Technical Appendices

- Appendix E, Activity Levels
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- Appendix H, Noise Abatement
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E

Activity Levels

This appendix provides detailed tables in support of Chapter 2, *Activity Levels*:

- Table E-1 Logan Airport Historical Air Passenger and Operations Data
- Table E-2 Logan Airport Changes in Domestic Passenger Operations by Carrier
- Table E-3 Logan Airport Changes in International Passenger Operations by Carrier
- Table E-4 Logan Airport Scheduled Passenger Departures by Destination

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Table E-1	Logan Airport Historical Air Passenger and Operations Data				
Year	**Operations**	**Air Passengers**	**Year**	**Operations**	**Air Passengers**
1980	258,167	14,722,363	1998	507,449	26,526,708
1981	251,961	14,827,684	1999	494,816	27,052,078
1982	244,468	15,867,722	2000	487,996	27,726,833
1983	288,956	17,848,797	2001	463,125	24,474,930
1984	318,959	19,417,971	2002	392,079	22,696,141
1985	349,518	20,448,424	2003	373,304	22,791,169
1986	363,995	21,862,718	2004	405,258	26,142,516
1987	414,968	23,369,002	2005	409,066	27,087,905
1988	407,479	23,732,959	2006	406,119	27,725,443
1989	388,797	22,272,860	2007	399,537	28,102,455
1990	424,568	22,878,191	2008	371,604	26,102,651
1991	430,403	21,450,143	2009	345,306	25,512,086
1992	474,378	22,723,138	2010	352,643	27,428,962
1993	493,093	23,579,726	2011	368,987	28,909,267
1994	458,623	24,468,178	2012	354,869	29,236,087
1995	466,327	24,192,095	2013	361,339	30,218,970
1996	456,226	25,134,826	2014	363,797	31,634,445
1997	482,542	25,567,888	2015	372,930	33,449,580

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Table E-2 Logan Airport Changes in Domestic Passenger Operations by Carrier

Airline	2000	2005	2010	2011	2012	2013	2014	2015	2014-2015 Change	2014-2015 Percent Change
Scheduled Jet Carriers	**233,993**	**190,991**	**203,052**	**207,369**	**203,376**	**211,176**	**214,854**	**225,629**	**10,775**	**5.0%**
AirTran Airlines	3,090	14,580	13,672	12,869						
Alaska Airlines		1,088	1,733	1,757	1,873	2,661	3,090	3,027	-63	-2.0%
America West Airlines	5,116	4,467								
American Airlines[1]	30,821	27,712	21,313	18,943	20,962	22,535	58,222	56,623	-1,599	-2.7%
American Trans Air	1,448	2,294								
Continental Airlines	16,894	13,546	10,869							
Delta Air Lines[2]	52,954	36,388	28,980	25,429	23,270	21,139	23,614	30,705	7,091	30.0%
Frontier Airlines	1,052		1,094		275					
Independence Air		4,676								
JetBlue		15,069	49,981	58,737	63,210	73,374	76,247	79,364	3,117	4.1%
Midway Airlines	4,096									
Midwest Airlines	3,726	3,570	1,961	2,786						
Northwest Airlines	13,147	9,685								
People Express							170			
Southwest Airlines[3]			13,727	17,413	23,667	23,701	21,967	21,542	-425	-1.9%
Spirit Airlines			3,023	3,054	3,365	2,721	2,945	4,896	1,951	66.2%
Sun Country Airlines	723		313	509	596	926	1,027	1,414	387	37.7%
Trans World Airlines	6,280									
United Airlines[4]	28,092	18,304	16,314	26,425	25,636	25,214	24,374	24,632	258	1.1%
US Airways[5]	66,554	39,612	36,678	36,421	36,633	35,613				
Virgin America			3,394	3,026	3,889	3,292	3,198	3,426	228	7.1%
Regional/Commuter Carriers	**160,041**	**137,203**	**94,535**	**89,586**	**79,790**	**79,922**	**76,682**	**70,274**	**-6,408**	**-8.4%**
America West Express	1,267									
American Eagle	62,140	37,394	15,291	6,669	4	4	5	52		
Cape Air	31,026	25,018	35,899	35,940	37,184	37,194	35,080	35,994	914	2.6%
Continental Connection			1,809	1,199	131					
Continental Express		12,544	529	902	385					
Delta Connection	15,438	26,557	18,445	23,243	20,925	20,848	20,265	15,466	-4,799	-23.7%
MidAtlantic Express										
Midwest/Republic			258							
Northwest Airlink		5,034								
PenAir					2,268	4,384	4,382	3,747	-635	-14.5%
Republic Airlines						58	53	34	-19	-35.8%
United Express		3,178	2,802	2,763	4,342	5,829	5,628	4,699	-929	-16.5%
US Airways Express	50,170	27,478	19,502	18,870	14,551	11,605	11,269	10,282	-987	-8.8%
Non-Scheduled Operations (Incl. Charter)	**1,008**	**325**	**501**	**106**	**181**	**200**	**164**	**176**	**12**	**7.3%**
Total Domestic Operations	**395,042**	**328,519**	**298,117**	**297,061**	**283,347**	**291,298**	**291,700**	**296,079**	**4,379**	**1.5%**

Source: Massport

Notes: Excludes general aviation and all-cargo operations.

Table E-3 Logan Airport Changes in International Passenger Operations by Carrier

Airline	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2014-2015 Change	2014-2015 Percent Change
Scheduled Jet Carriers	**27,427**	**29,284**	**26,457**	**26,079**	**26,804**	**24,550**	**22,081**	**22,834**	**22,768**	**22,065**	**20,771**	**24,973**	**25,633**	**23,301**	**25,065**	**28,225**	**3,160**	**12.6%**
Aer Lingus	1,160	1,247	1,120	1,173	1,096	1,016	1,020	1,221	1,347	1,268	1,097	1,130	1,273	1,513	1,933	1,973	40	2.1%
Aeromexico					649	534	210	131								345	345	n/a
Air Canada	10,047	10,109	8,982	8,526	6,846	5,782	3,950	3,377	3,215	2,988	3,895	4,125	4,517	1,747	1,084	1,686	602	55.5%
Air France	1,046	1,118	1,250	1,306	1,362	1,334	1,207	957	902	911	995	1,013	974	955	899	910	11	1.2%
Air Jamaica		443	617	610	662	349												
Air One									140									
Alitalia	729	707	724	690	894	986	810	886	667	638	624	604	530	542	550	562	12	2.2%
American Airlines[1]	4,657	5,097	5,237	5,415	5,175	4,672	4,824	4,700	4,115	3,167	2,422	2,149	1,901	447	344	571	227	66.0%
Astraeus												100						
British Airways	2,159	1,944	1,986	2,103	2,080	2,151	2,190	2,160	2,134	2,116	2,082	2,161	2,149	2,573	2,678	2,575	-103	-3.8%
Canadian Airlines	417																	
Cathay Pacific																279	279	n/a
Copa Airlines														347	730	646	-84	-11.5%
Delta Air Lines[2]	733	1,345	1,022	724	736	749	851	829	848	1,935	1,675	3,280	2,531	2,851	3,008	3,122	114	3.8%
El Al																152	152	n/a
Emirates															600	914	314	52.3%
Finnair						44	49	66	48	47								
FlyGlobespan								225										
Hainan Airlines															280	744	464	165.7%
Iberia Airlines								304	466	500	435	445	441	404	332	336	4	1.2%
Icelandair	726	696	834	882	892	811	807	869	821	777	816	928	938	1,120	1,227	1,287	60	4.9%
Japan Airlines													474	646	731	728	-3	-0.4%
JetBlue							555	1,363	1,839	2,293	2,262	5,173	5,902	6,138	6,348	6,488	140	2.2%
Korean Air Lines	314																	
LACSA Airlines			154	114	14													
Lufthansa	1,140	1,090	1,452	1,357	1,526	1,564	1,522	1,515	1,667	1,722	1,657	1,734	1,784	1,723	1,712	1,687	-25	-1.5%
Northwest Airlines	744	729	738	732	730	727	734	1,081	1,438									
Norwegian Air Shuttle																34	34	n/a
Olympic Airways	256	166																
Sabena	724	596																
SATA International Airlines						315	334	393	360	372	403	400	412	466	533	542	9	1.7%
SWISS International	926	1,152	728	718	714	704	708	727	722	664	720	725	716	720	722	711	-11	-1.5%
TACA				220	363	327	236											
TACV - Cabo Verde				53	157	154	139	165	154	210	240	236	234	214	186	60	-126	-67.7%
TAP - Air Portugal	200																	
Trans World Airlines		1,283																
Turkish Airlines															452	726	274	60.6%
United Airlines	728	840	722															
US Airways				732	2,048	1,607	1,208	1,133	1,155	1,722	667	49	146	186				
VG Airlines			164															
Virgin Atlantic Airways	721	722	727	724	860	724	727	732	730	735	707	721	711	709	716	702	-14	-2.0%
Wow Air																445	445	n/a
Regional/Commuter Carriers	**15,594**	**14,776**	**11,760**	**10,803**	**11,784**	**13,112**	**12,922**	**15,474**	**12,770**	**11,805**	**12,494**	**12,153**	**12,270**	**14,378**	**14,720**	**14,153**	**-567**	**-3.9%**
Air Canada Regional	4,088	2,912	2,850	2,747	5,060	5,120	7,676	8,499	8,478	7,542	7,065	6,803	7,058	9,563	10,364	10,024	-340	-3.3%
American Eagle Airlines	8,975	8,919	4,545	3,598	3,306	4,637	2,712	3,312	3,311	2,783	2,480	2,206						
Delta Connection	2,531	2,945	4,365	4,458	3,418	3,355	2,534	3,663	981	865	81	1	1,489	1,082	56	38	-18	-32.1%
Porter Airlines										615	2,868	3,143	3,723	3,733	4,300	4,091	567	15.2%
Non-Scheduled Operations	**2,141**	**1,892**	**1,184**	**1,313**	**1,467**	**1,068**	**727**	**527**	**375**	**320**	**305**	**300**	**268**	**277**	**185**	**248**	**63**	**34.1%**
Total International Operations	**45,162**	**45,952**	**39,401**	**38,195**	**40,055**	**38,643**	**35,730**	**38,835**	**35,913**	**34,198**	**33,570**	**37,426**	**38,171**	**37,956**	**39,970**	**42,626**	**2,656**	**6.6%**

Note: Excludes general aviation and all-cargo operations.
Source: Massport

Table E-4 Logan Airport Scheduled Passenger Departures by Destination

Destination Airport	Code	2000	2005	2010	2011	2012	2013	2014	2015	2014-2015 Change	2014-2015 Percent Change
Domestic		**210,068**	**163,684**	**149,962**	**152,303**	**143,871**	**147,078**	**149,208**	**152,210**	**3,002**	**2.0%**
New York La Guardia	LGA	11,872	13,350	11,705	11,489	9,564	9,255	9,056	9,352	296	3.3%
Washington National	DCA	8,474	10,680	9,419	9,793	8,543	8,360	8,645	8,678	33	0.4%
Philadelphia	PHL	11,785	7,014	6,548	7,985	6,301	7,305	8,092	7,971	-121	-1.5%
Chicago O'Hare	ORD	10,063	7,412	7,403	7,635	7,461	7,733	7,822	7,401	-421	-5.4%
New York J F Kennedy	JFK	9,899	4,985	7,054	5,969	5,428	5,919	6,139	6,745	606	9.9%
New York Newark	EWR	5,206	5,626	3,666	4,608	5,228	5,702	5,532	5,366	-165	-3.0%
Atlanta	ATL	7,110	6,003	5,548	5,569	5,574	5,501	5,454	5,192	-261	-4.8%
Baltimore	BWI	1,773	5,029	7,053	6,755	5,910	5,737	5,060	4,897	-163	-3.2%
Los Angeles	LAX	3,647	2,655	3,382	3,164	3,544	3,603	4,080	4,456	376	9.2%
Nantucket	ACK	5,022	3,452	3,884	3,382	3,469	3,601	3,567	4,311	744	20.9%
San Francisco	SFO	3,526	2,591	3,711	3,884	4,198	4,038	4,305	4,272	-33	-0.8%
Charlotte	CLT	2,758	3,288	4,180	3,976	3,991	3,911	3,916	3,920	4	0.1%
Detroit	DTW	2,937	2,827	2,353	2,437	2,314	2,340	3,354	3,875	521	15.5%
Raleigh/Durham	RDU	3,775	4,110	3,259	2,867	3,059	3,313	3,634	3,598	-37	-1.0%
Dallas/Fort Worth	DFW	5,002	3,544	2,938	2,781	3,790	4,147	3,705	3,406	-300	-8.1%
Orlando	MCO	4,914	3,517	3,179	3,580	3,496	3,399	2,883	3,057	173	6.0%
Minneapolis	MSP	3,078	1,791	1,927	2,031	2,062	2,200	2,322	2,737	415	17.9%
Martha's Vineyard	MVY	3,863	2,231	3,218	2,829	2,774	2,740	2,793	2,731	-62	-2.2%
Denver	DEN	2,628	1,990	2,812	2,640	2,518	2,433	2,446	2,611	165	6.7%
Richmond	RIC	1,537	1,404	1,431	1,525	1,481	1,723	2,450	2,603	153	6.2%
Miami	MIA	2,068	2,072	2,238	2,555	2,610	2,555	2,551	2,520	-30	-1.2%
Washington Dulles	IAD	8,625	6,139	4,625	3,910	3,014	2,974	2,714	2,505	-209	-7.7%
Pittsburgh	PIT	3,086	2,021	2,312	3,179	2,498	2,641	2,678	2,457	-221	-8.3%
Fort Lauderdale/Hollywood	FLL	3,327	3,065	2,370	2,517	2,371	2,379	2,173	2,258	85	3.9%
Buffalo	BUF	950	1,226	2,181	2,183	2,264	2,468	2,433	2,203	-231	-9.5%
Cleveland	CLE	2,797	1,260	1,369	1,326	1,455	1,501	1,260	2,070	810	64.3%
Provincetown	PVC	2,023	1,659	2,410	2,086	2,054	1,982	1,929	1,957	28	1.4%
Houston Intercontinental	IAH	1,995	1,752	1,717	1,697	1,704	1,789	1,822	1,831	9	0.5%
Fort Myers	RSW	949	1,525	1,587	1,620	1,738	1,806	1,734	1,742	8	0.5%
West Palm Beach	PBI	1,674	1,126	1,450	1,380	1,161	1,235	1,389	1,650	261	18.8%
Seattle/Tacoma	SEA	458	610	1,001	993	1,051	1,378	1,607	1,625	19	1.2%
Phoenix	PHX	1,386	944	1,348	1,895	1,773	1,413	1,557	1,569	12	0.8%
Chicago Midway	MDW	868	1,339	1,756	1,751	1,690	1,617	1,542	1,531	-10	-0.7%
Lebanon	LEB			1,734	1,460	1,464	1,460	1,460	1,460	0	0.0%
Rockland	RKD	1,152	1,374	1,301	1,279	1,282	1,279	1,279	1,372	93	7.3%
Augusta	AUG	584	621	1,000	1,187	1,091	1,248	1,248	1,248	0	0.0%
Cincinnati	CVG	2,235	2,637	1,364	1,308	1,272	1,269	1,239	1,218	-21	-1.7%
Indianapolis	IND	765	2,076	1,121	977	936	895	844	1,181	337	39.9%
Tampa	TPA	2,502	1,946	1,246	1,255	1,266	1,195	1,182	1,177	-5	-0.4%
Las Vegas	LAS	1,098	1,679	756	904	737	813	819	1,162	343	41.9%
Bar Harbor	BHB	1,196	1,154	815	1,030	1,213	1,283	1,156	1,095	-61	-5.3%
Albany	ALB	3,433	1,073	647	2,180	1,523	1,183	1,095	1,095	0	0.0%
Saranac Lake	SLK		800	1,174	1,157	1,222	1,157	1,095	1,095	0	0.0%
Rutland	RUT	1,259	643	1,095	1,148	1,160	1,095	1,095	1,095	0	0.0%
Columbus	CMH	2,708	2,114	972	1,048	972	871	844	1,081	237	28.1%
San Diego	SAN	366	365	571	535	476	859	1,030	1,052	21	2.1%
Presque Isle	PQI	1,835	1,017	991	991	993	991	991	991	0	0.0%
Houston Hobby	HOU						664	1,325	978	-347	-26.2%

Table E-4 Logan Airport Scheduled Passenger Departures by Destination

Destination Airport	Code	2000	2005	2010	2011	2012	2013	2014	2015	2014-2015 Change	2014-2015 Percent Change
Rochester	ROC	3,644	1,181	908	886	889	878	882	886	4	0.5%
Milwaukee	MKE	1,189	2,182	2,213	1,941	1,069	880	674	854	180	26.7%
Hyannis	HYA	2,274	1,059	1,165	1,047	1,028	705	731	787	56	7.6%
Jacksonville	JAX		428	365	544	619	593	984	767	-217	-22.0%
Plattsburgh International	PBG			1,025	899	623	639	787	756	-32	-4.0%
St. Louis	STL	2,187	1,461	934	713	815	748	722	722	0	0.0%
Nashville	BNA	642				153	588	628	688	61	9.7%
Kansas City	MCI	597	241	313	536	571	515	669	661	-8	-1.2%
Salt Lake City	SLC	1,094	730	669	438	370	584	597	617	21	3.5%
Syracuse	SYR	3,876	1,762	991	964	784	626	617	578	-39	-6.3%
Portland	PDX			352	440	528	615	494	519	26	5.2%
Austin	AUS			365	365	366	352	352	444	91	26.0%
Myrtle Beach	MYR	105	265	365	365	366	378	383	383	0	0.0%
Charleston	CHS		61				398	474	365	-109	-23.0%
New Orleans	MSY		191	348	304	335	339	344	365	21	6.2%
Savannah	SAV		78					306	365	59	19.3%
Harrisburg	MDT	1,307	886	551	574	540	469	434	325	-109	-25.0%
Long Beach	LGB		853	459	296	292	274	270	292	22	8.1%
Akron/Canton	CAK		730	475	488	497	557	457	287	-170	-37.2%
Westchester County	HPN	6,065	2,256						263	263	n/a
San Jose	SJC	842	245	232	292	227	205	214	223	9	4.1%
Sarasota/Bradenton	SRQ		30	82	242	248	348	181	212	31	17.1%
Dallas Love Field	DAL								153	153	n/a
Atlantic City Pomona Field	ACY			536	326	355	123	153	166	13	8.7%
Oakland	OAK		853	195	105	83	83	83	88	4	5.1%
Sacramento	SMF								48	48	n/a
Islip	ISP	4,222	1,581				293	324		-324	-100.0%
Norfolk	ORF	838	1,032		511	667	613	71		-71	-100.0%
Newport News	PHF		671	549	549	60		31		-31	-100.0%
Memphis	MEM	972	1,034	1,048	1,029	688	313				
Bangor	BGR	6,644	2,946								
Greensboro	GSO	415	1,120								
Trenton	TTN										
Watertown	ART										
Burlington	BTV	5,913	1,632								
Allentown/Bethlehem	ABE	780	626								
Louisville	SDF										
Manchester	MHT										
Massena	MSS										
Dayton	DAY										
Plattsburgh	PLB										
Portland (ME)	PWM	6,267	1,394								
Wilkes-Barre Scranton	AVP	584	420								
Columbia	CAE										
Ithaca	ITH	872									
Elmira/Corning	ELM	441									
Hartford	BDL										
Binghamton	BGM										
Providence	PVD	91									

Table E-4 Logan Airport Scheduled Passenger Departures by Destination

Destination Airport	Code	2000	2005	2010	2011	2012	2013	2014	2015	2014-2015 Change	2014-2015 Percent Change
International		**23,711**	**19,837**	**18,764**	**19,641**	**19,540**	**19,093**	**20,372**	**21,765**	**1,393**	**6.8%**
Toronto Pearson	YYZ	3,691	3,876	3,603	3,737	3,529	3,306	2,715	2,799	84	3.1%
Toronto Island Apt	YTZ			1,535	1,687	2,009	2,009	2,310	2,236	-74	-3.2%
Montreal-Trudeau	YUL	3,401	2,578	2,008	2,021	2,009	1,833	1,948	2,047	99	5.1%
London Heathrow	LHR	2,187	2,133	2,331	2,833	2,642	2,134	2,069	2,026	-43	-2.1%
San Juan	SJU	1,750	1,237	1,294	1,130	1,031	1,038	1,018	1,068	50	4.9%
Paris De Gaulle	CDG	898	853	710	946	619	784	780	916	136	17.4%
Reykjavik Keflavik Apt	KEF	393	361	404	531	467	561	614	854	240	39.1%
Halifax	YHZ	3,210	1,891	852	744	745	704	704	700	-4	-0.6%
Dublin	DUB	223		348	457	480	605	653	653	0	0.0%
Ottawa	YOW	2,575	864	744	696	623	652	635	630	-5	-0.8%
Amsterdam	AMS	366	365	457	553	558	575	536	579	43	8.1%
Frankfurt	FRA	580	575	548	544	572	545	532	536	4	0.8%
Bermuda	BDA	550	518	532	540	511	501	523	536	13	2.5%
Dubai	DXB							306	457	151	49.3%
Aruba	AUA	9	338	407	426	405	408	417	417	0	0.1%
Santo Domingo	SDQ		174	305	275	358	339	401	365	-36	-8.9%
Zurich	ZRH	523	356	365	365	366	365	365	365	0	0.0%
Tokyo Narita	NRT					236	352	365	365	0	0.0%
Istanbul	IST							236	365	129	54.6%
Munich	MUC		210	313	335	357	348	357	357	0	0.0%
Shannon	SNN	366	737	213	118	144	166	348	352	4	1.1%
Panama City	PTY							365	334	-31	-8.4%
Beijing	PEK							136	287	152	111.6%
Rome Leonardo Da Vinci-Fiumicino	FCO		135	313	314	266	271	258	271	13	5.1%
Cancun	CUN		207	307	270	217	225	273	264	-9	-3.4%
Santiago	STI				92	201	214	248	206	-42	-17.0%
Ponta Delgada	PDL	30	39	165	170	148	179	209	196	-13	-6.2%
Saint Thomas	STT	78	108	125	117	156	173	176	184	8	4.4%
Punta Cana	PUJ			95	92	139	134	160	174	13	8.3%
Mexico City	MEX		234						166	166	n/a
Madrid	MAD			218	231	222	209	166	166	0	0.0%
Hong Kong	HKG								140	140	n/a
Nassau	NAS		100	180	134	142	108	139	136	-3	-2.3%
Providenciales	PLS	4	43	39	26	69	52	82	86	4	4.5%
Shanghai Pudong	PVG								83	83	n/a
Tel Aviv	TLV								75	75	n/a
Saint Maarten	SXM			39	43	61	61	52	56	4	8.5%
Montego Bay	MBJ		238	126	52	69	56	73	56	-17	-23.4%
Lisbon	LIS	44		26	26	48	39	39	44	4	10.9%
Terceira	TER	44		17	17	17	17	17	31	13	76.2%
Praia	RAI		9	121	122	109	104	92	30	-61	-67.0%
Port Au Prince	PAP								26	26	n/a
Grand Cayman	GCM		31	17		9	26	26	26	0	0.0%
St. Lucia Hewanorra	UVF							9	26	17	196.7%
Liberia	LIR							9	26	17	196.7%
Puerto Plata	POP	4						9	26	17	196.7%
Barbados	BGI								9	9	n/a

Table E-4 Logan Airport Scheduled Passenger Departures by Destination

Destination Airport	Code	2000	2005	2010	2011	2012	2013	2014	2015	2014-2015 Change	2014-2015 Percent Change
Fort-de-France	FDF								9	9	n/a
Pointe-a-Pitre	PTP								9	9	n/a
Sao Vicente	VXE			4		4					
Charlottetown	YYG										
Helsinki	HEL										
Milan Malpensa	MXP	366	343								
Fredericton	YFC		686								
Quebec	YQB	1,229	30								
Manchester	MAN	26	241								
Glasgow	GLA										
Connaught	NOC										
Stockholm Arlanda	ARN										
Las Palmas	LPA										
San Salvador	SAL		178								
Vancouver	YVR	366	62								
Ilha Do Sal	SID		56								
Nykoping	NYO		31								
Lerwick Sumburgh Apt	LSI										
Freeport	FPO										
London Gatwick	LGW	362									
Brussels	BRU	362									
Gander	YQX										
Athens	ATH	74									
Total Scheduled Carrier Operations		**233,779**	**183,520**	**168,726**	**171,945**	**163,411**	**166,171**	**169,579**	**173,974**	**4,395**	**2.6%**

Source: OAG Schedules.

F

Regional Transportation

This appendix provides detailed tables in support of Chapter 4, *Regional Transportation*:

- Table F-1 Aircraft Operations by Classification for New England's Airports, 2000 to 2015
- Table F-2 Percentage Change in Aircraft Operations by Classification for New England's Airports, 2000 to 2015

Scheduled Passenger Operations by Market and Carrier for New England's Regional Airports

- Table F-3 Bradley International Airport, Connecticut
- Table F-4 T.F. Green Airport, Rhode Island
- Table F-5 Manchester-Boston Regional Airport, New Hampshire
- Table F-6 Portland International Jetport, Maine
- Table F-7 Burlington International Airport, Vermont
- Table F-8 Bangor International Airport, Maine
- Table F-9 Tweed-New Haven Airport, Connecticut
- Table F-10 Worcester Regional Airport, Massachusetts
- Table F-11 Hanscom Field, Massachusetts
- Table F-12 Portsmouth International Airport, New Hampshire

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Table F-1 Aircraft Operations by Classification for New England's Airports, 2000 to 2015

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan Airport[3]	Total
2000													
Commercial	132,062	103,750	61,506	47,609	45,745	21,446	5,260	4,029	6,104	6,572	434,083	452,763	886,846
General Aviation[1]	31,863	52,184	45,740	56,571	59,377	34,831	56,200	46,518	31,601	204,512	619,397	35,233	654,630
Military & Other	5,811	2,764	586	2,072	10,241	26,507	328	495	9,973	1,287	60,064	0	60,064
Total	169,736	158,698	107,832	106,252	115,363	82,784	61,788	51,042	47,678	212,371	1,113,544	487,996	1,601,540
2001													
Commercial	128,638	100,606	61,669	47,770	47,261	18,286	4,581	5,631	4,485	6,414	425,341	434,386	859,727
General Aviation[1]	30,478	45,095	44,358	62,014	61,986	35,230	56,092	45,464	30,148	197,770	608,635	28,739	637,374
Military & Other	5,913	2,635	607	2,259	11,821	26,623	437	917	8,221	1,252	60,685	0	60,685
Total	165,029	148,336	106,634	112,043	121,068	80,139	61,110	52,012	42,854	205,436	1,094,661	463,125	1,557,786
2002													
Commercial	113,194	96,595	62,346	45,899	38,929	24,412	3,827	4,062	5,059	6,603	400,926	366,476	767,402
General Aviation[1]	27,838	45,473	29,549	57,720	59,679	35,711	62,163	52,277	28,333	210,221	608,964	25,596	634,560
Military & Other	6,085	2,587	376	2,162	12,167	27,297	593	418	8,220	1,424	61,329	0	61,329
Total	147,117	144,655	92,271	105,781	110,775	87,420	66,583	56,757	41,612	218,248	1,071,219	392,072	1,463,291
2003													
Commercial	103,917	84,301	68,184	42,658	38,293	25,626	3,705	868	4,552	2,956	375,060	344,644	719,704
General Aviation[1]	27,115	42,878	29,552	44,036	50,461	36,706	54,224	55,972	24,866	190,789	556,599	28,660	585,259
Military & Other	4,214	2,496	324	1,449	11,466	32,938	776	378	7,720	1,142	62,903	0	62,903
Total	135,246	129,675	98,060	88,143	100,220	95,270	58,705	57,218	37,138	194,887	994,562	373,304	1,367,866
2004													
Commercial	108,823	83,496	75,360	46,474	41,719	24,970	4,501	0	3,981	4,308	393,632	374,022	767,654
General Aviation[1]	32,269	34,878	27,438	41,547	54,709	29,884	58,881	61,343	25,962	175,301	542,212	31,236	573,448
Military & Other	4,100	346	749	1,338	12,404	29,676	1,010	530	7,797	1,195	59,145	0	59,145
Total	145,192	118,720	103,547	89,359	108,832	84,530	64,392	61,873	37,740	180,804	994,989	405,258	1,400,247
2005													
Commercial	119,048	88,374	76,342	42,661	43,987	25,976	6,137	2,727	3,197	3,627	412,076	377,830	789,906
General Aviation[1]	33,341	28,138	26,369	36,191	49,888	30,016	60,893	62,743	25,446	165,424	518,449	31,236	549,685
Military & Other	3,701	241	479	1,405	11,468	24,154	1,063	519	7,669	904	51,603	0	51,603
Total	156,090	116,753	103,190	80,257	105,343	80,146	68,093	65,989	36,312	169,955	982,128	409,066	1,391,194

Table F-1 Aircraft Operations by Classification for New England's Airports, 2000 to 2015

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan Airport[3]	Total
2006													
Commercial	111,341	81,282	67,326	38,663	41,342	23,466	5,177	3,793	3,981	3,057	379,428	374,675	754,103
General Aviation[1]	34,548	25,510	25,074	35,572	44,471	29,848	51,702	56,770	25,962	167,560	497,017	31,444	528,461
Military & Other	4,348	229	738	1,536	9,299	22,359	1,157	609	7,797	1,433	49,505	0	49,505
Total	150,237	107,021	93,138	75,771	95,112	75,673	58,036	61,172	37,740	172,050	925,950	406,119	1,332,069
2007													
Commercial	107,097	80,525	69,134	41,450	39,928	22,571	4,594	3,162	4,270	3,477	376,208	370,905	747,113
General Aviation[1]	29,308	22,984	23,959	31,724	47,521	25,542	51,200	61,296	27,000	160,992	481,526	28,632	510,158
Military & Other	5,097	242	644	1,384	9,528	20,949	944	879	8,017	1,438	49,122	0	49,122
Total	141,502	103,751	93,737	74,558	96,977	69,062	56,738	65,337	39,287	165,907	906,856	399,537	1,306,393
2008													
Commercial	98,194	73,096	63,505	40,834	37,832	19,282	4,013	2,553	1,347	104	340,760	347,784	688,544
General Aviation[1]	22,908	19,470	16,198	31,869	46,391	27,143	44,642	43,763	31,051	164,195	447,630	23,820	471,450
Military & Other	3,637	187	840	974	9,688	20,449	243	886	7,993	1,590	46,487	0	46,487
Total	124,739	92,753	80,543	73,677	93,911	66,874	48,898	47,202	40,391	165,889	834,877	371,604	1,206,481
2009													
Commercial	82,021	62,233	54,336	35,909	31,153	16,485	3,096	2,527	422	0	288,182	333,064	621,246
General Aviation[1]	19,586	19,438	14,354	25,473	32,872	19,558	37,722	41,700	25,161	148,696	384,560	12,242	396,802
Military & Other	2,726	260	1,163	778	8,628	16,267	486	17	6,851	1,215	38,391	0	38,391
Total	104,333	81,931	69,853	62,160	72,653	52,310	41,304	44,244	32,434	149,911	711,133	345,306	1,056,439
2010													
Commercial	80,418	60,128	53,971	35,035	29,538	16,190	3,201	1,629	1,516	0	281,626	337,961	619,587
General Aviation[1]	18,759	21,096	13,636	24,776	36,106	20,142	31,884	41,843	25,674	161,942	395,858	14,682	410,540
Military & Other	3,028	347	933	446	4,776	15,525	381	572	7,707	1,795	35,510	0	35,510
Total	102,205	81,571	68,540	60,257	70,420	51,857	35,466	44,044	34,897	163,737	712,994	352,643	1,065,637
2011													
Commercial	86,838	57,194	51,379	35,157	29,166	16,177	3,367	2,017	1,717	750	283,762	340,757	624,519
General Aviation[1]	16,483	21,774	12,497	21,453	42,562	19,503	33,919	44,050	27,056	160,840	400,137	28,230	428,367
Military & Other	3,630	369	874	533	5,890	13,220	310	634	8,158	1,409	35,027	0	35,027
Total	106,951	79,337	64,750	57,143	77,618	48,900	37,596	46,701	36,931	162,999	718,926	368,987	1,087,913

Table F-1 Aircraft Operations by Classification for New England's Airports, 2000 to 2015

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan Airport[3]	Total
2012													
Commercial	79,704	50,301	45,379	33,118	27,067	14,826	3,936	1,639	502	635	257,107	326,755	583,862
General Aviation[1]	15,589	24,781	12,504	20,864	42,352	18,069	34,775	42,655	30,186	164,841	406,616	28,114	434,730
Military & Other	3,726	434	1,073	584	7,079	11,503	416	740	7,917	738	34,210	0	34,210
Total	99,019	75,516	58,956	54,566	76,498	44,398	39,127	45,034	38,605	166,214	697,933	354,869	1,052,802
2013													
Commercial	78,213	48,340	43,572	31,076	26,814	14,707	4,094	1,586	560	253	249,215	334,657	583,872
General Aviation[1]	15,192	24,729	11,432	20,021	40,413	15,535	28,794	32,888	28,951	153,706	371,661	26,682	398,343
Military & Other	2,558	435	1,224	471	6,972	11,045	423	593	7,573	529	31,823	0	31,823
Total	95,963	73,504	56,228	51,568	74,199	41,287	33,311	35,067	37,084	154,488	652,699	361,339	1,014,038
2014													
Commercial	79,060	44,351	38,674	29,538	26,057	14,428	4,795	2,368	8,278	256	247,805	337,381	585,186
General Aviation[1]	14,752	29,490	12,293	16,535	40,858	15,548	26,273	29,138	24,440	133,437	342,764	26,416	369,180
Military & Other	2,665	1,036	908	560	6,842	11,567	529	956	7,621	602	33,286	0	33,286
Total	96,477	74,877	51,875	46,633	73,757	41,543	31,597	32,462	40,339	134,295	623,855	363,797	987,652
2015													
Commercial	76,425	42,417	38,060	30,415	25,178	13,618	6,316	2,414	8,547	220	243,610	344,764	588,374
General Aviation[1]	14,402	22,700	12,934	17,916	41,576	16,487	27,711	35,711	26,848	127,467	343,752	28,166	371,918
Military & Other	2,680	430	811	567	5,912	10,684	685	889	7,499	592	30,749	0	30,749
Total	93,507	65,547	51,805	48,898	72,666	40,789	34,712	39,014	42,894	128,279	618,111	372,930	991,041

Source: Massport, Federal Aviation Administration (FAA) Tower Counts, and individual airport records

1 Includes itinerant and local general aviation (GA) operations at the regional airports. There are no local (touch-and-go training) operations at Logan Airport.

2 Commercial operations at Hanscom Field include scheduled commercial operations only; other air taxi operations counted as GA.

