. Approximately 27,600 GA operations were conducted at the Airport in 2007. Approximately 32,500 GA operations are forecast for 2035.

Historically, itinerant operations have accounted for the majority of GA operations at the Airport; in 2006 and 2007, itinerant operations accounted for approximately 97% and 98%, respectively, of total GA operations. Approximately 60% to 70% of itinerant GA aircraft at the Airport are jets and turboprops, which are generally associated with business aviation; these customers choose to operate at PDX because of its proximity to downtown Portland and Vancouver. Although southwest Washington has a number of GA airports, only Kelso/Longview Regional Airport has the capability to serve the business aviation market, but that airport lacks many of the facilities that make PDX more desirable. According to a recent long-range aviation study completed by the Washington State Department of Transportation (WSDOT), business aviation and turbine aircraft operations have been growing faster than other components of aviation. The FAA's latest forecasts indicate that business use of general aviation will continue to expand more rapidly than personal/sport use. This trend is true at the Airport, as an increasing percentage of total GA operations are in the business aviation segment of GA and operating jet or turboprop aircraft. This trend is reflected in the Port's philosophy toward managing its reliever airports and working with other airport operators to provide reasonable and appropriate alternatives to the Airport for smaller piston-engine aircraft.

The Port is committed to serving GA by providing facilities and services that are reasonable and appropriate to managing demand across a system of airports serving the region. Reliever airports for PDX include Hillsboro Airport, Troutdale Airport, and Mulino Airport operated by the Port, as well as Aurora State Airport, Scappoose Industrial Airpark, Pearson Field, Grove Field Airport, and Kelso/Longview Regional Airport. Each of these airports serves a unique need in a larger system, providing essential alternatives for smaller GA aircraft, thereby reducing congestion for commercial service aircraft and larger business aviation aircraft operating at PDX.

The WSDOT study also postulated that needs and expectations regarding types and quality of aviation services will increase along with increases in business jet traffic. Accordingly, airport sponsors should prepare for new or expanded fixed base operator (FBO) services with appropriate land use planning, developing up-to-date minimum standards for aeronautical service providers, and developing appropriate rates, charges, and leasing policies.

GA services offered at airports such as PDX typically include aircraft fuel and oil sales, aircraft parking, hangar storage, maintenance, aircraft charters or rentals, deicing, and ground services, such as towing and baggage handling. These services are typically provided by one or more FBOs or specialized aeronautical service operators, which provide any one or combination of commercial aeronautical services with the exception of aircraft fueling.

6.2 Current Situation

Requirements for additional GA facilities (i.e., land to accommodate an additional FBO or additional GA service providers) at PDX are driven by FAA policy and the Port's philosophy toward managing a system of airports serving the needs of a growing region. The Port's management philosophy has evolved with the growth of the region, regional economy, the development of PDX, other regional airports, and the evolution of the general aviation industry. In general, this philosophy is based on an understanding that the segment of the GA market most appropriate for PDX is the high-end cabin class business aviation aircraft. While the Port cannot prohibit smaller GA aircraft from using the Airport, its general approach is to continue to invest in more suitable reliever airports to accommodate that segment of the GA market. This approach is consistent with the Port's desire to balance the Airport's primary role as the region's primary commercial service airport with the desire to provide sufficient land for the development of additional GA facilities appropriate to PDX and continue to satisfy FAA grant assurances.

According to the FAA, when airport owners or sponsors, planning agencies, or other organizations accept funds from FAA-administered airport financial assistance programs, they must agree to certain obligations (or assurances). These assurances require the recipients to maintain and operate their airports in accordance with specified conditions.

The Port receives funding from the FAA's Airport Improvement Program (AIP). The AIP provides grants to public agencies for the planning and development of public-use airports within the National Plan of Integrated Airport Systems. Since the AIP is an FAA-administered financial assistance program, by accepting AIP funding, the Port also agrees to certain grant assurances.

As specified by the FAA in *Assurances Airport Sponsors*, Paragraph 23: "Exclusive Rights," March 2005:

> [The airport sponsor] will permit no exclusive right for the use of the airport by any person providing, or intending to provide, aeronautical services to the public. For purposes of this paragraph, the providing of the services at an airport by a single fixed-based [*sic*] operator shall not be construed as an exclusive right if both of the following apply:
>
> - It would be unreasonably costly, burdensome, or impractical for more than one fixed-based operator to provide such services, and
> - If allowing more than one fixed-based [*sic*] operator to provide such services would require the reduction of space leased pursuant to an existing agreement between such single fixed-based [*sic*] operator and such airport.

A strict interpretation of the grant assurances would imply that the Port should either (1) reserve land that could be developed by willing GA service providers should that demand materialize, or (2) make the case that it would be unreasonably costly, burdensome, or impractical for additional GA service providers to operate at the Airport.

Reserving land for the development of additional GA facilities would be consistent with the Port's policy of compliance with FAA grant assurances and a management philosophy that promotes competition and balanced use of the region's system of airports in a way that is reasonable, appropriate, and applicable to each airport's distinct role.

6.3 Approach to Determining GA Requirements

The amount of land that should be reserved for the development of additional GA facilities was determined considering the aviation demand forecasts, current business aviation activity, potential minimum commercial aeronautical activity standards, land areas occupied by FBOs and related GA facilities at other airports, and minimum standards for GA development at other airports.

6.3.1 Potential General Aviation Minimum Commercial Aeronautical Activity Standards

Airport staff is considering the development of minimum standards that would apply to all potential GA service providers at the Airport. The purpose of the minimum standards would be to encourage, promote, and ensure:

- Consistent delivery of high quality GA products, services, and facilities to Airport customers

- Development of high-quality GA improvements
- GA safety and security
- The economic health of GA businesses

These minimum standards would require FBOs and/or other GA service providers to have an adequate amount of land. For example, if the FBO owns or leases the aircraft ramp, 8 acres may be required. If the FBO does not own or lease that aircraft ramp, but manages the Port's ramp, 4 acres may be required. Additionally, minimum land requirements for other commercial GA operators may be identified. These would include aircraft maintenance, avionics, charter, sales, and storage. For planning purposes, it was assumed that minimum standards for land area would vary between 0.5 acre to 1.0 acre for specialized aeronautical service operators, depending on the type of service provided.

6.3.2 Fixed Base Operator Facilities at Other Airports

Land areas occupied by FBOs at other airports are described below. Additionally, minimum FBO commercial aeronautical activity standards at San Francisco International Airport are identified. A comparison of FBO land areas and minimum commercial aeronautical activity standards is presented in Table 6-1.

The airports included in Table 6-1 were not specifically selected for the purpose of comparing GA facilities. Rather, these airports (with the exception of Memphis International Airport) were selected as benchmark airports for this Master Plan for their similarity to PDX at current and future activity levels. The table illustrates: (1) minimum standards at San Francisco International Airport, (2) the range of area allocated to FBOs, and (3) that the number of FBOs at airports varies.

Table 6-1

FBO AREA COMPARISON (acres)

Airport	FBO 1	FBO 2	Total	Minimum Standards
Portland International Airport	30	--	30	--
Tampa International Airport	18	21	39	--
San Francisco International Airport	14	--	14	13.0
Memphis International Airport	11	19	30	--

Sources: Jacobs Consultancy, September 2008.
San Francisco International Airport staff, August 2008.
Tampa International Airport staff, August 2008.

Tampa International Airport

Tampa International Airport has two FBOs. The Tampa International Jet Center occupies a 21-acre facility located on the extreme southeast corner of the airport, adjacent to the facilities of the other FBO. Services provided include: fueling, aircraft maintenance, concierge services, automobile rental, conference facilities, pilot lounge, crew cars, and courtesy transportation.

The other FBO, Signature Flight Support, encompasses approximately 18 acres and offers its customers the following services: fueling, charter services, parts sales, avionics services, airframe maintenance, aircraft cleaning, and U.S. Customs and Border Protection services.

Memphis International Airport

The Memphis International Airport's two FBOs—Signature Flight Support and Wilson Air Center—are located in separate areas of the airport and provide a wide range of services to GA users.

Signature provides a complete range of GA services, including fueling, aircraft basing, airframe and engine repair and maintenance, flight instruction, ground handling, and aircraft charters. Signature leases 11 acres of land from the Memphis-Shelby County Airport Authority.

Wilson, either directly or through sublessees, offers a wide-range of GA services, including fueling, airframe and engine repair and maintenance, flight instruction, ground handling, and aircraft charters. Wilson leases 19 acres of land from the Authority.

San Francisco International Airport

San Francisco International Airport's sole FBO—Signature Flight Support—occupies a 14-acre site that accommodates an executive air terminal, two hangars, ground service equipment storage space, and aircraft and vehicle parking. Signature's services include aircraft fueling, maintenance, line service, minor aircraft repairs, conference rooms, and other amenities.

Minimum standards for FBO services have also been developed for San Francisco International Airport. As part of these minimum standards, each FBO operating at San Francisco International Airport must occupy not less than 13 acres of land.

6.3.3 Requirements for Future General Aviation Facilities

In keeping with the Port's management philosophy of reserving land area to accommodate additional GA service providers (if demand materializes), ensuring a competitive environment, and promoting balanced use of the region's system of airports in a way that is reasonable, appropriate, and applicable to each airport's distinct role, it is recommended that an additional 10 to 20 acres be reserved for future GA facilities. This recommendation is based on the following assumptions:

- The existing GA area may be relocated to facilitate other development essential to the Airport's primary role related to passengers and air cargo.
- Existing or future GA areas do not need to be in a contiguous parcel and do not need to be adjacent to the passenger terminal.
- Existing GA leaseholders will retain the land they currently lease or the equivalent at a future location.
- An additional FBO will require a site size consistent with site sizes at similar airports.
- Additional land will be reserved for specialized aeronautical service operators.
- An FBO or specialized aeronautical service operator may need more or less land depending on the geometry of a particular parcel.
- GA parcels must have public roadway access and access to the airfield.
- An increasing percentage of GA aircraft using the Airport are jets and turboprops; this trend is likely to continue and is consistent with the business aviation segment of GA that is most appropriate to PDX. This segment of GA elects to operate at PDX because the Airport is better suited to larger jet aircraft (e.g., multiple approaches and long runways), offers connections to commercial airline service, provides better access to commercial transportation services (e.g., taxicabs and town cars), and is more accessible to clients living or doing business in Portland and Vancouver.

7. MILITARY

Military units at the Airport include the 142nd Fighter Wing of the Oregon Air National Guard (ORANG), the 224th Combat Communications Squadron, the 272nd Combat Communications Squadron, the 366th Operating Location-Alpha Communications Squadron, and the 123rd Weather Flight unit. The units are located on 246 acres of land leased to ORANG until 2029, when the lease expires. The military has indicated that it intends to request an extension to its lease.

The scope of this Master Plan Update related to the military is limited to planning the appropriate location on the Airport for military area requirements, as determined by the military. At present, that requirement is being reviewed by the 142nd Fighter Wing of ORANG. For the purposes of this Master Plan Update, it was assumed that the current lease area, 246 acres, will satisfy the military requirement through PAL 5 (2035).

8. AIRLINE SUPPORT

This section identifies the amount of land that should be preserved for future growth of airline support facilities at PDX for inclusion in the land use plan. The requirements for each area were identified based on discussions with Port staff, observations of existing facilities, forecast growth at PDX, and comparison of similar facilities at other airports.

8.1 Airline Maintenance and Support

Approximately 28 acres of land at the Airport are currently allocated to airline maintenance and support functions. Two facilities are currently used for airline maintenance, the Horizon Air maintenance facility, located just south of the ground run-up enclosure near the intersection of the south parallel and crosswind runways, and the aircraft maintenance hangar, located in the AirTrans Cargo Center at the south end of the crosswind runway. Table 8-1 provides the building size and ramp area for these facilities. Other, limited maintenance facilities include the Ameriflight facility located on the Southwest Ramp and the SkyWest Airlines facility located north of NE Airport Way.

Table 8-1

AIRLINE MAINTENANCE AND SUPPORT FACILITY AND RAMP AREAS

PDX Maintenance Facilities	Building Size (square feet)	Ramp Area (square yards)	Total Acres
Horizon Air Maintenance Facility	150,935	47,484	13.3
Aircraft Maintenance Center	289,000	38,720	14.6
Total	439,935	86,204	27.9

Source: Port of Portland staff.

Airline maintenance hangars and facilities are typically constructed by the airlines based on corporate business decisions and are not necessarily related to the volume of airline traffic at a given airport. It is, therefore, difficult to estimate the requirement for such facilities. The factors that typically influence the construction of such facilities include the location of airline headquarters, hubbing characteristics, fleet size, maintenance scheduling, climate, and the location of terminating flights.

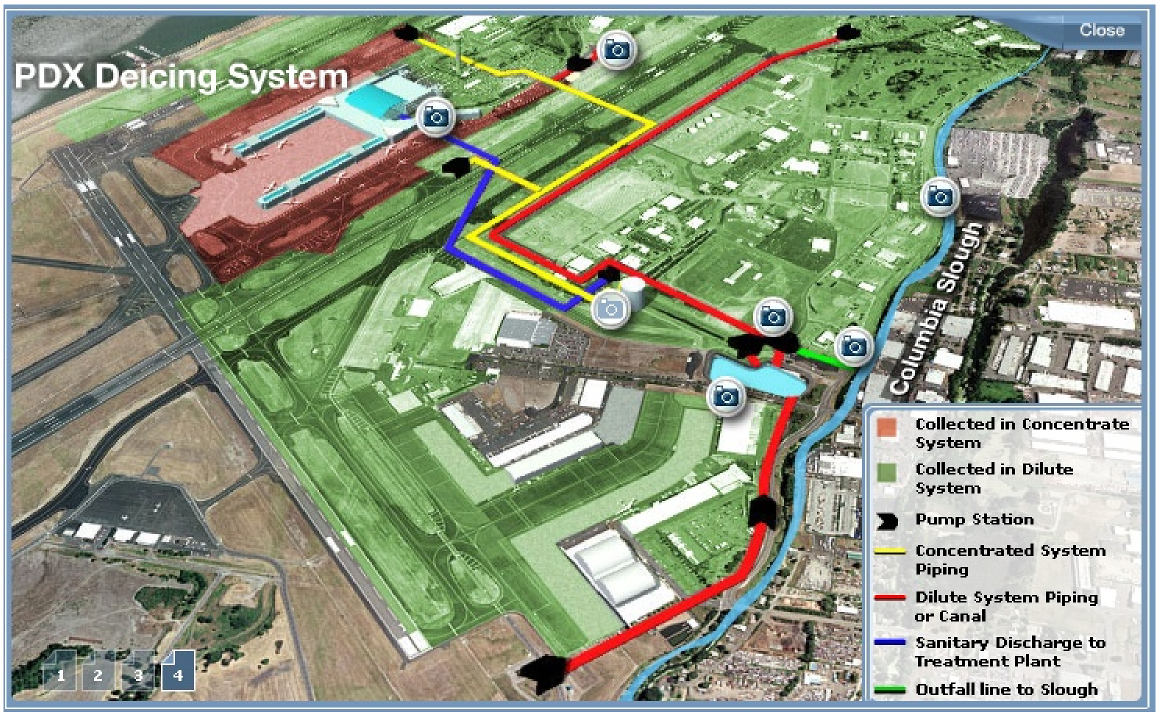
As indicated in the facility requirements Focus Group Meeting #1 held on June 10 and 11, 2008, there may be no imminent need to expand the maintenance facilities at the Airport, as no plans are yet in place to change existing airline maintenance operations. However, Port staff expressed a need, as further discussed in Section 9.3, to provide additional storage facilities for ground service equipment.

8.2 Deicing Facilities and Glycol Storage

The Port's existing deicing runoff collection system became operational in November 2003 following a 3-year construction period. The system protects the Columbia Slough by controlling the release of deicing runoff to ensure that biological organisms in the Columbia Slough will not use up oxygen at a rate deemed unhealthy for aquatic life. The Port uses a combination of glycol (a naturally biodegradable form of alcohol) and warm water to deice aircraft parking ramps and aircraft. Concentrated runoff is currently treated at the City of Portland's wastewater treatment plant. Dilute runoff is diverted to temporary storage and then discharged to the Columbia Slough. The existing deicing system is depicted on Figure 8-1 below.

Figure 8-1

PDX DEICING SYSTEM



Source: Port of Portland.

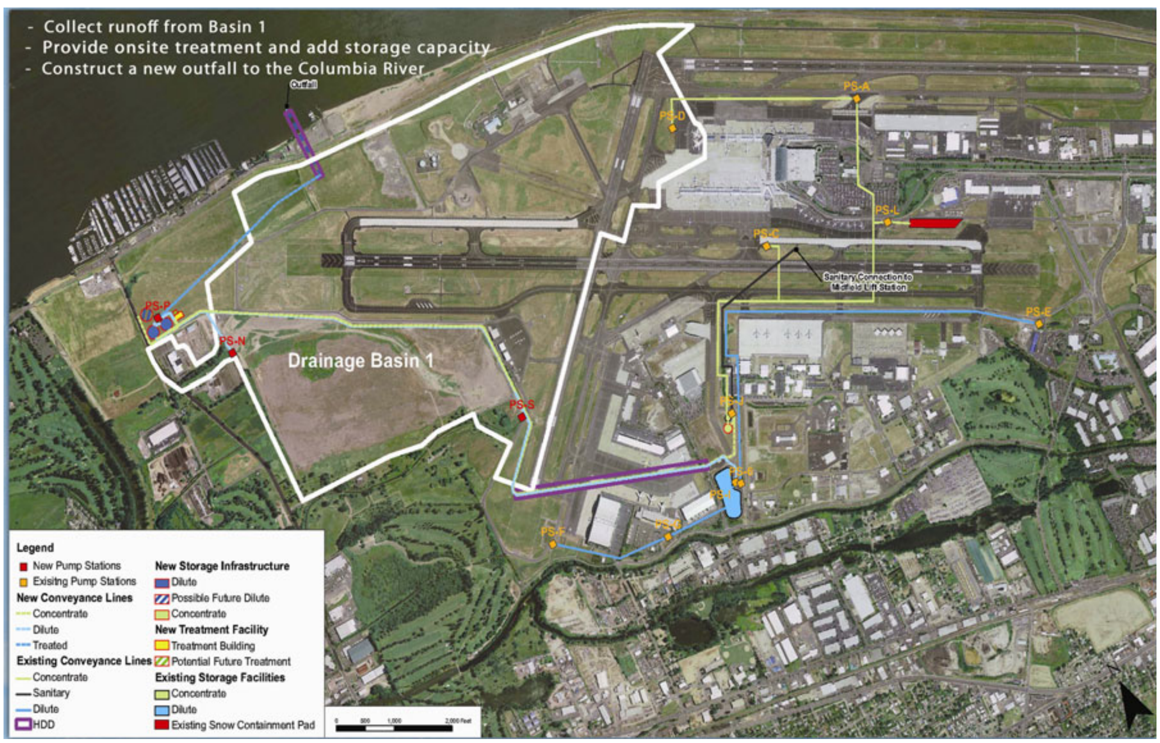
The Port has completed schematic design of deicing system enhancements and intends to complete final design by June 2009. The system improvements are scheduled to be operational by 2012. The key elements of the deicing system enhancements include:

- Onsite biological treatment
- Expansion of collection area to include the west airfield (drainage basin one, Figure 8-2)
- New permitted Columbia River outfall
- Additional storage capacity
- New pump stations and piping

The proposed deicing system enhancements are shown on Figure 8-2.

Figure 8-2

PROPOSED DEICING SYSTEM ENHANCEMENTS



Source: Port of Portland.

Future deicing system requirements will include increased deicing runoff detention basins and on-Airport treatment of dilute runoff in addition to concentrated deicing runoff.

8.3 Fuel Storage

The requirements for jet fuel storage facilities at the Airport are discussed below, focusing on the land area required for the fuel farm. Although the land for the fuel farm is owned by the Port, the Portland Fueling Facilities Corporation owns the storage tanks and distribution system.

Jet fuel used by the passenger and all-cargo airlines is stored in three above ground storage tanks with a total gross capacity of 3,360,000 gallons of jet fuel. Fuel for military units, general aviation, and other Airport users is not stored at the main fuel farm. Two of the tanks are 65 feet in diameter and 33 feet high. These tanks hold approximately 840,000 gallons each. The capacity of the third tank is 1,680,000 gallons.

Requirements were based on an analysis of historical fuel flowage and aircraft operations data for 2007, shown in Table 8-2, and the following planning guidelines and assumptions:

- As presented in *Technical Memorandum No. 2 – Aviation Demand Forecasts*, average day peak month (APDM) aircraft operations accounted for 8.9% of the annual aircraft operations in 2007 and are forecast to account for 9.1% of the annual aircraft operations at PALs 1 through 5.

- In August 2007 (the peak month for aircraft operations), approximately 17,500,000 gallons of jet fuel were dispensed from the fuel farm for approximately 10,000 aircraft departures. This equates to roughly 320 daily aircraft departures using 1,750 gallons of jet fuel per departure.

- Jet fuel reserves, in days' supply, were estimated by dividing the net usable storage capacity by the average daily fuel dispensed at the Airport in the peak month. The net usable storage capacity was assumed to be 90% of the gross storage capacity of the tanks, equaling 3,024,000 gallons. The fuel farm had 5 days of fuel reserves in August 2007.

- Future jet fuel requirements were projected by determining the product of three factors: forecast ADPM airline departures, average jet fuel dispensed per aircraft departure in the peak month, and the number of days reserves desired.

- At present, approximately 3,360,000 gallons (gross storage capacity) of jet fuel are stored on a 4-acre site that includes areas for storage tanks as well as facilities to support the fueling operation. This equates to a planning factor of 0.052 square feet of land required per gallon of storage, which was assumed to remain constant over the planning period.

Table 8-2

HISTORICAL FUEL AND AIRCRAFT OPERATIONS DATA
2007

Month	Fuel dispensed (gallons)	Average daily consumption (gallons)	Monthly aircraft operations *(a)*	Average daily aircraft operations	Jet fuel dispensed per departure (gallons)
January	13,219,051	426,421	9,034	291	1,463
February	12,367,213	441,686	8,358	299	1,480
March	14,393,060	464,292	9,402	303	1,531
April	14,581,901	486,063	9,084	303	1,605
May	15,693,864	506,254	9,526	307	1,647
June	16,039,399	534,647	9,509	317	1,687
July	17,143,864	553,028	9,774	315	1,754
August	17,423,826	562,059	9,980	322	1,746
September	15,579,357	519,312	9,044	301	1,723
October	15,277,941	492,837	9,536	308	1,602
November	14,520,575	484,019	9,198	307	1,579
December	15,021,095	484,551	9,506	307	1,580
Total/Average	181,261,146	496,606	111,951	307	1,616

(a) Includes only passenger and all-cargo airlines.

Sources: Jacobs Consultancy and the Port of Portland, October 2008.

Projected jet fuel requirements are presented in Table 8-3 and Figure 8-3.

Table 8-3

PROJECTED ADPM AIRLINE JET FUEL DEMAND AND GROSS STORAGE REQUIRED TO PROVIDE 3-, 5-, 7-, AND 10-DAY RESERVES

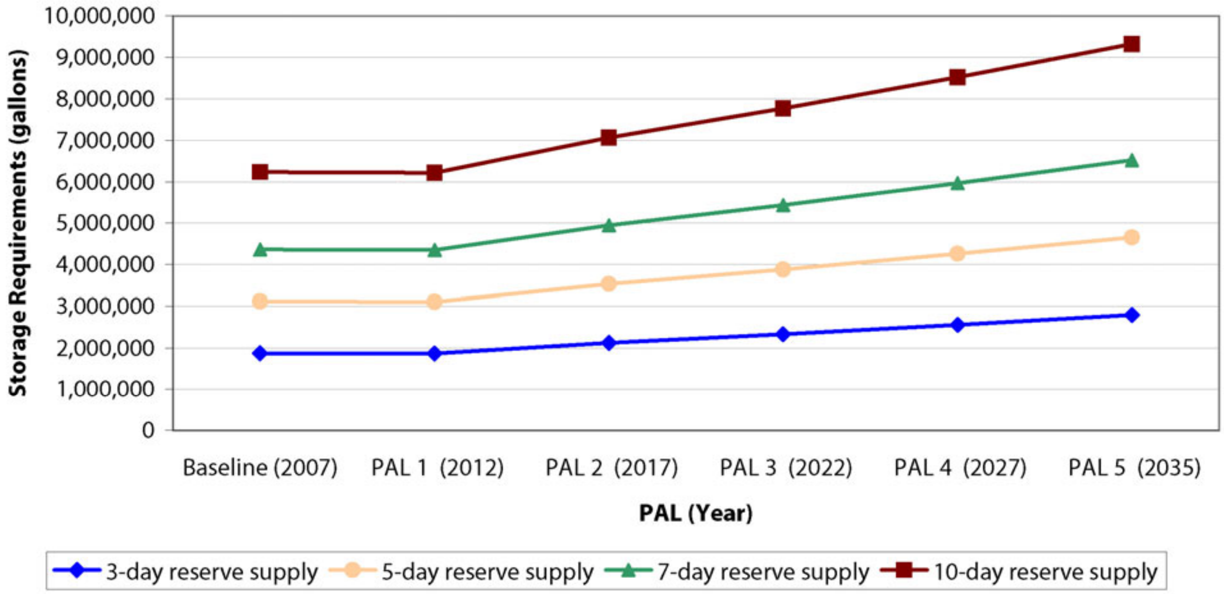
	Baseline 2007	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
Annual aircraft operations *(a)*	223,902	218,380	248,240	272,843	299,360	327,320
Peak month aircraft operations *(b)*	19,927	19,873	22,590	24,829	27,242	29,786
ADPM aircraft operations *(c)*	643	641	729	801	879	961
ADPM average jet fuel dispensed per departure (gallons) *(d)*	1,746	1,746	1,746	1,746	1,746	1,746
ADPM jet fuel demand (gallons) *(e)*	561,100	559,600	636,100	699,100	767,100	838,800
Gross jet fuel storage requirements (gallons) *(f)*						
3-day reserve supply	1,870,300	1,865,300	2,120,300	2,330,300	2,557,000	2,796,000
5-day reserve supply	3,117,200	3,108,900	3,533,900	3,883,900	4,261,700	4,660,000
7-day reserve supply	4,364,100	4,352,500	4,947,400	5,437,500	5,966,300	6,524,000
10-day reserve supply	6,234,500	6,217,800	7,067,700	7,767,800	8,523,400	9,320,000

(a) From Jacobs Consultancy, *Technical Memorandum 2 – Aviation Demand Forecasts,* September 2008.
(b) Calculated assuming that peak month operations equaled 8.9% of annual operations in activity levels in 2007 and operations are projected to equal 9.1% of annual operations in the future.
(c) Calculated by dividing peak month operations by the number of days in the peak month (31).
(d) Based on jet fuel dispensed per departure in August 2007 (refer to Table 8-2).
(e) Calculated by multiplying ADPM departures (operations divided by two) by the ADPM average jet fuel dispensed per departure.
(f) Includes adjustment factor to account for "bottoms" in the tank (90% of gross tank capacity contains usable fuel).