3 Operations at Logan Airport include international operations.

Table F-2 Percentage Change in Aircraft Operations by Classification for New England's Airports, 2000 to 2015

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan Airport[3]	Total
2000 to 2001													
Commercial	(2.59%)	(3.03%)	0.27%	0.34%	3.31%	(14.73%)	(12.91%)	39.76%	(26.52%)	(2.40%)	(2.01%)	(4.06%)	(3.06%)
General Aviation[1]	(4.35%)	(13.58%)	(3.02%)	9.62%	4.39%	1.15%	(0.19%)	(2.27%)	(4.60%)	(3.30%)	(1.74%)	(18.43%)	(2.64%)
Military & Other	1.76%	(4.67%)	3.58%	9.03%	15.43%	0.44%	33.23%	85.25%	(17.57%)	(2.72%)	1.03%	-	1.03%
Total	(2.77%)	(6.53%)	(1.11%)	5.45%	4.95%	(3.20%)	(1.10%)	1.90%	(10.12%)	(3.27%)	(1.70%)	(5.10%)	(2.73%)
2001 Percent of Total	10.59%	9.52%	6.85%	7.19%	7.77%	5.14%	3.92%	3.34%	2.75%	13.19%	70.27%	29.73%	100.00%
2001 to 2002													
Commercial	(12.01%)	(3.99%)	1.10%	(3.92%)	(17.63%)	33.50%	(16.46%)	(27.86%)	12.80%	2.95%	(5.74%)	(15.63%)	(10.74%)
General Aviation[1]	(8.66%)	0.84%	(33.39%)	(6.92%)	(3.72%)	1.37%	10.82%	14.99%	(6.02%)	6.30%	0.05%	(10.94%)	(0.44%)
Military & Other	2.91%	(1.82%)	(38.06%)	(4.29%)	2.93%	2.53%	35.70%	(54.42%)	(0.01%)	13.74%	1.06%	-	1.06%
Total	(10.85%)	(2.48%)	(13.47%)	(5.59%)	(8.50%)	9.09%	8.96%	9.12%	(2.90%)	6.24%	(2.14%)	(15.34%)	(6.07%)
2002 Percent of Total	10.05%	9.89%	6.31%	7.23%	7.57%	5.97%	4.55%	3.88%	2.84%	14.91%	73.21%	26.79%	100.00%
2002 to 2003													
Commercial	(8.20%)	(12.73%)	9.36%	(7.06%)	(1.63%)	4.97%	(3.19%)	(78.63%)	(10.02%)	(55.23%)	(6.45%)	(5.96%)	(6.22%)
General Aviation[1]	(2.60%)	(5.71%)	0.01%	(23.71%)	(15.45%)	2.79%	(12.77%)	7.07%	(12.24%)	(9.24%)	(8.60%)	11.97%	(7.77%)
Military & Other	(30.75%)	(3.52%)	(13.83%)	(32.98%)	(5.76%)	20.67%	30.86%	(9.57%)	(6.08%)	(19.80%)	2.57%	-	2.57%
Total	(8.07%)	(10.36%)	6.27%	(16.67%)	(9.53%)	8.98%	(11.83%)	0.81%	(10.75%)	(10.70%)	(7.16%)	(4.79%)	(6.52%)
2003 Percent of Total	9.89%	9.48%	7.17%	6.44%	7.33%	6.96%	4.29%	4.18%	2.72%	14.25%	72.71%	27.29%	100.00%
2003 to 2004													
Commercial	4.72%	(0.95%)	10.52%	8.95%	8.95%	(2.56%)	21.48%	(100.00%)	(12.54%)	45.74%	4.95%	8.52%	6.66%
General Aviation[1]	19.01%	(18.66%)	(7.15%)	(5.65%)	8.42%	(18.59%)	8.59%	9.60%	4.41%	(8.12%)	(2.58%)	8.99%	(2.02%)
Military & Other	(2.71%)	(86.14%)	131.17%	(7.66%)	8.18%	(9.90%)	30.15%	40.21%	1.00%	4.64%	(5.97%)	-	(5.97%)
Total	7.35%	(8.45%)	5.60%	1.38%	8.59%	(11.27%)	9.69%	8.14%	1.62%	(7.23%)	0.04%	8.56%	2.37%
2004 Percent of Total	10.37%	8.48%	7.39%	6.38%	7.77%	6.04%	4.60%	4.42%	2.70%	12.91%	71.06%	28.94%	100.00%
2004 to 2005													
Commercial	9.40%	5.84%	1.30%	(8.20%)	5.44%	4.03%	36.35%	-	(19.69%)	(15.81%)	4.69%	1.02%	2.90%
General Aviation[1]	3.32%	(19.32%)	(3.90%)	(12.89%)	(8.81%)	0.44%	3.42%	2.28%	(1.99%)	(5.63%)	(4.38%)	0.00%	(4.14%)
Military & Other	(9.73%)	(30.35%)	(36.05%)	5.01%	(7.55%)	(18.61%)	5.25%	(2.08%)	(1.64%)	(24.35%)	(12.75%)	-	(12.75%)
Total	7.51%	(1.66%)	(0.34%)	(10.19%)	(3.21%)	(5.19%)	5.75%	6.65%	(3.78%)	(6.00%)	(1.29%)	0.94%	(0.65%)
2005 Percent of Total	11.22%	8.39%	7.42%	5.77%	7.57%	5.76%	4.89%	4.74%	2.61%	12.22%	70.60%	29.40%	100.00%

Table F-2 Percentage Change in Aircraft Operations by Classification for New England's Airports, 2000 to 2015

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan Airport[3]	Total
2005 to 2006													
Commercial	(6.47%)	(8.02%)	(11.81%)	(9.37%)	(6.01%)	(9.66%)	(15.64%)	39.09%	24.52%	(15.72%)	(7.92%)	(0.84%)	(4.53%)
General Aviation[1]	3.62%	(9.34%)	(4.91%)	(1.71%)	(10.86%)	(0.56%)	(15.09%)	(9.52%)	2.03%	1.29%	(4.13%)	0.67%	(3.86%)
Military & Other	17.48%	(4.98%)	54.07%	9.32%	(18.91%)	(7.43%)	8.84%	17.34%	1.67%	58.52%	(4.07%)	-	(4.07%)
Total	(3.75%)	(8.34%)	(9.74%)	(5.59%)	(9.71%)	(5.58%)	(14.77%)	(7.30%)	3.93%	1.23%	(5.72%)	(0.72%)	(4.25%)
2006 Percent of Total	11.28%	8.03%	6.99%	5.69%	7.14%	5.68%	4.36%	4.59%	2.83%	12.92%	69.51%	30.49%	100.00%
2006 to 2007													
Commercial	(3.81%)	(0.93%)	2.69%	7.21%	(3.42%)	(3.81%)	(11.26%)	(16.64%)	7.26%	13.74%	(0.85%)	(1.01%)	(0.93%)
General Aviation[1]	(15.17%)	(9.90%)	(4.45%)	(10.82%)	6.86%	(14.43%)	(0.97%)	7.97%	4.00%	(3.92%)	(3.12%)	(8.94%)	(3.46%)
Military & Other	17.23%	5.68%	(12.74%)	(9.90%)	2.46%	(6.31%)	(18.41%)	44.33%	2.82%	0.35%	(0.77%)	-	(0.77%)
Total	(5.81%)	(3.06%)	0.64%	(1.60%)	1.96%	(8.74%)	(2.24%)	6.81%	4.10%	(3.57%)	(2.06%)	(1.62%)	(1.93%)
2007 Percent of Total	10.83%	7.94%	7.18%	5.71%	7.42%	5.29%	4.34%	5.00%	3.01%	12.70%	69.42%	30.58%	100.00%
2007 to 2008													
Commercial	(8.31%)	(9.23%)	(8.14%)	(1.49%)	(5.25%)	(14.57%)	(12.65%)	(19.26%)	(68.45%)	(97.01%)	(9.42%)	(6.23%)	(7.84%)
General Aviation[1]	(21.84%)	(15.29%)	(32.39%)	0.46%	(2.38%)	6.27%	(12.81%)	(28.60%)	15.00%	1.99%	(7.04%)	(16.81%)	(7.59%)
Military & Other	(28.64%)	(22.73%)	30.43%	(29.62%)	1.68%	(2.39%)	(74.26%)	0.80%	(0.30%)	10.57%	(5.36%)	-	(5.36%)
Total	(11.85%)	(10.60%)	(14.08%)	(1.18%)	(3.16%)	(3.17%)	(13.82%)	(27.76%)	2.81%	(0.01%)	(7.94%)	(6.99%)	(7.65%)
2008 Percent of Total	10.34%	7.69%	6.68%	6.11%	7.78%	5.54%	4.05%	3.91%	3.35%	13.75%	69.20%	30.80%	100.00%
2008 to 2009													
Commercial	(16.47%)	(14.86%)	(14.44%)	(12.06%)	(17.65%)	(14.51%)	(22.85%)	(1.02%)	(68.67%)	(100.00%)	(15.43%)	(4.23%)	(9.77%)
General Aviation[1]	(14.50%)	(0.16%)	(11.38%)	(20.07%)	(29.14%)	(27.94%)	(15.50%)	(4.71%)	(18.97%)	(9.44%)	(14.09%)	(48.61%)	(15.83%)
Military & Other	(25.05%)	39.04%	38.45%	(20.12%)	(10.94%)	(20.45%)	100.00%	(98.08%)	(14.29%)	(23.58%)	(17.42%)	-	(17.42%)
Total	(16.36%)	(11.67%)	(13.27%)	(15.63%)	(22.64%)	(21.78%)	(15.53%)	(6.27%)	(19.70%)	(9.63%)	(14.82%)	(7.08%)	(12.44%)
2009 Percent of Total	9.88%	7.76%	6.61%	5.88%	6.88%	4.95%	3.91%	4.19%	3.07%	14.19%	67.31%	32.69%	100.00%
2009 to 2010													
Commercial	(1.95%)	(3.38%)	(0.67%)	(2.43%)	(5.18%)	(1.79%)	3.39%	(35.54%)	259.24%	-	(2.27%)	1.47%	(0.27%)
General Aviation[1]	(4.22%)	8.53%	(5.00%)	(2.74%)	9.84%	2.99%	(15.48%)	0.34%	2.04%	8.91%	2.94%	19.93%	3.46%
Military & Other	11.08%	33.46%	(19.78%)	(42.67%)	(44.65%)	(4.56%)	(21.60%)	3264.71%	12.49%	47.74%	(7.50%)	-	(7.50%)
Total	(2.04%)	(0.44%)	(1.88%)	(3.06%)	(3.07%)	(0.87%)	(14.13%)	(0.45%)	7.59%	9.22%	0.26%	2.12%	0.87%
2010 Percent of Total	9.59%	7.65%	6.43%	5.65%	6.61%	4.87%	3.33%	4.13%	3.27%	15.37%	66.91%	33.09%	100.00%
2010 to 2011													
Commercial	7.98%	(4.88%)	(4.80%)	0.35%	(1.26%)	(0.08%)	5.19%	23.82%	13.26%	-	0.76%	0.83%	0.80%
General Aviation[1]	(12.13%)	3.21%	(8.35%)	(13.41%)	17.88%	(3.17%)	6.38%	5.27%	5.38%	(0.68%)	1.08%	92.28%	4.34%
Military & Other	19.88%	6.34%	(6.32%)	19.51%	23.32%	(14.85%)	(18.64%)	10.84%	5.85%	(21.50%)	(1.36%)	-	(1.36%)
Total	4.64%	(2.74%)	(5.53%)	(5.17%)	10.22%	(5.70%)	6.01%	6.03%	5.83%	(0.45%)	0.83%	4.63%	2.09%
2011 Percent of Total	9.83%	7.29%	5.95%	5.25%	7.13%	4.49%	3.46%	4.29%	3.39%	14.98%	66.08%	33.92%	100.00%

Table F-2 Percentage Change in Aircraft Operations by Classification for New England's Airports, 2000 to 2015

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan[3]	Total
2011 to 2012													
Commercial	(8.22%)	(12.05%)	(11.68%)	(5.80%)	(7.20%)	(8.35%)	16.90%	(18.74%)	(70.76%)	-	(9.39%)	(4.11%)	(6.51%)
General Aviation[1]	(5.42%)	13.81%	0.06%	(2.75%)	(0.49%)	(7.35%)	2.52%	(3.17%)	11.57%	2.49%	1.62%	(0.41%)	1.49%
Military & Other	2.64%	17.62%	22.77%	9.57%	20.19%	(12.99%)	34.19%	16.72%	(2.95%)	(47.62%)	(2.33%)	-	(2.33%)
Total	(7.42%)	(4.82%)	(8.95%)	(4.51%)	(1.44%)	(9.21%)	4.07%	(3.57%)	4.53%	1.97%	(2.92%)	(3.83%)	(3.23%)
2012 Percent of Total	9.41%	7.17%	5.60%	5.18%	7.27%	4.22%	3.72%	4.28%	3.67%	15.79%	66.29%	33.71%	100.00%
2012 to 2013													
Commercial	(1.87%)	(3.90%)	(3.98%)	(6.17%)	(0.93%)	(0.80%)	4.01%	(3.23%)	11.55%	(60.16%)	(3.07%)	2.42%	0.00%
General Aviation[1]	(2.55%)	(0.21%)	(8.57%)	(4.04%)	(4.58%)	(14.02%)	(17.20%)	(22.90%)	(4.09%)	(6.75%)	(8.60%)	(5.09%)	(8.37%)
Military & Other	(31.35%)	0.23%	14.07%	(19.35%)	(1.51%)	(3.98%)	1.68%	(19.86%)	(4.35%)	(28.32%)	(6.98%)	-	(6.98%)
Total	(3.09%)	(2.66%)	(4.63%)	(5.49%)	(3.01%)	(7.01%)	(14.86%)	(22.13%)	(3.94%)	(7.05%)	(6.48%)	1.82%	(3.68%)
2013 Percent of Total	9.46%	7.25%	5.54%	5.09%	7.32%	4.07%	3.28%	3.46%	3.66%	15.23%	64.37%	35.63%	100.00%
2013 to 2014													
Commercial	1.08%	(8.25%)	(11.24%)	(4.95%)	(2.82%)	(1.90%)	17.12%	49.31%	1378.21%	1.19%	(0.57%)	0.81%	0.23%
General Aviation[1]	(2.90%)	19.25%	7.53%	(17.41%)	1.10%	0.08%	(8.76%)	(11.40%)	(15.58%)	(13.19%)	(7.78%)	(1.00%)	(7.32%)
Military & Other	4.18%	138.16%	(25.82%)	18.90%	(1.86%)	4.73%	25.06%	61.21%	0.63%	13.80%	4.60%	-	4.60%
Total	0.54%	1.87%	(7.74%)	(9.57%)	(0.60%)	0.62%	(5.15%)	(7.43%)	8.78%	(13.07%)	(4.42%)	0.68%	(2.60%)
2014 Percent of Total	9.77%	7.58%	5.25%	4.72%	7.47%	4.21%	3.20%	3.29%	4.08%	13.60%	63.17%	36.83%	100.00%
2014 to 2015													
Commercial	(3.33%)	(4.36%)	(1.59%)	2.97%	(3.37%)	(5.61%)	31.72%	1.94%	3.25%	(14.06%)	(1.69%)	2.19%	0.54%
General Aviation[1]	(2.37%)	(23.02%)	5.21%	8.35%	1.76%	6.04%	5.47%	22.56%	9.85%	(4.47%)	0.29%	6.62%	0.74%
Military & Other	0.56%	(58.49%)	(10.68%)	1.25%	(13.59%)	(7.63%)	29.49%	(7.01%)	(1.60%)	(1.66%)	(7.62%)	-	(7.62%)
Total	(3.08%)	(12.46%)	(0.13%)	4.86%	(1.48%)	(1.81%)	9.86%	20.18%	6.33%	(4.48%)	(0.92%)	2.51%	0.34%
2015 Percent of Total	9.44%	6.61%	5.23%	4.93%	7.33%	4.12%	3.50%	3.94%	4.33%	12.94%	62.37%	37.63%	100.00%

Source: Massport, Federal Aviation Administration (FAA) Tower Counts, and individual airport records.

1 Includes itinerant and local general aviation (GA) operations at the regional airports. There are no local (touch-and-go training) operations at Logan Airport.

2 Commercial operations at Hanscom Field include scheduled commercial operations only; other air taxi operations counted as GA.

3 Operations at Logan Airport include international operations.

Table F-3 Scheduled Passenger Operations by Market and Carrier for Bradley International Airport

			Departures										Departing Seats									
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Jet Carriers																						
Alaska	Chicago O'Hare	ORD	30								-	-	4,050								-	-
America West	Columbus	CMH	149								-	-	18,441								-	-
America West	Las Vegas	LAS	210								-	-	27,469								-	-
America West	Phoenix	PHX	275	365							-	-	37,772	54,570							-	-
American	Charlotte	CLT							1,763	1,775	12	0.7%							257,645	244,756	-12,889	-5.0%
American	Chicago O'Hare	ORD	2,139	1,570							-	-	304,855	203,929							-	-
American	Dallas/Fort Worth	DFW	1,343	1,052	1,052	1,078	1,068	1,069	1,008	695	-313	-31.1%	185,922	136,897	160,983	172,457	170,811	171,017	157,952	103,576	-54,376	-34.4%
American	Los Angeles	LAX	214					122	243		-243	-100.0%	31,244					19,520	38,880		-38,880	-100.0%
American	Miami	MIA	366	365	413	516	366	396	476	400	-76	-16.0%	51,427	49,990	63,559	82,560	58,560	63,360	74,981	59,600	-15,381	-20.5%
American	Philadelphia	PHL							265	31	-234	-88.3%							29,004	3,069	-25,935	-89.4%
American	New York J F Kennedy	JFK									-	-									-	-
American	San Juan	SJU	366	365	365	365	91				-	-	69,348	84,425	55,856	58,400	14,560				-	-
American	St. Louis	STL									-	-									-	-
American	Washington National	DCA							103	18	-85	-82.5%							12,536	2,196	-10,340	-82.5%
Boston-Maine Airways	Fort Lauderdale/Hollywood	FLL		13							-	-		1,993							-	-
Continental	Cleveland	CLE	582	131							-	-	68,974	16,262							-	-
Continental	Houston Intercontinental	IAH	366	313							-	-	45,790	34,072							-	-
Continental	New York Newark	EWR	331								-	-	38,916								-	-
Delta	Atlanta	ATL	2,192	3,098	2,099	2,094	2,105	2,109	2,391	2,374	-17	-0.7%	392,835	479,098	300,185	310,149	317,331	319,290	355,968	354,751	-1,217	-0.3%
Delta	Boston	BOS	4								-	-	634								-	-
Delta	Cancun	CUN			35	35	17	13	17	35	18	105.9%			5,470	5,397	2,735	1,973	2,571	5,207	2,636	102.5%
Delta	Cincinnati	CVG	1,464	1,373						4	4	-	244,837	196,741						471	471	-
Delta	Cleveland	CLE								60	60	-								3,000	3,000	-
Delta	Detroit	DTW			1,003	658	506	753	1,053	1,388	335	31.8%			129,228	91,657	73,117	110,361	145,867	188,469	42,602	29.2%
Delta	Fort Lauderdale/Hollywood	FLL	732	673	237	210					-	-	87,108	133,927	33,674	29,280					-	-
Delta	Fort Myers	RSW			99	90					-	-			13,104	12,780					-	-
Delta	Las Vegas	LAS			9						-	-			1,394						-	-
Delta	Los Angeles	LAX		100	83						-	-		19,928	13,257						-	-
Delta	Minneapolis	MSP			758	576	511	549	605	862	257	42.5%			99,431	79,418	75,291	82,545	87,377	115,026	27,649	31.6%
Delta	New York J F Kennedy	JFK	183								-	-	39,894								-	-
Delta	Orlando	MCO	1,838	1,095	261	608		57			-	-	218,705	217,905	99,129	88,041		8,514			-	-
Delta	Salt Lake City	SLC		27							-	-		3,986							-	-
Delta	Tampa	TPA		678	813	120					-	-		134,894	33,625	15,420					-	-
Delta	West Palm Beach	PBI	732	516	205	120					-	-	87,108	102,684	37,536	16,500					-	-
Frontier Airlines	Denver	DEN									-	-									-	-
jetBlue	Washington National	DCA							402	730	328	81.6%							40,229	85,300	45,071	112.0%
jetBlue	Fort Lauderdale/Hollywood	FLL			101	599	627	612	590	590	-	0.0%			15,086	90,231	94,029	91,800	87,836	88,479	643	0.7%
jetBlue	Fort Myers	RSW						61	181	212	31	17.1%						9,150	27,150	31,800	4,650	17.1%
jetBlue	Orlando	MCO			101	730	723	730	747	730	-17	-2.3%			15,086	109,860	108,300	109,500	112,071	109,500	-2,571	-2.3%
jetBlue	San Juan	SJU					366	365	405	465	60	14.8%					54,900	54,793	60,729	69,686	8,957	14.7%
jetBlue	Tampa	TPA						61	365	365	-	0.0%						9,150	44,693	48,750	4,057	9.1%
jetBlue	West Palm Beach	PBI					366	365	365	365	-	0.0%					45,700	54,750	44,907	45,550	643	1.4%
Laker Airways (Bahamas)	Freeport	FPO	39								-	-	5,850								-	-
Midway Airlines	Raleigh/Durham	RDU	683								-	-	69,213								-	-
Midwest/Republic	Milwaukee	MKE	619								-	-	44,455								-	-
Northwest	Amsterdam	AMS									-	-									-	-
Northwest	Detroit	DTW	1,699	1,451							-	-	215,750	192,679							-	-
Northwest	Fort Myers	RSW									-	-									-	-
Northwest	Minneapolis	MSP	1,177	1,042							-	-	135,570	140,194							-	-
Northwest	Orlando	MCO									-	-									-	-
Northwest	Tampa	TPA									-	-									-	-
Northwest	West Palm Beach	PBI									-	-									-	-
Southwest	Atlanta	ATL						174	1,086	172	-914	-84.2%						20,391	131,627	24,482	-107,145	-81.4%
Southwest	Baltimore	BWI	2,841	3,094	2,700	2,708	2,658	2,610	2,448	2,435	-13	-0.5%	389,158	423,878	367,534	367,414	362,995	372,650	353,791	353,038	-753	-0.2%
Southwest	Chicago Midway	MDW	723	953	923	979	964	967	961	974	13	1.4%	99,090	130,541	126,412	133,267	133,533	146,270	142,513	147,672	5,159	3.6%
Southwest	Denver	DEN			306	365	366	365	374	374	0	-0.1%			41,922	50,005	50,982	54,860	58,570	61,917	3,347	5.7%
Southwest	Fort Lauderdale/Hollywood	FLL			70	365	366	348	369	387	18	4.8%			9,551	50,005	50,272	49,521	53,381	57,309	3,928	7.4%
Southwest	Fort Myers	RSW					147	203	216	212	-4	-1.9%					20,413	28,917	30,949	30,586	-363	-1.2%
Southwest	Las Vegas	LAS	52	365	361	365	270	245	245	306	61	24.9%	7,163	50,005	49,398	50,005	40,466	34,876	35,035	44,037	9,002	25.7%
Southwest	Nashville	BNA	672	365	361	304					-	-	92,064	50,005	49,398	41,648					-	-
Southwest	Orlando	MCO	375	1,108	1,016	1,003	997	944	975	1,003	28	2.9%	51,336	151,816	139,212	137,411	137,843	136,115	140,866	151,806	10,940	7.8%
Southwest	Philadelphia	PHL		1,590							-	-		217,850							-	-
Southwest	Tampa	TPA		695	570	656	623	629	656	651	-5	-0.8%		95,156	78,129	89,852	85,873	90,219	93,662	93,905	243	0.3%
Southwest	West Palm Beach	PBI				61				4	4	-				8,357				633	633	-
Sunworld International	Philadelphia	PHL									-	-									-	-
Trans World Airlines	Portland (ME)	PWM	305								-	-	43,310								-	-
Trans World Airlines	St. Louis	STL	1,460								-	-	206,109								-	-
United	Chicago O'Hare	ORD	2,034	1,812	1,296	1,077	697	593	800	554	-246	-30.8%	299,522	259,437	198,709	159,738	104,725	86,911	112,864	72,529	-40,335	-35.7%
United	Denver	DEN	366								-	-	46,901								-	-

Table F-3 Scheduled Passenger Operations by Market and Carrier for Bradley International Airport

			Departures										Departing Seats									
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
United	New York Newark	EWR						18			-	-						2,126			-	-
United	San Francisco	SFO	366								-	-	45,384								-	-
United	Washington Dulles	IAD	1,455	726	1,192	812	514	180	222	82	-140	-63.1%	173,869	81,631	155,750	108,500	66,780	25,418	32,132	11,182	-20,950	-65.2%
US Airways	Baltimore	BWI	488								-	-	41,760								-	-
US Airways	Charlotte	CLT	1,464	2,188	1,588	1,664	1,665	1,734			-	-	214,719	350,776	228,119	238,508	241,320	255,885			-	-
US Airways	Fort Lauderdale/Hollywood	FLL	366	123							-	-	39,232	15,161							-	-
US Airways	Orlando	MCO	1,098	30							-	-	117,696	3,842							-	-
US Airways	Philadelphia	PHL	2,148	2,102	361	317	340	365			-	-	310,118	301,242	49,914	44,595	46,989	49,083			-	-
US Airways	Phoenix	PHX									-	-									-	-
US Airways	Pittsburgh	PIT	1,800	27							-	-	278,575	3,189							-	-
US Airways	Washington Dulles	IAD	732								-	-	86,376								-	-
US Airways	Washington National	DCA	1,329	1,064	361	365	335	208			-	-	171,891	141,068	51,434	52,210	46,511	25,610			-	-
US Airways	West Palm Beach	PBI	366								-	-	39,232								-	-
USA 3000 Airlines	Cancun	CUN		26							-	-		4,336							-	-
USA 3000 Airlines	Punta Cana	PUJ		13							-	-		2,128							-	-
Subtotal			38,171	30,507	18,695	18,841	16,686	16,845	19,331	18,252	-1,079	-5.6%	5,179,671	4,486,236	2,622,086	2,693,666	2,404,036	2,484,577	2,765,786	2,608,282	-157,504	-5.7%
Regional/Commuter Carriers																						
Air Canada Express	Montreal Dorval	YUL	1,385	1,038	1,021	986	976	952	996	1,008	12	1.2%	19,392	19,475	19,399	18,739	18,549	17,144	17,925	18,141	216	1.2%
Air Canada Express	Toronto	YYZ	1,589	1,342	1,287	1,308	1,294	1,295	1,313	1,395	82	6.2%	61,991	38,242	36,960	38,342	33,044	28,103	25,102	25,118	16	0.1%
America West Express	Columbus	CMH	450								-	-	22,493								-	-
American Connection	St. Louis	STL		947							-	-		44,356							-	-
American Eagle	Charlotte	CLT							366	290	-76	-20.9%							28,940	22,265	-6,675	-23.1%
American Eagle	Chicago O'Hare	ORD			1,501	1,630	1,613	1,630	1,622	1,604	-18	-1.1%			79,594	95,985	80,413	90,663	115,856	115,366	-490	-0.4%
American Eagle	New York J F Kennedy	JFK	1,460								-	-	48,166								-	-
American Eagle	Philadelphia	PHL							2,234	2,502	268	12.0%							136,683	146,222	9,539	7.0%
American Eagle	Pittsburgh	PIT							939	782	-157	-16.7%							67,549	39,086	-28,463	-42.1%
American Eagle	Raleigh/Durham	RDU		1,364	257						-	-		54,521	10,774						-	-
American Eagle	St. Louis	STL									-	-									-	-
American Eagle	Washington National	DCA							2,119	2,125	6	0.3%							141,783	130,975	-10,808	-7.6%
Continental Connection	Albany	ALB		51							-	-		961							-	-
Continental Connection	Binghamton	BGM									-	-									-	-
Continental Connection	Boston	BOS									-	-									-	-
Continental Connection	Buffalo	BUF	89								-	-	1,683								-	-
Continental Connection	Burlington	BTV	4								-	-	84								-	-
Continental Connection	New York J F Kennedy	JFK									-	-									-	-
Continental Connection	New York Newark	EWR			608						-	-			22,485						-	-
Continental Connection	Philadelphia	PHL									-	-									-	-
Continental Connection	Rochester	ROC	93								-	-	1,767								-	-
Continental Connection	Syracuse	SYR	97								-	-	1,851								-	-
Continental Express	Cleveland	CLE	803	1,102	1,208						-	-	39,357	54,951	60,400						-	-
Continental Express	New York Newark	EWR	1,747	1,351	465						-	-	82,365	67,455	23,264						-	-
Delta Connection	Atlanta	ATL				48	9	4	4	4	-	0.0%				3,396	647	279	288	326	38	13.2%
Delta Connection	Cincinnati	CVG			1,218	1,251	902	895	839	475	-364	-43.4%			61,642	66,559	45,181	44,757	43,557	25,537	-18,020	-41.4%
Delta Connection	Cleveland	CLE							170	183	13	7.6%							11,898	12,450	552	4.6%
Delta Connection	Columbus	CMH		994							-	-		49,196							-	-
Delta Connection	Detroit	DTW			1,004	1,323	1,429	1,195	659	300	-359	-54.5%			54,265	82,915	100,525	80,351	45,421	20,224	-25,197	-55.5%
Delta Connection	Fort Lauderdale/Hollywood	FLL									-	-									-	-
Delta Connection	Fort Myers	RSW		612							-	-		42,840							-	-
Delta Connection	Indianapolis	IND									-	-									-	-
Delta Connection	Minneapolis	MSP			481	814	858	812	738	338	-400	-54.2%			36,567	61,731	64,643	61,035	55,233	25,252	-29,981	-54.3%
Delta Connection	Myrtle Beach	MYR	61								-	-	3,057								-	-
Delta Connection	New York J F Kennedy	JFK			365	304	183				-	-			18,250	15,200	9,216				-	-
Delta Connection	Orlando	MCO							43	35	-8	-18.6%							3,156	2,354	-802	-25.4%
Delta Connection	Raleigh/Durham	RDU			100	569	454	270	257	261	4	1.6%			6,136	28,436	22,686	13,500	12,850	17,611	4,761	37.1%
Delta Connection	Tampa	TPA									-	-									-	-
Delta Connection	Washington National	DCA			166	929	360				-	-			11,324	51,524	18,074				-	-
Delta Connection	West Palm Beach	PBI									-	-									-	-
Frontier Express	Milwaukee	MKE			140	417					-	-			6,313	18,746					-	-
Independence Air	Washington Dulles	IAD		1,966							-	-		98,307							-	-
Midway Airlines	Raleigh/Durham	RDU	1,348								-	-	67,393								-	-
Midwest Connect	Milwaukee	MKE	4	965							-	-	142	30,871							-	-
Northwest Airlink	Detroit	DTW									-	-									-	-
Northwest Airlink	Indianapolis	IND		638							-	-		31,907							-	-
Northwest Airlink	Memphis	MEM									-	-									-	-
Northwest Airlink	Minneapolis	MSP		31							-	-		1,550							-	-
Shuttle America	Albany	ALB	66								-	-	3,286								-	-
Shuttle America	Bedford	BED	233								-	-	11,671								-	-
Shuttle America	Buffalo	BUF	337								-	-	16,857								-	-
Shuttle America	Islip	ISP	27								-	-	1,329								-	-

Table F-3 Scheduled Passenger Operations by Market and Carrier for Bradley International Airport

Carrier	Market	Code	Departures 2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change	Departing Seats 2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Shuttle America	Wilmington	ILG	159								-	-	7,936								-	-
Swissair	New York J F Kennedy	JFK	31								-	-	1,023								-	-
Trans World Airlines	New York J F Kennedy	JFK	1,098								-	-	31,842								-	-
United Express	Chicago O'Hare	ORD		691	548	685	1,038	1,045	877	904	27	3.1%		48,370	36,797	43,701	63,807	59,896	47,419	60,980	13,561	28.6%
United Express	Cleveland	CLE				1,200	1,125	1,127	235		-235	-100.0%				59,979	55,744	56,436	11,750		-11,750	-100.0%
United Express	Houston	IAH							96	365	269	280.2%							7,521	26,998	19,477	259.0%
United Express	New York Newark	EWR				1,159	1,347	1,269	853	1,335	482	56.5%				46,231	56,787	61,339	38,317	65,086	26,769	69.9%
United Express	Washington Dulles	IAD		1,519	494	889	928	1,280	1,224	1,243	19	1.6%		84,484	30,270	54,707	59,507	72,861	68,684	77,783	9,099	13.2%
US Airways Express	Baltimore	BWI	1,185								-	-	43,850								-	-
US Airways Express	Buffalo	BUF	1,032	839							-	-	38,200	28,607							-	-
US Airways Express	Charlotte	CLT		4	537	452	462	364			-	-		221	45,043	37,510	39,235	28,392			-	-
US Airways Express	New York La Guardia	LGA			139	1,057	364				-	-			5,159	39,098	13,468				-	-
US Airways Express	New York Newark	EWR									-	-									-	-
US Airways Express	Philadelphia	PHL		439	2,404	2,430	2,356	2,260			-	-		27,685	183,838	163,675	151,526	133,663			-	-
US Airways Express	Pittsburgh	PIT		1,646	939	939	941	939			-	-		84,598	46,929	46,929	47,057	77,901			-	-
US Airways Express	Rochester	ROC	937	574	478						-	-	34,658	19,555	16,242						-	-
US Airways Express	Syracuse	SYR	732	478							-	-	27,084	9,077							-	-
US Airways Express	Washington National	DCA		551	1,334	1,411	1,574	1,825			-	-		34,454	89,629	89,940	109,321	115,989			-	-
Subtotal			14,968	19,143	16,694	19,799	18,212	17,164	15,584	15,149	-435	-2.8%	567,477	871,682	901,282	1,063,342	989,430	942,310	879,932	831,774	-48,158	-5.5%
Total			53,139	49,651	35,389	38,640	34,898	34,009	34,915	33,402	-1,513	-4.3%	5,747,148	5,357,918	3,523,368	3,757,008	3,393,466	3,426,886	3,645,718	3,440,056	-205,662	-5.6%

Source: OAG Schedules.