Fuel storage requirements are expressed in terms of gross tank storage volume as well as land area required so that the Port can (1) prepare to accommodate future demand for storage capacity without interfering with the business decisions of the passenger and all-cargo airlines; and (2) ensure that no other facilities encroach on the area required for future fuel storage development.

Figure 8-3

PROJECTED JET FUEL STORAGE REQUIREMENTS



Source: Jacobs Consultancy, October 2008.

Table 8-4 summarizes the gross storage volume and land area requirements for future fueling facilities. As shown, the 3,360,000 gallons of jet fuel storage capacity, situated on approximately four acres of land, provided a 5-day reserve supply of jet fuel in 2007. By PAL 5 (2035), storage requirements would range from approximately 2.8 million gallons for a 3-day reserve to 9.3 million gallons for a 10-day reserve, occupying land areas ranging from 3.3 acres to 11.1 acres.

The number of days' supply of fuel stored onsite in reserve is a business decision to be made by the airlines. In addition, the number and configuration of the tanks to be provided are ultimately determined by the airlines based on operating considerations, such as the tank filling and fuel settling process, as well as the reserve supply desired. Preserving land for 5 days of reserve fuel capacity (approximately 1 to 2 additional acres compared with a 3-day reserve) would ensure an adequate reserve fuel capacity throughout the planning period, and would be consistent with the historical capacity provided at the Airport.

Table 8-4

PROJECTED FUEL FARM STORAGE REQUIREMENTS

		Projected Requirements				
	2007	PAL 1 2012	PAL 2 2017	PAL 3 2022	PAL 4 2027	PAL 5 2035
3-day reserve supply						
Fuel storage (gallons)	1870300	1,865,300	2,120,300	2,330,300	2,557,000	2,796,000
Land area (acres)	2.2	2.2	2.5	2.8	3	3.3
5-day reserve supply						
Fuel storage (gallons)	3117200	3,108,900	3,533,900	3,883,900	4,261,700	4660000
Land area (acres)	3.7	3.7	4.2	4.6	5.1	5.5
7-day reserve supply						
Fuel storage (gallons)	4364100	4,352,500	4,947,400	5,437,500	5,966,300	6524000
Land area (acres)	5.2	5.2	5.9	6.5	7.1	7.8
10-day reserve supply						
Fuel storage (gallons)	6234500	6,217,800	7,067,700	7,767,800	8,523,400	9320000
Land area (acres)	7.4	7.4	8.4	9.2	10.1	11.1

Note: The number and configuration of fuel tanks are business and operations decisions, determined by the airlines.

Source: Jacobs Consultancy, October 2008.

8.4 Flight Kitchen

Flight catering facilities are operated by LSG Sky Chefs and Gate Gourmet. LSG Sky Chefs occupies approximately 39,500 square feet of building space and serves approximately 40 aircraft daily. The kitchen has a capacity of 10,000 meals per day. LSG Sky Chefs serves Alaska Airlines, US Airways, FedEx, JetBlue Airways, and Lufthansa German Airlines. The facility is located on NE Alderwood Road and is approximately a 5-minute drive from the terminal ramp. Gate Gourmet occupies 32,000 square feet of building space on the north side of NE Airport Way.

The need for flight kitchens has somewhat diminished over the past decade as a result of airline cutbacks on complementary onboard meal services. Even with the slight increase in the availability of "buy-on-board" meal services, the packaging and distribution of these on-board meal types are more efficient than the hot meals more common in the past. Although complementary hot meal service is still widely available on international flights, limited growth in international transoceanic airline service is forecast at the Airport, approximately 12 daily operations through PAL 5 (2035).

Port staff present at the Focus Group Meeting #1 held on June 10 and 11, 2008, indicated both flight kitchens are satisfied with their current facilities. The existing flight kitchens at PDX—approximately 6.5 acres—are adequately sized to serve forecast growth in this market area.

8.5 Triturator

A triturator grinds lavatory waste collected from aircraft and inserts the waste into the sewage system for processing.

Three triturators are in operation at PDX. Airport operations manage the facilities and the Airport utilities staff maintains the system. The triturator system capacity was determined to be sufficient for future operations levels.

At Focus Group Meeting #1 held on June 10, 2008, Port staff expressed concerns regarding the potential leakage of waste material into the water supply and odors from the triturator located closest to the passenger terminal building. Accordingly, Port staff may wish to determine whether the relocation of one or more of the triturators is justified as part of any future terminal project.

9. AIRPORT SUPPORT

This section identifies the amount of land that should be preserved for future growth of airport support facilities at PDX for inclusion in the land use plan. The requirements for each area were identified based on discussions with Port staff, observations of existing facilities, forecast growth at the Airport, and comparison of similar facilities at other airports.

9.1 Aircraft Rescue and Fire Fighting Facilities

Aircraft rescue and fire fighting (ARFF) facility requirements and recommendations are provided in 14 CFR Part 139 (Part 139). Airports certified under Part 139 (most recently updated as of June 9, 2004), must comply with specific ARFF requirements, including response time and extinguishing agents. Part 139 is used to determine the aircraft rescue and fire fighting index (A through E) for airports serving certificated air carriers/commercial service based on the length of the longest aircraft operated by an airline performing an average of five scheduled departures per day (computed on an annual basis). Determination of the appropriate amount of ARFF equipment for an airport is based on the airport's ARFF index. The five ARFF indexes are presented in Table 9-1, with the specific requirements for each index.

Table 9-1

ARFF INDEX CLASSIFICATIONS

Airport ARFF Index	Required Number of Vehicles	Aircraft Length (feet)	Scheduled Daily Departures	Agent plus Water for Foam
A	1	< 90 ≥ 90, < 126	> 1 < 5	500# sodium-based dry chemical or halon 1211 or clean agent; or 450# potassium-based dry chemical plus water to produce 100 gallons of aqueous film-forming foam
B	1 or 2	≥ 90, < 126 ≥ 126, <159	≥ 5 < 5	Index A plus 1,500 gallons of water
C	2 or 3	≥ 126, < 159 ≥ 159, <200	≥ 5 < 5	Index A plus 3,000 gallons of water
D	3	≥ 159, <200 ≥ 200	≥ 5 < 5	Index A plus 4,000 gallons of water
E	3	≥ 200	≥ 5	Index A plus 6,000 gallons of water

Source: 14 CFR Part 139 Certification of Airports, June 9, 2004.

PDX currently satisfies the ARFF Index E airport requirement. Index E requires an airport to have at least one lightweight, quick response vehicle carrying at least 500 pounds of sodium-based dry chemical, halon 1211, or clean agent, or 450 pounds of potassium-based dry chemical, and at least two additional fire fighting vehicles carrying an amount of water and the commensurate quantity of aqueous film-forming foam. The total quantity of water for foam production carried by all three vehicles must total at least 6,000 gallons.

The 29,200-square-foot ARFF facility at the Airport, located on approximately 5.8 acres, includes six 10-foot bays (26 feet deep), seven 16-foot bays (42 feet deep), and one 24-foot bay (42 feet deep for washing vehicles). The facility currently does not have enough capacity to store all ARFF vehicles. Additional space is currently needed for offices, sleeping areas, and fire apparatus and equipment (i.e., auxiliary fire fighting equipment, personal protective gear, uniform items, foam/agent supply, fire extinguisher maintenance, self-contained breathing apparatus, and station supplies) storage.

The former Delta Cargo building, located in the Northeast Cargo Complex, is currently being used to temporarily house two backup ARFF vehicles (a fire truck and a crash truck).

Port staff has stated that planning for a supplemental facility will begin in approximately 2010. This supplemental ARFF facility is required to provide access to the terminal ramps without crossing active runways, taxiways, or difficult terrain and to satisfy FAA response time requirements, as outlined in FAA AC 150/5210-15, *Airport Rescue and Firefighting Station Building Design*. Port staff has recommended locating the ARFF facility on the south side of the airfield and that it occupy approximately half the landside area of the existing facility, or approximately 2.9 acres. The building area would be approximately 13,000 square feet and would include additional office, sleeping, apparatus, and equipment storage space. The total land area for the ARFF facilities would increase from 5.8 acres to 9.0 acres.

9.2 FAA Facilities

FAA facilities on the Airport include the Airport traffic control tower (ATCT), located near the parking garages and the terminal curbside roadway loop, and several navigational aids. Requirements associated with navigational aids are discussed in Section 2.6.

The sizing of ATCT facilities for FAA staff is not within the scope of this Master Plan Update, which considered only the requirement to maintain, as the Airport is developed, an unobstructed line of site from the ATCT cab to all active areas of the airfield. Currently, the ATCT is adequately sited and has sufficient elevation to allow an unobstructed view from the cab of all active airfield areas with one exception. Controllers have an obstructed view of the area around Taxiway T between Taxiways M and E3. This obstructed view does not necessitate moving the ATCT and the FAA has not indicated that the ATCT is undersized or in need of expansion.

9.3 Airport Maintenance Facilities

Increasing numbers of enplaned passengers and aircraft operations at the Airport will require an increase in the number of employees in operations and Airport maintenance. Airport maintenance facilities are provided at four separate sites. Three of these sites are on Airport property and one is off Airport. On-Airport sites include the Maintenance Facility located off the southeast end of Runway 28L, the Central Utility Plant (CUP), and the passenger terminal. The off-Airport site is the Myers Drum Building, located on NE 82nd Avenue. The Maintenance Facility contains 71,820 square feet of shop and administrative space, as well as vehicle, bulk and pallet storage areas. The Myers Drum Building contains 13,440 square feet of electrical and general maintenance space in addition to bulk material, vehicle, and long-term storage space.

Because tenant space has priority at the terminal building, only a small amount of storage space for parts and tools is allotted to Airport maintenance. The CUP has adequate space for the Heating, Ventilation, and Air Conditioning (HVAC) Maintenance Group located therein.

The PDX Airport maintenance staff has expressed the need for expanded facilities to accommodate existing and forecast growth in Airport activity. At the PDX facility requirements Focus Group Meeting #1 on June 11, 2008, Port staff indicated that priorities for expanding Airport maintenance space include an increase in storage space for maintenance vehicles, workshop space, office space, and employee parking. The needs expressed at this meeting by Airport maintenance staff are aligned with the Airport maintenance facility requirements presented in the 2000 Airport Master Plan, which identified a two-stage expansion requirement for these facilities. The existing deficiency would be corrected by an initial 2.2 acre expansion, bringing the Airport Maintenance Facility site to 14.4 acres by 2010. This expansion has not yet occurred and it is recommended that this requirement be carried forward for this Master Plan Update. The 2000 Airport Master Plan also identified an additional 5.6 acre requirement by about 2020, bringing the Airport Maintenance Facility site to 20 acres. This requirement was assumed to be based on the maintenance requirements associated with the recommendation in the previous Master Plan to construct a third parallel runway. It should be noted that this 5.6 acre expansion of the Airport Maintenance Facility would only be required if an additional runway were constructed. Thus, the final recommendation in this Master Plan Update is that the existing Airport Maintenance Facility site be expanded by 2.2 acres for a total of 14.4 acres, allowing for the development of additional storage and maintenance facilities.

9.4 Airport Administration

Airport administration is currently located within the terminal building. A majority of Port staff will relocate to the Port's new headquarters in Parking Garage P2, referred to as HQP2, when it is completed. HQP2 will consolidate Airport staff with the rest of Port staff currently located in downtown Portland. The existing administration offices in the terminal building could be used for a variety of other airline or Airport support functions.

There is no requirement for additional Airport administration space throughout the planning period.

9.5 Central Utility Plant

The central utility plant (CUP) provides heated and cooled water to Concourses B, C, D, and E, totaling approximately 1.5 million square feet, and the pedestrian tunnels to Parking Garage P1. Concourse A, encompassing approximately 36,000 square feet, has a stand-alone heating and cooling system. The CUP also provides emergency power to all concourses and to the pedestrian tunnels to Parking Garage P1.

9.5.1 CUP Heating

Equipment

The CUP contains the following heating equipment:

- Three 18,000 pounds per hour water tube steam boilers
- One 10,000 pounds per hour water tube steam boiler
- Future space for an additional 18,000 pounds per hour boiler
- Support equipment, including a de-aerator tank, boiler feedwater pumps, and condensate return and chemical treatment systems

System Capacity

The capacity of the heating equipment is 64,000 pounds per hour.

Distribution

The CUP supplies 125 pounds per square inch (psi) of steam to shell and tube steam-hot water exchangers located within the passenger terminal via two 8-inch lines. The steam condenses in the heat exchangers and is pumped back to the CUP boilers. Hot water is pumped throughout the terminal buildings to air handler coils, terminal boxes, and radiant heating systems.

Peak Heating Loads

During winter (i.e., when the temperature is 17 degrees Fahrenheit or lower), the peak heating load is 43,000 pounds per hour. The minimum heating load during the summer is 5,000 pounds per hour.

Redundancy

Redundant equipment is installed to minimize risks resulting from boiler failure, pump failure, or maintenance. Currently, the CUP has 21,000 pounds per hour of excess heating capacity available in addition to the existing peak heating requirements of the plant.

Heating System Observations and Recommendations

The existing heating system, as described by Port staff, is adequate for current Airport needs.

Sufficient space is available to accommodate an 18,000 pounds per hour boiler, should additional capacity be required. Alternatively, additional heating could be provided by replacing the existing boilers with new higher capacity boilers within the same footprint. This potential will need to be validated.

If a new terminal is planned on the west side of the existing fuel farm or the south or east sides of the Airport, a second CUP should be considered depending on the distribution distance from the existing CUP.

9.5.2 CUP Cooling

Equipment

The CUP contains the following cooling equipment:

- Two 500-ton York chillers
- Three 1,000-ton chillers
- Space for one future 2,000-ton chiller
- Space for one additional cooling tower
- One BAC tower cell to match the 1,000-ton York chiller
- One EVAPCO tower cell to match 3,000-ton chillers
- Ancillary support equipment, including primary/secondary chilled water pumps, condenser water pumps, and chemical treatment systems

System Capacity

The capacity of the cooling equipment is 4,000 tons.

Distribution

Chilled water is run through each chiller by primary pumps. Secondary pumps distribute the chilled water to the passenger terminal to supply cooling to air handler coil systems. Chilled water is distributed to a north loop and a west loop by two 12-inch and two

14-inch water lines, respectively. The north and west loop piping is connected by one 6-inch chilled water line.

Peak Cooling Load

The peak summer cooling load is 3,600 tons.

Redundancy

The existing CUP has 400 tons of excess cooling capacity. The baggage system that is under constructing (please refer to section 3.6 Checked Baggage Security Screening) is programmed to use 200 tons of the available excess cooling capacity, which will reduce the CUP's available excess capacity to 200 tons available for use in either Concourse E or the Concourse A-B projects.

The Port has plans to increase the cooling capacity at the Airport by 2,000 tons by adding a new 2,000 ton chiller and 200 horsepower chilled water pump. This additional chiller would replace the abandoned cooling tower with a new cooling tower to match the 2,000 ton chiller load.

The electrical equipment needed to add a new 2,000 ton chiller and cooling tower systems should be determined. Redundant equipment carries a load of 21,000 pounds per hour.

Cooling System Observations and Recommendations

The existing cooling system, as described by Port staff, is adequate for current Airport needs. However, redundant cooling is not available. Sufficient space exists in the CUP to accommodate a future 2,000-ton cooling tower.

If a new terminal is planned on the west side of the existing fuel farm or the south or east sides of the Airport, a second CUP should be considered depending on the distribution distance from the existing CUP.

9.5.3 CUP Emergency Power

The CUP contains three 1,000-kilowatt generators, one 1,500-kilowatt generator, and sufficient space to accommodate one future 1,500-kilowatt generator. This reserved space is sufficient through PAL 5.

10. SECURITY

10.1 Background and Summary

The security assessment focused on six elements of Airport security operations and facilities:

- Passenger security screening
- Checked baggage screening
- Access control and credentials
- Air cargo
- General aviation
- Other (including ground access and vehicle parking, utilities, fuel farm, concessions delivery, and access to public facilities)

The objectives of the security assessment were to review possible changes to existing security legislation and any future legislation with the potential to significantly affect facilities or operations, and to recommend how changed or new legislation should be considered in planning Airport improvements.

The results of the security assessment for each element of Airport security operations and facilities listed above (1) were coordinated with the requirements assessments for other facilities as presented in this Technical Memorandum, and (2) are summarized in three parts below—baseline (i.e., existing facilities or procedures), major regulatory changes expected, and recommended planning.

10.2 Passenger Security Screening

10.2.1 Baseline

Passengers at the Airport undergo security screening at three locations. Two checkpoints in the main terminal (the north and south checkpoints) are used to screen all passengers originating their trips at the Airport with the following equipment:

- 14 Smiths HS 6040i x-ray machines
- 2 Rapiscan 520B x-ray machines
- 8 CEIA walk-through metal detectors

Each checkpoint is configured with eight checkpoint lanes and the equipment is divided equally between the north and south checkpoints. Two x-ray machines are assigned to each checkpoint lane and each lane is equipped with a single walk-through metal detector.

Passengers arriving at the Airport on flights originating outside the United States and continuing their journeys on domestic flights are screened after they exit the international facilities (located on level 1 of Concourse D) and before they enter level 2 of Concourse D. Four Metorex walk-through metal detectors and four Rapiscan 520B x-ray machines, with a combined screening capacity of approximately 720 passengers per hour, are used to screen these passengers.