Notes:

All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger)

All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger)

All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger)

All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger)

Table F-4 Scheduled Passenger Operations by Market and Carrier for T.F. Green Airport

Departures

Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Jet Carriers												
American	Charlotte	CLT							1,275	1,176	-99	-7.8%
American	Chicago O'Hare	ORD	1,464	1,113							-	-
American	Dallas/Fort Worth	DFW		365							-	-
American	Philadelphia	PHL							347	366	19	5.5%
American	Washington National	DCA							77	52		
Continental	Cleveland	CLE	569	13							-	-
Continental	Houston Intercontinental	IAH	366								-	-
Continental	New York Newark	EWR	738	282							-	-
Condor	Frankfurt	FRA								22		
Delta	Atlanta	ATL	1,464	1,976	510	1,043	990	978	993	997	4	0.4%
Delta	Cincinnati	CVG	732	695							-	-
Delta	Detroit	DTW			414	58		218	476	707	231	48.5%
Delta	Fort Lauderdale/Hollywood	FLL									-	-
Delta	Minneapolis	MSP			74						-	-
Delta	Orlando	MCO	732								-	-
jetBlue	Fort Lauderdale/Hollywood	FLL					31	365	365	365	-	0.0%
jetBlue	Orlando	MCO					62	713	713	713	0	-0.1%
Laker Airways (Bahamas)	Freeport	FPO									-	-
Northwest	Detroit	DTW	1,682	1,550							-	-
Northwest	Minneapolis	MSP		539							-	-
Sata Internacional	Ponta Delgada	PDL									-	-
Southwest	Baltimore	BWI	3,913	4,180	3,260	3,043	3,128	3,004	2,820	2,793	-27	-1.0%
Southwest	Chicago Midway	MDW	1,072	1,349	1,135	1,095	1,094	992	975	988	13	1.3%
Southwest	Denver	DEN					366	304	9		-9	-100.0%
Southwest	Fort Lauderdale/Hollywood	FLL	9		594	590	500	479	474	477	3	0.6%
Southwest	Fort Myers	RSW					86	40	44	48	4	9.4%
Southwest	Houston	HOU	152								-	-
Southwest	Islip	ISP	608								-	-
Southwest	Kansas City	MCI	366	365							-	-
Southwest	Las Vegas	LAS		31	365	365	362				-	-
Southwest	Nashville	BNA	706	721	296	123					-	-
Southwest	Orlando	MCO	955	1,821	1,799	1,659	1,585	1,423	1,419	1,464	45	3.2%
Southwest	Philadelphia	PHL		1,773	1,402	1,298					-	-
Southwest	Phoenix	PHX	366	726	361	365					-	-
Southwest	Tampa	TPA	745	1,086	813	808	763	753	748	735	-13	-1.7%
Southwest	West Palm Beach	PBI						31	35	31	-4	-11.4%
Spirit Airlines	Detroit	DTW		120							-	-
Spirit Airlines	Fort Lauderdale/Hollywood	FLL		568							-	-
Spirit Airlines	Fort Myers	RSW		365							-	-
TACV	Praia	RAI								39	39	-
United	Chicago O'Hare	ORD	1,477	1,460	644	626	388	334	320	144	-176	-55.0%
US Airways	Baltimore	BWI	2,462								-	-
US Airways	Charlotte	CLT	977	1,858	1,643	1,599	1,726	1,608			-	-
US Airways	Fort Lauderdale/Hollywood	FLL		17							-	-
US Airways	Orlando	MCO	52	43							-	-
US Airways	Philadelphia	PHL	1,830	2,182	1,299	1,012	399	313			-	-
US Airways	Pittsburgh	PIT	1,339	31							-	-
US Airways	Washington National	DCA	1,333	1,270	365	313	182	124			-	-
Subtotal			26,108	26,499	14,974	13,998	11,661	11,677	11,090	11,116	26	0.2%

Departing Seats

Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Jet Carriers												
American	Charlotte	CLT							196,644	170,310	-26,334	-13.4%
American	Chicago O'Hare	ORD	203,104	143,522							-	-
American	Dallas/Fort Worth	DFW		47,085							-	-
American	Philadelphia	PHL							34,381	36,514	2,133	6.2%
American	Washington National	DCA							9,566	6,483	-3,083	-32.2%
Continental	Cleveland	CLE	69,771	1,630							-	-
Continental	Houston Intercontinental	IAH	45,946								-	-
Continental	New York Newark	EWR	96,448	34,808							-	-
Condor	Frankfurt	FRA								5,940		
Delta	Atlanta	ATL	207,888	290,915	72,461	150,526	147,729	145,241	148,012	148,078	66	0.0%
Delta	Cincinnati	CVG	103,944	89,235							-	-
Delta	Detroit	DTW			50,065	7,139		30,414	62,046	87,078	25,032	40.3%
Delta	Fort Lauderdale/Hollywood	FLL									-	-
Delta	Minneapolis	MSP			9,211						-	-
Delta	Orlando	MCO	87,108								-	-
jetBlue	Fort Lauderdale/Hollywood	FLL					4,650	54,750	54,750	54,750	-	0.0%
jetBlue	Orlando	MCO					9,300	103,786	106,886	106,886	0	0.0%
Laker Airways (Bahamas)	Freeport	FPO									-	-
Northwest	Detroit	DTW	200,509	202,255							-	-
Northwest	Minneapolis	MSP		68,977							-	-
Sata Internacional	Ponta Delgada	PDL									-	-
Southwest	Baltimore	BWI	535,911	572,699	442,637	415,554	433,081	429,658	411,154	407,651	-3,503	-0.9%
Southwest	Chicago Midway	MDW	146,844	184,813	153,121	149,877	150,303	154,633	156,543	158,640	2,097	1.3%
Southwest	Denver	DEN					51,110	44,281	1,246		-1,246	-100.0%
Southwest	Fort Lauderdale/Hollywood	FLL	1,194		81,378	80,791	68,347	70,413	68,401	70,778	2,377	3.5%
Southwest	Fort Myers	RSW					11,743	5,520	6,292	7,305	1,013	16.1%
Southwest	Houston	HOU	20,824								-	-
Southwest	Islip	ISP	83,237								-	-
Southwest	Kansas City	MCI	50,142	50,005							-	-
Southwest	Las Vegas	LAS		4,247	50,005	50,005	49,932				-	-
Southwest	Nashville	BNA	96,702	98,816	39,578	16,067					-	-
Southwest	Orlando	MCO	130,855	249,418	245,156	225,244	216,998	210,082	204,947	215,253	10,306	5.0%
Southwest	Philadelphia	PHL		238,366	192,054	177,001					-	-
Southwest	Phoenix	PHX	50,142	99,403	49,398	50,005					-	-
Southwest	Tampa	TPA	102,065	148,821	111,231	109,572	104,140	107,959	107,481	108,451	970	0.9%
Southwest	West Palm Beach	PBI						4,433	5,046	4,433	-613	-12.1%
Spirit Airlines	Detroit	DTW		18,000							-	-
Spirit Airlines	Fort Lauderdale/Hollywood	FLL		84,117							-	-
Spirit Airlines	Fort Myers	RSW		54,750							-	-
TACV	Praia	RAI								7,739	7,739	-
United	Chicago O'Hare	ORD	239,076	200,677	82,802	78,487	48,697	46,258	42,658	17,570	-25,088	-58.8%
US Airways	Baltimore	BWI	263,921								-	-
US Airways	Charlotte	CLT	128,984	274,039	233,886	226,854	238,503	225,454			-	-
US Airways	Fort Lauderdale/Hollywood	FLL		2,186							-	-
US Airways	Orlando	MCO	5,605	5,831							-	-
US Airways	Philadelphia	PHL	253,015	312,890	130,008	101,987	39,529	30,973			-	-
US Airways	Pittsburgh	PIT	185,109	4,446							-	-
US Airways	Washington National	DCA	167,278	170,009	49,501	44,006	24,350	14,997			-	-
Subtotal			3,475,622	3,651,961	1,992,492	1,883,114	1,598,412	1,678,851	1,616,053	1,613,859	-2,194	-0.1%

Table F-4 Scheduled Passenger Operations by Market and Carrier for T.F. Green Airport

			Departures										Departing Seats									
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Regional/Commuter Carriers																						
Air Canada Express	Toronto	YYZ	989	734	625	591	593	84			-	-	37,482	13,783	11,880	11,232	11,262	1,517			-	-
American Eagle	Charlotte	CLT							175	341	166	94.9%							13,971	26,810	12,839	91.9%
American Eagle	Chicago O'Hare	ORD									-	-									-	-
American Eagle	Detroit	DTW					12				-	-					808				-	-
American Eagle	New York J F Kennedy	JFK	1,291								-	-	42,589								-	-
American Eagle	New York La Guardia	LGA	2,756								-	-	90,957								-	-
American Eagle	Raleigh/Durham	RDU		343							-	-		13,081							-	-
American Eagle	Philadelphia	PHL							2,213	2,163	-50	-2.3%							150,139	142,721	-7,418	-4.9%
American Eagle	Washington National	DCA							1,609	1,755	146	9.1%							111,183	111,865	682	0.6%
Cape Air	Block Island	BID							538	418	-120	-22.3%							4,846	3,765	-1,081	-22.3%
Cape Air	Hyannis	HYA									-	-									-	-
Cape Air	Martha's Vineyard	MVY	1,762	1,015	747	672	659	501	285	192	-93	-32.6%	15,861	9,132	6,722	6,048	5,930	4,513	2,561	1,725	-836	-32.6%
Cape Air	Nantucket	ACK	2,453	1,199	681	668	576	501	271	244	-27	-10.0%	22,073	10,787	6,128	6,012	5,181	4,510	2,438	2,196	-242	-9.9%
Continental Connection	Albany	ALB		51							-	-		961							-	-
Continental Connection	Boston	BOS									-	-									-	-
Continental Connection	New York Newark	EWR			427						-	-			31,630						-	-
Continental Connection	Plattsburgh	PLB									-	-									-	-
Continental Connection	Washington Dulles	IAD									-	-									-	-
Continental Express	Cleveland	CLE	699	1,238	1,217						-	-	34,936	61,900	60,836						-	-
Continental Express	New York Newark	EWR	1,482	1,455	1,028						-	-	86,552	71,185	51,407						-	-
Delta Connection	Atlanta	ATL		31	724	9	43	70	51	43	-8	-15.7%		1,550	52,959	662	3,279	4,522	3,380	3,001	-379	-11.2%
Delta Connection	Cincinnati	CVG		373	43						-	-		19,109	2,150						-	-
Delta Connection	Detroit	DTW			1,324	1,995	2,054	1,748	871	289	-582	-66.8%			78,701	111,901	113,630	90,191	45,809	18,671	-27,138	-59.2%
Delta Connection	Minneapolis	MSP			347	392	266	240	170		-170	-100.0%			26,192	29,553	20,189	17,380	12,878		-12,878	-100.0%
Delta Connection	New York J F Kennedy	JFK									-	-									-	-
Delta Connection	New York La Guardia	LGA	610								-	-	19,520								-	-
Delta Connection	Raleigh/Durham	RDU				131					-	-				6,557					-	-
Delta Connection	Washington National	DCA				685	225				-	-				34,243	11,271				-	-
Independence Air	Washington Dulles	IAD		1,509							-	-		75,429							-	-
Midway Airlines	Raleigh/Durham	RDU									-	-									-	-
Northwest Airlink	Detroit	DTW									-	-									-	-
Northwest Airlink	Minneapolis	MSP		31							-	-		1,550							-	-
Swissair	New York J F Kennedy	JFK	31								-	-	1,023								-	-
United Express	Chicago O'Hare	ORD		262	455	375	309	306	325	605	280	86.2%		18,330	29,820	24,079	19,900	19,896	19,443	34,473	15,030	77.3%
United Express	Cleveland	CLE				1,079	886	875	102		-102	-100.0%				53,943	42,991	43,757	5,100		-5,100	-100.0%
United Express	New York Newark	EWR				1,439	1,346	1,213	994	1,356	362	36.4%				69,724	61,168	65,636	57,558	73,682	16,124	28.0%
United Express	Washington Dulles	IAD	1,468	1,716	1,569	1,421	1,157	1,035	1,031	837	-194	-18.8%	52,832	85,821	99,719	89,593	73,470	65,632	67,077	52,139	-14,938	-22.3%
US Airways Express	Albany	ALB	679								-	-	12,898								-	-
US Airways Express	Boston	BOS	48								-	-	909								-	-
US Airways Express	Charlotte	CLT		18	126	147	65	166			-	-		879	10,047	12,035	5,423	12,857			-	-
US Airways Express	Hyannis	HYA									-	-									-	-
US Airways Express	Nantucket	ACK									-	-									-	-
US Airways Express	New York La Guardia	LGA	2,298	1,669	1,222	957	286				-	-	84,116	55,077	45,225	33,141	10,582				-	-
US Airways Express	New York Newark	EWR	1,569								-	-	31,176								-	-
US Airways Express	Philadelphia	PHL	366	716	1,526	1,713	2,206	2,347			-	-	13,542	45,199	107,790	122,386	152,816	154,401			-	-
US Airways Express	Pittsburgh	PIT		1,360							-	-		72,808							-	-
US Airways Express	Plattsburgh	PLB	26								-	-	497								-	-
US Airways Express	Washington National	DCA		482	1,373	1,304	1,479	1,492			-	-		30,996	92,151	95,527	110,451	107,775			-	-
Subtotal			18,527	14,200	13,436	13,577	12,161	10,577	8,635	8,243	-392	-4.5%	546,963	587,576	713,356	706,634	648,351	592,587	496,383	471,048	-25,335	-5.1%
Total			44,635	40,699	28,409	27,575	23,822	22,255	19,725	19,359	-366	-1.9%	4,022,585	4,239,537	2,705,848	2,589,748	2,246,763	2,271,438	2,112,436	2,084,907	-27,529	-1.3%

Source: OAG Schedules.

Notes:

All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger)

All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger)

All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger)

All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger)

Table F-5 Scheduled Passenger Operations by Market and Carrier for Manchester Airport

			Departures										Departing Seats									
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Jet Carriers																						
Boston-Maine Airways	Myrtle Beach	MYR									-	-									-	-
Boston-Maine Airways	Portsmouth	PSM									-	-									-	-
Boston-Maine Airways	Sanford	SFB									-	-									-	-
Continental	Cleveland	CLE	130								-	-	16,151								-	-
Continental	New York Newark	EWR	462	286							-	-	62,358	30,953							-	-
Delta	Atlanta	ATL	244	668	275	565	514	463	459	365	-94	-20.5%	34,648	94,856	39,050	81,600	76,629	69,307	68,468	53,545	-14,923	-21.8%
Delta	Cincinnati	CVG		664							-	-		86,583							-	-
Delta	Detroit	DTW			796					122	122	-			89,289					14,414	14,414	-
Delta	New York - LGA	LGA								4	4	-								596	596	-
Northwest	Detroit	DTW	1,609	1,399							-	-	194,058	180,879							-	-
Northwest	Minneapolis	MSP		365							-	-		46,933							-	-
Southwest	Baltimore	BWI	2,828	3,850	2,891	2,761	2,775	2,726	2,494	2,476	-18	-0.7%	387,397	527,405	393,093	376,945	385,044	387,879	364,979	363,524	-1,455	-0.4%
Southwest	Chicago Midway	MDW	706	1,355	1,144	1,244	1,168	1,010	984	948	-36	-3.6%	96,702	185,481	155,466	169,440	161,822	158,820	157,501	148,825	-8,676	-5.5%
Southwest	Denver	DEN				92	366	304			-	-				12,604	50,379	43,211			-	-
Southwest	Fort Lauderdale/Hollywood	FLL			9	9	152	90		4	4	-			1,194	1,194	21,190	12,793		633	633	-
Southwest	Kansas City	MCI	366								-	-	50,142								-	-
Southwest	Las Vegas	LAS		365	365	365	122	61	9	9	-	0.0%		50,005	50,005	50,005	16,766	8,723	1,246	1,246	-	0.0%
Southwest	Nashville	BNA	397	730							-	-	54,389	99,879							-	-
Southwest	Orlando	MCO	410	1,468	1,125	977	906	831	752	743	-9	-1.2%	56,111	201,175	154,145	133,829	125,620	123,873	109,202	113,888	4,686	4.3%
Southwest	Philadelphia	PHL		1,786	1,411	1,325					-	-		244,356	192,456	180,871					-	-
Southwest	Phoenix	PHX			322	273					-	-			44,114	37,401					-	-
Southwest	Tampa	TPA		1,099	782	629	579	466	470	479	9	1.9%		150,165	107,173	86,212	79,639	68,120	67,509	70,529	3,020	4.5%
United	Chicago O'Hare	ORD	1,403	1,339							-	-	221,523	179,151							-	-
United	Portland (ME)	PWM	57								-	-	7,241								-	-
US Airways	Baltimore	BWI	1,782								-	-	191,078								-	-
US Airways	Charlotte	CLT		1,308	365	51					-	-		178,836	52,560	7,406					-	-
US Airways	Orlando	MCO	52								-	-	5,605								-	-
US Airways	Philadelphia	PHL	1,821	2,021	365	313	187	351			-	-	222,331	274,215	33,132	30,973	18,499	34,791			-	-
US Airways	Pittsburgh	PIT	1,085								-	-	139,837								-	-
US Airways	Washington National	DCA	675	575							-	-	82,085	77,461							-	-
Subtotal			14,026	19,279	9,850	8,604	6,769	6,302	5,168	5,150	-18	-0.3%	1,821,657	2,608,335	1,311,677	1,168,481	935,588	907,518	768,905	767,200	-1,705	-0.2%
Regional/Commuter Carriers																						
Air Canada Express	Montreal Dorval	YUL									-	-									-	-
Air Canada Express	Toronto	YYZ	339	930	707	403					-	-	5,616	17,439	13,441	7,652					-	-
American Eagle	Charlotte	CLT							496	730	234	47.3%							37,761	54,688	16,927	44.8%
American Eagle	New York La Guardia	LGA	1,833								-	-	60,480								-	-
American Eagle	Philadelphia	PHL							2,295	2,237	-58	-2.5%							149,598	152,206	2,608	1.7%
American Eagle	Washington National	DCA							1,198	1,152	-46	-3.9%							77,065	74,008	-3,057	-4.0%
Boston-Maine Airways	Bangor	BGR									-	-									-	-
Boston-Maine Airways	Martha's Vineyard	MVY									-	-									-	-
Boston-Maine Airways	Nantucket	ACK									-	-									-	-
Boston-Maine Airways	New London/Groton	GON									-	-									-	-
Boston-Maine Airways	Portsmouth	PSM									-	-									-	-
Boston-Maine Airways	Saint John	YSJ									-	-									-	-
Continental Connection	Albany	ALB	80	313							-	-	1,515	5,944							-	-
Continental Connection	New York J F Kennedy	JFK									-	-									-	-
Continental Connection	New York Newark	EWR			141						-	-			9,483						-	-
Continental Connection	Plattsburgh	PLB									-	-									-	-
Continental Connection	Rochester	ROC	44								-	-	841								-	-
Continental Connection	Syracuse	SYR	22								-	-	421								-	-
Continental Connection	Westchester County	HPN									-	-									-	-
Continental Express	Cleveland	CLE	593	1,186	1,178						-	-	29,614	58,991	58,921						-	-
Continental Express	New York Newark	EWR	1,028	1,165	1,267						-	-	64,944	58,140	63,336						-	-
Delta Connection	Atlanta	ATL	488	485	90			51	59		-59	-100.0%	24,400	26,620	6,300			3,843	4,484		-4,484	-100.0%
Delta Connection	Bangor	BGR	244								-	-	12,200								-	-
Delta Connection	Cincinnati	CVG	1,673	735							-	-	83,657	38,426							-	-
Delta Connection	Detroit	DTW			499	1,858	1,609	1,510	1,296	912	-384	-29.6%			32,795	95,802	80,786	75,507	69,261	51,960	-17,301	-25.0%
Delta Connection	New York J F Kennedy	JFK									-	-									-	-
Delta Connection	New York La Guardia	LGA	727	486			586	1,165	1,140	970	-170	-14.9%	36,357	24,300			31,216	66,132	63,202	55,968	-7,234	-11.4%
Delta Connection	Minneapolis	MSP																				
Independence Air	Washington Dulles	IAD		1,568							-	-		78,379							-	-

Table F-5 Scheduled Passenger Operations by Market and Carrier for Manchester Airport

Departures

Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Northwest Airlink	Detroit	DTW									-	-
Northwest Airlink	Minneapolis	MSP		233							-	-
United Express	Chicago O'Hare	ORD		31	1,040	983	867	695	857	779	-78	-9.1%
United Express	Cleveland	CLE				935	759	740	111		-111	-100.0%
United Express	New York Newark	EWR				1,391	1,298	1,120	965	1,304	339	35.1%
United Express	Washington Dulles	IAD		1,760	1,104	658	427	90			-	-
US Airways Express	Boston	BOS									-	-
US Airways Express	Charlotte	CLT		307	153	318	366	417			-	-
US Airways Express	New York La Guardia	LGA	2,583	2,499	1,381	1,269	594				-	-
US Airways Express	Philadelphia	PHL		562	2,116	2,068	2,092	2,004			-	-
US Airways Express	Pittsburgh	PIT		1,022							-	-
US Airways Express	Washington National	DCA		508	1,039	1,043	1,002	1,252			-	-
Subtotal			9,655	13,788	10,716	10,925	9,600	9,045	8,417	8,084	-333	-4.0%
Total			23,681	33,067	20,566	19,529	16,369	15,347	13,585	13,234	-351	-2.6%

Departing Seats

Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Northwest Airlink	Detroit	DTW									-	-
Northwest Airlink	Minneapolis	MSP		11,664							-	-
United Express	Chicago O'Hare	ORD		2,170	67,675	62,096	45,929	39,114	49,854	42,976	-6,878	-13.8%
United Express	Cleveland	CLE				46,736	36,046	36,986	5,564		-5,564	-100.0%
United Express	New York Newark	EWR				67,250	60,049	54,604	44,824	60,052	15,228	34.0%
United Express	Washington Dulles	IAD		90,419	55,951	33,514	20,788	5,444			-	-
US Airways Express	Boston	BOS									-	-
US Airways Express	Charlotte	CLT		21,863	13,146	27,181	31,476	32,885			-	-
US Airways Express	New York La Guardia	LGA	96,936	86,492	49,420	43,737	21,962				-	-
US Airways Express	Philadelphia	PHL		30,239	140,277	135,156	134,567	126,552			-	-
US Airways Express	Pittsburgh	PIT		51,107							-	-
US Airways Express	Washington National	DCA		25,379	81,095	81,683	78,512	84,499			-	-
Subtotal			416,980	627,572	591,840	600,808	541,331	525,567	501,613	491,858	-9,755	-1.9%
Total			2,238,636	3,235,907	1,903,517	1,769,288	1,476,919	1,433,085	1,270,518	1,259,058	-11,459	-0.9%

Source: OAG Schedules.

Notes:

All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger)

All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger)

All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger)

All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger)

Table F-6 Scheduled Passenger Operations by Market and Carrier for Portland International Jetport

			Departures										Departing Seats									
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Jet Carriers																						
American	Charlotte	CLT							374	365	-9	-2.4%							46,341	45,504	-837	-1.8%
American	Philadelphia	PHL							92		-92	-100.0%							9,108		-9,108	-100.0%
American	Washington National	DCA								30	30	-								3,720	3,720	-
AirTran	Atlanta	ATL			92	167					-	-			10,764	19,522					-	-
AirTran	Baltimore	BWI			944	927					-	-			112,951	109,024					-	-
AirTran	Orlando	MCO			52	52					-	-			6,503	6,355					-	-
Continental	Cleveland	CLE									-	-									-	-
Continental	New York Newark	EWR									-	-									-	-
Delta	Atlanta	ATL	732	486	424	793	751	737	693	714	21	3.0%	103,944	61,229	60,167	114,597	110,397	109,750	103,571	107,000	3,429	3.3%
Delta	Cincinnati	CVG	1,089	486							-	-	154,658	69,012							-	-
Delta	New York La Guardia	LGA					184	239	79	30	-49	-62.0%					24,256	35,374	11,750	3,300	-8,450	-71.9%
Independence Air	Washington Dulles	IAD		307							-	-		40,524							-	-
jetBlue	New York J F Kennedy	JFK			1,201	1,323	1,239	1,307	1,332	1,295	-37	-2.8%			128,936	135,379	124,571	130,671	133,200	130,314	-2,886	-2.2%
jetBlue	Orlando	MCO			212	181					-	-			21,214	21,344					-	-
Northwest	Detroit	DTW	523	427							-	-	52,105	42,700							-	-
Southwest	Baltimore	BWI					1,016	1,005	1,084	1,106	22	2.0%					119,112	136,588	152,939	158,358	5,419	3.5%
Southwest	Orlando	MCO					13		4	9	5	117.9%					1,521		633	1,246	613	96.9%
Southwest	Chicago Midway	MDW							9	4	-5	-50.8%							1,246	633	-613	-49.2%
Trans World Airlines	Hartford	BDL	305								-	-	43,310								-	-
United	Chicago O'Hare	ORD	728								-	-	88,996								-	-
United	Manchester	MHT	366								-	-	53,802								-	-
US Airways	Charlotte	CLT			395	352	366	365			-	-			48,688	47,130	49,044	45,260			-	-
US Airways	Philadelphia	PHL	1,312	154		217	18				-	-	163,051	19,404		21,525	1,895				-	-
US Airways	Pittsburgh	PIT	1,081								-	-	137,472								-	-
US Airways	Washington National	DCA		52							-	-		6,668							-	-
Subtotal			6,135	1,912	3,320	4,013	3,587	3,653	3,667	3,553	-114	-3.1%	797,338	239,537	389,224	474,876	430,796	457,644	458,788	450,075	-8,713	-1.9%
Regional/Commuter Carriers																						
Air Canada Express	Montreal Dorval	YUL	344								-	-	4,734								-	-
Air Canada Express	Toronto	YYZ			481	783	671	97			-	-			9,142	14,872	12,749	1,741			-	-
America West	New York Newark	EWR	52								-	-	2,457								-	-
American Eagle	Boston	BOS	3,804								-	-	125,518								-	-
American Eagle	Charlotte	CLT							26	143	117	450.0%							2,065	11,666	9,601	464.9%
American Eagle	Chicago O'Hare	ORD									-	-									-	-
American Eagle	New York La Guardia	LGA	2,033								-	-	67,084								-	-
American Eagle	Philadelphia	PHL							1,986	2,148	162	8.2%							125,325	141,789	16,464	13.1%
American Eagle	Washington National	DCA							1,426	1,613	187	13.1%							99,757	107,469	7,712	7.7%
Continental Conenction	Albany	ALB		291							-	-		5,537							-	-
Continental Conenction	Boston	BOS	204	241							-	-	3,871	4,576							-	-
Continental Conenction	New York Newark	EWR			1,426						-	-			105,503						-	-
Continental Conenction	Presque Isle	PQI									-	-									-	-
Continental Express	Cleveland	CLE	425	223	188						-	-	20,378	11,021	9,400						-	-
Continental Express	New York Newark	EWR	1,429	1,394	4						-	-	70,393	69,605	200						-	-
Delta Connection	Atlanta	ATL		700	350						-	-		48,440	25,532						-	-
Delta Connection	Boston	BOS		1,153							-	-		57,650							-	-
Delta Connection	Cincinnati	CVG		600							-	-		31,166							-	-
Delta Connection	Detroit	DTW			1,217	1,314	1,264	1,249	1,061	896	-165	-15.6%			62,320	65,686	64,758	62,436	60,448	59,315	-1,133	-1.9%
Delta Connection	New York J F Kennedy	JFK			270						-	-			13,500						-	-
Delta Connection	New York La Guardia	LGA	475	1,095	786	1,034	1,050	1,202	1,231	1,284	53	4.3%	15,191	54,750	41,440	57,437	67,453	80,898	80,103	76,325	-3,778	-4.7%
Delta Connection	Minneapolis	MSP																				
Independence Air	Washington Dulles	IAD		1,384							-	-		69,186							-	-
Lufthansa German Airlines	Washington Dulles	IAD	31								-	-	1,550								-	-
Northwest Airlink	Detroit	DTW	484	915							-	-	33,366	53,132							-	-
Northwest Airlink	Minneapolis	MSP		404							-	-		20,186							-	-
Starlink Aviation	Yarmouth	YQI			521	521	217				-	-			9,386	9,386	3,909				-	-
Swissair	Boston	BOS	31								-	-	1,023								-	-
United Express	Chicago O'Hare	ORD		1,095	1,249	1,176	1,125	1,045	1,038	1,029	-9	-0.9%		67,590	82,273	72,457	59,896	65,872	63,099	64,054	955	1.5%
United Express	Cleveland	CLE				188	249	298			-	-				9,400	11,906	14,886			-	-
United Express	New York Newark	EWR				1,426	1,596	1,630	1,470	1,779	309	21.0%				103,511	81,454	102,156	92,953	108,900	15,947	17.2%
United Express	Washington Dulles	IAD	996	1,456	1,078	1,066	885	750	689	560	-129	-18.7%	49,779	83,730	64,767	62,493	43,839	39,624	37,949	35,213	-2,736	-7.2%
US Airways Express	Bangor	BGR	231								-	-	8,558								-	-
US Airways Express	Boston	BOS	2,229								-	-	42,359								-	-
US Airways Express	Charlotte	CLT		365	88	18	31	35			-	-		23,710	5,323	1,364	2,542	2,777			-	-
US Airways Express	New York La Guardia	LGA	1,218	1,665	1,647	1,526	598				-	-	43,901	77,909	78,477	68,755	26,013				-	-
US Airways Express	Philadelphia	PHL		1,913	1,947	1,987	2,153	2,131			-	-		100,307	133,521	129,133	139,908	137,137			-	-
US Airways Express	Pittsburgh	PIT		219							-	-		10,971							-	-
US Airways Express	Plattsburgh	PLB	48								-	-	909								-	-
US Airways Express	Presque Isle	PQI									-	-									-	-
US Airways Express	Washington National	DCA	1,089	1,149	1,043	1,043	1,260	1,408			-	-	33,976	75,568	83,302	87,190	102,160	100,248			-	-
US Airways Express	Westchester County	HPN	65								-	-	1,235								-	-
Subtotal			15,187	16,261	12,296	12,081	11,098	9,843	8,927	9,452	525	5.9%	526,282	865,033	724,086	681,682	616,586	607,775	561,699	604,731	43,032	7.7%
Total			21,322	18,174	15,615	16,094	14,684	13,496	12,594	13,005	411	3.3%	1,323,619	1,104,570	1,113,310	1,156,558	1,047,382	1,065,419	1,020,487	1,054,806	34,320	3.4%

Source: OAG Schedules.

Notes:

All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger)

All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger)

All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger)

All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger)

Table F-7 Scheduled Passenger Operations by Market and Carrier for Burlington Airport

			Departures										Departing Seats									
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Jet Carriers																						
AirTran	Baltimore	BWI									-	-									-	-
Allegiant Air	Orlando/Sanford	SFB							94	104	10	10.6%							15,873	17,880	2,007	12.6%
American	Philadelphia	PHL							116										11,470			
Continental	New York Newark	EWR									-	-									-	-
Delta	Atlanta	ATL						153	92	92	-	0.0%						21,394	13,708	13,708	-	0.0%
jetBlue	New York J F Kennedy	JFK	244	1,126	1,434	1,405	1,363	1,365	1,244	1,156	-88	-7.1%	39,528	173,920	180,286	163,839	163,821	143,907	124,357	115,600	-8,757	-7.0%
jetBlue	Orlando	MCO			330	339	326				-	-			33,014	33,871	32,643				-	-
Northwest	Detroit	DTW		174							-	-		17,429							-	-
United	Chicago O'Hare	ORD	815	365						113	113	-	105,509	42,379						13,777	13,777	-
United	Portland (ME)	PWM									-	-									-	-
US Airways	Philadelphia	PHL	1,098	365				26			-	-	150,338	46,170				2,546			-	-
US Airways	Pittsburgh	PIT	732								-	-	103,568								-	-
US Airways	Washington National	DCA		4							-	-		558							-	-
Subtotal			2,889	2,035	1,764	1,744	1,690	1,543	1,546	1,465	-81	-5.2%	398,943	280,456	213,300	197,710	196,464	167,847	165,408	160,965	-4,443	-2.7%
Regional/Commuter Carriers																						
America West	New York Newark	EWR	166								-	-	7,889								-	-
American Eagle	Boston	BOS	3,094								-	-	102,111								-	-
American Eagle	Charlotte	CLT								122	122	-								9,516	9,516	-
American Eagle	Chicago O'Hare	ORD									-	-									-	-
American Eagle	Philadelphia	PHL							1,823	1,921	98	5.4%							110,129	126,772	16,643	15.1%
American Eagle	Washington National	DCA							1,276	1,339	63	4.9%							89,462	86,015	-3,448	-3.9%
Continental Connection	Albany	ALB									-	-									-	-
Continental Connection	Boston	BOS	244	634							-	-	4,628	12,054							-	-
Continental Connection	Buffalo	BUF	4								-	-	84								-	-
Continental Connection	Hartford	BDL									-	-									-	-
Continental Connection	New York Newark	EWR			405						-	-			30,002						-	-
Continental Connection	Plattsburgh	PLB	213	367							-	-	4,039	6,970							-	-
Continental Connection	Plattsburgh International	PBG									-	-									-	-
Continental Connection	Poughkeepsie	POU	66								-	-	1,262								-	-
Continental Connection	Washington Dulles	IAD									-	-									-	-
Continental Connection	Westchester County	HPN									-	-									-	-
Continental Express	Cleveland	CLE	322	509	366						-	-	16,064	25,351	18,286						-	-
Continental Express	New York Newark	EWR	1,458	1,455	1,020						-	-	70,203	72,707	51,000						-	-
Continental Express	Westchester County	HPN									-	-									-	-
Delta Connection	Atlanta	ATL		62				61	273	273	-	0.0%		3,100				4,636	20,701	20,748	47	0.2%
Delta Connection	Boston	BOS		1,002							-	-		50,100							-	-
Delta Connection	Cincinnati	CVG		1,060							-	-		52,979							-	-
Delta Connection	Detroit	DTW			1,227	1,309	1,282	1,223	1,201	1,004	-197	-16.4%			61,417	65,443	64,114	61,224	60,043	57,053	-2,990	-5.0%
Delta Connection	New York J F Kennedy	JFK			1,336	1,338	221				-	-			67,071	81,259	14,884				-	-
Delta Connection	New York La Guardia	LGA	355				781	1,279	1,248	1,257	9	0.7%	11,351				50,144	83,899	82,592	76,339	-6,253	-7.6%
Independence Air	Washington Dulles	IAD		1,903							-	-		95,136							-	-
Lufthansa German Airlines	Washington Dulles	IAD	31								-	-	1,550								-	-
Northwest Airlink	Detroit	DTW		1,159							-	-		61,983							-	-
Northwest Airlink	Minneapolis	MSP		61							-	-		3,050							-	-
Porter Airlines	Toronto Island Apt	YTZ				9	31	56	47	39	-8	-17.0%				620	2,150	3,910	3,308	2,886	-422	-12.8%
Swissair	Boston	BOS	31								-	-	1,023								-	-
United Express	Chicago O'Hare	ORD		1,003	1,353	1,565	1,391	1,396	1,402	1,144	-258	-18.4%		59,930	84,431	88,435	81,204	84,669	85,350	63,845	-21,505	-25.2%
United Express	Cleveland	CLE				348	331	409	73		-73	-100.0%				17,421	15,376	20,464	3,636		-3,636	-100.0%
United Express	New York Newark	EWR				1,425	1,425	1,456	1,281	1,569	288	22.5%				94,675	80,261	85,373	82,670	96,340	13,670	16.5%
United Express	Washington Dulles	IAD	1,477	1,456	1,130	1,112	1,000	910	892	738	-154	-17.3%	73,843	72,786	61,988	69,793	58,665	48,930	50,633	41,127	-9,506	-18.8%
US Airways Express	Boston	BOS	2,404								-	-	48,139								-	-
US Airways Express	Charlotte	CLT									-	-									-	-
US Airways Express	New York La Guardia	LGA	2,074	2,175	1,680	1,487	650				-	-	76,749	80,491	62,144	55,008	24,050				-	-
US Airways Express	Philadelphia	PHL		1,980	1,903	1,956	1,873	1,803			-	-		97,288	128,140	131,727	121,653	111,615			-	-
US Airways Express	Pittsburgh	PIT									-	-									-	-
US Airways Express	Plattsburgh	PLB	2,427								-	-	46,116								-	-
US Airways Express	Poughkeepsie	POU	718								-	-	13,639								-	-
US Airways Express	Saranac Lake	SLK	44								-	-	841								-	-
US Airways Express	Washington National	DCA	988	990	1,043	1,043	1,072	1,347			-	-	31,574	61,458	77,625	82,974	85,623	100,348			-	-
US Airways Express	Wilkes-Barre Scranton	AVP	22								-	-	415								-	-
Subtotal			16,138	15,816	11,461	11,593	10,058	9,941	9,516	9,405	-111	-1.2%	511,521	755,382	642,104	687,357	598,123	605,069	588,524	580,640	-7,884	-1.3%
Total			19,028	17,851	13,225	13,336	11,748	11,484	11,062	10,870	-192	-1.7%	910,464	1,035,838	855,404	885,067	794,588	772,916	753,932	741,605	-12,327	-1.6%

Source: OAG Schedules.

Notes:

Allegiant Air stopped reporting to the OAG in 2009, so Allegiant Air 2009-2015 statistics are from the T100 database.

All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger)

All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger)

All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger)

All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger)

Table F-8 Scheduled Passenger Operations by Market and Carrier for Bangor Airport

			Departures										Departing Seats									
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Jet Carriers																						
Allegiant Air	Orlando/Sanford	SFB			181	150	156	165	153	180	27	17.6%			27,150	22,500	23,912	27,335	26,536	31,156	4,620	17.4%
Allegiant Air	Punta Gorda	PGD							33	0	-33	-100.0%							5,478	0	-5,478	-100.0%
Allegiant Air	St. Petersburg/Clearwater	PIE			107	93	112	115	119	134	15	12.6%			16,050	13,950	16,944	19,090	20,501	23,531	3,030	14.8%
Delta	Detroit	DTW								175	175	-								19,334	19,334	-
Pan American Airways	Allentown/Bethlehem	ABE									-	-									-	-
Pan American Airways	Baltimore	BWI									-	-									-	-
Pan American Airways	Pittsburgh	PIT	285								-	-	42,729								-	-
Pan American Airways	Portsmouth	PSM	389								-	-	58,414								-	-
Pan American Airways	Sanford	SFB									-	-									-	-
Subtotal			674	0	288	243	268	280	305	489	184	60.3%	101,143	0	43,200	36,450	40,856	46,425	52,515	74,021	21,506	41.0%
Regional/Commuter Carriers																						
American Eagle	Boston	BOS	4,670	1,530							-	-	154,115	56,594							-	-
American Eagle	New York La Guardia	LGA	382	518							-	-	12,606	19,166							-	-
American Eagle	Philadelphia	PHL							1,496	1,452	-44	-2.9%							94,849	91,163	-3,686	-3.9%
American Eagle	Washington National	DCA							791	771	-20	-2.5%							41,033	40,260	-773	-1.9%
Boston-Maine Airways	Halifax	YHZ									-	-									-	-
Boston-Maine Airways	Manchester	MHT									-	-									-	-
Boston-Maine Airways	Portsmouth	PSM									-	-									-	-
Boston-Maine Airways	Saint John	YSJ									-	-									-	-
Continental Connection	Albany	ALB		189							-	-		3,583							-	-
Continental Express	New York Newark	EWR		481							-	-		22,698							-	-
Delta Connection	Atlanta	ATL									-	-									-	-
Delta Connection	Boston	BOS		1,416							-	-		70,800							-	-
Delta Connection	Cincinnati	CVG	1,342	1,394							-	-	67,100	82,439							-	-
Delta Connection	Detroit	DTW			975	871	703	706	711	279	-432	-60.8%			50,540	54,640	46,260	46,371	47,269	19,614	-27,655	-58.5%
Delta Connection	New York J F Kennedy	JFK			180						-	-			9,000						-	-
Delta Connection	New York La Guardia	LGA			537	844	1,043	1,153	975	976	1	0.1%			26,958	49,368	62,868	71,955	59,239	57,025	-2,214	-3.7%
Delta Connection	Minneapolis	MSP									-	-										
Northwest Airlink	Boston	BOS	27								-	-	797								-	-
Northwest Airlink	Detroit	DTW		1,012							-	-		55,222							-	-
Northwest Airlink	Minneapolis	MSP		61							-	-		3,050							-	-
Pan American Airways	Portsmouth	PSM									-	-									-	-
Pan American Airways	Saint John	YSJ									-	-									-	-
United Express	Chicago O'Hare	ORD							245	215	-30	-12.2%							16,170	14,190	-1,980	-12.2%
US Airways Express	Boston	BOS	1,942								-	-	36,906								-	-
US Airways Express	New York La Guardia	LGA	35	158	1,017	1,230	299				-	-	1,295	7,914	44,051	53,371	14,950				-	-
US Airways Express	Philadelphia	PHL	428	1,179	1,156	1,405	1,543	1,564			-	-	15,836	58,943	68,510	89,548	99,457	101,167			-	-
US Airways Express	Pittsburgh	PIT									-	-									-	-
US Airways Express	Portland (ME)	PWM	231								-	-	8,558								-	-
US Airways Express	Presque Isle	PQI	299								-	-	6,224								-	-
US Airways Express	Washington National	DCA			31	52	589	883			-	-			1,529	2,607	29,464	47,981			-	-
Subtotal			9,357	7,937	3,896	4,402	4,178	4,307	4,218	3,693	-525	-12.4%	303,436	380,408	200,587	249,535	253,000	267,474	258,560	222,252	-36,308	-14.0%
Total			10,031	7,937	4,184	4,645	4,446	4,587	4,523	4,182	-341	-7.5%	404,579	380,408	243,787	285,985	293,856	313,899	311,075	296,273	-14,802	-4.8%

Source: OAG Schedules.