10.2.2 Major Regulatory Changes Expected

The Transportation Security Administration (TSA) is implementing a fundamental shift in its approach to passenger security screening that encompasses the critical elements of people, processes and technology. Independently, each element is important and effective, but together they provide an integrated, layered approach to ensuring security. The new approach, referred to as Checkpoint Evolution (CPE) was launched in March 2008, and will result in the most significant changes in passenger screening since the airport security checkpoint was established in the 1970s. The first airport to implement many of the CPE elements is Baltimore/Washington International Thurgood Marshall Airport (BWI).

CPE involves helping passengers better understand and prepare for the screening process by providing timely instructions using easy to understand signage and multimedia communications. CPE also involves extensive training of Transportation Security Officers to help these officers become more engaged in providing security, as well as physical changes in the checkpoint layout (e.g., calming colors and sounds and improved passenger queuing areas) designed to create a quieter checkpoint where passengers will likely be calmer and suspicious behavior among passengers can be more easily detected. CPE is intended to reduce secondary alarms, increase overall checkpoint throughput, and improve passenger level of service.

CPE will also involve significant technological changes to enhance security and better match evolving threats. Following are the most significant technologies to be implemented through CPE:

- **Multi-view x-ray machines** will give Transportation Security Officers a better view of the contents of carry-on baggage and have the potential to speed up the process because fewer manual baggage checks will be required. These machines can be readily upgraded as new software is developed. Multi-view x-ray machines will be deployed in the immediate future.

- **Whole body imagers** will improve the detection of threat items on passengers' bodies. Whole body imagers will also be deployed in the immediate future.

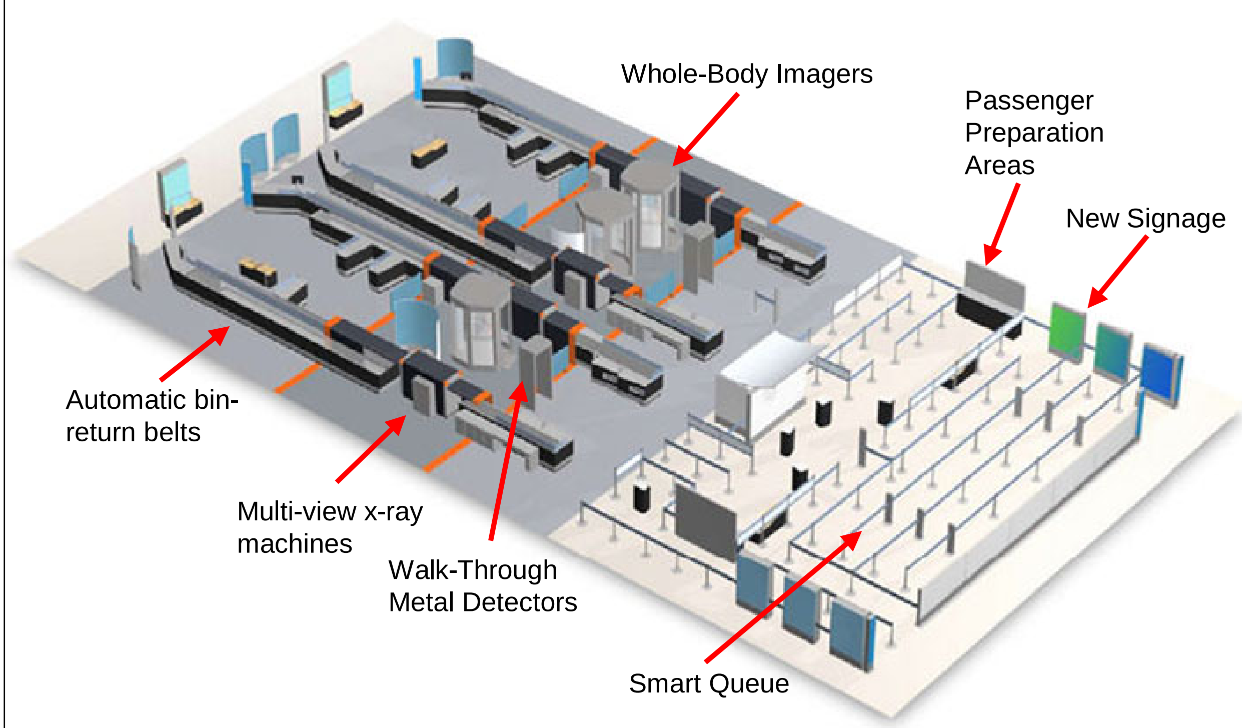
- **Bottle liquid scanners** will automatically discern liquid explosives from benign liquids. Bottle liquid scanners are likely to be deployed in the near future.

- **Shoe scanners** will automatically detect weapons and explosives without requiring passengers to remove their footwear. Shoe scanners are likely to be deployed but the timing is uncertain.

- **Cast and prosthetics scanners** are a new imaging capability to inspect passengers with limb casts or prosthetics for concealed weapons, prohibited items, and explosives. Cast and prosthetics scanners are likely to be deployed in 2009.

Figure 10-1

ILLUSTRATION OF CHECKPOINT EVOLUTION CONCEPT



It is estimated that, with CPE, each checkpoint lane be about 10% wider than they are currently to accommodate new, larger equipment and 10% longer (prior to and after the checkpoint) to account for a more labor-intensive concept of operations. The increased lane width and length are expected to be balanced by a higher throughput rate (the throughput of each lane is expected to be about 20% higher than it is now).

10.2.3 Required Planning

On a per-passenger basis, the overall space required to accommodate a future security checkpoint according to the CPE concept may not be significantly different from that required today. It is unclear when CPE would be implemented at the Airport. The TSA is preparing to conduct pilot projects at airports to test and refine the CPE concept, after which large scale deployment would begin. It is estimated that the pilot program will span at least 2 years, and it is recommended that Airport staff monitor the process and results.

10.3 Checked Baggage Screening

10.3.1 Baseline

Six areas in the passenger terminal ticket lobby, previously used for passenger circulation, currently accommodate equipment used to screen baggage checked at the Airport. These areas accommodate a total of 10 General Electric CTX-5500 explosives detection systems (EDS) and 16 explosives trace detectors (ETD). Each CTX machine is capable of processing approximately 200 bags per hour; therefore, the Airport's total baggage screening capacity is approximately 2,000 bags per hour. Some of these machines have reached the end of their useful lives and the TSA has begun replacing them before the Airport's new inline baggage screening system becomes operational.

Passengers arriving at the Airport on flights originating outside the United States and continuing their journeys on domestic flights must recheck their baggage after they clear the international facilities on the lower level of Concourse D. This rechecked baggage is then screened using one Reveal CT-80 EDS and seven Smiths Barringer ETD machines.

10.3.2 Major Regulatory Changes Expected

The primary goals of the Electronic Baggage Screening Program, as set forth in the *Baggage Screening Investment Study* (TSA, September 2006) submitted to the U.S. Congress in February 2007, are to:

- Increase security by deploying EDS equipment at as many airports as practicable and implementing more labor-intensive ETD screening protocols at those locations where ETD will continue to be used for primary screening (small airports).
- Minimize Electronic Baggage Screening Program life-cycle costs by implementing the best possible screening solutions at each airport, appropriately balancing capital investments and operating cost tradeoffs through use of next generation screening equipment.

- Minimize effects to TSA and airport/airline operations through well-designed and well-placed EDS solutions, while providing a flexible security infrastructure "platform" for accommodating growing airline traffic and other industry changes over the next 20 years and addressing potential threats.

To achieve these goals and fully implement the design philosophies embraced by the TSA, version 1.0 *Planning Guidelines and Design Standards for Checked Baggage Inspection Systems* (TSA, October 10, 2007) was published as an industry reference for airport operators, airlines, planners, and designers involved in implementing improved checked baggage inspection systems to:

- Establish common design principles and metrics that all screening system designs must meet.
- Consolidate collective industry experience and insights on the best practices for planning, designing, and implementing baggage screening systems.
- Disseminate the latest information on screening technologies, in-line screening concepts, and screening protocols.
- Standardize the methodology for planning, designing, and evaluating various system design alternatives.

The design for the Airport's new checked baggage security screening system, completed in June 2008 and approved by the FAA, is based on next generation high-volume EDS equipment (specifically the Analogic XLB 1100 machine). Construction of two checked baggage screening zones (north and south) is under way. Each zone will contain four high-volume EDS machines, which can provide a total screening capacity of approximately 2,400 to 3,300 bags per hour. As described in Section 3 of this Technical Memorandum, this capacity is adequate to accommodate the 50th percentile passenger forecast at PAL 4.

10.3.3 Required Planning

The checked baggage security screening system under construction at the Airport was designed in accordance with version 1.0 *Planning Guidelines and Design Standards*. Jacobs Consultancy is not aware of any changes to the *Planning Guidelines and Design Standards* that could affect the Airport's system. The design has been approved by the FAA, and the capacity of the system will meet forecast demand. Therefore, no further planning related to the checked baggage inspection system is expected.

The equipment used to screen rechecked baggage from arriving international flights at the Airport does not provide adequate screening capacity. When the Airport transitions from lobby screening to inline screening, it may be possible to relocate unused lobby EDS equipment to the international baggage recheck area to provide the required screening capacity.

10.4 Access Control and Credentials

10.4.1 Baseline

A Physical Access Control System (PACS) is used to control entry to the secured areas of the Airport (secured areas are those wherein passengers enplane or deplane and baggage is sorted and loaded). The PACS is a computerized system that validates magnetically stored information obtained from a security badge combined with a personal code, and uses that information to either grant or deny access to the secured areas using electronic locking mechanisms. Major PACS elements and their functions are summarized below.

- The **PACS host server** acts as a clearing house for processing requests from users and other system components. Authorizations to access the system and its data are controlled by an access control administrator through the use of individually password protected user profiles.

- **Badging workstations** are used to create and manage security badges and their supporting data.

- **Access control points** are installed at more than 350 doors, elevators, pedestrian gates, and vehicle gates that separate secured areas from public areas and the air operations area (AOA). The AOA includes aircraft movement areas, aircraft parking areas, loading ramps, and safety areas for aircraft and any adjacent areas.

- Security card readers are installed at the two **midfield secured area checkpoints** where contract security guards verify the access privileges of all individuals desiring to enter the secured areas from the airfield. Gate arms at these checkpoints are manually controlled by the contract security guards.

- The **Communications Center** is operated continuously by Port of Portland police department dispatchers and Airport operations staff. Essential functions of the Communications Center include managing emergencies; dispatching medical, fire, safety, and security personnel; communicating with first responder teams; and monitoring the PACS and CCTV systems.

- **Perimeter security** consists of a perimeter fence that is continuously patrolled by Port law enforcement officers and Airport operations staff. The perimeter fence is linked to the PACS to enable perimeter breach detection.

10.4.2 Major Regulatory Changes Expected

Numerous initiatives during the past several years have resulted in significantly enhanced access control and requirements for credentials at airports. These initiatives, some of which are expected to continue evolving, include the Transportation Worker

Identification Credential prototype, the Airport Access Control Pilot Program, biometrics for the Airport Access Control Guidance Package issued by the TSA, the Personal Identity Verification Program and its associated standards, the Aviation Credential Interoperability Solution (ACIS), and the Integrated Security System Standard for Airport Access Control.

The TSA is currently considering how and when to implement biometrics in airport security systems. It is clear that biometrics and interoperability will be required for physical access control systems and integrated security systems at some point in the future; however, the implementation timeline is uncertain.

Employee screening will likely be required in the near future. Airport staff has made adequate preparations for employee screening, including formation of the 100% Employee Physical Screening Task Force, which published its recommendations in October 2007.

10.4.3 Risk Mitigation and Required Planning

To best meet the new requirements and anticipated changes, it is recommended that Airport staff continue to develop the existing integrated security system to provide communications and services that enable decision-making regarding access issues, detection of security events, and responses to anomalies and detected security events. An integrated security system typically has two main access control components: an Identity Management and Credential System to control and manage the issuance and maintenance of access credentials to individuals and a PACS, which will provide means (such as portals, barriers, readers, field controllers, and servers) to ensure that access to secure areas is denied to unauthorized individuals and provided to authorized personnel. An Identity Management and Credential System is now seen as a critical part of an integrated security system as a result of a steady increase in security directives and the complexity of identity management and credential issuance.

It is recommended that Airport staff remain aware of evolving security initiatives, such as ACIS, and plan for their incorporation into existing and future systems. The first phase of ACIS will involve strengthened applicant identity and eligibility vetting. Later, ACIS cards will be used for identification and access control. All airport PACS should be compatible with long-term requirements, such as those resulting from ACIS.

Airport staff has developed a plan to upgrade the entire PACS in 2013 to ensure that it meets regulatory requirements. Staff should continue to review integrated security system components as they are implemented and evaluate their compatibility with future regulations, standards, and best practices. This evaluation would enable Airport staff to determine the scope and schedule for necessary technology changes. It is also recommended that biometrics and interoperable PACS be included in the Airport capital improvement program.

10.5 Air Cargo

10.5.1 Baseline

Air cargo handling, inspection, and screening are conducted by Airport tenants (airlines and freight forwarders) at their own facilities in accordance with applicable TSA regulations.

10.5.2 Major Regulatory Changes Expected

On August 3, 2007, President Bush signed into law the implementing recommendations of the 9/11 Commission Act of 2007. In accordance with this law, the TSA is required to establish a system to screen 100% of cargo transported on passenger aircraft to provide a level of security commensurate with that resulting from the screening of passenger baggage. The law requires that 50% of cargo must be screened by February 2009 and 100% of cargo must be screened by August 2010.

The effect of this legislation is that all cargo must be screened at the piece level (i.e., consolidated cargo palettes must be disassembled to individual crates and boxes) by TSA-approved methods prior to being loaded onto a passenger aircraft. However, it is likely that the screening capacity at most points in the cargo supply chain will not be sufficient to accomplish this screening requirement without resulting in significant aircraft delays, cargo backlogs, and transit time increases.

The TSA's air cargo strategic plan, which defines the agency's long-term strategy for air cargo screening in the United States, focuses on securing the air cargo supply and transportation system through implementation of a risk-based and layered security approach. This approach includes (1) reviewing specific information on all cargo shipments to determine the relative level of risk, thus ensuring that 100% of cargo identified as posing an elevated risk is physically inspected, (2) pursuing technological solutions to physically inspect air cargo, and (3) implementing regulations and programs that support enhanced security measures.

The TSA has implemented a variety of actions intended to strengthen the security of air cargo as it endeavors to fully implement its strategic plan for securing air cargo. These actions focus on four areas: (1) improving the screening and inspection of air cargo, (2) strengthening the physical security of aircraft and cargo operation areas, (3) conducting security checks on cockpit crew members, and (4) verifying and validating the identity of indirect air carriers (an indirect air carrier does not possess an FAA air carrier operating certificate but engages indirectly in the air transportation of property using the services of a passenger air carrier; an example of an indirect air carrier is a cargo consolidator).

One of the main programs being pursued by the TSA is the Certified Cargo Screening Program (CCSP), which is intended to allocate screening responsibility across the supply chain (e.g., freight forwarders, airlines, manufacturers, and shippers). This allocation will be accomplished through future rule-making, which will establish the broad regulatory framework for the CCSP and ensure TSA regulation of all Certified Cargo Screening Facilities (CCSFs). CCSFs will have to comply with TSA regulations and standards pertaining to air cargo screening.

Currently, participation in the CCSP is voluntary, but once an entity has opted in, the program requires (1) screening of cargo early in the air cargo supply chain by a trusted, vetted, and audited CCSF; (2) establishing the integrity of a shipment through enhanced physical and personnel security standards at CCSFs; and (3) maintaining the integrity of a shipment throughout the supply chain by implementing a stringent chain of custody methods.

To become a CCSF, an entity must (1) adhere to increased TSA-directed security standards, (2) share responsibility for supply chain security, (3) implement chain of custody procedures, (4) permit onsite validations, and (5) be subject to security inspection.

As part of the process of establishing this regulatory program, the TSA is testing the concept of screening earlier in the supply chain by conducting two pilot programs: The first is the CCSP (Phase One) pilot program involving shippers and other entities, such as manufacturers, distributors, and third-party logistics companies. The second is the indirect air carrier technology pilot program, which is being conducted at major gateway airports in the following cities: Atlanta, Chicago, Dallas-Fort Worth, Los Angeles, Miami, New York/Newark, Philadelphia, San Francisco, and Seattle-Tacoma. The pilot program for indirect air carriers is also being conducted at airports in the following cities: Boston, Denver, Detroit, Honolulu, Houston (Bush Intercontinental), Orlando, San Juan, and Washington, D.C. (Dulles).

10.5.3 Required Planning

It is unclear whether or not the TSA's plan to delegate responsibility for inspections across the supply chain (to private sector operators, freight forwarders, airlines, etc.) can actually be implemented. Several major airlines and freight forwarders have recommended that the TSA assume direct responsibility for inspections and more aggressively adapt the flow of air cargo at airports to fit security requirements. The airline rationale is that, by establishing government-run inspection facilities at major airports, the TSA can at least double the volume of cargo inspected within 3 years using existing inspection technologies and procedures.

We recommend that the Port continue to track cargo screening trends and monitor the TSA pilot programs. Additional TSA and tenant resources may be required to facilitate the TSA air cargo screening mandate. While it is unlikely that new or expanded facilities would be required to facilitate air cargo screening by individual airport tenants, new or expanded facilities may be required to allow for centralized screening of air cargo by the airlines or freight forwarders.

10.6 General Aviation

10.6.1 Baseline

General aviation tenants are required to comply with TSA regulations and requirements related to GA security. Airport access by GA tenants is controlled by the PACS administered by Airport staff.