Notes:

Allegiant Air stopped reporting to the OAG in 2009, so Allegiant Air 2009-2015 statistics are from the T100 database.

All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger)

All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger)

All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger)

All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger)

Table F-9 Scheduled Passenger Operations by Market and Carrier for Tweed-New Haven Airport

			Departures										Departing Seats									
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Regional/Commuter Carriers																						
American Eagle	Philadelphia	PHL							1,356	1,222	-134	-9.9%							50,161	49,657	-504	-1.0%
Delta Connection	Cincinnati	CVG		1,025							-	-		51,236							-	-
Boston-Maine Airways	Baltimore	BWI									-	-									-	-
Boston-Maine Airways	Bedford	BED									-	-									-	-
Boston-Maine Airways	Elmira/Corning	ELM									-	-									-	-
Boston-Maine Airways	Portsmouth	PSM									-	-									-	-
US Airways Express	Philadelphia	PHL	1,773	1,904	1,608	1,535	1,381	1,399			-	-	65,612	76,208	59,491	56,806	52,972	51,768			-	-
US Airways Express	Washington National	DCA	937								-	-	34,658								-	-
											-	-										
Total			2,710	2,929	1,608	1,535	1,381	1,399	1,356	1,222	-134	-9.9%	100,270	127,444	59,491	56,806	52,972	51,768	50,161	49,657	-504	-1.0%

Source: OAG Schedules.

Notes:

All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger)

All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger)

All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger)

All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger)

Table F-10 Scheduled Passenger Operations by Market and Carrier for Worcester Regional Airport

			Departures										Departing Seats									
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Jet Carriers																						
Allegiant Air	Sanford	SFB									-	-									-	-
Boston-Maine Airways	Allentown/Bethlehem	ABE									-	-									-	-
Boston-Maine Airways	Portsmouth	PSM									-	-									-	-
Boston-Maine Airways	Sanford	SFB									-	-									-	-
Direct Air	Myrtle Beach	MYR			73	96					-	-			9,782	14,120					-	-
Direct Air	Orlando/Sanford	SFB			144	148					-	-			21,937	24,339					-	-
Direct Air	Punta Gorda	PGD			94	105					-	-			14,541	17,287					-	-
Direct Air	West Palm Beach	PBI			13	51					-	-			1,872	7,444					-	-
jetBlue	Fort Lauderdale/Hollywood	FLL						61	365	365	-	0.0%						6,100	36,500	36,500	-	0.0%
jetBlue	Orlando	MCO						61	365	365	-	0.0%						6,100	36,500	36,500	-	0.0%
Subtotal			0	0	324	400	0	122	730	730	-	0.0%	0	0	48,132	63,190	0	12,200	73,000	73,000	-	0.0%
Regional/Commuter Carriers																						
American Eagle	Chicago O'Hare	ORD									-	-									-	-
American Eagle	New York J F Kennedy	JFK	552								-	-	18,216								-	-
Delta Connection	Atlanta	ATL	670								-	-	33,500								-	-
US Airways Express	Philadelphia	PHL	1,464								-	-	54,168								-	-
Subtotal			2,686	0	0	0	0	0	0	0	-	-	105,884	0	0	0	0	0	0		-	-
Total			2,686	0	324	400	0	122	730	730	-	0.0%	105,884	0	48,132	63,190	0	12,200	73,000	73,000	-	0.0%

Source: OAG Schedules.

Notes:

All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger)

All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger)

All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger)

All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger)

Table F-11 Scheduled Passenger Operations by Market and Carrier for Hanscom Field

			Departures										Departing Seats									
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'13-'14 Change	'13-'14 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Regional/Commuter Carriers																						
Boston-Maine Airways	Elmira/Corning	ELM									-	-									-	-
Boston-Maine Airways	Hyannis	HYA									-	-									-	-
Boston-Maine Airways	Manchester	MHT									-	-									-	-
Boston-Maine Airways	Martha's Vineyard	MVY									-	-									-	-
Boston-Maine Airways	Nantucket	ACK									-	-									-	-
Boston-Maine Airways	New Haven	HVN									-	-									-	-
Boston-Maine Airways	New London/Groton	GON		9							-	-		159							-	-
Boston-Maine Airways	Portsmouth	PSM		193							-	-		3,482							-	-
Boston-Maine Airways	Trenton	TTN		867							-	-		15,606							-	-
Pan American Airways	Atlantic City Pomona Field	ACY									-	-									-	-
Pan American Airways	Martha's Vineyard	MVY									-	-									-	-
Pan American Airways	New York Newark	EWR									-	-									-	-
Pan American Airways	Portsmouth	PSM									-	-									-	-
Pan American Airways	Westchester County	HPN									-	-									-	-
Shuttle America	Buffalo	BUF	1,119								-	-	55,950								-	-
Shuttle America	Hartford	BDL	173								-	-	8,636								-	-
Shuttle America	New York La Guardia	LGA	523								-	-	26,143								-	-
Shuttle America	Trenton	TTN	2,062								-	-	103,093								-	-
Streamline	Trenton	TTN				155					-	-				4,650					-	-
US Airways	Martha's Vineyard	MVY									-	-									-	-
US Airways	Nantucket	ACK									-	-									-	-
US Airways	New York La Guardia	LGA									-	-									-	-
US Airways	Philadelphia	PHL									-	-									-	-
US Airways	Trenton	TTN									-	-									-	-
US Airways	Westchester County	HPN									-	-									-	-
Total			3,876	1,069	0	155	0	0	0	0	-	-	193,821	19,247	0	4,650	0	0	0	0	-	-

Source: OAG Schedules.

Notes:

All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger)

All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger)

All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger)

All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger)

Table F-12 Scheduled Passenger Operations by Market and Carrier for Portsmouth International Airport

			Departures										Departing Seats									
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	'14-'15 Change	'14-'15 Pct. Change
Jet Carriers																						
Allegiant Airways	Orlando/Sanford	SFB		35				16	83	95	12	14.5%		5,229				2,656	14,242	16,111	1,869	13.1%
Allegiant Airways	Punta Gorda	PGD							22	35	13	59.1%							3,652	5,909	2,257	61.8%
Allegiant Airways	Fort Lauderdale/Hollywood	FLL								27	27	-								4,779	4,779	-
Boston-Maine Airways	Fort Lauderdale/Hollywood	FLL		13							-	-		1,993							-	-
Boston-Maine Airways	Hartford	BDL		13							-	-		1,993							-	-
Boston-Maine Airways	Newburgh	SWF		48							-	-		7,179							-	-
Boston-Maine Airways	Sanford	SFB		57							-	-		8,593							-	-
Pan American Airways	Allentown/Bethlehem	ABE	93								-	-	13,950								-	-
Pan American Airways	Bangor	BGR	389								-	-	58,414								-	-
Pan American Airways	Gary	GYY	51								-	-	7,714								-	-
Pan American Airways	Manchester	MHT									-	-									-	-
Pan American Airways	New York Newark	EWR									-	-									-	-
Pan American Airways	Pittsburgh	PIT	261								-	-	39,171								-	-
Pan American Airways	Sanford	SFB	296								-	-	44,400								-	-
Pan American Airways	Santo Domingo	SDQ									-	-									-	-
Pan American Airways	St. Petersburg/Clearwater	PIE									-	-									-	-
Pan American Airways	Worcester	ORH									-	-									-	-
Skybus	Columbus	CMH									-	-									-	-
Skybus	Greensboro	GSO									-	-									-	-
Skybus	Punta Gorda	PGD									-	-									-	-
Skybus	Saint Augustine	UST									-	-									-	-
Subtotal			1,091	167	0	0	0	16	105	157	52	49.5%	163,650	24,986	0	0	0	2,656	17,894	26,799	8,905	49.8%
Regional/Commuter Carriers																						
Boston-Maine Airways	Baltimore	BWI									-	-									-	-
Boston-Maine Airways	Bangor	BGR									-	-									-	-
Boston-Maine Airways	Bedford	BED		171							-	-		3,083							-	-
Boston-Maine Airways	Hyannis	HYA									-	-									-	-
Boston-Maine Airways	Manchester	MHT									-	-									-	-
Boston-Maine Airways	Martha's Vineyard	MVY									-	-									-	-
Boston-Maine Airways	Nantucket	ACK									-	-									-	-
Boston-Maine Airways	New Haven	HVN									-	-									-	-
Boston-Maine Airways	New London/Groton	GON									-	-									-	-
Boston-Maine Airways	Saint John	YSJ									-	-									-	-
Boston-Maine Airways	Trenton	TTN		22							-	-		399							-	-
Boston-Maine Airways	Westchester County	HPN									-	-									-	-
Pan American Airways	Atlantic City Pomona Field	ACY									-	-									-	-
Pan American Airways	Baltimore	BWI									-	-									-	-
Pan American Airways	Bangor	BGR									-	-									-	-
Pan American Airways	Bedford	BED									-	-									-	-
Pan American Airways	Martha's Vineyard	MVY									-	-									-	-
Pan American Airways	Saint John	YSJ									-	-									-	-
Subtotal			0	193	0	0	0	0	0	0	-	-	0	3,482	0	0	0	0	0	0	-	-
												-										
Total			1,091	360	0	0	0	16	105	157	52	49.5%	163,650	28,467	0	0	0	2,656	17,894	26,799	8,905	49.8%

Source: OAG Schedules.

Notes:

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All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger)

G

Ground Access

This appendix provides information in support of Chapter 5, *Ground Access to and from Logan Airport*:

- Table G-1A Logan Express Bus Service Ridership (Annual)
- Table G-1B Logan Express Back Bay Service Ridership (Annual)
- Table G-2 Water Transportation Services Ridership (Annual)
- Table G-3 Massachusetts Bay Transportation Authority (MBTA) Airport Station Passengers
- Table G-4 Annual Taxi Dispatches (Tickets Sold)
- Table G-5 Logan Airport Employee Parking Supply
- Table G-6 Logan Airport Commercial Parking Supply
- Table G-7 2015 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment, and Vehicle Miles Traveled (VMT) Summary
- VISSIM Traffic Roadway Network
- March 2015 Logan Airport Parking Space Inventory, submitted to Massachusetts Department of Environmental Protection (also known as the *Parking Freeze Report*)
- September 2015 Logan Airport Parking Space Inventory, submitted to Massachusetts Department of Environmental Protection (also known as the *Parking Freeze Report*)

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Table G-1A	Logan Express Bus Service Ridership					
	Ridership			Percent Change		
Service Year	**Air Passengers**	**Employees**	**Total**	**Air Passengers**	**Employees**	**Total**
Framingham						
1992	207,847	7,573	215,420	4.3%	21.3%	4.8%
1993	229,064	12,307	241,371	10.2%	62.5%	12.0%
1994	250,342	17,352	267,694	9.3%	41.0%	10.9%
1995	274,754	21,129	295,883	9.8%	21.8%	10.5%
1996	325,665	22,932	348,597	18.5%	8.5%	17.8%
1997	316,306	29,871	346,175	(2.9)%	30.3%	(0.7)%
1998	337,007	33,971	370,978	6.5%	13.7%	7.2%
1999	345,715	31,946	380,661	3.5%	(6.0)%	2.6%
2000	371,560	34,508	406,068	6.6%	8.0%	6.7%
2001	354,521	38,740	393,261	(4.6)%	12.3%	(3.2)%
2002	342,746	42,441	385,187	(3.3)%	8.7%	(2.1)%
2003	310,024	55,979	366,003	(9.5)%	31.9%	(5.0)%
2004	323,931	54,763	378,694	4.5%	(2.2%)	3.5%
2005	318,125	57,569	375,694	(1.8%)	5.1%	(0.8%)
2006	349,022	60,764	409,789	9.7%	5.5%	9.1%
2007	311,299	57,252	368,551	(2.1%)[5]	(0.6%)[5]	(1.9%)[5]
2008	276,112	57,797	333,909	(11.3%)	1.0%	(9.4%)
2009	264,233	59,840	324,073	(4.3%)	3.5%	(2.9%)
2010	272,190	62,226	334,416	3.0%	4.0%	3.2%
2011[1]	272,301	68,228	340,529	0.0%	9.6%	1.8%
2012	279,603	82,951	362,554	2.7%	21.6%	6.5%
2013	295,654	84,008	379,662	5.7%	1.3%	4.7%
2014	303,646	87,488	391,134	2.7%	4.1%	3.0%
2015	**345,680**	**82,943**	**428,623**	**13.8%**	**(5.2%)**	**9.6%**

Table G-1A Logan Express Bus Service Ridership (Continued)

	Ridership			Percent Change		
Service Year	**Air Passengers**	**Employees**	**Total**	**Air Passengers**	**Employees**	**Total**
Braintree						
1992	186,217	9,694	195,911	10.6%	16.6%	10.8%
1993	205,209	22,768	227,977	10.2%	134.9%	16.4%
1994	247,636	37,489	285,125	20.7%	64.7%	25.1%
1995	264,579	70,723	335,302	6.8%	88.7%	17.6%
1996	335,232	103,519	438,751	26.7%	46.4%	30.1%
1997	300,006	135,340	435,346	(10.5)%	30.7%	(0.8)%
1998	300,005	156,105	456,110	0.0%	15.3%	4.8%
1999	328,818	125,286	454,105	9.6%	(19.7)%	(0.5)%
2000	355,932	149,687	505,619	8.2%	19.5%	11.3%
2001	345,249	156,240	501,489	(3.0)%	4.4%	(0.8)%
2002	323,115	190,360	513,475	(6.4)%	21.8%	2.4%
2003	301,013	216,765	517,778	(6.8)%	13.9%	0.8%
2004	318,100	208,566	526,666	5.7%	(3.8%)	1.7%
2005	307,659	189,531	497,190	(3.2%)	(9.1%)	(5.5%)
2006	333,413	202,983	536,396	8.4%	7.1%	7.9%
2007	300,715	196,955	497,670	(2.3%)5	3.9%[5]	0.1%[5]
2008	252,289	221,591	473,880	(16.1%)	12.5%	(4.8%)
2009	231,151	234,908	466,059	(8.4%)	6.0%	(1.7%)
2010	231,422	251,443	482,865	0.1%	7.0%	3.6%
2011[1]	233,521	285,515	519,036	0.9%	13.6%	7.5%
2012	247,346	314,542	561,888	5.9%	10.2%	8.3%
2013	268,154	320,329	588,483	8.4%	1.8%	4.7%
2014	296,975	313,334	610,309	10.7%	(2.2%)	3.7%
2015	**313,576**	**311,695**	**625,271**	**5.6%**	**(0.5%)**	**2.5%**

Table G-1A Logan Express Bus Service Ridership (Continued)

	Ridership			Percent Change		
Service Year	**Air Passengers**	**Employees**	**Total**	**Air Passengers**	**Employees**	**Total**
Woburn[2]						
1992[3]	3,052	91	3,143	NA	NA	-
1993	59,635	5,027	64,662	NA	NA	-
1994	119,567	9,082	128,649	100.5%	80.7%	99.0%
1995	150,147	13,376	163,523	25.6%	47.3%	27.1%
1996	190,566	17,322	207,888	26.9%	29.5%	27.1%
1997	199,715	20,018	219,733	4.8%	15.6%	5.7%
1998	208,286	22,876	231,162	4.3%	14.3%	5.2%
1999	191,454	23,495	214,949	(8.1)%	2.7%	(7.0)%
2000	195,744	27,522	223,266	2.2%	17.1%	3.9%
2001	177,375	38,318	215,530	(9.4)%	39.2%	(3.4)%
2002	161,145	73,277	234,422	(9.2)%	91.0%	8.7%
2003	164,980	103,963	268,943	(2.4)%	41.9%	14.7%
2004	172,110	111,326	283,436	4.3%	7.1%	5.4%
2005	163,227	110,961	274,188	(5.1%)	(0.3%)	(3.2%)
2006	167,341	121,672	289,013	2.5%	9.7%	5.4%
2007	149,149	123,066	272,215	(8.6%)[5]	10.9%[5]	(0.7%)[5]
2008	129,385	122,777	252,162	(13.3%)	(0.2%)	(7.4%)
2009	113,607	121,633	235,240	(12.2%)	(0.9%)	(6.7%)
2010	115,257	127,120	242,377	1.5%	4.5%	3.0%
2011[1]	118,232	151,029	269,261	2.6%	18.8%	11.1%
2012	126,549	188,747	315,296	7.0%	25.0%	17.1%
2013	140,407	192,289	332,696	11.0%	1.9%	5.5%
2014	156,045	194,341	350,386	11.1%	1.1%	5.3%
2015	**163,469**	**191,242**	**354,711**	**4.8%**	**(1.6%)**	**1.2%**
Peabody						
2001[4]	8,151	3,097	11,248	NA	NA	NA
2002	28,626	20,629	49,255	NA	NA	NA
2003	32,318	23,425	55,743	21.4%	13.6%	13.2%
2004	43,389	33,642	77,031	34.3%	43.6%	38.2%
2005	51,023	39,599	87,622	17.6%	17.7%	13.7%
2006	42,142	32,632	74,774	(17.4%)	(17.6%)	(14.7%)
2007	36,367	26,949	63,316	(28.7%)[5]	(31.9%)[5]	(27.7%)[5]
2008	30,887	30,596	61,483	(15.1%)	13.5%	(2.9%)
2009	27,856	32,220	60,076	(9.8%)	5.3%	(2.3%)
2010	25,543	26,231	51,744	(8.3%)	(18.6%)	(13.8%)
2011[1]	25,555	31,741	57,296	0.0%	21.0%	10.7%
2012	27,542	37,909	65,451	7.8%	19.4%	14.2%
2013	28,790	38,067	66,857	4.5%	0.4%	2.1%
2014	31,485	36,848	68,333	9.4%	(3.2%)	2.2%
2015	**37,478**	**36,125**	**73,603**	**19.0%**	**(2.0%)**	**7.7%**

Table G-1A Logan Express Bus Service Ridership (Continued)						
	Ridership			Percent Change		
Service Year	**Air Passengers**	**Employees**	**Total**	**Air Passengers**	**Employees**	**Total**
Total System Ridership						
1992	397,116	17,358	414,474	8.0%	19.2%	8.5%
1993	493,908	39,832	533,740	24.4%	129.5%	28.8%
1994	617,545	63,923	681,468	25.0%	60.5%	27.7%
1995	689,480	105,228	794,708	11.6%	64.6%	16.6%
1996	851,463	143,773	995,236	23.4%	36.6%	25.2%
1997	816,015	185,229	1,001,254	(4.2)%	28.8%	0.6%
1998	845,598	212,952	1,058,550	3.6%	15.0%	5.7%
1999	868,987	180,727	1,049,714	2.7%	(15.2)%	(0.8)%
2000	923,236	211,717	1,134,953	6.2%	17.1%	8.1%
2001	885,296	236,395	1,121,691	(4.1)%	11.7%	(1.2)%
2002	855,632	326,707	1,182,339	(3.4)%	38.2%	5.4%
2003	808,335	400,132	1,208,467	(5.5%)	22.5%	2.2%
2004	857,530	408,297	1,265,827	6.1%	2.0%	2.2%
2005	837,034	397,660	1,234,694	(2.4%)	(2.6%)	(2.4%)
2006	891,918	418,051	1,309,969	6.6%	5.1%	6.1%
2007	797,530	404,222	1,201,752	(4.7%)[5]	1.7%[5]	(2.7%)[5]
2008	688,673	432,761	1,121,434	(13.6%)	7.1%	(6.7%)
2009	636,847	448,601	1,085,448	(7.5%)	3.7%	(3.2%)
2010	644,412	467,020	1,111,432	1.2%	4.1%	2.4%
2011[1]	649,609	536,513	1,186,122	0.8%	14.9%	6.7%
2012	681,040	624,149	1,305,189	4.8%	16.3%	10.0%
2013	733,005	634,693	1,367,698	8.0%	2.0%	5.0%
2014	788,151	632,011	1,420,162	7.5%	(0.4%)	3.8%
2015	**860,203**	**622,005**	**1,482,208**	**9.1%**	**-1.6%**	**4.4%**

Notes: Jan. 23, 2008: I-90/Ted Williams Tunnel opens to all traffic. The last toll increase for Ted Williams Tunnel was Jan. 1, 2008.
NA Not applicable.
1 Changes to employee parking and bus fares were implemented in October 2011.
2 Woburn Express moved from Mishawum Station to the Anderson Regional Transportation Center (ARTC) in Woburn in May 2001.
3 Reflects a partial year of operation. Woburn Logan Express service was implemented in November 1992.
4 Reflects a partial year of operation. The Peabody Logan Express service commenced in September 2001.
5 Percent comparison between 2007 and 2005. The I-90 Ted Williams Tunnel closures in 2006 resulted in atypical ridership.

Table G-1B Logan Express Back Bay Service Ridership[1]		
	Ridership	**Percent Change**
Service Year		
2014	152,892	NA
2015	**290,796**	**NA**

1 Back Bay Logan Express service commenced in April 2014. Only total ridership available.

Table G-2 Water Transportation Services Ridership to and from Logan Airport

	Rowes Wharf/Fan Pier Water Shuttle	**Private Water Taxi (on-demand)[1]**	**Harbor Express (Long Wharf/Quincy/Hull)[2]**	**Boston-Logan Water Shuttle (Long Wharf)**	**Total**
1990	181,530	NS	NS	NS	181,530
1991	142,500	NS	NS	NS	142,500
1992	133,297	NS	NS	NS	133,297
1993	159,525	NS	NS	NS	159,525
1994	209,057	NS	NS	NS	209,057
1995	203,829	NS	NS	NS	203,829
1996	159,992	3,364	11,781	NS	175,137
1997	132,542	6,299	71,309	NS	210,150
1998	124,836	9,243	101,174	NS	235,253
1999	122,211	17,252	98,539	NS	238,002
2000	128,097	26,335	83,243	NS	237,675
2001	107,400	29,642	82,704	NS	219,746
2002	75,304	36,736	66,471	NS	178,511
2003	26,480[3]	35,724[4]	61,849	5,722[5]	129,775
2004	NS	54,540	58,788	3,202[6]	116,530
2005	NS	44,975	51,960	NS	96,935
2006	NS	63,639	70,998	NS	134,637
2007	NS	50,737	59,460	NS	110,197
2008	NS	48,630	48,003	NS	96,633
2009	NS	50,734	37,861	NS	88,595
2010	NS	54,382	34,794	NS	89,176
2011	NS	58,879	33,403	NS	92,282
2012	NS	60,840	30,337	NS	91,177
2013	NS	70,378	21,925	NS	92,303
2014	NS	67,479	19,340	NS	86,819
2015	**NS**	**70,798**	**7,748**	**NS**	**78,546**

Note: Figures from 2003 – 2007 have been revised from previous documents.
NS Operation not in service.
1 Operates April-October only.
2 Service to Quincy was discontinued in 2013 and now operates between Long Wharft/Hingham/Hull.
3 Rowes Wharf Water Shuttle operated from January to June only in 2003.
4 Operated from May to October only in 2003.
5 Long Wharf Boston-Logan Water Shuttle operated from August to December in 2003.
6 Joint operation with City Water Taxi began on August 16, 2003.

Table G-3 Massachusetts Bay Transportation Authority (MBTA) Airport Station Passengers				
Year	**Entrances**	**Exits**	**Total Turnstile Count[1]**	**Percent Change**
1990	NA	NA	2,854,317	-
1991	NA	NA	2,515,293	(11.9)%
1992	NA	NA	2,626,572	4.2%
1993	NA	NA	2,604,980	(0.8)%
1994	NA	NA	3,108,734	19.3%
1995	NA	NA	3,040,868	(2.2)%
1996	NA	NA	2,974,850	(2.2)%
1997[2]	NA	NA	2,774,268	(6.7)%
1998	NA	NA	2,850,367	2.7%
1999	NA	NA	2,974,045	4.3%
2000	NA	NA	3,019,086	1.5%
2001	NA	NA	2,896,638	(4.1)%
2002	NA	NA	2,670,594	(7.8)%
2003[3]	1,300,272	1,275,627	2,575,899	(3.6)%
2004	1,373,861	1,366,511	2,740,372	6.4%
2005	NA	NA	NA	NA
2006	NA	NA	NA	NA
2007[4]	1,412,055	--	2,524,079	--
2008[5]	2,212,111	--	3,647,394	56.7%
2009[5]	2,329,370	--	3,750,549	5.3%
2010[5]	2,270,241	--	3,629,193	(2.5%)
2011	2,277,311	NA	NA	0.3%
2012	2,442,085	NA	NA	7.2%
2013	2,597,306	NA	NA	6.3%
2014	2,378,965	NA	NA	(8.4%)[6]
2015	**2,122,597**	**NA**	NA	**(10.8%)[6]**

Source: MBTA.
Note: Turnstile counts include both Logan Airport bound (turnstile exits) and non-Logan Airport bound (turnstile entrances) passengers.
NA Data not available
1 As stated in the *Logan Airport 1999 ESPR*, Massport believes that ridership estimates through 2005 from the old Airport Station were actually understated because many travelers that were destined for the Airport with baggage had been observed to avoid the turnstiles and exit the old Airport Station via the wide gate (designed for handicapped access) that did not have the capability to count passengers.
2 Airport Station was closed on six weekends during September and October 1997 due to construction.
3 Airport Station was closed on eight weekend days during 2003.
4 Automated fare collection and new fare gates implemented beginning January 2007. Station access to Bremen Street Park opened June 2007. Exits are undercounted.
5 Exits are undercounted, as some exits occur through exit doors rather than turnstiles.
6 Due to the closure of Government Center Station in 2014, it is possible that passengers who would normally take the Blue Line to the Green Line have switched to alternate modes for their trips.

Table G-4 Annual Taxi Dispatches (Tickets Sold)

Year	Total (yearly tickets sold)	Percent Change
1990	1,330,418	
1991	1,208,611	(9.2)%
1992	1,266,033	4.8%
1993	1,336,603	5.6%
1994	1,409,505	5.5%
1995	1,499,869	6.4%
1996	1,721,093	14.7%
1997	1,827,244	6.2%
1998	1,888,281	3.3%
1999	1,955,895	3.6%
2000	2,140,724	9.4%
2001	1,789,736	(16.4)%
2002	1,679,508	(6.2)%
2003	1,562,076	(7.0)%
2004	1,713,696	9.7%
2005	1,769,876	3.3%
2006	1,857,609	5.0%
2007	1,925,817	3.7%
2008	1,749,730	(9.1)%
2009	1,630,333	(6.8)%
2010	1,829,961	12.1%
2011	1,937,743	6.0%
2012	2,022,239	4.4%
2013	2,131,371	5.0%
2014	2,237,793	5.0%
2015	**2,302,059**	**2.9%**

Table G-5 Logan Airport Employee Parking Supply

	Number of Spaces			
Location	**March 2014**	**September 2014**	**March 2015**	**September 2015**
Terminal Area	857	868	**868**	**865**
North Service Area	883	883	**881**	**876**
Southwest Service Area	4	4	**14**	**16**
South Service Area	681	681	**674**	**665**
Airside (Fire/Rescue)	0	0	**0**	**0**
Total spaces in service	2,425	2,436	**2,437**	**2,422**
Total spaces out of service	248	237	**236**	**251**
Total employee spaces	2,673	2,673	**2,673**	**2,673**

Source: Logan Airport Parking Space Inventory submitted to Massachusetts Department of Environmental Protection (MassDEP), March and September 2014 and 2015.
Note: As of June 2013, the Logan Airport Parking Freeze sets a limit of 18,415 commercial spaces and 2,673 employee spaces at the Airport.

Table G-6 Logan Airport Commercial Parking Supply

	Number of Spaces			
Location	**March 2014**	**September 2014**	**March 2015**	**September 2015**
Terminal Area				
Central Garage and West Garage	10,267	10,267	**10,267**	**10,340**
Terminal B Garage	2,254	2,254	**2,254**	**2,201**
Terminal E Lot 1	275	275	**243**	**237**
Terminal E Lot 2	248	248	**248**	**249**
Terminal E Lot 3 (Gulf Lot)	219	219	**219**	**217**
Signature (General Aviation)	35	35	**35**	**35**
Logan Airport Hilton	235	235	**35**	**35**
North Service Area				
Economy Garage	2,809	2,809	**2,809**	**2,864**
Overflow Green Lot (Wood Island)	0	0	**235**	**242**
South Service Area				
Harborside Hyatt Conference Center and Hotel	270	270	**270**	**270**
Overflow Blue Lot (Harborside Dr.)	0	0	**315**	**339**
Southwest Service Area				
Overflow Red Lot (Tomahawk Dr.)	0	0	**282**	**282**
Total spaces in service	16,612	16,612	**17,212**	**17,311**
Total spaces out of service	1,803	1,803	**1,203**	**1,104**
Total commercial spaces	18,415	18,415	**18,415**	**18,415**

Source: Logan Airport Parking Space Inventory submitted to MassDEP, March and September 2014 and 2015.
Note: Logan Airport Parking Freeze sets a limit of 21,088 spaces on Airport. As of June 2013, the allocation is 18,415 commercial and 2,673 employee spaces.

Table G-7 2015 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
1	344	23	994	1235	8812	19556	64.77	80.48	574.21	1274.31
2	496	26	532	661	4716	10467	49.97	62.09	442.99	983.20
3	1347	20	488	606	4324	9596	124.50	154.61	1103.16	2448.18
4	1166	27	1001	1243	8869	19683	221.04	274.48	1958.44	4346.36
5	378	24	1488	1849	13193	29278	106.60	132.46	945.12	2097.41
6	441	29	473	588	4195	9311	39.52	49.13	350.48	777.91
7	896	23	1013	1258	8976	19920	171.98	213.57	1523.89	3381.88
8	644	27	957	1189	8484	18828	116.81	145.13	1035.57	2298.16
9	1214	23	361	448	3197	7094	82.98	102.98	734.90	1630.72
10	1303	23	671	833	5944	13190	165.63	205.62	1467.22	3255.82
11	421	19	579	719	5130	11385	46.17	57.34	409.09	907.89
12	236	26	44	55	392	871	1.96	2.46	17.50	38.88
13	1311	26	68	85	606	1346	16.88	21.10	150.43	334.11
14	750	23	1526	1896	13528	30023	216.77	269.32	1921.63	4264.73
15	441	24	1296	1610	11488	25494	108.21	134.43	959.22	2128.69
16	1724	22	24	30	214	475	7.84	9.80	69.87	155.10
17	644	18	623	774	5523	12256	75.93	94.34	673.16	1493.79
18	354	25	603	749	5344	11860	40.44	50.23	358.37	795.34
19	687	17	71	88	628	1393	9.23	11.44	81.65	181.12
20	94	14	506	629	4488	9960	9.02	11.22	80.03	177.61
21	877	6	30	37	264	586	4.99	6.15	43.87	97.37
22	79	28	29	36	257	570	0.43	0.54	3.83	8.49
23	81	28	24	30	214	475	0.37	0.46	3.26	7.24
24	79	5	25	31	221	491	0.38	0.47	3.33	7.39
25	87	9	32	40	285	633	0.53	0.66	4.68	10.40
26	209	5	32	40	285	633	1.27	1.59	11.30	25.11
27	187	13	25	31	221	491	0.89	1.10	7.83	17.39
28	124	5	57	71	507	1124	1.34	1.67	11.94	26.47
29	226	28	361	448	3197	7094	15.45	19.18	136.85	303.67
30	1070	5	438	544	3882	8614	88.72	110.19	786.35	1744.88
31	385	31	292	363	2590	5748	21.27	26.45	188.69	418.76
32	516	25	68	85	606	1346	6.65	8.31	59.23	131.56
34	181	21	326	405	2890	6413	11.15	13.86	98.88	219.43
35	248	25	394	490	3496	7759	18.49	23.00	164.10	364.20
36	89	20	333	414	2954	6556	5.61	6.97	49.73	110.37
37	102	25	61	76	542	1203	1.18	1.47	10.52	23.35
38	110	32	105	131	935	2074	2.19	2.73	19.46	43.18
39	219	31	25	31	221	491	1.04	1.28	9.16	20.35
40	232	11	33	41	293	649	1.45	1.80	12.87	28.51
41	177	27	6	8	57	127	0.20	0.27	1.91	4.26
42	205	30	9	11	78	174	0.35	0.43	3.02	6.74
43	597	25	27	34	243	538	3.06	3.85	27.50	60.88
44	587	32	66	82	585	1298	7.34	9.12	65.03	144.29
45	96	32	59	73	521	1156	1.07	1.33	9.48	21.03
46	112	14	5	6	43	95	0.11	0.13	0.92	2.02
47	859	28	12	15	107	238	1.95	2.44	17.40	38.70
48	94	16	261	324	2312	5130	4.63	5.75	41.02	91.01
49	420	8	273	339	2419	5368	21.74	26.99	192.63	427.46
50	353	33	25	31	221	491	1.67	2.07	14.76	32.79
51	717	8	296	368	2626	5827	40.18	49.96	356.50	791.06
52	403	29	225	280	1998	4434	17.18	21.38	152.55	338.53
53	321	26	5	6	43	95	0.30	0.36	2.61	5.77
54	612	10	230	286	2041	4529	26.65	33.14	236.51	524.82

Table G-7 2015 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
55	194	8	472	586	4181	9279	17.31	21.50	153.38	340.39
56	101	5	0	0	0	0	0.00	0.00	0.00	0.00
57	97	27	119	148	1056	2344	2.19	2.73	19.46	43.21
58	103	5	0	0	0	0	0.00	0.00	0.00	0.00
59	105	5	0	0	0	0	0.00	0.00	0.00	0.00
60	331	8	599	744	5309	11781	37.49	46.57	332.32	737.43
61	224	5	188	234	1670	3705	7.96	9.91	70.69	156.83
62	218	23	289	359	2562	5685	11.96	14.85	106.01	235.24
63	242	5	0	0	0	0	0.00	0.00	0.00	0.00
64	232	5	43	54	385	855	1.89	2.38	16.95	37.64
65	593	8	701	871	6215	13792	78.77	97.87	698.37	1549.78
66	465	25	17	21	150	333	1.50	1.85	13.20	29.30
67	483	21	10	12	86	190	0.92	1.10	7.87	17.40
68	487	27	0	0	0	0	0.00	0.00	0.00	0.00
69	361	15	30	37	264	586	2.05	2.53	18.05	40.05
90	582	5	398	495	3532	7838	43.88	54.57	389.40	864.12
103	85	33	14	17	121	269	0.22	0.27	1.94	4.32
104	85	5	0	0	0	0	0.00	0.00	0.00	0.00
105	95	5	0	0	0	0	0.00	0.00	0.00	0.00
106	95	5	0	0	0	0	0.00	0.00	0.00	0.00
107	260	15	127	158	1127	2502	6.26	7.79	55.55	123.33
108	389	11	83	103	735	1631	6.11	7.59	54.14	120.13
109	114	14	29	36	257	570	0.63	0.78	5.55	12.31
110	169	16	29	36	257	570	0.93	1.15	8.21	18.21
111	261	5	0	0	0	0	0.00	0.00	0.00	0.00
112	237	28	17	21	150	333	0.76	0.94	6.74	14.97
113	565	19	29	36	257	570	3.11	3.86	27.52	61.04
114	609	5	20	25	178	396	2.31	2.88	20.52	45.66
115	451	20	262	326	2326	5162	22.38	27.85	198.68	440.92
116	399	5	30	37	264	586	2.27	2.80	19.95	44.28
117	283	5	44	55	392	871	2.36	2.95	21.02	46.71
118	295	20	275	341	2433	5400	15.36	19.04	135.86	301.54
119	240	21	202	251	1791	3975	9.18	11.41	81.43	180.72
120	365	26	60	75	535	1188	4.15	5.19	37.00	82.16
121	356	24	86	107	763	1694	5.80	7.22	51.47	114.27
122	486	23	81	100	714	1583	7.45	9.20	65.70	145.67
123	486	32	99	123	878	1948	9.10	11.31	80.74	179.15
124	280	26	50	62	442	982	2.65	3.29	23.42	52.04
125	280	19	70	87	621	1378	3.71	4.61	32.91	73.03
126	631	15	128	159	1134	2518	15.30	19.00	135.54	300.97
127	652	11	83	103	735	1631	10.25	12.72	90.78	201.44
128	257	28	29	36	257	570	1.41	1.75	12.50	27.73
129	257	17	30	37	264	586	1.46	1.80	12.84	28.51
130	422	27	0	0	0	0	0.00	0.00	0.00	0.00
131	493	18	5	6	43	95	0.47	0.56	4.01	8.86
132	361	22	146	181	1291	2866	9.98	12.37	88.24	195.90
133	236	24	74	92	656	1457	3.31	4.11	29.31	65.10
134	1521	27	200	249	1777	3943	57.60	71.71	511.75	1135.53
135	1542	24	69	86	614	1362	20.16	25.12	179.35	397.85
136	384	26	14	18	128	285	1.02	1.31	9.31	20.73
137	354	16	10	12	86	190	0.67	0.80	5.77	12.75

Table G-7 2015 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
138	225	22	39	49	350	776	1.66	2.08	14.88	33.00
139	96	15	39	49	350	776	0.71	0.89	6.38	14.14
140	295	24	70	87	621	1378	3.91	4.86	34.69	76.97
142	257	16	158	196	1398	3104	7.68	9.53	67.95	150.86
144	518	8	171	212	1513	3357	16.76	20.78	148.30	329.05
145	195	18	60	74	528	1172	2.22	2.74	19.54	43.37
146	463	18	56	70	499	1108	4.91	6.14	43.74	97.12
147	230	18	213	264	1884	4180	9.29	11.51	82.17	182.30
148	794	18	42	52	371	823	6.31	7.82	55.76	123.70
149	661	19	88	109	778	1726	11.02	13.65	97.39	216.07
150	281	19	89	110	785	1742	4.74	5.85	41.78	92.72
151	360	19	40	50	357	792	2.73	3.41	24.32	53.96
152	88	33	3	4	29	63	0.05	0.07	0.49	1.06
153	66	30	47	59	421	934	0.59	0.74	5.26	11.66
154	173	32	52	64	457	1013	1.71	2.10	14.99	33.22
155	258	30	216	268	1912	4244	10.57	13.12	93.59	207.75
156	645	26	115	143	1020	2264	14.04	17.46	124.52	276.38
157	218	22	101	125	892	1979	4.17	5.16	36.81	81.67
158	185	23	243	302	2155	4782	8.52	10.59	75.60	167.75
159	354	19	343	426	3040	6746	23.01	28.58	203.94	452.57
160	470	28	44	55	392	871	3.91	4.89	34.86	77.46
161	94	14	159	197	1406	3119	2.84	3.52	25.13	55.74
162	50	14	2	2	14	32	0.02	0.02	0.13	0.30
163	66	14	157	195	1391	3088	1.98	2.45	17.50	38.85
164	367	33	66	82	585	1298	4.59	5.70	40.69	90.28
165	124	28	102	127	906	2011	2.39	2.97	21.22	47.10
166	84	28	87	108	771	1710	1.39	1.73	12.32	27.33
167	956	28	88	109	778	1726	15.93	19.74	140.86	312.51
168	380	15	41	51	364	808	2.95	3.67	26.18	58.11
169	293	14	129	160	1142	2534	7.17	8.89	63.44	140.76
170	205	33	16	20	143	317	0.62	0.78	5.54	12.29
171	158	5	0	0	0	0	0.00	0.00	0.00	0.00
172	180	5	0	0	0	0	0.00	0.00	0.00	0.00
173	48	5	0	0	0	0	0.00	0.00	0.00	0.00
174	502	13	241	299	2133	4735	22.90	28.41	202.67	449.90
175	640	14	296	368	2626	5827	35.88	44.61	318.31	706.33
176	319	22	1260	1565	11166	24781	76.02	94.42	673.67	1495.10
177	286	29	1260	1565	11166	24781	68.27	84.80	605.02	1342.73
178	353	22	1019	1266	9033	20047	68.21	84.75	604.68	1341.98
179	348	31	757	940	6707	14885	49.85	61.90	441.63	980.12
180	366	30	808	1004	7164	15898	56.01	69.59	496.58	1101.98
181	453	14	76	95	678	1504	6.52	8.15	58.16	129.01
182	119	14	76	95	678	1504	1.71	2.13	15.22	33.76
183	50	14	64	80	571	1267	0.61	0.76	5.40	11.99
184	54	14	49	61	435	966	0.50	0.62	4.41	9.80
185	62	14	52	64	457	1013	0.61	0.75	5.35	11.86
186	39	14	108	134	956	2122	0.80	1.00	7.10	15.76
187	208	5	0	0	0	0	0.00	0.00	0.00	0.00
188	212	5	0	0	0	0	0.00	0.00	0.00	0.00
189	218	5	0	0	0	0	0.00	0.00	0.00	0.00
190	193	32	13	16	114	253	0.47	0.58	4.16	9.24

Table G-7 2015 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
191	169	5	0	0	0	0	0.00	0.00	0.00	0.00
192	540	5	56	70	499	1108	5.73	7.16	51.07	113.41
193	138	14	295	367	2619	5811	7.70	9.58	68.36	151.67
194	932	16	291	362	2583	5732	51.35	63.88	455.79	1011.45
195	79	13	15	19	136	301	0.23	0.29	2.04	4.52
196	49	13	270	336	2397	5320	2.49	3.10	22.09	49.02
197	83	14	270	336	2397	5320	4.27	5.31	37.90	84.12
198	692	14	322	400	2854	6334	42.20	52.43	374.06	830.18
199	70	28	296	368	2626	5827	3.94	4.90	34.95	77.56
200	158	5	0	0	0	0	0.00	0.00	0.00	0.00
201	160	9	49	61	435	966	1.48	1.84	13.15	29.21
202	335	22	50	62	442	982	3.17	3.93	28.03	62.28
203	30	5	0	0	0	0	0.00	0.00	0.00	0.00
204	2022	8	106	132	942	2090	40.59	50.54	360.70	800.27
205	71	25	370	460	3282	7284	5.00	6.21	44.33	98.38
206	142	25	243	302	2155	4782	6.55	8.14	58.07	128.86
207	859	33	229	285	2034	4513	37.24	46.35	330.80	733.98
208	284	33	187	232	1655	3674	10.06	12.48	89.02	197.61
209	80	30	683	849	6058	13444	10.40	12.92	92.21	204.63
210	71	30	808	1004	7164	15898	10.93	13.58	96.87	214.97
211	390	30	870	1081	7713	17117	64.23	79.81	569.47	1263.79
212	117	30	407	506	3610	8012	9.04	11.24	80.16	177.90
213	1344	24	1297	1611	11495	25510	330.26	410.21	2927.00	6495.67
214	449	31	987	1226	8748	19413	83.89	104.20	743.52	1649.97
215	1110	31	75	93	664	1473	15.76	19.54	139.54	309.55
216	905	31	396	492	3510	7791	67.91	84.37	601.92	1336.05
217	1050	31	263	327	2333	5178	52.30	65.02	463.91	1029.63
218	581	28	627	779	5558	12335	68.96	85.68	611.29	1356.66
219	1063	32	329	409	2918	6476	66.26	82.37	587.69	1304.29
220	415	32	328	408	2911	6461	25.77	32.06	228.74	507.69
221	698	32	0	0	0	0	0.00	0.00	0.00	0.00
222	1920	23	17	21	150	333	6.18	7.64	54.56	121.12
223	1564	29	957	1189	8484	18828	283.44	352.16	2512.80	5576.49
224	377	26	529	657	4688	10403	37.81	46.96	335.06	743.53
225	551	26	172	214	1527	3389	17.95	22.33	159.34	353.63
226	788	32	78	97	692	1536	11.64	14.48	103.27	229.23
227	1303	32	307	381	2718	6033	75.74	93.99	670.54	1488.36
228	580	29	993	1233	8798	19524	109.14	135.52	966.96	2145.83
229	1653	30	379	471	3361	7458	118.64	147.44	1052.14	2334.67
230	2058	29	613	761	5430	12050	238.94	296.62	2116.51	4696.85
231	1300	18	774	962	6864	15233	190.51	236.79	1689.51	3749.46
232	736	21	690	857	6115	13570	96.15	119.42	852.09	1890.91
233	488	28	630	783	5587	12399	58.23	72.37	516.40	1146.03
234	449	11	423	525	3746	8313	35.96	44.64	318.50	706.80
235	310	24	326	405	2890	6413	19.14	23.77	169.65	376.46
236	310	5	97	120	856	1900	5.70	7.06	50.34	111.73
237	105	5	263	327	2333	5178	5.24	6.52	46.49	103.19
238	697	31	92	114	813	1805	12.14	15.04	107.26	238.13
239	186	25	56	69	492	1093	1.97	2.43	17.29	38.42
240	145	29	155	192	1370	3040	4.27	5.29	37.71	83.68
241	578	29	210	261	1862	4133	23.01	28.59	204.00	452.81

Table G-7 2015 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
242	125	32	91	113	806	1789	2.15	2.67	19.05	42.29
243	564	32	91	113	806	1789	9.72	12.07	86.08	191.06
244	88	32	91	113	806	1789	1.51	1.87	13.36	29.65
245	48	5	0	0	0	0	0.00	0.00	0.00	0.00
246	175	13	202	251	1791	3975	6.69	8.32	59.35	131.73
247	65	23	3	4	29	63	0.04	0.05	0.36	0.78
248	39	13	296	368	2626	5827	2.17	2.70	19.28	42.79
249	128	13	205	255	1819	4038	4.96	6.17	44.02	97.72
250	484	13	215	267	1905	4228	19.73	24.50	174.80	387.95
251	388	5	0	0	0	0	0.00	0.00	0.00	0.00
252	308	16	306	380	2711	6017	17.88	22.20	158.38	351.52
253	54	12	10	12	86	190	0.10	0.12	0.88	1.94
254	51	5	0	0	0	0	0.00	0.00	0.00	0.00
255	290	31	3	4	29	63	0.17	0.22	1.60	3.47
256	377	31	37	46	328	728	2.64	3.29	23.43	52.01
257	215	31	23	28	200	443	0.94	1.14	8.15	18.05
258	321	29	7	9	64	143	0.43	0.55	3.89	8.69
259	203	29	2	3	21	48	0.08	0.12	0.81	1.84
260	362	29	2	3	21	48	0.14	0.21	1.44	3.29
261	219	31	20	25	178	396	0.83	1.04	7.39	16.45
262	218	13	6	7	50	111	0.25	0.29	2.06	4.57
263	177	33	24	30	214	475	0.80	1.00	7.16	15.90
264	157	5	0	0	0	0	0.00	0.00	0.00	0.00
265	2458	26	103	128	913	2027	47.95	59.58	425.01	943.58
266	752	26	147	183	1306	2898	20.94	26.06	186.00	412.72
267	1323	26	215	267	1905	4228	53.86	66.88	477.19	1059.10
268	1252	29	409	508	3625	8044	96.95	120.42	859.29	1906.79
269	302	18	19	23	164	364	1.09	1.32	9.40	20.85
270	1005	25	683	849	6058	13444	130.00	161.59	1153.03	2558.83
271	954	14	506	629	4488	9960	91.40	113.62	810.68	1799.10
272	656	18	465	578	4124	9152	57.78	71.82	512.43	1137.19
273	485	5	518	644	4595	10198	47.59	59.17	422.16	936.93
274	1244	19	159	198	1413	3135	37.46	46.65	332.91	738.62
275	419	9	0	0	0	0	0.00	0.00	0.00	0.00
276	649	19	147	182	1299	2882	18.06	22.36	159.61	354.13
277	2473	26	101	125	892	1979	47.31	58.56	417.86	927.07
278	573	30	197	245	1748	3880	21.39	26.60	189.76	421.20
279	458	18	263	327	2333	5178	22.80	28.35	202.26	448.91
280	295	24	159	198	1413	3135	8.89	11.07	79.00	175.27
281	440	14	157	195	1391	3088	13.07	16.23	115.80	257.08
282	76	14	101	126	899	1995	1.46	1.82	13.02	28.88
283	697	14	321	399	2847	6318	42.35	52.63	375.57	833.45
284	690	19	526	653	4659	10340	68.69	85.28	608.45	1350.38
285	91	19	511	635	4531	10055	8.80	10.94	78.05	173.21
286	464	19	836	1039	7413	16452	73.48	91.32	651.56	1446.03
287	229	19	806	1001	7142	15851	34.98	43.45	309.99	687.99
288	500	9	803	997	7114	15787	75.97	94.32	673.03	1493.56
289	738	21	1837	2282	16282	36135	256.78	318.98	2275.92	5051.00
290	190	25	1619	2011	14349	31844	58.18	72.27	515.66	1144.39
291	494	31	464	577	4117	9137	43.44	54.01	385.39	855.31
292	689	18	1156	1436	10246	22739	150.76	187.27	1336.20	2965.44

Table G-7 2015 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
293	325	25	1298	1612	11502	25526	79.91	99.24	708.13	1571.54
294	396	18	233	289	2062	4576	17.49	21.69	154.78	343.49
295	1017	23	1064	1322	9433	20934	204.97	254.67	1817.18	4032.74
296	162	16	222	276	1969	4370	6.82	8.48	60.47	134.20
297	140	16	222	276	1969	4370	5.88	7.31	52.16	115.77
298	951	7	167	208	1484	3294	30.09	37.48	267.38	593.49
299	805	17	240	298	2126	4719	36.60	45.44	324.17	719.55
300	518	9	103	128	913	2027	10.11	12.56	89.62	198.96
301	749	7	132	164	1170	2597	18.73	23.27	166.01	368.48
302	652	7	231	287	2048	4545	28.52	35.44	252.89	561.22
303	547	6	136	169	1206	2676	14.08	17.50	124.86	277.04
304	406	10	35	43	307	681	2.69	3.31	23.60	52.35
305	442	5	24	30	214	475	2.01	2.51	17.92	39.78
306	207	5	59	73	521	1156	2.31	2.86	20.43	45.34
307	70	5	194	241	1720	3816	2.57	3.20	22.81	50.60
308	319	8	60	75	535	1188	3.63	4.53	32.33	71.79
309	281	6	87	108	771	1710	4.63	5.75	41.02	90.97
310	555	30	491	610	4352	9659	51.57	64.07	457.08	1014.47
311	208	26	491	610	4352	9659	19.34	24.03	171.44	380.51
312	125	26	1195	1485	10596	23515	28.29	35.16	250.85	556.70
313	332	8	704	875	6243	13855	44.31	55.07	392.92	872.01
314	440	8	1057	1313	9368	20791	88.12	109.47	781.02	1733.37
315	215	18	840	1044	7449	16531	34.21	42.52	303.38	673.26
316	543	14	118	146	1042	2312	12.14	15.02	107.20	237.86
317	180	8	249	309	2205	4893	8.49	10.53	75.18	166.82
318	221	9	249	309	2205	4893	10.41	12.92	92.18	204.54
319	2544	10	341	424	3025	6714	164.29	204.28	1457.41	3234.72
320	552	7	57	71	507	1124	5.96	7.42	52.97	117.44
321	628	5	339	421	3004	6666	40.34	50.10	357.48	793.26
322	181	8	423	525	3746	8313	14.50	18.00	128.44	285.02
323	58	8	366	455	3246	7205	4.04	5.02	35.83	79.53
324	387	9	5	6	43	95	0.37	0.44	3.15	6.97
325	406	9	371	461	3289	7300	28.51	35.42	252.70	560.88
326	89	5	83	103	735	1631	1.39	1.73	12.35	27.40
327	463	10	415	515	3675	8155	36.39	45.16	322.27	715.14
328	79	19	497	617	4402	9770	7.44	9.24	65.92	146.30
329	103	19	497	617	4402	9770	9.66	11.99	85.54	189.85
330	323	11	27	33	235	523	1.65	2.02	14.37	31.97
331	179	10	342	425	3032	6730	11.59	14.40	102.75	228.07
332	993	5	386	479	3418	7585	72.58	90.07	642.69	1426.21
333	384	5	0	0	0	0	0.00	0.00	0.00	0.00
334	366	6	349	433	3090	6856	24.17	29.99	213.99	474.80
335	583	31	564	700	4995	11084	62.27	77.29	551.51	1223.81
336	428	26	906	1125	8027	17814	73.49	91.25	651.07	1444.90
337	94	26	290	360	2569	5701	5.18	6.42	45.85	101.74
338	366	5	152	189	1349	2993	10.53	13.09	93.46	207.36
339	311	5	138	172	1227	2724	8.12	10.12	72.17	160.22
340	273	19	20	25	178	396	1.03	1.29	9.20	20.46
341	66	17	20	25	178	396	0.25	0.31	2.22	4.93
342	48	11	0	0	0	0	0.00	0.00	0.00	0.00
343	52	22	47	58	414	918	0.46	0.57	4.08	9.04

Table G-7 2015 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
344	82	12	35	44	314	697	0.54	0.68	4.88	10.84
345	25	5	71	88	628	1393	0.34	0.42	2.97	6.60
346	121	5	70	87	621	1378	1.60	1.99	14.18	31.47
347	303	9	105	130	928	2059	6.02	7.46	53.24	118.12
348	146	6	494	614	4381	9723	13.67	17.00	121.27	269.15
349	67	6	188	234	1670	3705	2.38	2.96	21.11	46.84
350	446	5	186	231	1648	3658	15.70	19.50	139.13	308.81
351	335	5	32	40	285	633	2.03	2.54	18.11	40.22
352	430	5	266	331	2362	5241	21.64	26.93	192.20	426.47
353	360	5	43	53	378	839	2.93	3.61	25.74	57.13
354	50	14	105	130	928	2059	0.99	1.23	8.79	19.50
355	88	5	182	226	1613	3579	3.04	3.77	26.94	59.77
356	113	5	491	610	4352	9659	10.51	13.06	93.17	206.78
358	463	18	0	0	0	0	0.00	0.00	0.00	0.00
359	229	5	4	5	36	79	0.17	0.22	1.56	3.43
360	245	25	4	5	36	79	0.19	0.23	1.67	3.67
361	248	14	44	55	392	871	2.06	2.58	18.40	40.88
362	199	13	44	55	392	871	1.66	2.07	14.79	32.86
363	230	21	48	60	428	950	2.09	2.61	18.63	41.34
364	256	27	48	60	428	950	2.33	2.91	20.76	46.09
365	201	8	14	18	128	285	0.53	0.68	4.87	10.84
366	201	23	71	88	628	1393	2.71	3.35	23.93	53.08
367	337	31	658	818	5837	12953	42.01	52.22	372.62	826.89
368	868	8	404	502	3582	7949	66.45	82.57	589.15	1307.40
369	167	5	357	444	3168	7031	11.32	14.07	100.43	222.88
370	96	11	354	440	3139	6967	6.41	7.97	56.87	126.22
371	141	24	723	898	6407	14220	19.30	23.97	170.99	379.51
372	283	16	278	345	2462	5463	14.89	18.48	131.89	292.65
373	283	24	136	169	1206	2676	7.29	9.05	64.61	143.35
			Logan Airport VMT				**8,580**	**10,660**	**76,058**	**168,791**

AWDT = Average annual weekday daily traffic

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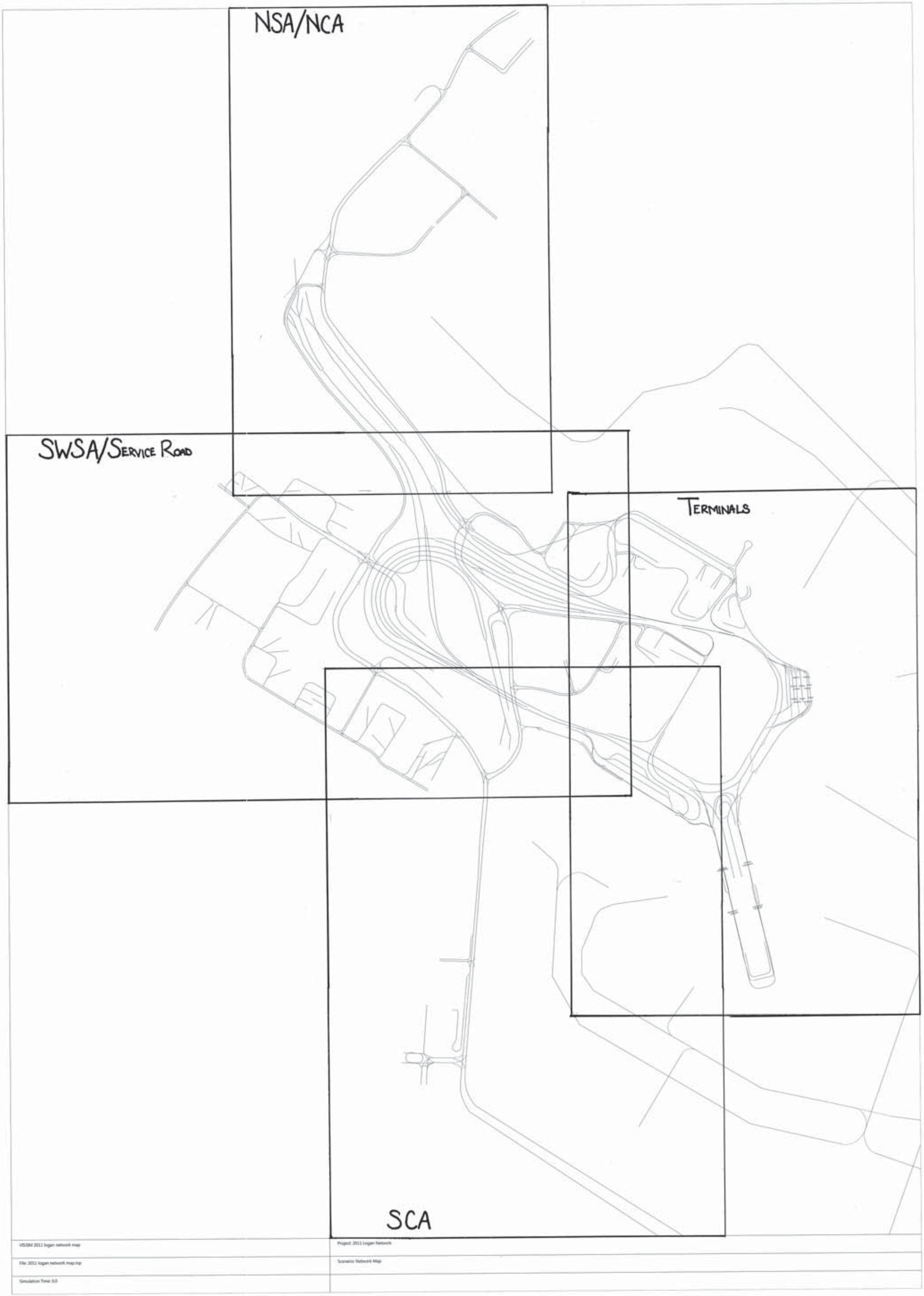
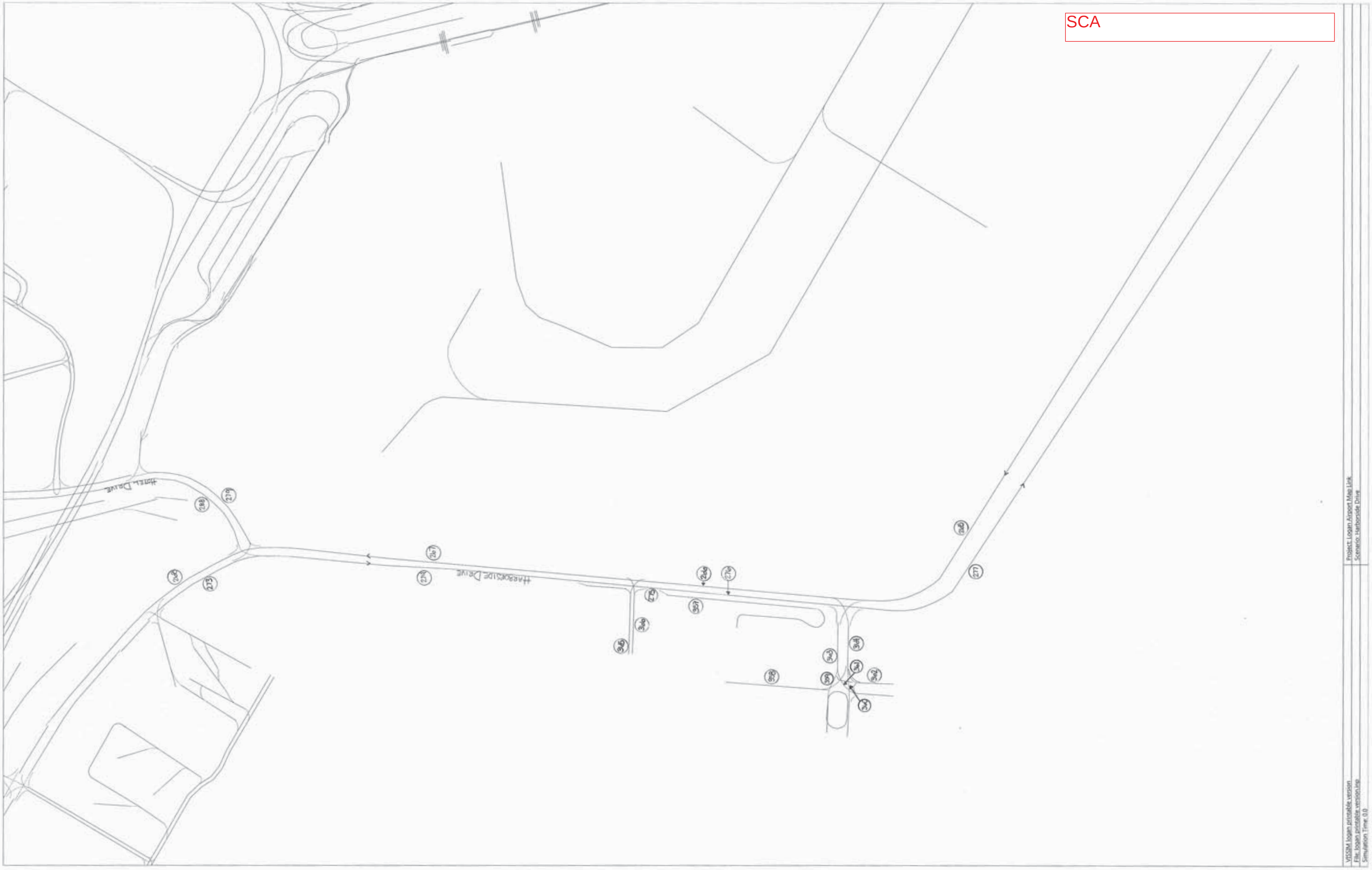
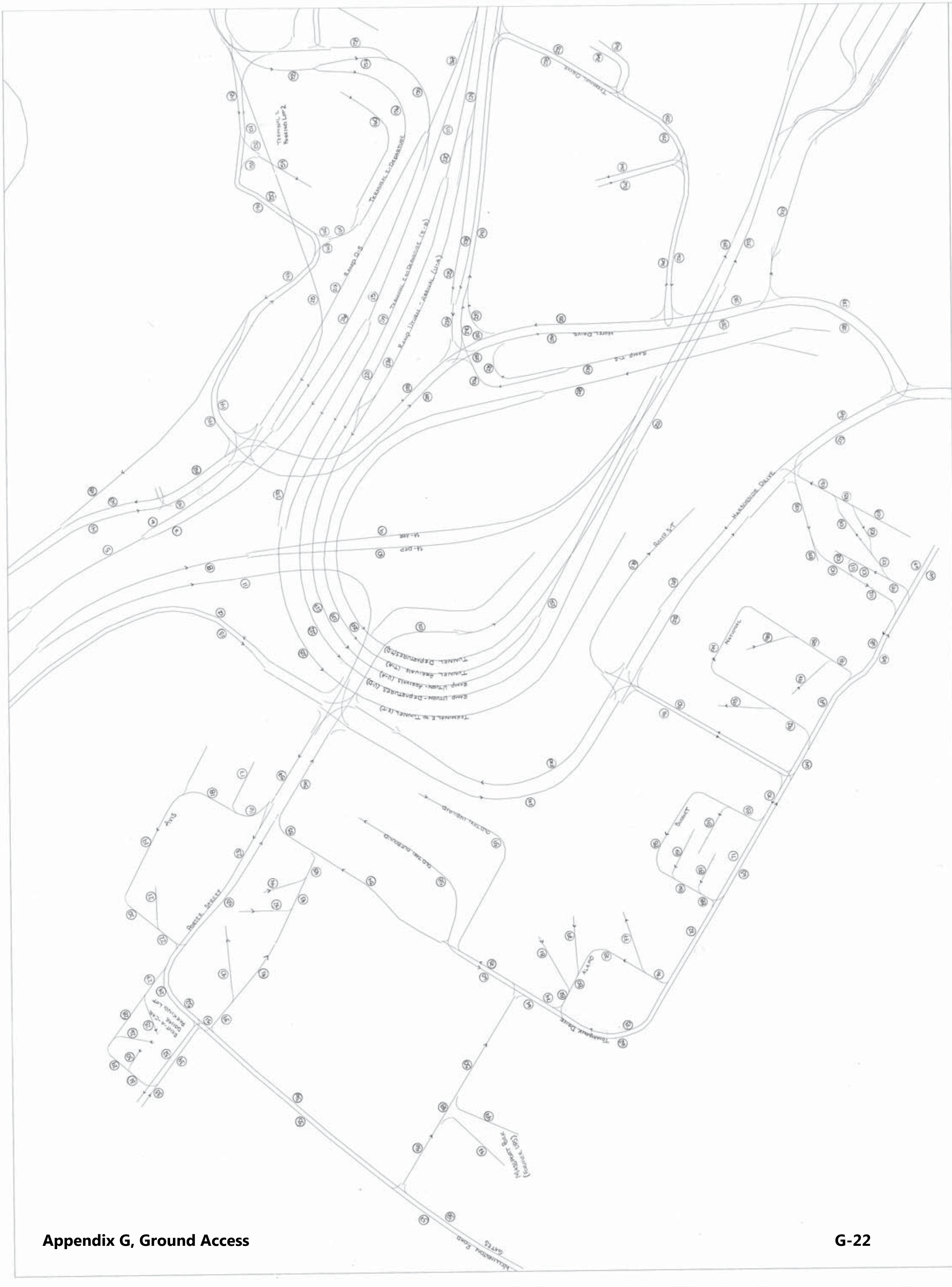
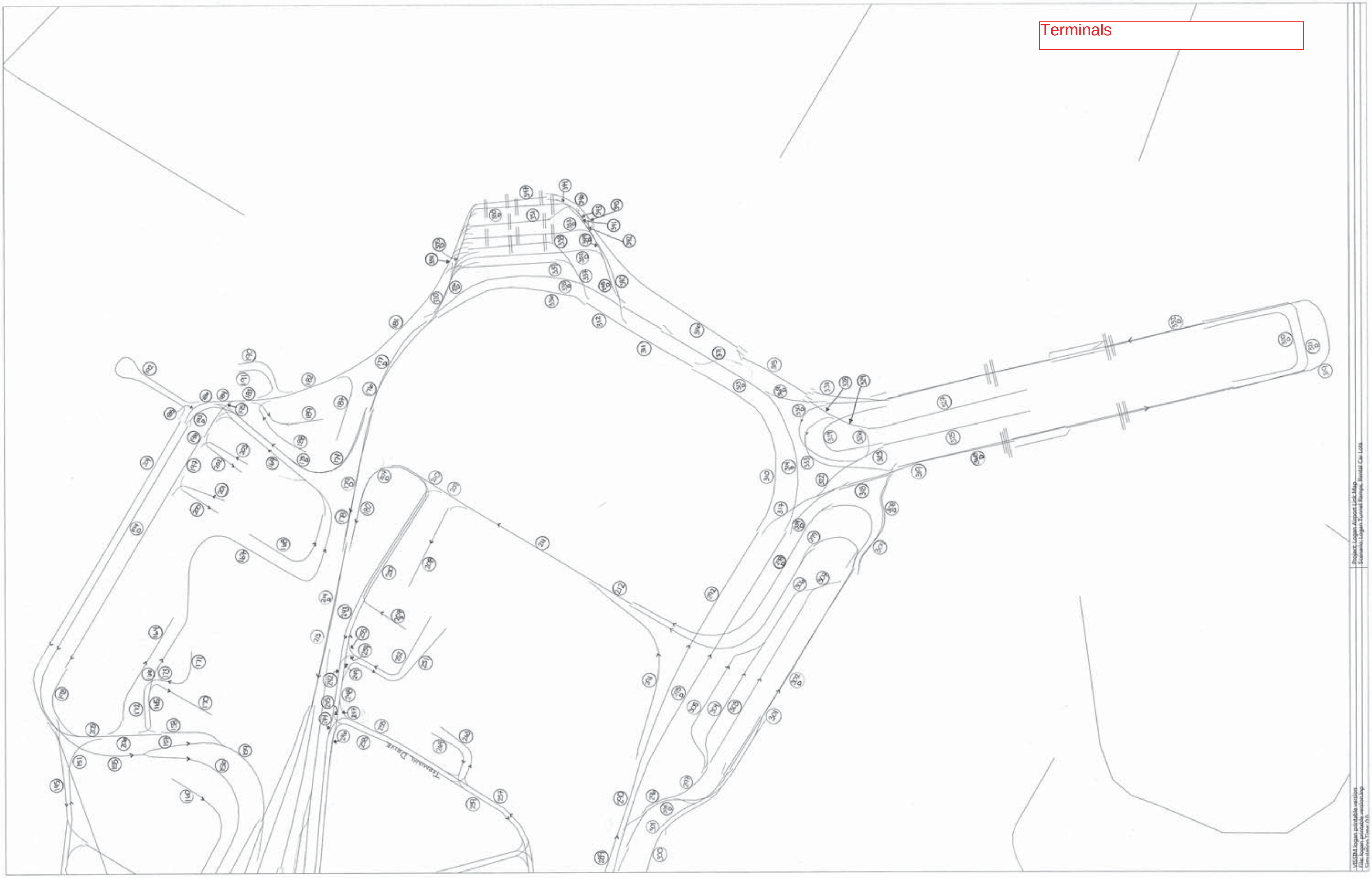

NSA/NCA
SWSA/Service Road
Terminals
SCA
VISSIM 2011 logan network map
File: 2011 logan network map.inp
Simulation Time: 0.0
Project: 2011 Logan Network
Scenario: Network Map


NSA/NCA
Service Road
Cottage Street
Economy Bus Driveway
Economy Parkway Drive
Prescott Street
Frankfort Street
Lovell
Ramp 1A-SB
SCT IB
RT 1A-IB
RT 1A-OB
SCT OB


SCA
Harborside Drive
Hotel Drive

SWSA/Service Roadways




Terminals

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massport
Massachusetts Port Authority
One Harborside Drive, Suite 200-S
East Boston, MA 02128-2909
Telephone: 617-568-5000
www.massport.com

March 4, 2015

Christine Kirby, Director, Air & Climate Division
Department of Environmental Protection
Bureau of Air & Waste
One Winter Street
Boston, MA 02108

Re: March 1st, 2015, Logan Airport Parking Space Inventory

Dear Ms. Kirby:

In compliance with the reporting requirements of 310 CMR 7.30 (3)(d), enclosed are the following March 1st, 2015, Massachusetts Port Authority (Massport) submissions for Logan Airport:

- Commercial Parking Space Inventory
- Employee Parking Space Inventory
- Location Map

The attachments provide the quantity, physical distribution, and allocation of commercial and employee parking spaces on the airport, as defined by 310 CMR 7.30, as amended. These inventory tables represent information provided by the Aviation Department; the employee and commercial space counts are supported by comprehensive field checks and counts recently conducted in late February 2015. We continue to provide information on rental car spaces as a courtesy.

Massport's parking program remains in compliance with the Aviation and Transportation Security Act of 2001 (ATSA) and supplemental FAA security directives, and our top priority continues to be the safe and secure operation of our transportation and parking facilities.

The Commercial Parking Space Inventory totals 18,415 spaces; the Employee Parking Space Inventory totals 2,673 parking spaces; the total inventory of spaces at Logan Airport is 21,088. The allocations within each of the categories had changes because of the recent relocation of the taxi pool, the relocation of the bus/limo pool, and construction impacting a hotel lot.

Demand for commercial parking at Logan Airport continues to be strong. While the Aviation Department deploys operational innovations to accommodate passenger parking demand, a broader strategic planning effort is underway to plan for ground access needs at future passenger levels. As part of this effort, Massport is planning to consolidate all remaining (i.e., designated) parking spaces allowed under the freeze by adding to the West Garage structure located in the central terminal area.