10.6.2 Major Regulatory Changes Expected

In its May 2004 publication, *Security Guidelines for General Aviation Airports*, the TSA did not take the position that GA aircraft per se are a security threat. However, as vulnerabilities within other areas of aviation have been reduced, GA may be perceived as a more attractive target and, consequently, more vulnerable to terrorism. The TSA has urged airport managers and GA aircraft operators to determine which security measures they should implement to reduce vulnerabilities and has encouraged the adoption of consistent and appropriate security measures across the nation.

The TSA recommends that airport operators use the TSA-developed airport characteristics measurement tool to assess the security risk at particular GA facilities. Depending on the results of the assessment, the TSA recommends that airport operators provide enhancements related to personnel identification, aircraft security, airport facility security (e.g., perimeter security, signage and lighting, surveillance and intrusion detection systems), security procedures (e.g., reporting), communications, and specialty operations (e.g., fueling facilities).

Since publication of the security guidelines for GA airports, the TSA has been working on a significant expansion of aviation security rules for GA. This expansion of security rules is likely to require operators of aircraft with a maximum certificated takeoff weight of more than 12,500 pounds to adhere to higher security standards to address TSA concerns about terrorists transporting themselves or hazardous materials on private aircraft and/or flying them into a building. The TSA plan to enhance GA security is currently being reviewed by the Office of Management and Budget. The main elements of this plan are:

- Positive pilot identification
- Large aircraft security program
- GA security action items (voluntary and similar to actions items in the *Security Guidelines for General Aviation Airports*)
- GA airport vulnerability study (with priority on higher risk GA airports)
- Secure fixed base operator program

10.6.3 Required Planning

It is likely that the TSA initiative to expand GA security will be implemented in the near future. It is likely that the outcome of this expansion of GA security rules will be new requirements that must be satisfied by the Airport's GA tenants and audited by Airport staff. Airport staff should plan accordingly on how best to prepare for these expected changes related to procedures rather than facilities.

10.7 Other

Based on the security assessment, Jacobs Consultancy is not aware of possible changes to existing security legislation or possible new legislation that would have the potential to significantly affect the following other facilities or operations at airports:

- Ground access and vehicle parking
- Utilities
- Fuel farm
- Concession deliveries
- Access to public facilities (e.g., changes relating to hardening the passenger terminal against bomb blasts)

11. UTILITIES AND PAVEMENT

11.1 Utilities

Existing utilities and planned utilities improvements were evaluated to assess their conditions and ability to support additional development at the Airport. This section discusses the results of the evaluation.

11.1.1 Water

The Airport's existing water distribution system is in good condition. The Airport receives its water from the City of Portland's main distribution system. A 6-inch diameter water line runs northwest through the Southwest Ramp area to the north side of the terminal complex via the crossfield taxiway. There are no plans to increase the size of the water line because of the expense involved. A 24-inch water line runs along NE 82nd Avenue to serve the CUP. Nonpotable well water is used for landscaping along NE Airport Way. There are sufficient water pressure and capacity for the foreseeable future.

11.1.2 Wastewater/Sewer

The wastewater system at the Airport has additional capacity through PAL 5 (2035). The City of Portland has operated the system for the last 10 years. Prior to that, the Port was responsible for the system's management and maintenance.

The Airport's main sewer line flows east from the Airport. The system has a main lift station at the southern end of the terminal complex that delivers all sewage from the terminal and rental car facility to the wastewater system, with flows past the CUP as it approaches the wastewater line along NE Airport Way. Near-term system redundancy is required, as this sewer line is the only means of exit for sewage from the Airport. Further, the lift station capacity is inadequate to discharge water at full volume. ORANG has its own sewer line, which connects with the main Airport line at the second lift station.

11.1.3 Natural Gas System

One main natural gas pipeline runs to the CUP. The main line pressure is 45 pounds per square inch gauge (psig), which is reduced to 10 psig in the CUP header. Pressures less than 25 psig are inadequate to serve the CUP regulator and provide 10 psig to the boilers.

It was assumed that the main line gas pressure may be increased to 50 psig to 55 psig by adjusting the regulator if additional capacity is needed. This assumption needs to be validated with the gas company. If another boiler is added, the gas system will need to be evaluated.

Natural gas is used in the following Airport equipment:

- CUP boilers
- Gas infrared heaters for temporary projects
- Food concession equipment located in the passenger terminal

11.1.4 Electrical System

There are three primary electrical feeds to the Airport from different Pacific Gas and Electric Company (PG&E) substations. The Alderwood and Killingsworth substations are primary electrical feeders for the Airport, and the Cully Substation is a standby feeder in place because of problems with ice storms. The feeds terminate at the CUP and are distributed to all facilities. Near-term improvement of electrical distribution to all NE Airport Way areas is needed.

The existing peak electrical demand at the Airport is approximately 10,330 kilovolt-amperes (kVA), of which 5470 kVA is supplied by PG&E's Killingsworth Substation and 4860 kVA is supplied by PG&E's Alderwood Substation. Power is distributed at 12.47 kilovolts to various load centers at Airport facilities, at which point it is stepped down to 5 kV, 480 volts, and less. During future Airport expansion, it must be taken into consideration that, under a contingency, either substation must be able to handle the existing load plus any additional demand that results from expansion or renovation.

Special attention should be given to Concourse D Substation TDA and Concourse B Substation USM1. Existing Concourse D Substation TDA would not be able to handle full load conditions under the loss of transformer TDB contingency. Load data indicate that, while Substation TDB is on outage, Substation TDA has been loaded to 1,353 million-volt amperes with an emergency rating of only 1,288 kVA. Under these conditions, there is a strong possibility that transformer TDA would be overloaded and shut down under a transformer TDB contingency, resulting in a loss of power to all of Concourse D. At a minimum, the transformer should be upgraded from 1,000 kVA to 1,500 kVA.

Concourse B Substation USM1 needs updating. Currently, the power distribution system at Concourse B is designed for temporary use and has only one transformer. It is recommended that the single-ended substation be updated to a double-ended substation so that, during the transformer USM1 outage contingency, the concourse will not suffer a blackout.

Tables 11-1, 11-2, and 11-3 summarize allowances for electrical loads that can be used to estimate power requirements in the event facilities, aircraft gates, or the CUP, respectively, are expanded.

Table 11-1

ELECTRICAL LOAD ALLOWANCES FOR ESTIMATING POWER REQUIREMENTS ASSOCIATED WITH FACILITIES EXPANSION

Description of Services	Load (watts per square foot)
Public Space	
Ticketing Lobby	10
Main Terminal Circulation	10
Concourse Circulation	10
Airline Check-in and Ticketing	6
Security Screening	
Baggage Security Screening	6
Passenger Security Screening	6
Baggage Handling	3
Baggage Claim Facilities (main terminal)	6
Federal Inspection Services	
U.S. Immigration and Naturalization Service	6
U.S. Public Health Service	6
U.S. Customs and Border Protection	6
Animal and Plant Health Inspection Service	6
U.S. Fish and Wildlife Service	6
Baggage Claim Facilities (Concourse D)	3
Ground Transportation and Parking	
Outdoor Parking	0.05
Indoor Parking	0.50
Curbside Parking	0.05
Rental Car Parking	10
Air Cargo	
Warehouse Space	3
Aircraft Parking Ramp	0.05
General Aviation	
Terminal and Parking	0.05
Aircraft Storage	0.05
Aircraft Maintenance Hangar	3

Source: HNTB Corporation, October 2008.

Table 11-2

ELECTRICAL LOAD ALLOWANCES FOR ESTIMATING POWER REQUIREMENTS FOR ADDITIONAL AIRCRAFT GATES

	Load (kVA)
Preconditioned Air	
Narrowbody	70
Widebody	110
New Large Aircraft	220
400 Hz Power	
Narrowbody	90
Widebody	80
Jumbo	180

kVA = Kilovolt-amperes

Source: HNTB Corporation, October 2008.

Table 11-3

ELECTRICAL LOAD ALLOWANCES FOR ESTIMATING POWER REQUIREMENTS ASSOCIATED WITH CENTRAL UTILITY PLANT EXPANSION

	Load
Chilling Capacity	0.6619 kVA/ton
Cooling Tower	0.2143 kVA/ton
Boiler	0.0017 kVA/ton
Primary and Secondary Pumps	1 kVA/hp

hp = Horsepower
kVA = Kilovolt/amperes

Source: HNTB Corporation, October 2008.

11.2 Pavement

The Port of Portland operates an extensive Pavement Management Program to manage the continuous improvement and maintenance of approximately 800 acres of pavement at the Airport. This program includes the monitoring of pavement conditions, forecasting and scheduling of pavement projects to optimize life cycles, and minimizing maintenance costs. Pavement management projects may consist of reconstruction, rehabilitation, partial rehabilitation, slurry seal and fog seal applications. Other maintenance activities include vegetation control, sweeping, patching, crack sealing, and pavement marking placements. For the purposes of this Master Plan Update, there are no requirements related to pavement maintenance.