The attached Logan Airport Parking Space Inventory reflects Massport's successful management of its parking program, within the requirements of 310 CMR 7.30, as amended. If you have any questions, please call me at 617-561-3425.

Sincerely,

Lourenço Dantas, AICP
Senior Transportation Planner
Strategic & Business Planning Department

cc: S. Dalzell, MPA
B. Desrosiers, MPA
I. Wallach, MPA
D. Conroy, EPA

Commercial Parking Space Inventory
Logan International Airport
March 1, 2015 Submission

Commercial Parking Spaces

Map ID#	Location of Commercial Parking Areas	Number of Spaces
Terminal Area and Economy Spaces		
C1	Central Garage	7,077
C2	West Garage	3,190
C3	Terminal B Garage	2,254
C5	Terminal E Lot 1	243
C6	Terminal E Lot 2	248
C7	Terminal E Lot 3 (fka "Gulf Station" Lot)	219
C8	Economy Garage	2,809
	subtotal	*16,040*
Overflow Commercial Spaces		
C11	Red Lot (Tomahawk Dr.)	282
C12	Blue Lot (Harborside Dr.)	315
C13	Green Lot (Wood Island)	235
	subtotal	*832*
Hotel Spaces		
C4a ~~& C4b~~	Logan Airport Hilton Hotel (one lot)	35
C10	Harborside Hyatt Conference Center	270
	subtotal	*305*
General Aviation Spaces		
C9	Signature (General Aviation Terminal)	35
	subtotal	*35*

Total In-Service Commercial Parking Spaces	**17,212**
Total Designated Commercial Parking Spaces	**1,203**
Total Commercial Parking Spaces	**18,415**
Total Employee Parking Spaces *(see table on next page)*	**2,673**
TOTAL PARKING FREEZE SPACES	**21,088**

Employee Parking Space Inventory
Logan International Airport
March 1, 2015 Submission

Employee Parking Spaces

	Map ID#	Location of Employee Parking Areas	Number of Spaces
Terminal Area	E81	West Garage	98
	E26	Airport Tower/Administration (parking in Central Garage)	524
	E20	Terminal C Pier A (Old Terminal D) (two lots)	122
	E18	Massport Facilities 1 (Heating Plant)	92
	E34	Hilton Hotel employee lot	28
	E86	Gulf Gas Station	4
North Service Area	E68a	LSG Sky Chefs (Bldg. 68), main lot	25
	E68b	LSG Sky Chefs (Bldg. 68), overflow lot	126
	E1	Flight Kitchen Building 1 (and nearby lot)	80
	E40	Lovell Street Lot (contractor trailer)	25
	E53	Green Bus Depot (Bus Maintenance Facility)	12
	E11a	North Cargo Building 11, TSA lot	93
	E11b	North Cargo Building 11, State Police lot	136
	E43	North Gate & EMS Trailer (EMS Station A7)	26
	E8	North Cargo Building 8	114
	E5	US Airways Administration/Hangar (Bldg. 5)	75
	N/A	Massport Facilities 2 (airside, Bldg. 3)	0
	E4	Massport Facilities 3 (landside, Bldg. 4)	69
	E13	UPS (Cargo Building 13)	44
	E94	United Aircraft Maintenance (Buildings 93 & 94)	56
SWSA	E59	Bus/Limo Pool Lot	3
	E60	Rental Car Center (Customer Service Center)	4
	E72	Taxi Pool Lot	7
South Service Area	E84	Bird Island Flats / Logan Office Center (LOC) Garage	425
	E63	South Cargo Building 63	16
	E62	South Cargo Building 62	43
	E58	South Cargo Building 58	23
	E57	South Cargo Building 57	44
	E56	South Cargo Building 56	39
	E78	Fire-Rescue HQ & Amelia Earhart Terminal/Hangar	84
	N/A	*ARFF Satellite Station* [1]	0

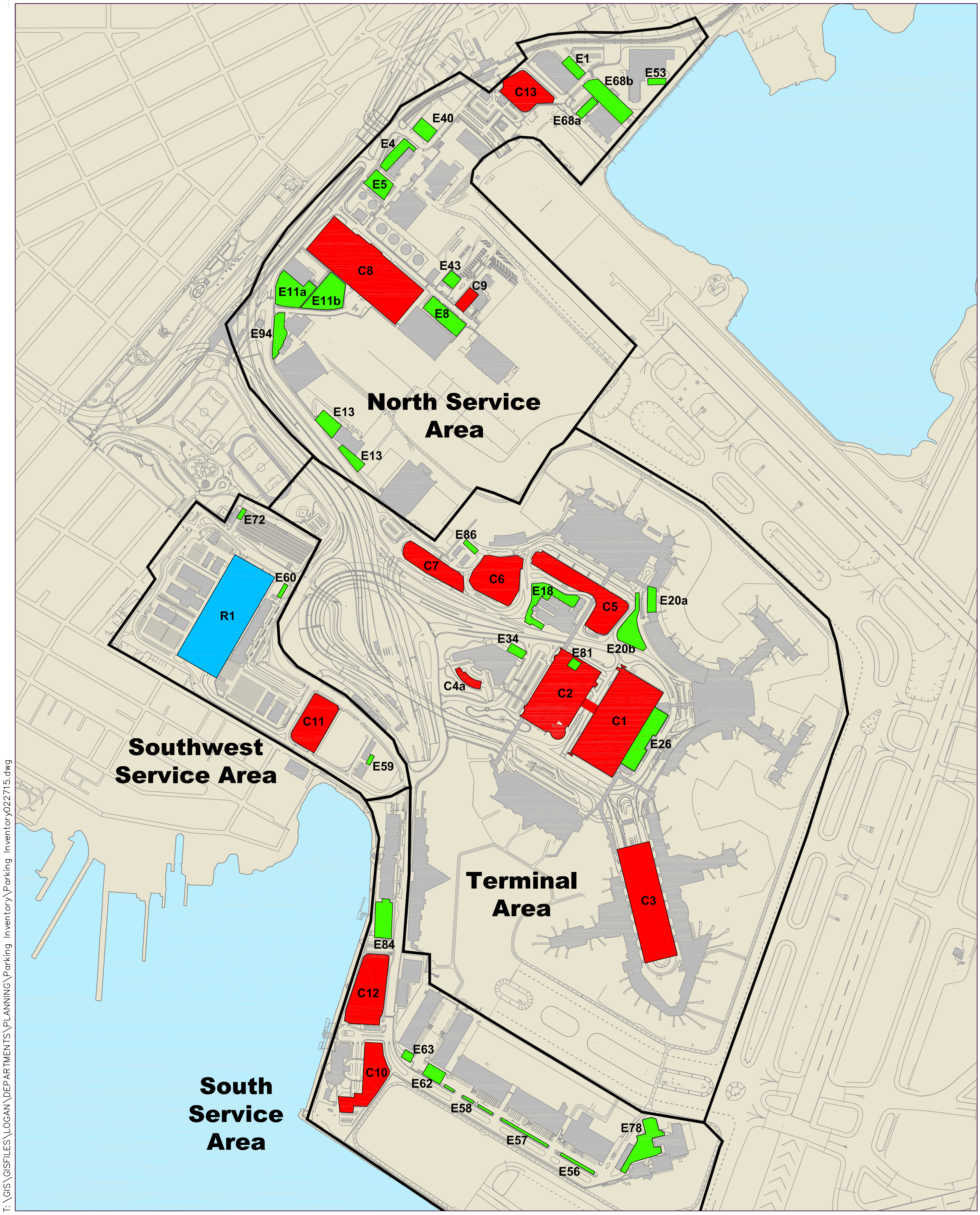
[1] This facility is located on the airfield and is not shown in the map. No employee parking spaces are provided.

Total In-Service Employee Parking Spaces	**2,437**
Total Designated Employee Parking Spaces	**236**
Total Employee Parking Spaces	**2,673**
Total Commercial Parking Spaces *(see table on previous page)*	**18,415**
TOTAL PARKING FREEZE SPACES	**21,088**

For Information Only:
Rental Car Spaces Inventory
Logan International Airport
March 1, 2015 Submission

Rental Car Company Parking Spaces

Map ID#		Number of Spaces
R1	Rental Car Center (RCC)	5,020
Total Rental Car Spaces		**5,020**



Logan Airport
Parking Space Inventory

Logan International Airport
East Boston, MA

massport

Massachusetts Port Authority
March 1, 2015

Legend:

- Logan Parking Service Area Zones
- Commercial Parking Space Locations
- Employee Parking Space Locations
- Rental Car Parking Space Locations

N

0 250 500 1000
in feet

Notes:

This plan is intended for informational purposes only and no use may be made of the same without the express written permission of the Massachusetts Port Authority ("Massport"). Massport does not certify the accuracy, information or title to the properties contained in this plan nor make any warranties of any kind, express or implied, in fact or by law, with respect to any boundaries, easements, restrictions, claims, overlaps or other encumbrances affecting such properties.

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One Harborside Drive, Suite 200-S
East Boston, MA 02128-2909
Telephone: 617-568-5000
www.massport.com

September 1, 2015

Christine Kirby, Director, Air & Climate Division
Massachusetts Department of Environmental Protection
Bureau of Air & Waste
One Winter Street
Boston, MA 02108

Re: September 1st, 2015, Logan Airport Parking Space Inventory

Dear Ms. Kirby:

In compliance with the reporting requirements of 310 CMR 7.30 (3)(d), enclosed are the following September 1st, 2015, Massachusetts Port Authority (Massport) submissions for Logan Airport:

- Commercial Parking Space Inventory
- Employee Parking Space Inventory
- Location Map

The attachments provide the quantity, physical distribution, and allocation of commercial and employee parking spaces on the airport, as defined by 310 CMR 7.30, as amended. These inventory tables represent information provided by the Aviation Department and are supported by comprehensive field checks and counts conducted in late August 2015.

The Commercial Parking Space Inventory totals 18,415 spaces; the Employee Parking Space Inventory totals 2,673 parking spaces; the total inventory of spaces at Logan Airport is 21,088. For your information, we continue to provide information on rental car spaces.

As noted in our March letter, Massport is consolidating all remaining (i.e., designated) parking spaces allowed under the freeze by adding to the central terminal area's West Garage. We expect that the additional spaces will be open to the public by the end of the year.

The attached Logan Airport Parking Space Inventory reflects Massport's successful management of its parking program, within the requirements of 310 CMR 7.30, as amended. If you have any questions, please call me at 617-561-3425.

Sincerely,

Lourenço Dantas, AICP
Senior Transportation Planner
Strategic & Business Planning Department

cc: D. Conroy, EPA
S. Dalzell, MPA
B. Desrosiers, MPA
H. Morrison, MPA
I. Wallach, MPA

Commercial Parking Space Inventory
Logan International Airport
September 1, 2015 Submission

Commercial Parking Spaces

Map ID#	Location of Commercial Parking Areas	Number of Spaces
Terminal Area and Economy Spaces		
C1	Central Garage	7,213
C2	West Garage	3,127
C3	Terminal B Garage	2,201
C5	Terminal E Lot 1	237
C6	Terminal E Lot 2	249
C7	Terminal E Lot 3 (fka "Gulf Station" Lot)	217
C8	Economy Garage	2,864
	subtotal	*16,108*
Overflow Commercial Spaces		
C11	Red Lot (Tomahawk Dr.)	282
C12	Blue Lot (Harborside Dr.)	339
C13	Green Lot (Wood Island)	242
	subtotal	*863*
Hotel Spaces		
C4a ~~& C4b~~	Logan Airport Hilton Hotel (one lot)	35
C10	Harborside Hyatt Conference Center	270
	subtotal	*305*
General Aviation Spaces		
C9	Signature (General Aviation Terminal)	35
	subtotal	*35*

Total In-Service Commercial Parking Spaces	**17,311**
Total Designated Commercial Parking Spaces	**1,104**
Total Commercial Parking Spaces	**18,415**
Total Employee Parking Spaces *(see table on next page)*	**2,673**
TOTAL PARKING FREEZE SPACES	**21,088**

Employee Parking Space Inventory
Logan International Airport
September 1, 2015 Submission

Employee Parking Spaces

Area	Map ID#	Location of Employee Parking Areas	Number of Spaces
Terminal Area	E81	West Garage	98
	E26	Airport Tower/Administration (parking in Central Garage)	521
	E20	Terminal C Pier A (Old Terminal D) (two lots)	122
	E18	Massport Facilities 1 (Heating Plant)	92
	E34	Hilton Hotel employee lot	28
	E86	Gulf Gas Station	4
North Service Area	E68a	LSG Sky Chefs (Bldg. 68), main lot	25
	E68b	LSG Sky Chefs (Bldg. 68), overflow lot	126
	E1	Flight Kitchen Building 1 (and nearby lot)	80
	E40	Lovell Street Lot (contractor trailer)	25
	E53	Green Bus Depot (Bus Maintenance Facility)	12
	E11a	North Cargo Building 11, TSA lot	93
	E11b	North Cargo Building 11, State Police lot	136
	E43	North Gate & EMS Trailer (EMS Station A7)	21
	E8	North Cargo Building 8	114
	E5	US Airways Administration/Hangar (Bldg. 5)	75
	N/A	Massport Facilities 2 (airside, Bldg. 3)	0
	E4	Massport Facilities 3 (landside, Bldg. 4)	69
	E13	UPS (Cargo Building 13)	44
	E94	United Aircraft Maintenance (Buildings 93 & 94)	56
SWSA	E59	Bus/Limo Pool Lot	4
	E60	Rental Car Center (Customer Service Center)	4
	E72	Taxi Pool Lot	8
South Service Area	E84	Bird Island Flats / Logan Office Center (LOC) Garage	416
	E63	South Cargo Building 63	16
	E62	South Cargo Building 62	43
	E58	South Cargo Building 58	23
	E57	South Cargo Building 57	44
	E56	South Cargo Building 56	39
	E78	Fire-Rescue HQ & Amelia Earhart Terminal/Hangar	84
	N/A	*ARFF Satellite Station*[1]	0

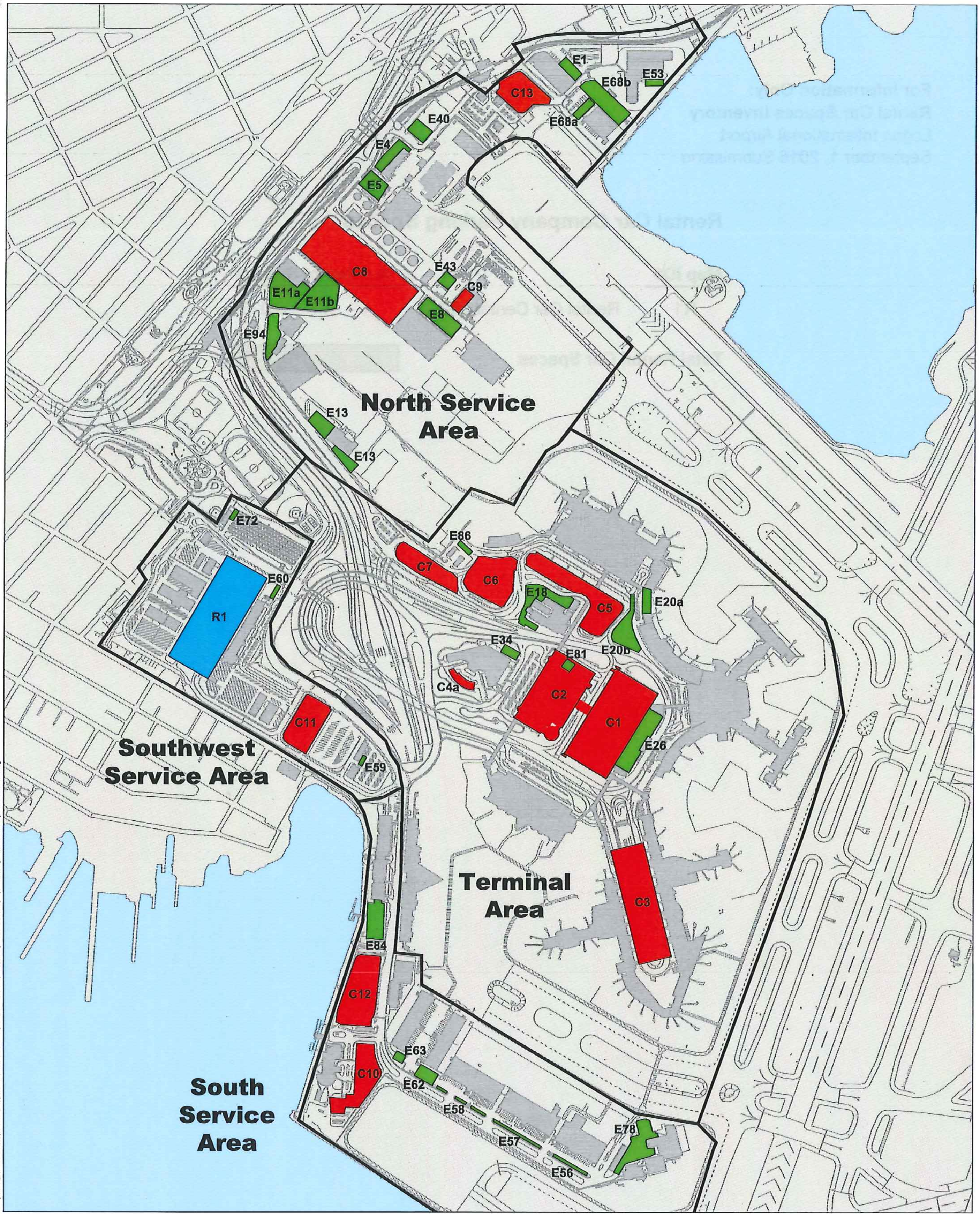
[1] This facility is located on the airfield and is not shown in the map. No employee parking spaces are provided.

Total In-Service Employee Parking Spaces	**2,422**
Total Designated Employee Parking Spaces	**251**
Total Employee Parking Spaces	**2,673**
Total Commercial Parking Spaces *(see table on previous page)*	**18,415**
TOTAL PARKING FREEZE SPACES	**21,088**

For Information Only:
Rental Car Spaces Inventory
Logan International Airport
September 1, 2015 Submission

Rental Car Company Parking Spaces

Map ID#		Number of Spaces
R1	Rental Car Center (RCC)	5,020
Total Rental Car Spaces		**5,020**



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Logan Airport
Parking Space Inventory

Logan International Airport
East Boston, MA
Massachusetts Port Authority
September 1, 2015

Legend:

- Logan Parking Service Area Zones
- Commercial Parking Space Locations
- Employee Parking Space Locations
- Rental Car Parking Space Locations

Notes:

This plan is intended for informational purposes only and no use may be made of the same without the express written permission of the Massachusetts Port Authority ("Massport"). Massport does not certify the accuracy, information or title to the properties contained in this plan nor make any warranties of any kind, express or implied, in fact or by law, with respect to any boundaries, easements, restrictions, claims, overlaps or other encumbrances affecting such properties.

H

Noise Abatement

This appendix provides detailed information, tables, and figures in support of Chapter 6, *Noise Abatement*. The contents of this appendix are summarized below.

- Massport Letter to FAA Regarding AEDT Model Results
- Fundamentals of Acoustics and Environmental Noise
  - Figure H-1 Frequency-Response Characteristics of Various Weighting Networks
  - Figure H-2 Common Environmental Sound Levels, in dBA
  - Figure H-3 Variations in the A-Weighted Sound Level Over Time
  - Figure H-4 Sound Exposure Level (SEL)
  - Figure H-5 Example of a One Minute Equivalent Sound Level (L_{eq})
  - Figure H-6 Daily Noise Dose
  - Figure H-7 Examples of Day-Night Average Sound Levels (DNL)
  - Figure H-8 Outdoor Speech Intelligibility
  - Figure H-9 Probability of Awakening at Least Once from Indoor Noise Event
  - Figure H-10 Percentage of People Highly Annoyed
  - Figure H-11 Community Reaction as a Function of Outdoor DNL
- Regulatory Framework
- Logan Airport RealContours™ Data Inputs
  - Figure H-12 Schematic Noise Modeling Process (Standard INM vs. RealContours™)
  - Table H-1a 2014 Annual Modeled Operations
  - Table H-1b 2015 Annual Modeled Operations
  - Table H-2a 2014 Modeled Runway Use by Aircraft Group
  - Table H-2b 2015 Modeled Runway Use by Aircraft Group
  - Table H-3a Summary of Jet and Non-Jet Aircraft Runway Use: 2014
  - Table H-3b Summary of Jet and Non-Jet Aircraft Runway Use: 2015
  - Table H-4 Total 2014 and 2015 Modeled Runway Use by All Operations
  - Table H-5 Total Count of Flight Tracks Modeled in RealContours™ (2014 and 2015)
  - Table H-6 Modeled Daily Operations by Commercial & GA Aircraft – 1990 to 2015

- Table H-7 Percentage of Commercial Jet Operations by Part 36 Stage Category – 1999 to 2015
- Table H-8 Modeled Nighttime Operations at Logan Airport – 1990 to 2015
- Table H-9 Summary of Jet Aircraft Runway Use – 1990 to 2015

- Annual Model Results and Status of Mitigation Programs

- Table H-10 Noise-Exposed Population by Community
- Table H-11 Residential Sound Insulation Program (RSIP) Status (1986-2015)
- Table H-12 Schools Treated Under Massport Sound Insulation Program
- Figure H-13 Number of Callers and Complaints between 2000 and 2015
- Table H-13 Noise Complaint Line Summary
- Table H-14 Cumulative Noise Index (EPNL) – 1990 to 2015

- Flight Track Monitoring Report

- Figure H-14 Logan Airport Flight Track Monitor Gates
- Table H-15a Runway 4R Nahant Gate Summary for 2014
- Table H-15b Runway 4R Nahant Gate Summary for 2015
- Table H-16a Runway 4R Shoreline Crossings Above 6,000 Feet for 2014
- Table H-16b Runway 4R Shoreline Crossings Above 6,000 Feet for 2015
- Table H-17a Runway 9 Gate Summary – Winthrop Gates 1 and 2 for 2014
- Table H-17b Runway 9 Gate Summary – Winthrop Gates 1 and 2 for 2015
- Table H-18a Runway 9 Shoreline Crossings Above 6,000 feet for 2014
- Table H-18b Runway 9 Shoreline Crossings Above 6,000 feet for 2015
- Table H-19a Runway 15R Shoreline Crossings Above 6,000 feet for 2014
- Table H-19b Runway 15R Shoreline Crossings Above 6,000 feet for 2015
- Table H-20a Runways 22R and 22L Squantum 2 Gate Summary for 2014
- Table H-20b Runways 22R and 22L Squantum 2 Gate Summary for 2015
- Table H-21a Runways 15R, 22R, and 22L Hull 1 Gate Summary – North of Hull Peninsula for 2014
- Table H-21b Runways 15R, 22R, and 22L Hull 1 Gate Summary – North of Hull Peninsula for 2015
- Table H-22a Runways 22R and 22L Shoreline Crossings Above 6,000 Feet for 2014
- Table H-22b Runways 22R and 22L Shoreline Crossings Above 6,000 Feet for 2015
- Table H-23a Runway 27 Corridor Percent of Tracks Through Each Gate for 2014
- Table H-23b Runway 27 Corridor Percent of Tracks Through Each Gate for 2015

  - Table H-24a	Runway 33L Gates – Passages Below 3,000 Feet for 2014
  - Table H-24b	Runway 33L Gates – Passages Below 3,000 Feet for 2015
  - Table H-25	Runway Usage by Runway End
- Logan Airport Census Block Group Noise Levels
  - Table H-26	Logan Census Block Group Noise Levels
- Dourado, E. and Russell, R. October 2016. "Airport Noise NIMBYism: An Empirical Investigation." *Mercatus on Policy: Mercatus Center at George Mason University*.

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November 16, 2016

Richard Doucette
Airports Division
Federal Aviation Administration, New England Region
1200 District Avenue
Burlington, MA 01803

Dear Mr. Doucette:

Following up to our October 17th meeting where we discussed the FAA's new AEDT model for noise and air emissions, I am writing to you to request that FAA review the AEDT model results as applied to Boston Logan International Airport (Boston Logan) both related to noise and air quality. We also request that the FAA work with Massport and our consultants to develop Logan specific modification to the AEDT so that the model more accurately reflects the local noise and air quality environment.

As you are aware, Massport produces and circulates an annual environmental and planning report for Boston Logan to state officials and the interested public. FAA noise and air quality models form the basis of much of these reports. Massport also seeks to maintain with the FAA an updated Noise Exposure Map that supports our soundproofing efforts of eligible homes. As a result, Massport publishes annually Boston Logan specific noise and air quality data based on the latest FAA approved models (previously the INM and EDMS models). Overtime, Massport has worked closely with the FAA, and USDOT Volpe Center, to enhance the INM including, for example, Logan-specific modifications for "hill effects" and "over water propagation".

For the 2015 calendar year EDR, Massport's noise and air quality consultants utilized the FAA's new AEDT model (Version 2B Service Pack 2). Based on preliminary results, we have strong concerns on the general applicability of the noise module to accurately reflect Boston Logan's noise environment. To assist with the development of a Boston Logan specific modeling process, we have asked our consultant to put together a request (attached) to be sent to FAA AEE for review and approval of AEDT Non-standard modeling and methods. Finally, we also have a narrower concern on the AEDT's estimate of Particulate Matter (PM) which we would also like to discuss.

We look forward to working with you on reviewing and modifying the AEDT to better reflect Boston Logan's noise and air quality footprint.

Very truly yours,

Flavio Leo
Director, Aviation Planning & Strategy

CC: Mary Walsh (FAA), Gail Latrell (FAA), Stewart Dalzell (Massport)

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TECHNICAL MEMORANDUM

To:	Flavio Leo Massport One Harborside Drive, Suite 2005 East Boston, MA 02128
From:	Robert Mentzer Jr., HMMH Bradley Dunkin, HMMH
Date:	November 16, 2016
Subject:	Logan International Airport Annual DNL Noise Contours - Requested Review and Approval of Aviation Environmental Design Tool Non-Standard Modeling
Reference:	HMMH Project Number 307260.002

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1. INTRODUCTION

Harris Miller Miller & Hanson Inc. (HMMH) is assisting the Massachusetts Port Authority (Massport) in the preparation of their annual DNL noise contours for the Massachusetts Environmental Policy Act (MEPA) review. Massport will also potentially use the updated DNL contour to submit to FAA for additional sound insulation funding. We plan to use the Aviation Environmental Design Tool (AEDT) Version 2c (released September 2016) for all future aircraft noise modeling. Consistent with Federal Aviation Administration (FAA) policies and procedures, any changes to the standard AEDT modeling procedures require prior written approval from the FAA Office of Environment and Energy Noise Division (AEE-100). This requirement applies to the use of custom adjustments to the model and use of non-standard data.

As part of the preparation of Massport's annual Environmental Data Review (EDR) for 2015, an AEDT study using the latest version available at the time (Version 2b, Service Pack 2) was conducted in order to assess consistency with an INM study of the same data, as well as INM results for previous years. The judgment was made that the results were not consistent, and that this was largely due to unique conditions at Logan Airport that have, in the past, been addressed by specific FAA-approved adjustments to the INM process. Massport seeks to work with the FAA to develop and implement approved methods to address these conditions in future AEDT studies.

Massport has historically strived to provide an accurate DNL contour to the public. This has resulted in several model methods and adjustments that are Logan-specific:

- 1996 – Overwater adjustment approved for INM model
- 1999 – Hill Effects adjustment approved for the INM model
- 2004 – All radar tracks used for modeling - RealContours & RealProfiles
    - Stagelength selected by Profile match
    - Custom Profile developed for each flight
- 2007 Incorporation of daily weather averages for modeling

Massport has consistently used the updated INM version in the year of or the year after its release. The Overwater and Hill Effects adjustments were also approved for use in the Logan Airside EIS (LAIP) completed in 2001.

On behalf of Massport, HMMH is evaluating the options and data available in AEDT and is in the process of developing recommended adjustments and non-standard data for AEDT. Massport is requesting AEE review and concurrence of this process to develop and implement adjustments and the use of non-standard data for AEDT for Logan International Airport.

2. OVERWATER ADJUSTMENT

2.1 Background

Logan Airport is surrounded on three sides by water. Massport has several permanent noise monitoring sites located near the edge of the Harbor that have consistently measured noise and reported levels higher than modeled with the standard INM. Massport commissioned additional noise measurement data and along with their consultants developed a method to increase the thrust of aircraft in the INM on takeoff roll to more accurately reflect the monitoring results.

2.2 Current Method

The current method involves the development of an adjustment grid to increase the noise levels from aircraft departing on the runways at Logan Airport. The adjustment generally results in a 6 dB increase from departing aircraft up to 100 feet above the runway. A point is inserted in the profile at 100 feet to return the aircraft to its normal model thrust and climb.

All jet departures for each year are run in the model with the adjustment and then without. The grid without the increase is subtracted from the grid with the increased thrust. This results in an adjustment grid which can be applied to the annual INM result. This results in increased noise levels on the west sides of Runway 15R-33L and portions of Runway 4L-22R that are not adjacent to water however most of this area is airport property.

2.3 Proposed Method

We are aware that ACRP 02-52, *Improving AEDT Noise Modeling of Ground Surfaces* is underway and is designed to provide a method for incorporating modeling of mixed surfaces within the AEDT. Until such time that this option is available in AEDT, we propose to use the GIS capabilities of the AEDT and modify noise levels over identified hard water surfaces. This method will also eliminate noise increases over areas of non-water surfaces as was done by the previous method. The existing Department of Defense NOISEMAP model has a method for modeling mixed surfaces once they have been identified using mapping however its civil aircraft database is very limited (Lear35, older 747, DC9 aircraft). The NOISEMAP model also uses the NMPLOT grid format which can easily be applied to the AEDT NMPLOT result grid.

HMMH has been evaluating this method and propose to incorporate a representative current fleet of aircraft into the Noisemap database to develop an adjustment grid for AEDT. Using the representative fleet, we will model a set of prototypical flight tracks for arrivals and departures in the model both with and without the mixed surfaces adjustment turned on. The grid without the adjustment will be subtracted from the grid with the adjustment and the result added to the AEDT NMPLOT result grid.

As this approach incorporates the effects of surface reflections directly rather than using increased thrust as a proxy, the results should have equal or better accuracy than the former method if implemented correctly.

Please let us know if you concur with this approach or suggest an alternate method.

3. HILL EFFECTS ADJUSTMENT

3.1 Background

This adjustment has been used since 1999 and was developed and approved by FAA for use in the INM (was used in LAIP EIS). Orient Heights just to the northwest of Runway 22R has a rapid increase in elevation and residents look down onto the runway and start of takeoffs from Runway 22R.

Massport conducted a measurement program for this area and an adjustment grid was developed. FAA and the Volpe Center reviewed and ultimately approved for INM at Logan Airport. This resulted in a grid adjustment that shifted the DNL contour up the hill and the adjustment area only applies to the area of the hill.

3.2 Current Method

After the annual DNL contour is completed, the Hill Effects grid is applied to the INM results. This grid increases the DNL values on the side of the hill facing the airport.

3.3 Proposed Method

ACRP 02-79, *AEDT Noise Model Improvements to Account for Terrain and Man-made Structures* is anticipated to begin in 2017. Massport plans to cooperate with the study if possible. Until such time that this study is completed and an option is added to the AEDT to account for this condition, we propose to use the existing Hill Effects adjustment grid. It is a NMPLOT adjustment grid and is easily applied to the AEDT NMplot result grid.

Since this adjustment is unchanged from the former approach, the results should be identical.

Please let us know if you concur with this approach or suggest an alternate method.

4. STAGELENGTH SELECTION

4.1 Background

Logan Airport has a diverse set of operations including domestic and international traffic. The INM modeling since 2004 has includes stagelength selection based on radar profile matching instead of city pair assignments.

4.2 Current Method

For INM, each radar ground track is imported into the study for modeling. The flight profile up to 3,000 feet is compared to the set of available standard profiles in the INM for that aircraft type. Using a least squares fit method; the best match stagelength is selected.

4.3 Proposed Method

For AEDT, following FAA guidance, each city pair would be used to select the stagelength. This generally results in a lower stagelength than the method historically used and does not take advantage of the available radar data. Since, for the Logan Airport modeling each radar ground track is imported into the AEDT database, we propose to use the data to select the stagelength. The flight profile up to 3,000 feet will be compared to the set of available standard profiles in the AEDT for that aircraft type. Using a least squares fit method the best match stagelength is selected. This results in a stagelength best match for each ground track.

This approach is a straightforward port of the former method, and thus should yield identical results.

Please let us know if you concur with this approach or suggest an alternate method.

5. CUSTOM PROFILES

5.1 Background

Since 2004, Logan Airport modeling has used a pre-processor to develop custom profiles for each track based on the radar data. This process uses the SAE 1845 equations and procedure step data available in the model. AEDT now provides a method for developing custom profiles without additional FAA approval.

5.2 Current Method

The current INM modeling for Logan Airport processes each radar track through a pre-processor. This pre-processor uses the radar data, procedure step data and the SAE 1845 equations to develop a custom profile to closely match the radar data profile. This allows the mode to account for ATC level segments and low departure climbs where necessary. If a custom profile cannot be constructed, the flight is modeled using the best match INM standard profile that is available.

5.3 Proposed Method

The AEDT model now has the ability to use altitude control codes (ACC) to allow the model to develop custom profiles. However, there is no guidance on how to use these options in the model. Massport would like to use this option to the extent possible especially since the local community is accustomed to this type of modeling and every radar track is being modeled. Does FAA have any guidance on how best to add the codes? Should they be added every x number of miles in distance or every 1000 feet in altitude? The ACC = 2 (Match) frequently results in errors which then discard the operation instead of defaulting to another method to allow the flight to continue. With hundreds or thousands of tracks, this results in an enormous amount of effort by the modeler to correct these errors in order to retain these tracks. Does the FAA have any suggestions to reduce this effort? We did encounter odd results with AEDT 2B Service Pack 2 but understand these have been corrected in AEDT 2C. Are there other known issues with the custom profile construction and use?

As there are currently many unknowns with this approach, the results are uncertain and Massport looks forward to collaboration with the FAA to ensure that a method can be developed that is robust, repeatable, and automated.

We will be using AEDT 2C to evaluate the application of this method to Logan Airport modeling and any assistance you can provide will be helpful.

6. NON-STANDARD WEATHER DATA

6.1 Background

Since 2007, the daily DNL modeling conducted for BOS has used daily weather averages. The current version of AEDT does not appear to have this capability except for when using High Fidelity weather. The FAA guidance also requires the use of the 30-year normal weather data built into the model or the modeler can request use of other data from the FAA.

6.2 Current Method

The prior INM modeling was run for each day and daily weather averages were used in the INM model to adjust aircraft performance and atmospheric absorption. These daily DNL results were then averaged to develop the annual average DNL.

6.3 Proposed Method

The AEDT only allows for one set of average weather data for the study. Even though, the model can be setup to use a detailed flight schedule which includes the date and time, the weather is fixed to this average unless detailed High Fidelity weather data is selected. We expect that the High Fidelity weather data will further reduce processing times and increase database size therefore we would prefer to just use the daily average.

FAA guidance requires the use of the 30 –year normal data built into the model. Since contours for BOS are developed for each specific year at a minimum we request the use of annual average weather data (acquired from the National Climatic Data Center (NCDC)) for the year being modeled. We also would appreciate any suggestions for using daily average values without having to use the High Fidelity weather data.

Approval of the use of annual weather will improve accuracy for an annual study by removing the effects of long-term weather trends. If a method for using daily weather can be developed, this will allow for equal accuracy to the former approach by modeling performance using existing conditions.

hmmh

Fundamentals of Acoustics and Environmental Noise

This section introduces the fundamentals of acoustics and noise terminology as well as the effects of noise on human activity and community annoyance.

Introduction to Acoustics and Noise Terminology

Chapter 6, *Noise Abatement* of this *2015 Environmental Data Report (EDR)* relies largely on a measure of cumulative noise exposure over an entire calendar year, in terms of a metric called the Day-Night Average Sound Level (DNL). However, DNL does not always provide a sufficient description of noise for many purposes. Other measures are available to address essentially any issue of concern. This section introduces the following acoustic metrics, which are all related to DNL, but provide bases for evaluating a broad range of noise situations. These metrics include:

- Decibel (dB)
- A-Weighted Decibel (dBA)
- Sound Exposure Level (SEL)
- Equivalent Sound Level (Leq)
- Time Above (TA)
- Time Above, Night (TAN)
- DNL

The Decibel (dB)

All sounds come from a sound source – a musical instrument, a voice speaking, or an airplane that passes overhead. It takes energy to produce sound. The sound energy produced by any sound source is transmitted through the air in the form of sound waves – tiny, quick oscillations of pressure just above and just below atmospheric pressure. These oscillations, or sound pressures, impinge on the ear, creating the sound we hear.

Our ears are sensitive to a wide range of sound pressures. The loudest sounds that we hear without pain have about one million times more energy than the quietest sounds we hear. However, our ears are incapable of detecting small differences in these pressures. Thus, to match how we hear this sound energy, we compress the total range of sound pressures to a more meaningful range by introducing the concept of sound pressure level (SPL). SPL is a measure of the sound pressure of a given noise source relative to a standard reference value (typically the quietest sound that a young person with good hearing can detect). SPLs are measured in decibels (abbreviated dB). Decibels are logarithmic quantities – logarithms of the squared ratio of two pressures, the numerator being the pressure of the sound source of interest, and the denominator being the reference pressure (the quietest sound we can hear).

The logarithmic conversion of sound pressure to SPL means that the quietest sound we can hear (the reference pressure) has a SPL of about zero decibels, while the loudest sounds we hear without pain have SPLs of about 120 dB. Most sounds in our day-to-day environment have SPLs from 30 to 100 dB.

Because decibels are logarithmic quantities, they do not behave like regular numbers with which we are more familiar. For example, if two sound sources each produce 100 dB and they are operated together, they produce only 103 dB – not 200 dB as we might expect. Four equal sources operating simultaneously result in a total SPL of 106 dB. In fact, for every doubling of the number of equal sources, the SPL goes up another three decibels. A tenfold increase in the number of sources makes the SPL go up 10 dB. A hundredfold increase makes the level go up 20 dB, and it takes a thousand equal sources to increase the level 30 dB.

If one source is much louder than another source, the two sources together will produce the same SPL (and sound to our ears) as if the louder source were operating alone. For example, a 100 dB source plus an 80 dB source produces 100 dB when operating together. The louder source "masks" the quieter one, but if the quieter source gets louder, it will have an increasing effect on the total SPL. When the two sources are equal, as described above, they produce a level three decibels above the sound of either one by itself.

From these basic concepts, note that one hundred 80 dB sources will produce a combined level of 100 dB; if a single 100 dB source is added, the group will produce a total SPL of 103 dB. Clearly, the loudest source has the greatest effect on the total decibel level.

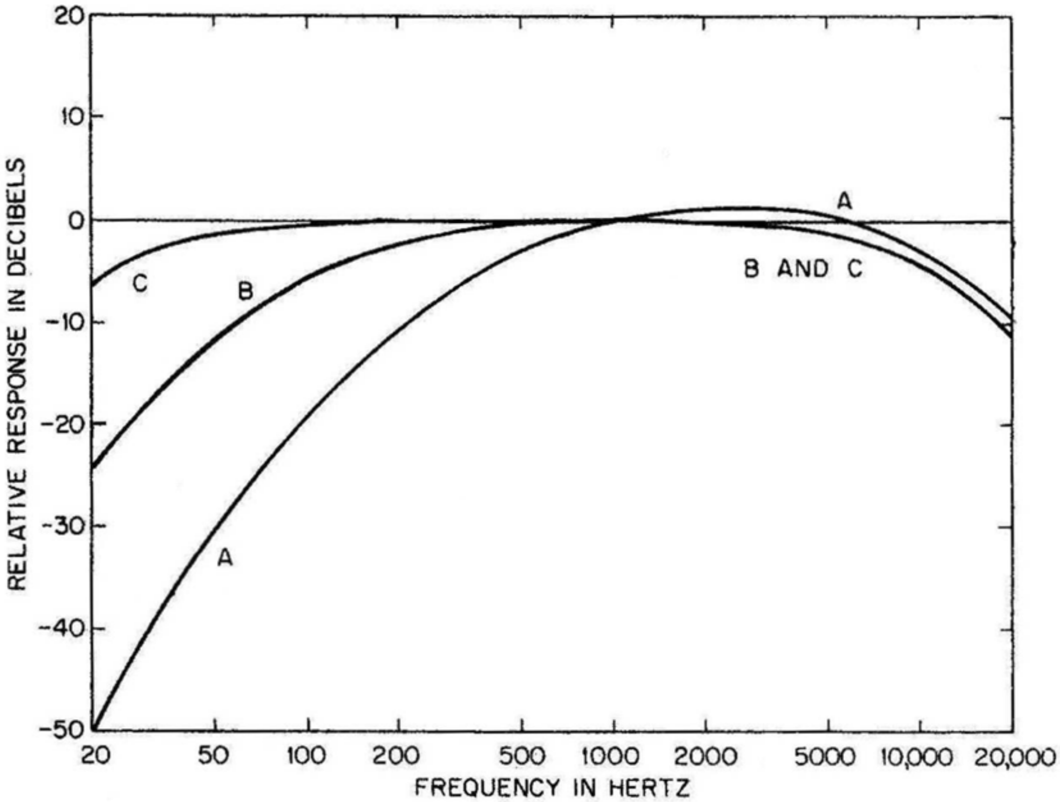
A-Weighted Decibel, dBA

Another important characteristic of sound is its frequency, or "pitch." This is the rate of repetition of the sound pressure oscillations as they reach our ear. Formerly expressed in cycles per second, frequency is now expressed in units known as Hertz (Hz).

Most people hear from about 20 Hz to about 10,000 to 15,000 Hz. People respond to sound most readily when the predominant frequency is in the range of normal conversation, around 1,000 to 2,000 Hz. Acousticians have developed "filters" to match our ears' sensitivity and help us to judge the relative loudness of sounds made up of different frequencies. The so-called "A" filter does the best job of matching the sensitivity of our ears to most environmental noises. SPLs measured through this filter are referred to as A-weighted levels (dBA). A-weighting significantly de-emphasizes noise at low and very high frequencies (below about 500 Hz and above about 10,000 Hz) where we do not hear as well. Because this filter generally matches our ears' sensitivity, sounds having higher A-weighted sound levels are usually judged louder than those with lower A-weighted sound levels, a relationship which does not always hold true for unweighted levels. It is for these reasons that A-weighted sound levels are normally used to evaluate environmental noise.

Other weighting networks include the B and C filters. They correspond to different level ranges of the ear. The rarely used B-weighting attenuates low frequencies (those less than 500 Hz), but to a lesser degree than A-weighting. C weighting is nearly flat throughout the audible frequency range, hardly de-emphasizing low frequency noise. C-weighted levels can be preferable in evaluating sounds whose low-frequency components are responsible for secondary effects such as the shaking of a building, window rattle, or perceptible vibrations. Uses include the evaluation of blasting noise, artillery fire, and in some cases, aircraft noise inside buildings. **Figure H-1** compares these various weighting networks.

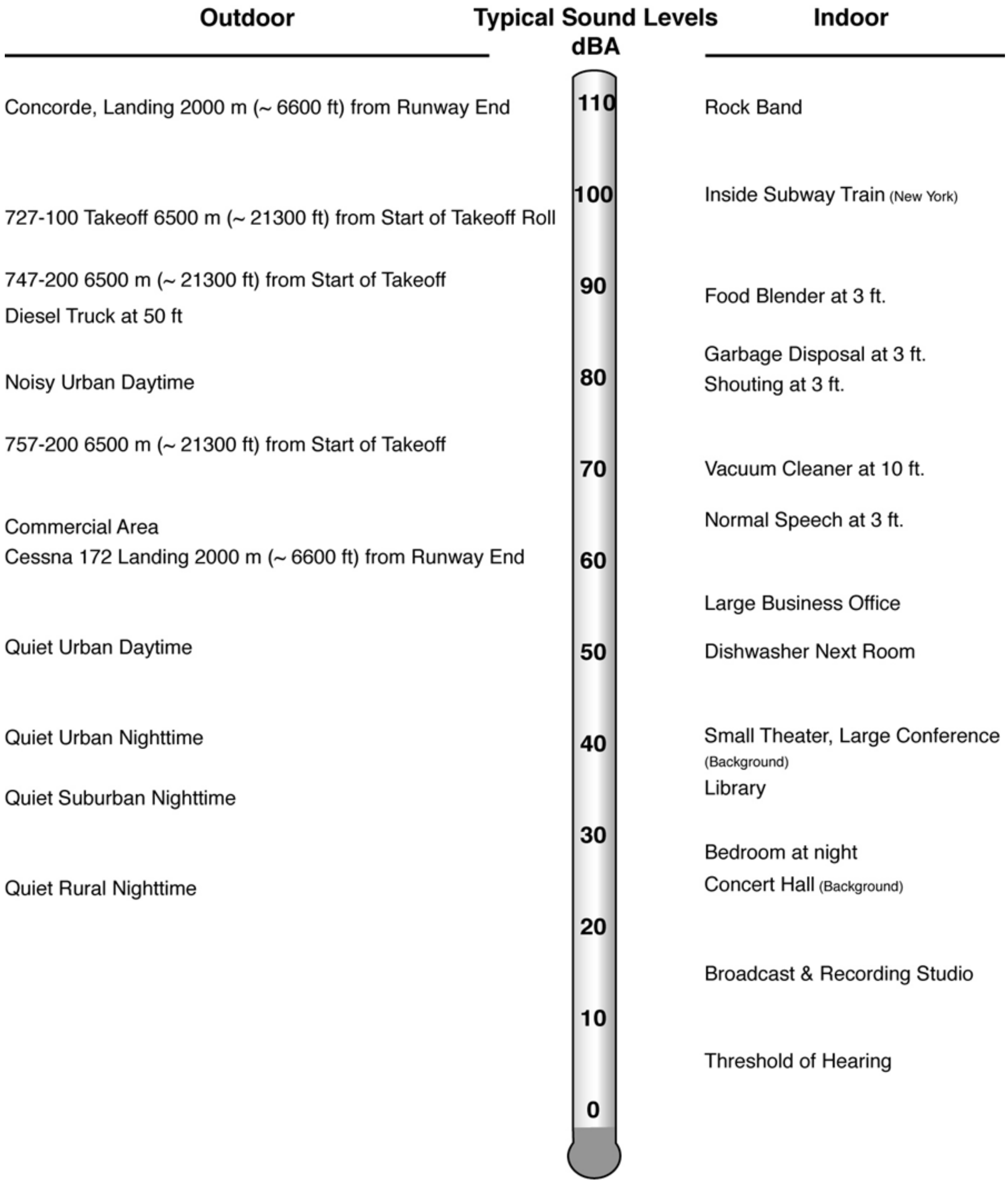
Figure H-1 Frequency-Response Characteristics of Various Weighting Networks



Source: Harris, Cyril M., editor; Handbook of Acoustical Measurements and Noise Control, (Chapter 5, "Acoustical Measurement Instruments"; Johnson, Daniel L.; Marsh, Alan H.; and Harris, Cyril M.); New York; McGraw-Hill, Inc.; 1991; p. 5.13.

Because of the correlation with our hearing, the A-weighted level has been adopted as the basic measure of environmental noise by the U.S. Environmental Protection Agency (EPA) and by nearly every other federal and state agency concerned with community noise. **Figure H-2** presents typical A-weighted sound levels of several common environmental sources.

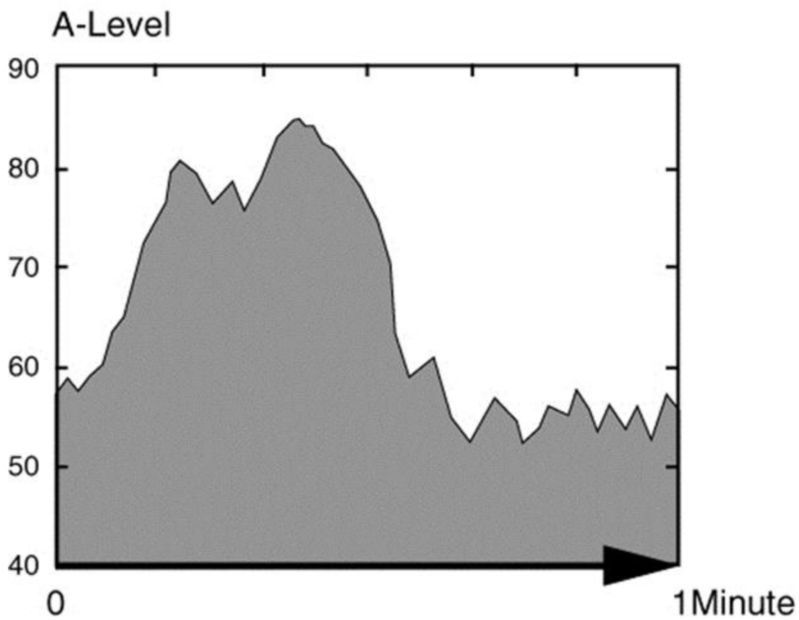
Figure H-2 Common Environmental Sound Levels, in dBA



Source: HMMH (Aircraft noise levels from FAA Advisory Circular 36-3H)

An additional dimension to environmental noise is that A-weighted levels vary with time. For example, the sound level increases as an aircraft approaches, then falls and blends into the background as the aircraft recedes into the distance (though even the background varies as birds chirp or the wind blows or a vehicle passes by). **Figure H-3** illustrates this concept.

Figure H-3 Variations in the A-Weighted Sound Level Over Time



Source: HMMH

Maximum A-Weighted Noise Level, L_{max}

The variation in noise level over time often makes it convenient to describe a particular noise "event" by its maximum sound level, abbreviated as L_{max}. In the figure above, it is approximately 85 dBA.

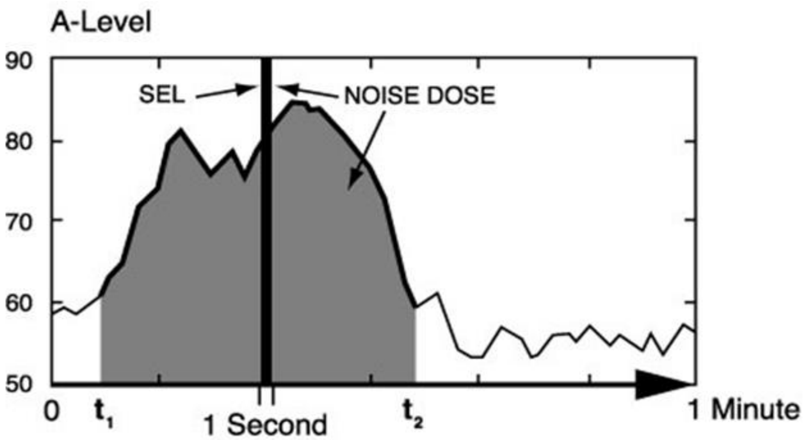
The maximum level describes only one dimension of an event; it provides no information on the cumulative noise exposure. In fact, two events with identical maxima may produce very different total exposures. One may be of very short duration, while the other may continue for an extended period and be judged much more annoying. The next measure corrects for this deficiency.

Sound Exposure Level (SEL)

The most frequently used measure of noise exposure for an individual aircraft noise event (and the measure that Part 150 specifies for this purpose) is the SEL. SEL is a measure of the total noise energy produced during an event, from the time when the A-weighted sound level first exceeds a threshold level (normally just above the background or ambient noise) to the time that the sound level drops back down below the threshold. To allow comparison of noise events with very different durations, SEL "normalizes" the duration in every case to one second; that is, it is expressed as the steady noise level with just a one-second duration that includes the same amount of noise energy as the actual longer duration, time-varying noise. In lay terms, SEL "squeezes" the entire noise event into one second.

Figure H-4 depicts this transformation. The shaded area represents the energy included in an SEL measurement for the noise event, where the threshold is set to 60 dBA. The dark shaded vertical bar, which is 90 dBA high and just one second long (wide), contains exactly the same sound energy as the full event.

Figure H-4 Sound Exposure Level (SEL)



Source: HMMH

Because the SEL is normalized to one second, it will always be larger than the L_{max} for an event longer than one second. In this case, the SEL is 90 dB; the L_{max} is approximately 85 dBA. For most aircraft overflights, the SEL is normally on the order of 7 to 12 dB higher than L_{max}. Because SEL considers duration, longer exposure to relatively slow, quiet aircraft, such as propeller models, can have the same or higher SEL than shorter exposure to faster, louder planes, such as corporate jets.

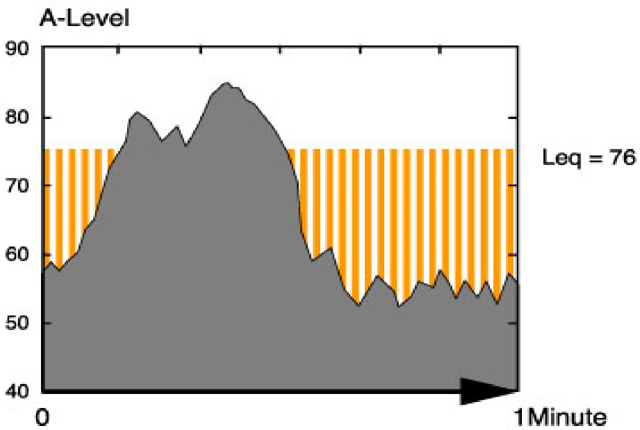
Equivalent Sound Level (L_{eq})

The L_{max} and SEL quantify the noise associated with individual events. The remaining metrics in this section describe longer-term cumulative noise exposure that can include many events.

The Equivalent Sound Level (L_{eq}) is a measure of exposure resulting from the accumulation of A-weighted sound levels over a particular period of interest (e.g., an hour, an eight-hour school day, nighttime, or a full 24-hour day). Because the length of the period can differ, the applicable period should always be identified or clearly understood when discussing the metric. Such durations are often identified through a subscript, for example $L_{eq(8)}$ or $L_{eq(24)}$.

L_{eq} is equivalent to the constant sound level over the period of interest that contains as much sound energy as the actual time-varying level. This is illustrated in **Figure H-5**. Both the solid and striped shaded areas have a one-minute L_{eq} value of 76 dB. It is important to recognize, however, that the two signals (the constant one and the time-varying one) would sound very different in real life. Also, be aware that the "average" sound level suggested by L_{eq} is not an arithmetic value, but a logarithmic, or "energy-averaged" sound level. Thus, loud events dominate L_{eq} measurements.

Figure H-5 Example of a One Minute Equivalent Sound Level (L_{eq})



Source: HMMH

In airport noise studies, L_{eq} is often presented for consecutive one-hour periods to illustrate how the exposure rises and falls throughout a 24-hour period, and how individual hours are affected by unusual activity, such as rush hour traffic or a few loud aircraft.

Time Above (TA)

TA is a metric that gives the duration, in minutes, for which aircraft-related noise exceeds a specified A-weighted sound level during a given period. The measure is referred to generally as TA. For this *2015 EDR*, three threshold sound levels are used in the analysis: 65, 75, and 85 dBA. These times are computed using the Federal Aviation Administration (FAA)-approved Integrated Noise Model (INM).

Time Above Night (TAN)

Identical to TA, except it is computed for only the 9-hour period between 10:00 PM and 7:00 AM. The TAN is also developed using three threshold sound levels 65, 75, and 85 dBA.

Day-Night Average Sound Level (DNL)

Virtually all studies of aircraft noise rely on a slightly more complicated measure of noise exposure that describes cumulative noise exposure during an average annual day: the DNL. The EPA identified DNL as the most appropriate means of evaluating airport noise based on the following considerations:[1]

1. The measure should be applicable to the evaluation of pervasive long-term noise in various defined areas and under various conditions over long periods.

2. The measure should correlate well with known effects of the noise environment and on individuals and the public.

3. The measure should be simple, practical, and accurate. In principal, it should be useful for planning as well as for enforcement or monitoring purposes.

---

1 Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," U. S. EPA Report No. 550/9-74-004, March 1974

4. The required measurement equipment, with standard characteristics, should be commercially available.

5. The measure should be closely related to existing methods currently in use.

6. The single measure of noise at a given location should be predictable, within an acceptable tolerance, from knowledge of the physical events producing the noise.

7. The measure should lend itself to small, simple monitors, which can be left unattended in public areas for long periods.

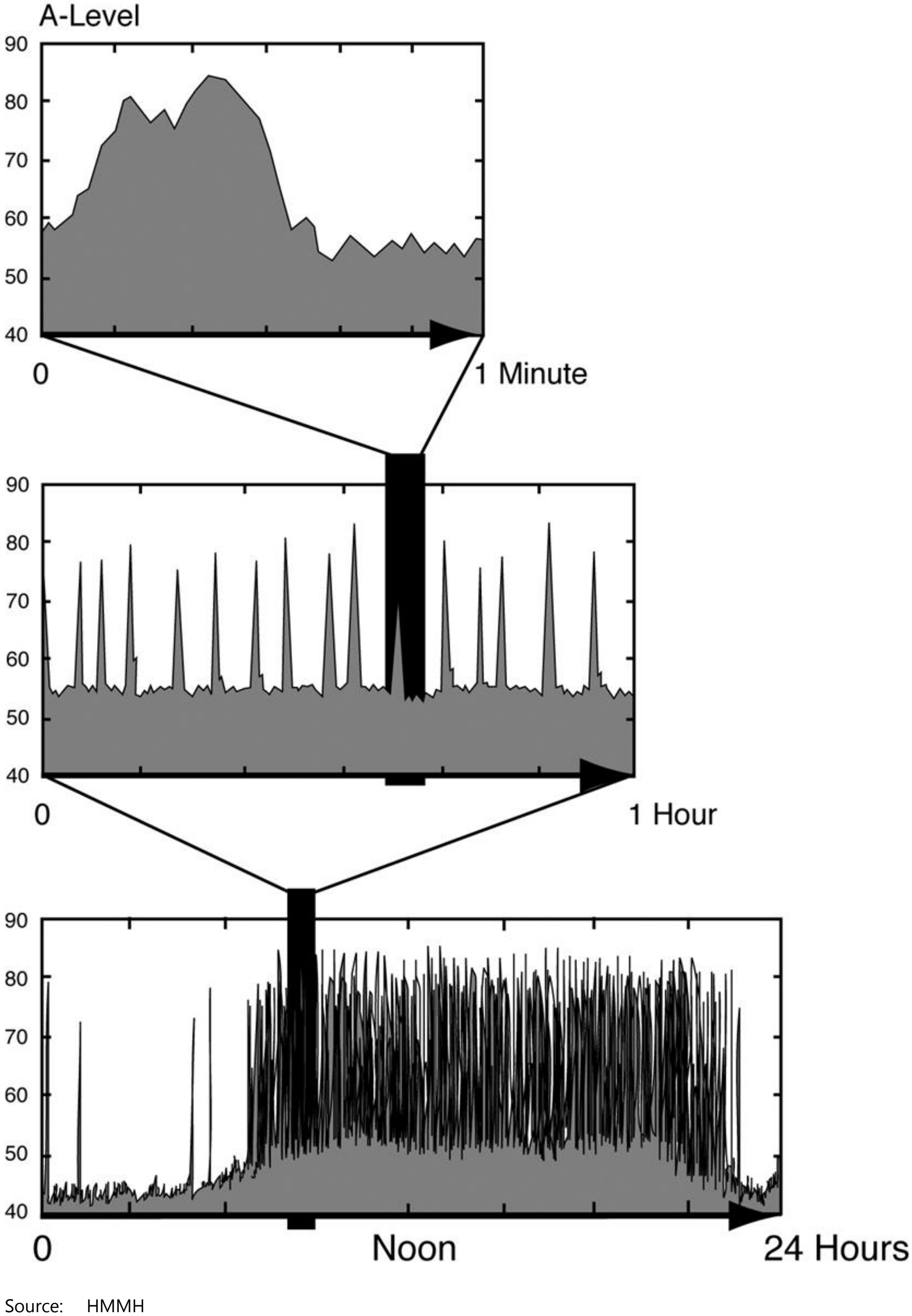
Most federal agencies dealing with noise have formally adopted DNL. The Federal Interagency Committee on Noise (FICON) reaffirmed the appropriateness of DNL in 1992. The FICON summary report stated; "There are no new descriptors or metrics of sufficient scientific standing to substitute for the present DNL cumulative noise exposure metric."

The DNL represents noise as it occurs over a 24-hour period, with one important exception: DNL treats nighttime noise differently from daytime noise. In determining DNL, it is assumed that the A-weighted levels occurring at night (defined as 10:00 PM to 7:00 AM) are 10 dB louder than they really are. This 10 dB penalty is applied to account for greater sensitivity to nighttime noise, and the fact that events at night are often perceived to be more intrusive because nighttime ambient noise is less than daytime ambient noise.

Figure H-4 illustrated the A-weighted sound level due to an aircraft fly-over as it changed with time. The top frame of **Figure H-6** repeats this figure. The shaded area reflects the noise dose that a listener receives during the one-minute period of the sample. The center frame of **Figure H-4** includes this one-minute sample within a full hour. The shaded area represents the noise during that hour with 16 noise events, each producing an SEL. Similarly, the bottom frame includes the one-hour interval within a full 24 hours. Here the shaded area represents the listener's noise dose over a complete day. Note that several overflights occur at a time when the background noise drops some 10 dB, to approximately 45 dBA.

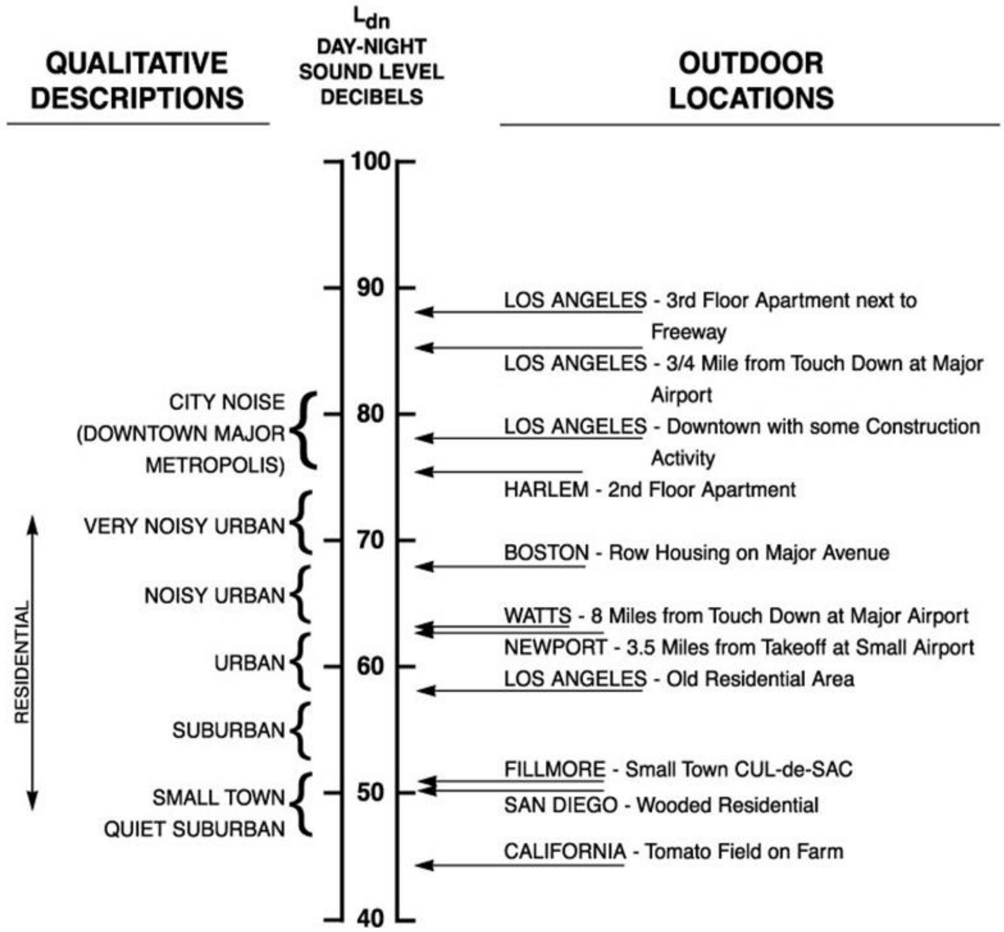
DNL can be measured or estimated. Measurements are practical only for obtaining DNL values for relatively limited numbers of points, and, in the absence of a permanently installed monitoring system, only for relatively short time periods. Most airport noise studies are based on computer-generated DNL estimates, determined by accounting for all of the SELs from individual events, which comprise the total noise dose at a given location. Computed DNL values are often depicted in terms of equal-exposure noise contours (much as topographic maps have contours of equal elevation). **Figure H-7** depicts typical DNL values for a variety of noise environments.

Figure H-6 Daily Noise Dose



Source: HMMH

Figure H-7 Examples of Day-Night Average Sound Levels (DNL)



Source: EPA, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974, p. 14.

As of May 2015, the FAA is beginning work on the next step in a multi-year Noise Research Program that will update the scientific evidence on the relationship between aircraft noise exposure and its effects on communities around airports. If changes are warranted, FAA will propose revised policy and related guidance and regulations, subject to interagency coordination, as well as public review and comment.

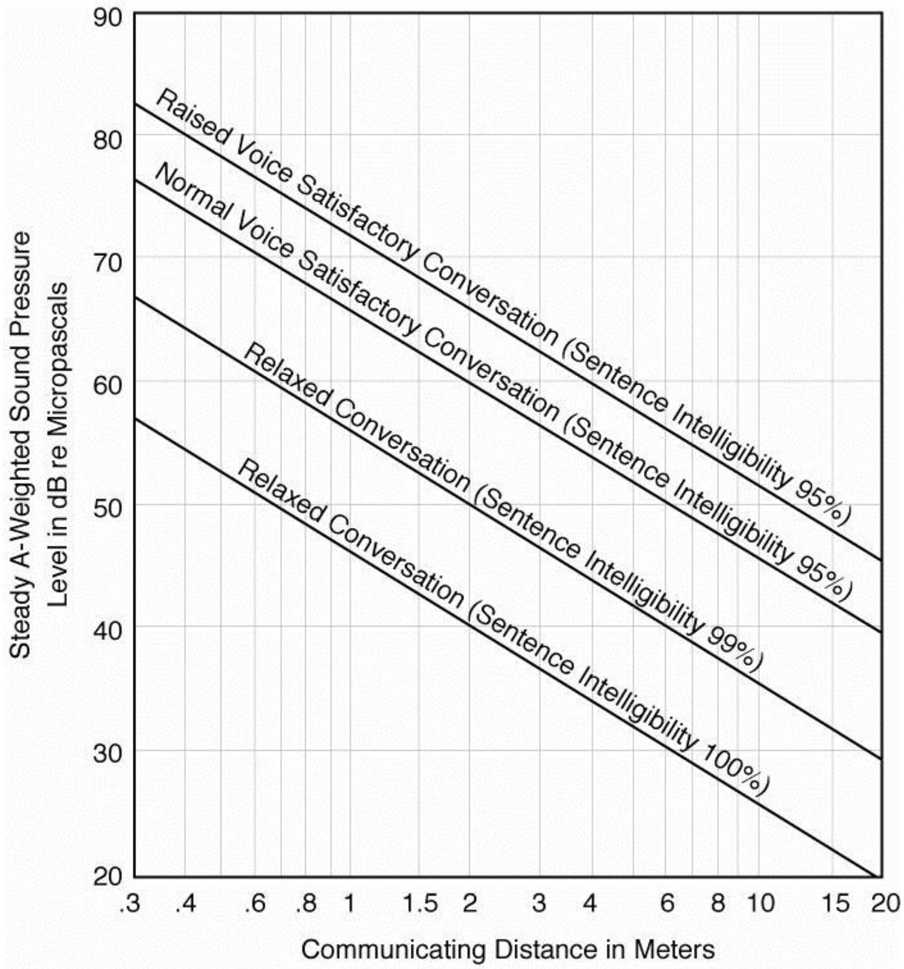
The Effects of Aircraft Noise on People

To residents around airports, aircraft noise can be an annoyance and a nuisance. It can interfere with conversation and listening to television, it can disrupt classroom activities in schools, and it can disrupt sleep. Relating these effects to specific noise metrics helps in the understanding of how and why people react to their environment.

Speech Interference

A primary effect of aircraft noise is its tendency to drown out or "mask" speech, making it difficult to carry on a normal conversation. The sound level of speech decreases as the distance between a talker and listener increases. As the background sound level increases, it becomes harder to hear speech. **Figure H-8** presents typical distances between talker and listener for satisfactory outdoor conversations, in the presence of different steady A-weighted background noise levels for raised, normal, and relaxed voice effort. As the background level increases, the talker must raise his/her voice, or the individuals must get closer together to continue talking.

Figure H-8 Outdoor Speech Intelligibility



Source: EPA, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974, p. D-5.

As indicated in the figure, "satisfactory conversation" does not always require hearing every word; 95 percent intelligibility is acceptable for many conversations. Listeners can infer a few unheard words when they occur in a familiar context. However, in relaxed conversation, we have higher expectations of hearing speech and generally require closer to 100 percent intelligibility. Any combination of talker-listener distances and background noise that falls below the bottom line in **Figure H-8** (thus assuring 100 percent intelligibility) represents an ideal environment for outdoor speech communication and is considered necessary for acceptable indoor conversation as well.

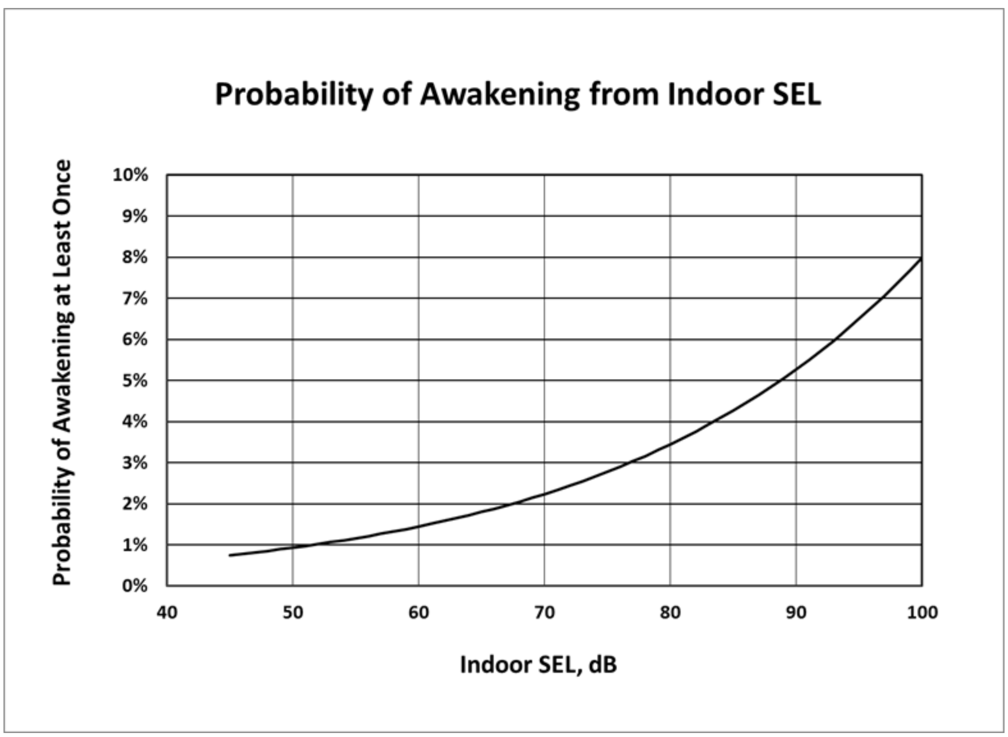
One implication of the relationships in **Figure H-8** is that for typical communication at distances of 3 or 4 feet (1 to 1.5 meters), acceptable outdoor conversations can be carried on in a normal voice as long as the background noise outdoors is less than about 65 dBA. If the noise exceeds this level, as might occur when an aircraft passes overhead, intelligibility would be lost unless vocal effort were increased or communication distance were decreased.

Indoors, typical distances, voice levels, and intelligibility expectations generally require a background level less than 45 dBA. With windows partly open, housing generally provides about 12 dBA of interior-to-exterior noise level reduction. Thus, if the outdoor sound level is 60 dBA or less, there is a reasonable chance that the resulting indoor sound level will afford acceptable conversation inside. With windows closed, 24 dB of attenuation is typical.

Sleep Interference

Research on sleep disruption from noise has led to widely varying observations. In part, this is because (1) sleep can be disturbed without awakening, (2) the deeper the sleep the more noise it takes to cause arousal, and (3) the tendency to awaken increases with age, and other factors. **Figure H-9** shows one such relationship from recent research conducted in the U.S. – the probability that a group of people will be awakened at least once when exposed to a given indoor SEL.

Figure H-9 Probability of Awakening at Least Once from Indoor Noise Event



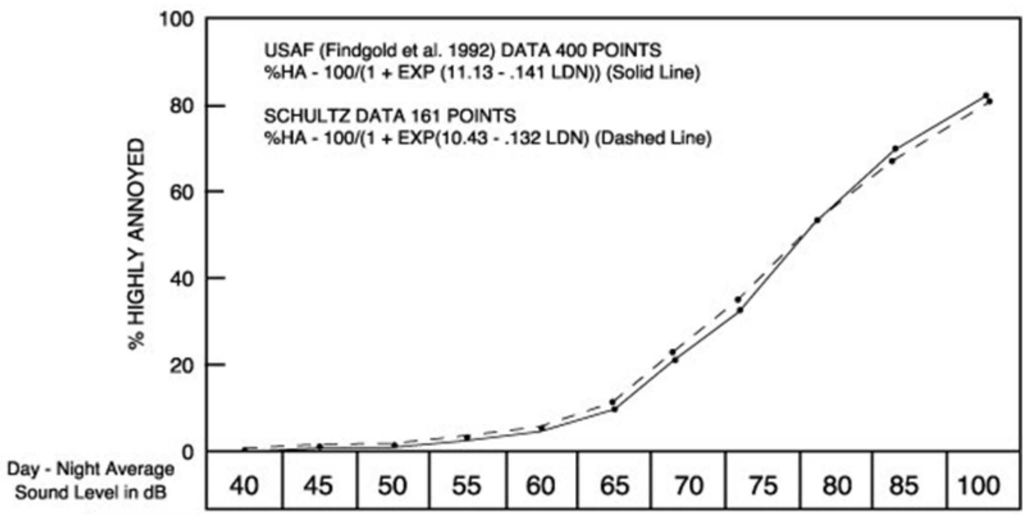
Source: ANSI S12.9-2008/Part 6, Quantities and Procedures for Description and Measurement of Environmental Sound — Part 6: Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes; Equation 1

For example, an indoor SEL of 80 dB results in approximately 3.5 percent of the exposed population being awakened. If windows are open in the bedroom on a warm evening and a house provides a typical outside-to-inside noise level reduction of around 15 dB, which suggests it takes an SEL of about 95 dB outdoors to awaken 3.5 percent of the population. The American National Standards Institute (ANSI) has extended this concept further and developed a standard (ANSI S12.9-2008/Part 6) for computing the percentage of the population that is likely to be awakened by multiple noise events occurring throughout the night. The Federal Interagency Committee on Aviation Noise (FICAN) subsequently endorsed the standard as the best available means of estimating behavioral awakenings from aircraft noise.

Community Annoyance

Social survey data make it clear that individual reactions to noise vary widely for a given noise level. Nevertheless, as a group, people's aggregate response is predictable and relates well to measures of cumulative noise exposure such as DNL. **Figure H-10** shows a widely recognized relationship between environmental noise and annoyance.

Figure H-10 Percentage of People Highly Annoyed



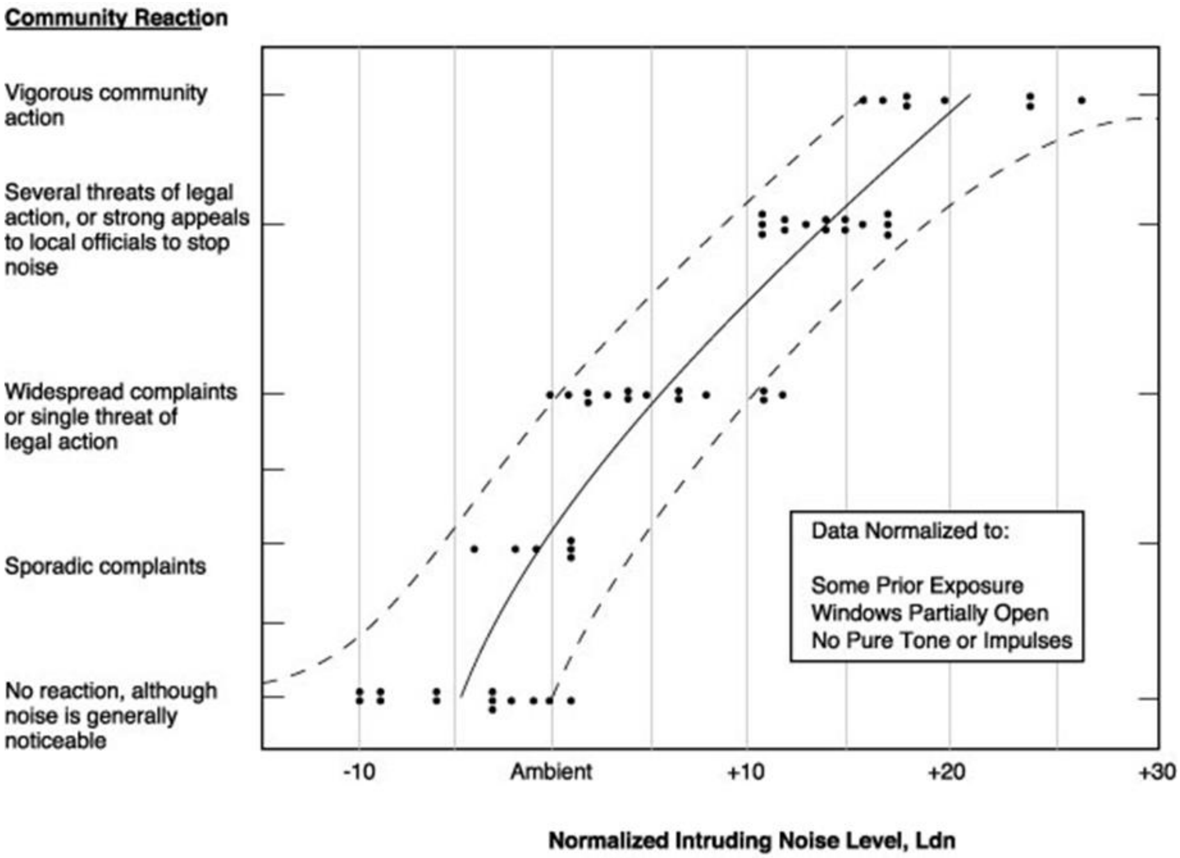
Calculated %HA Points	USAF	0.41	0.831	1.66	3.31	6.48	12.29	22.1	36.47	53.74	70.16	82.64
	SCHULTZ	0.576	1.11	2.12	4.03	7.52	13.59	23.32	37.05	53.25	68.78	81

Source: FICON. "Federal Agency Review of Selected Airport Noise Analysis Issues." August 1992. (From data provided by USAF Armstrong Laboratory). pp. 3-6.

Based on data from 18 surveys conducted worldwide, the curve indicates that at levels as low as DNL 55, approximately 5.0 percent of the people will still be highly annoyed, with the percentage increasing more rapidly as exposure increases above DNL 65.

Separate work by the EPA has shown that overall community reaction to a noise environment can also be related to DNL. This relationship is shown in **Figure H-11**. Levels have been normalized to the same set of exposure conditions to permit valid comparisons between ambient noise environments. Data summarized in **Figure H-11** suggest that little reaction would be expected for intrusive noise levels five decibels below the ambient, while widespread complaints can be expected as intruding noise exceeds background levels by about five decibels. Vigorous action is likely when the background is exceeded by 20 dB.

Figure H-11 Community Reaction as a Function of Outdoor DNL



Source: Wyle Laboratories, "Community Noise," prepared for the U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C., December 1971, pg. 63

Regulatory Framework

Logan Airport Noise Abatement Rules and Regulations

Massport's primary mechanism for reducing noise impacts from Logan Airport's operations is the Noise Rules.[2] The Noise Rules were designed to reduce noise impacts by encouraging use of quieter aircraft by requiring decreased use of noisier aircraft and by limiting nighttime activity by louder Stage 2 types. Many secondary goals aimed at limiting noise in specific areas also were stated.

Specific provisions of the Noise Rules, which continue to serve these goals, include:

- Limiting cumulative noise exposure at Logan Airport (as measured by Massport's CNI) to a maximum of 156.5 Effective Perceived Noise Decibels (EPNdB);

2 The Logan International Airport Noise Abatement Rules and Regulations, effective July 1, 1986, are codified at 740 Code of Massachusetts Regulations (CMR) 24.01 et seq (also known as the Noise Rules).

- Maximizing use of Stage 3 aircraft;
- Restricting nighttime operations by Stage 2 aircraft;
- Placing limitations on times and locations of engine run-ups and use of auxiliary power units (APU); and
- Restricting use of certain runways by noisier aircraft and time of day.

These restrictions and limitations are subject to FAA implementation and safe operation of the airport and airspace.

Federal Aviation Regulation (FAR) Part 36

Logan Airport operates within a framework of federal aviation regulations that limits an airport operator's ability to control noise. For example, the FAA's FAR Part 36[3] sets noise limits for aircraft certification and the procedures by which aircraft noise emission levels must be measured to determine compliance. The regulation defines noise emission limits for turbojets, turboprops, and helicopters, classifying turbojets into categories referred to as stages based on noise levels at each of three locations: takeoff, landing, and to the side of the runway during takeoff (sideline). The stages are:

- Stage 1 aircraft are the oldest and usually have the loudest operations, having preceded the existence of any noise emission regulation. Rare examples include old, restored civil or military aircraft. There are no Stage 1 aircraft operating at Logan Airport
- Stage 2 aircraft are less old and less noisy than Stage 1; they were the first aircraft types required to meet a noise limit. A subsequent regulation, FAR Part 91 (described in the next section), prohibits the operation of a Stage 2 aircraft in the continental U.S. unless its takeoff weight is 75,000 pounds or less. The FAA Reauthorization bill of 2012 also mandated the phase out of Stage 2 aircraft with a takeoff weight less than 75,000 pounds by 2015. In 2014, for the first time, there were no Stage 2 operations at Logan Airport which is a reduction from 2013 when less than 0.1 operations per day occurred (approximately 107 operations)
- Stage 3 aircraft were certified for service before 2006 and have relatively quiet jets, although some are Stage 2 aircraft that have been re-engined, or have been fitted with hushkits, enabling them to meet Stage 3 noise limits.
- Stage 4 aircraft are the newest and quietest of the jets. These aircraft will be required to operate with noise levels at least 10 dB quieter than Stage 3 aircraft at three prescribed measurement points. Jet aircraft certificated after January 1, 2006 must meet the Stage 4 limits. Although not required, the majority of aircraft in the 2015 Logan Airport fleet would also meet the Stage 4 noise limits if they were recertificated.

3 14 CFR Part 36, "Noise Standards: Aircraft Type and Air Worthiness Certification."

FAR Part 150

First implemented in February 1981, FAR Part 150[4] defines procedures that an airport operator must follow if it chooses to conduct and implement an airport noise and land use compatibility plan. Part 150 Noise Compatibility studies require the use of DNL to evaluate the airport noise environment. FAR Part 150 identifies noise compatibility guidelines for different land uses depending on their sensitivity. Key values include a DNL of 75 dB, above which no residences, schools, hospitals, or churches are considered compatible, and a DNL of 65 dB, above which those land uses are considered compatible only if they are sound insulated.

Noise abatement or mitigation measures that an airport operator must consider in a Part 150 study include acquisition of incompatible land, construction of noise barriers, sound insulation of buildings, implementation of a preferential runway program, use of noise abatement flight tracks, implementation of airport use restrictions, and any other actions that would have a beneficial effect on the public.

While Massport has implemented variations of all of these and additional measures at Logan Airport, Massport has not filed an official Part 150 noise compatibility study with the FAA because all of Logan Airport's program elements, while regularly reviewed and updated, preceded the promulgation of Part 150 and are effectively grandfathered under the regulation.

FAR Parts 91 and 161

The Airport Noise and Capacity Act of 1990 (ANCA)[5] directed the U.S. Secretary of Transportation to undertake three key noise-related actions:

- Establish a schedule for a phase out of Part 36 Stage 2 aircraft by the year 2000;
- Establish a program for FAA review of all new airport noise and access restrictions limiting operations of Stage 2 aircraft; and
- Establish a program for FAA review and approval of any restriction that limits operations of Stage 3 aircraft, including public notice requirements.

The FAA addressed these requirements through amendment of an existing federal regulation, "Part 91,"[6] and establishment of a new regulation, "Part 161."[7] ANCA effectively ended Massport's pursuit of any additional operational restrictions outside of this program.

Amendment to Part 91

The FAA establishes and regulates operating noise limits for civil aircraft operation in Subpart I, "Operating Noise Limits," of 14 CFR Part 91, "General Operating and Flight Rules." The noise limits are based on aircraft noise certification criteria set forth in 14 CFR Part 36, "Noise Standards: Aircraft Type and Airworthiness Certification." For transport category "large" aircraft (with maximum takeoff weights of

4 14 CFR Part 150, "Airport Noise Compatibility Planning."
5 Pub. L. No. 101-508, 104 Stat. 1388, as recodified at 49 United States Code 47521- 47533.
6 14 CFR Part 91, "General Operating and Flight Rules."
7 14 CFR Part 161, "Notice and Approval of Airport Noise and Access Restrictions."

12,500 pounds or more) and for all turbojet-powered aircraft, Part 36 identifies four "stages" of aircraft with respect to their relative noisiness:

- Stage 1 aircraft, which have never been shown to meet any noise standards, because they have never been tested, or because they have been tested and failed to meet any established standards;
- Stage 2 aircraft, which meet original noise limits, set in 1969;
- Stage 3 aircraft, which meet more stringent limits, established in 1977; and
- Stage 4 aircraft, which meet the most stringent limits, established in 2005.

In 1976, the FAA ordered a phase out of all Stage 1 aircraft with a maximum gross takeoff weight (MGTOW) over 75,000 pounds, to be completed on January 1, 1985. After that date, Stage 1 civil aircraft over 75,000 pounds MGTOW were banned from operating in the U.S. (with limited exemptions related to commercial service at "small communities," which has since expired in 1988). ANCA required a similar phase out of Stage 2 aircraft over 75,000 pounds by December 31, 1999. The 75,000-pound weight limit exempted most "business" (or "corporate") jets and a very small number of the very smallest "air carrier" type jets until December 31, 2015 when a full ban will take effect.[8] Aircraft operators responded to the Stage 1 and 2 phase-outs by retiring their non-compliant aircraft or modifying some of their aircraft to meet the more stringent standards. The modifications undertaken include installation of quieter engines, noise-reducing physical modifications to the airframe and/or existing engines, and limitation of operating weights and procedures to meet the applicable Part 36 limits. Some former Stage 2 airline aircraft that were "recertificated" as Stage 3 with these modifications still operate at Logan Airport, but are generally declining due to the aircrafts' age and high operating costs (in particular due to the generally low fuel efficiency of these older aircraft).

As airlines add new aircraft, Stage 4 aircraft have been added to their fleets. The new Stage 4 noise standard applies to any new jet aircraft type designs over 12,500 pounds requiring FAA approval after January 1, 2006. The International Civil Aviation Organization (ICAO) has already adopted a similar regulation for international operators, but neither the FAA nor ICAO have indicated there will be restrictions on the remaining recertificated Stage 3 aircraft from carrier fleets.

FAA is in the process of adopting a higher standard of noise classification called Stage 5 which, if implemented, will be effective for new aircraft type certification after December 31, 2017 and December 31, 2020, depending on the weight of the aircraft.[9]

Part 161

FAA implemented the ANCA requirements related to notice, analysis, and approval of use restrictions affecting Stage 2 and 3 aircraft through the establishment of a new regulation, 14 CFR Part 161, "Notice and Approval of Airport Noise and Access Restrictions." In simple terms, Part 161 requires an airport operator that proposes to implement a restriction on Stage 2 or 3 aircraft operations to undertake, document, and publicize certain benefit-cost analyses, comparing the noise benefits of the restriction to

8 The FAA Modernization and Reform Act of 2012 sets a January 1, 2016 ban of Stage 2 aircraft less than 75,000 lbs.

9 The Notice of Proposed Rulemaking (NPRM) was published on January 14, 2016.

its economic costs. Operators must obtain specific FAA approvals of the analysis, documentation, and notice processes, and – for Stage 3 restrictions – approval of the restriction itself.

Part 161 and ANCA define more demanding requirements and explicit guidance for Stage 3 restrictions. To implement a Stage 3 restriction, formal FAA approval is required. The FAA's role for Stage 2 restrictions is limited to commenting on compliance with Part 161 notice and analysis procedural requirements. Part 161 provides guidance regarding appropriate information to provide in support of these findings. While Part 161 does not require this information for a Stage 2 restriction, Part 161 states that it would be "useful." Moreover, the FAA has required airports to provide this same information for Stage 2 restrictions (and even for Stage 1 restrictions pursued under FAR Part 150), on the grounds that they are required for airports to comply with grant assurance 22(a), "Economic Nondiscrimination," which states that an airport operator "will make its airport available as an airport for public use on reasonable terms and without unjust discrimination to all types, kinds, and classes of aeronautical activities, including commercial aeronautical activities offering services to the public at the Airport."[10]

Although several (on the order of a dozen) airports have embarked on efforts to adopt both Stage 2 and 3 restrictions in the past two decades, the FAA has found that only one, Naples Municipal Airport, a GA airport in Naples, Florida, has fully complied with Part 161 analysis, notice, and documentation requirements for a ban on Stage 2 jet operations. FAA found the airport was in violation of prior FAA grant assurances. The airport operator successfully sued the FAA to overturn that ruling and has implemented the restriction.

ANCA and Part 161 specifically exempt Stage 3 use restrictions that were effective on or before October 1, 1990 and Stage 2 restrictions that were proposed before that date. The Logan Airport Noise Rules were promulgated in 1986; therefore, ANCA and Part 161 have no bearing on their continued implementation in their current form. Any future proposals to make the rules more stringent with regard to Stage 2 operations or to restrict Stage 3 operations in any way would almost certainly trigger Part 161 notice, analysis, and approval processes for Stage 3 restrictions. In 2006, Massport requested an opinion from the FAA regarding the pursuit of a Part 161 waiver or exemption to allow Massport to implement a curfew of nighttime operations of hush-kitted Stage 3 aircraft. FAA informed Massport that a waiver or exemption from the requirements of Part 161 is not authorized under, or consistent with, federal statutory and regulatory requirements. A copy of FAA's letter to Massport was provided in *Appendix H, Noise Abatement* in the *2005 EDR*.

Logan Airport RealContours™ Data Inputs

To relate portions of the foregoing discussion to the specific noise environment around Logan Airport, for this *2015 EDR*, the Massachusetts Port Authority (Massport) has produced a set of DNL noise contours, TA noise metrics, and population counts for 2015 using the pair of software packages RealProfiles™ and RealContours™. This software takes radar data from individual flights occurring throughout the year,

10 **FAA Order 5190.6(b),"Airport Compliance Manual" Chapter 13, Section 14, paragraph (a). To be approved, restrictions must meet the following six statutory criteria: 1) The proposed restriction is reasonable, nonarbitrary, and nondiscriminatory. 2) The proposed restriction does not create an undue burden on interstate or foreign commerce. 3) The proposed restriction maintains safe and efficient use of the navigable airspace. 4) The proposed restriction does not conflict with any existing federal statute or regulation. 5) The applicant has provided adequate opportunity for public comment on the proposed restriction. 6) The proposed restriction does not create an undue burden on the national aviation system.**

processes the information, and formats it into a form usable as input to the latest version of the FAA's INM, which serves as the computational "engine" for calculating noise. Version 7.0d was used for 2015, incorporating improvements in the updated version of the INM that became available at the end of 2013. The RealProfiles™ and RealContours™ system used the individual flight tracks taken directly from the Massport Noise and Operations Management System (NOMS) rather than relying on consolidated data summaries. For 2014, the INM noise model used 345,090 flights from the NOMS that retained suitable data. For 2015, the INM noise model used 370,014 flights from the NOMS that retained suitable data.

Overview

Standard INM input methodology involves development of operational inputs and calculation of the DNL for a prototypical average annual day.[11] This approach requires manually collecting, refining, and entering the enormous amount of data averaged over a full year of activity at an airport. Typically, the model inputs may include an aircraft fleet mix with several dozen representative aircraft types, on the order of 100 to 300 representative flight tracks (common for a facility the size of Logan Airport), and runway use and flight track use percentages for three or four categories of aircraft types with similar performance characteristics.

This normal approach to noise modeling meets accepted professional standards, and reduces the effort and cost that would be associated with manually entering the parameters for every actual operation. However, it represents a significant simplification of the extraordinary diversity of actual aircraft operations over a year. It also does not take full advantage of the investment that Massport has made in installing and maintaining a state-of-the-art radar system,[12] which automatically collects flight track data and flight identification data for all operations at the Airport and feeds the NOMS.

Instead, for this report, Massport has utilized an INM pre-processor, RealContours™, which takes maximum possible advantage of both the INM's capabilities and the investment that Massport has made in operations monitoring. RealContours™ automates the process of preparing the INM inputs directly from the actual flight operations, and permits airports to model the full diversity of activity as precisely as possible, at a cost equivalent to the more simplified manual approach. RealContours™ improves the precision of modeling by utilizing operations monitoring results in five key areas:

- Directly converts the flight track for every identified aircraft operation to an INM track, rather than assigning multiple operations to a limited number of prototypical tracks.
- Models each operation on the specific runway that it actually used, rather than applying a generalized distribution to broad ranges of aircraft types.
- Models each operation in the period that it occurred, which takes into account delays at the Airport during the year.
- Selects the specific airframe and engine combination to model, on an operation-by-operation basis, based on the registration data for each flight wherever possible; otherwise, the published compositions of the fleets of the specific airlines operating at Logan Airport are used.

11 FAA INM Version 7.0 User's Guide, April 2007, p. 12.

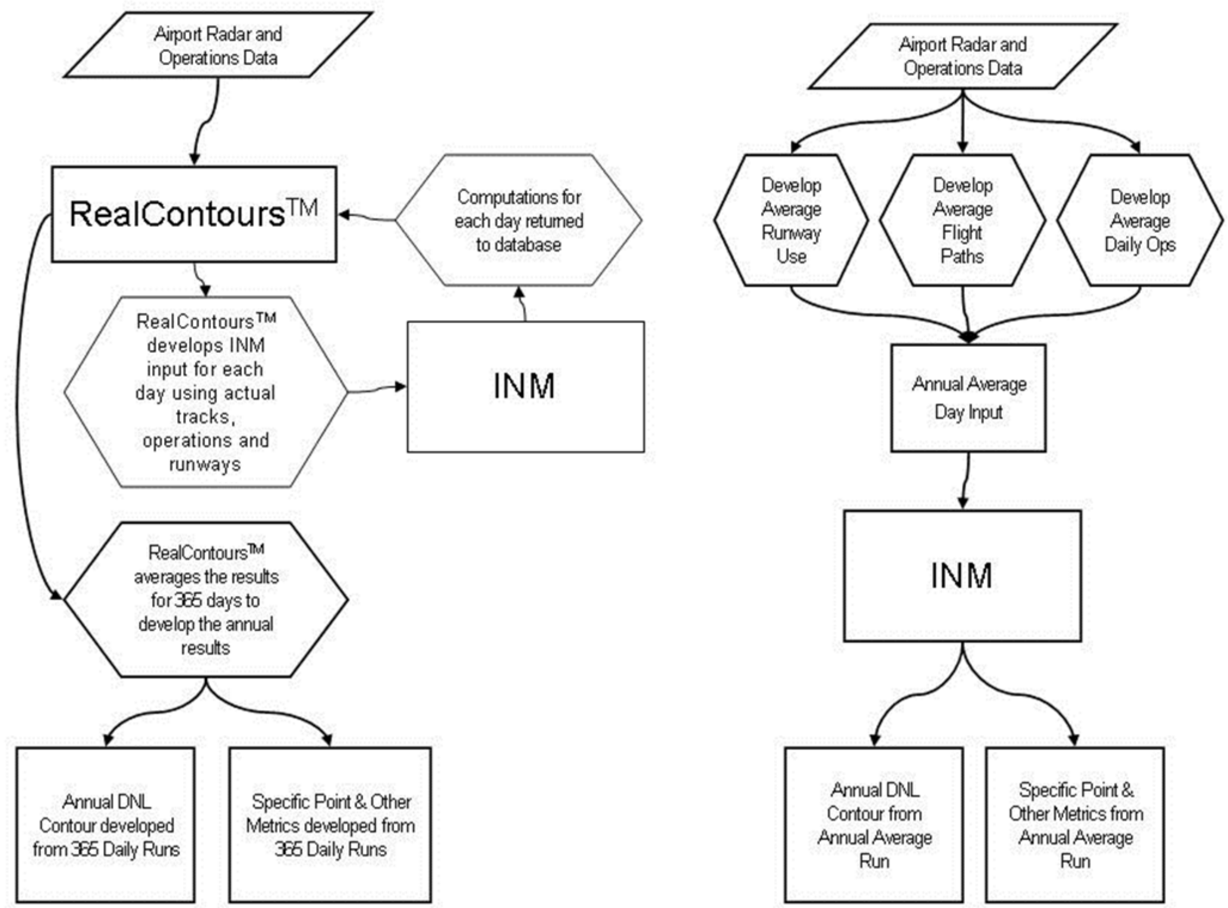
12 Starting in 2010, the Massport system utilized the Airscene.com product of Era Corporation. The radar data source has been updated and the system is now provided by Harris.

- Uses each aircraft's actual performance and altitude profile to develop inputs to the model, which define the actual climb, descent, and speed profile for every operation.

RealContours™ completes the task of computing noise by running the INM in the middle of the night to obtain DNL or other noise metrics for the previous day's operations, and then averages the results to obtain the annual contour.

Figure H-12 provides a schematic representation of the RealContours™ noise modeling process compared to the standard INM process.

Figure H-12 Schematic Noise Modeling Process (Standard INM vs. RealContours™)



Source: FAA, HMMH

INM v7.0d Model

The FAA's INMv7.0d was released for general use on May 23, 2013 with a Software Service Update on September 24, 2013. The latest version has been used for the 2014 and 2015 DNL contour in this report as the primary analytical tool to assess the noise environment at Logan Airport. This version of the model includes data for the Boeing 787-8R, Embraer E170, and Embraer E190, all types in use at Logan Airport.

The remaining sections of this appendix provide several tables describing the data for 2015. Where possible, the data for 2014 are included for comparison and in general the tables listed as (a) are for 2014 and (b) for 2015.

2015 Radar Data

Logan Airport's radar data provide the key to the RealContours™ system. Since February 2004, Massport has collected Passive Surveillance Radar System (PASSUR) radar data, which supplies information to the Airport's web-based Airport Monitor software. This dataset was used for the *2004 Environmental Status and Planning Report (2004 ESPR)* through the *2008 EDR*. Beginning with the *2009 EDR*, Massport began utilizing the radar data from its Exelis NOMS system. These radar data are obtained from a multilateration system of eight sensors deployed around the Airport. The positioning data from all of these sensors are correlated to provide better, more accurate coverage of aircraft (in areas where the traditional FAA radar has limitations) and provide a more complete set of points to define each track. Traditional radar provides points every four to five seconds where the multilateration system provides data every second. In 2015, the Massport system switched to the FAA's Nextgen data which incorporates several different radar systems into one data feed. The system was able to collect 365 complete days of data for 2015 with approximately 88 percent of these tracks usable for the development of the noise exposure contours.

Fleet Mix

The 2015 radar data was first processed to establish a baseline set of operations. After processing the 365 days of radar data (372,930 operations), flight tracks with sufficient operational information were identified to use as the baseline for the 2015 contours. The operations from these tracks were then scaled upwards by airline and aircraft type to match the reported totals provided by Massport for 2015. **Tables H-1a** (2014 for comparison) and **H-1b** (2015) provide the scaled annual operations, by INM aircraft type. Each INM type listed in **Tables H-1a** and **H-1b** is also mapped to a Runway Use group based on its weight and performance characteristics described in the Runway Use section below.

RJs are defined as those aircraft with 90 or fewer seats, consistent with the categorization in Chapter 2, *Activity Levels*.[13] For years prior to 2010, the RJs in this report were classified as aircraft with less than 100 seats. When RJs first started gaining popularity, the aircraft types available were typically 50 seats or less with the traditional air carrier jet being 100 seats and higher. As newer aircraft types have become available, the smaller 35 to 50 seat types have been replaced by 70 to 99-seat types, with the 90 and above seat types flying many of the traditional air carrier routes. The majority of the newer types fall into two categories: the 70 to 75-seat category, which remain categorized as RJs, and the 91- to 99-seat

13 U.S. Code, 2006 Edition, Supplement 3, Title 49 – Transportation Subtitle VII – Aviation Programs Part A – Air Commerce and Safety, Subpart II, Economic Regulation, Chapter 417 - Operations or Carriers, Subchapter III - Regional Air Service Incentive Program, Sec. 41762 – Definitions – defines RJ air carrier service to be aircraft with a maximum of 75 seats. Therefore, this report categorizes aircraft with 70-75 seats and below as RJ and aircraft with 90 seats and higher aircraft as air carrier (Note: there are no types with 75 to 90 seats).

category, which are categorized as air carrier jets. The Embraer 190 falls into this category and is now in the Light Jet B group.

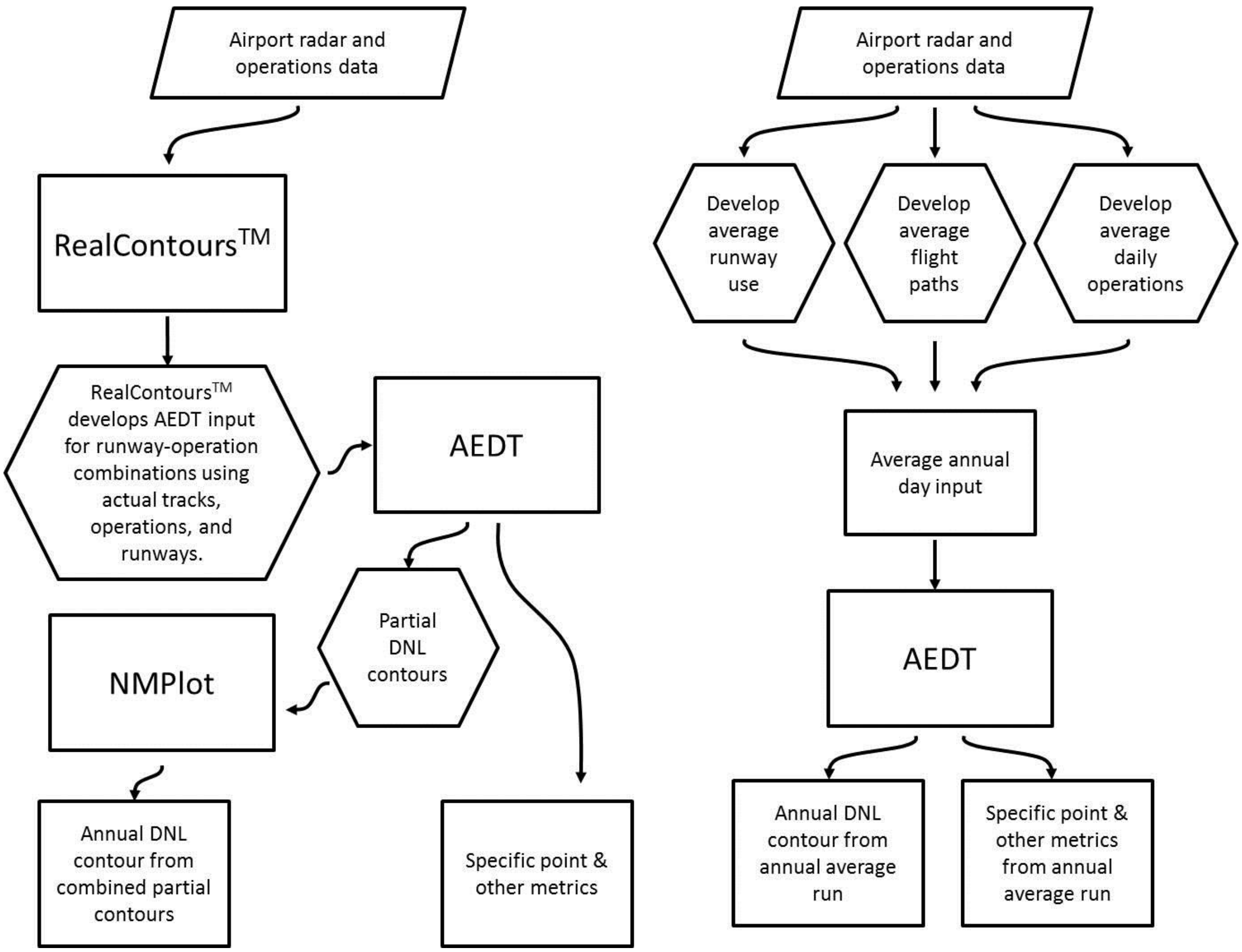
AEDT 2b Model Evaluation

The FAA's AEDT version 2b was released for general use on May 29, 2015 with a service pack SP2 released on December 22, 2015. Massport has been evaluating this version for use in the EDR. In September 2016, FAA released AEDT 2C with adjustments and modifications to the model. The AEDT model incorporates several new features including updated atmospheric absorption and bank angle adjustments. The FAA recommends, the atmospheric absorption type "SAE-ARP-5534" must be selected in AEDT Processing Options. This function uses the method described in Society of Automotive Engineers' (SAE) Aerospace Recommended Practice (ARP) 5534, taking into account changes in atmospheric absorption due to airport specific temperature, relative humidity, and atmospheric pressure.[14] The bank angle is calculated based on ground track curvature and an airplane speed and takes into account the position of the aircraft engines as it passes through a turn.

The INM modeling for Logan Airport includes several specific adjustments that are incorporated into the model and these need to be developed and evaluated for use with AEDT. Massport is working with FAA to develop the proper adjustments and to seek their approval for its use. Massport expects to have these AEDT adjustments ready for inclusion in the *2016 ESPR* and AEDT is expected to be the official model for next year's ESPR.

Similar to the INM modeling, the Logan Airport radar data will be processed through the RealContours™ AEDT pre-processor. This prepares each ground track to be modeled in AEDT (the same as INM) and assigns the same model aircraft type as INM. These data will be entered into the AEDT model database and run as shown in **Figure H-13.**

Figure H-13 Schematic Noise Modeling Process (Standard AEDT vs. RealContours™ AEDT Process)



Source: FAA, HMMH

Table H-1a 2014 Annual Modeled Operations

		Arrivals		Departures		
INM Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
Commercial Jet						
747400	Heavy Jet A	1,223	9	859	373	2,463
7478	Heavy Jet A	2	0	0	2	3
A340-211	Heavy Jet A	701	4	348	357	1,408
A340-642	Heavy Jet A	398	1	207	193	799
A380-841	Heavy Jet A	1	0	1	0	2
767300	Heavy Jet B	356	243	331	269	1,198
767400	Heavy Jet B	203	1	201	3	408
767CF6	Heavy Jet B	13	14	13	13	53
767JT9	Heavy Jet B	165	79	1	243	489
777200	Heavy Jet B	775	88	726	137	1,726
7773ER	Heavy Jet B	308	0	11	298	616
7878R	Heavy Jet B	507	0	504	3	1,013
A300-622R	Heavy Jet B	185	481	318	348	1,331
A310-304	Heavy Jet B	266	7	34	238	545
A330-301	Heavy Jet B	1,441	10	1,174	277	2,901
A330-343	Heavy Jet B	646	1	469	179	1,294
DC1010	Heavy Jet B	256	171	137	289	853
DC1030	Heavy Jet B	72	63	50	84	269
MD11GE	Heavy Jet B	216	84	153	147	599
MD11PW	Heavy Jet B	125	60	93	92	370
717200	Light Jet A	2,501	458	2,608	351	5,918
727EM2	Light Jet A	5	0	1	4	10
MD9025	Light Jet A	886	73	879	80	1,917
MD9028	Light Jet A	450	41	455	36	982
737300	Light Jet B	1,607	166	1,625	148	3,547
7373B2	Light Jet B	110	12	107	15	243
737400	Light Jet B	60	25	63	22	170
737500	Light Jet B	6	1	7	0	14
737700	Light Jet B	6,032	2,493	7,071	1,454	17,049
737800	Light Jet B	13,591	5,544	16,370	2,765	38,270
737N17	Light Jet B	1	0	1	0	2
757300	Light Jet B	242	96	329	9	678
757PW	Light Jet B	2,833	572	3,007	398	6,809
757RR	Light Jet B	3,294	707	3,596	405	8,000
A319-131	Light Jet B	8,127	2,275	8,837	1,566	20,806
A320-211	Light Jet B	3,630	716	3,880	466	8,693
A320-232	Light Jet B	15,555	5,506	18,160	2,902	42,123
A321-232	Light Jet B	2,043	698	2,312	428	5,481
EMB190	Light Jet B	29,268	2,968	28,378	3,858	64,472

Table H-1a 2014 Annual Modeled Operations

		Arrivals		Departures		
INM Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
EMB195	Light Jet B	13	1	14	0	28
MD82	Light Jet B	9	0	6	3	18
MD83	Light Jet B	878	55	827	106	1,866
CL601	RJ	5,140	334	5,305	168	10,947
CRJ9-ER	RJ	3,489	285	3,342	432	7,547
CRJ9-LR	RJ	1,680	109	1,571	218	3,577
EMB145	RJ	60	1	55	6	122
EMB14L	RJ	1,947	64	1,798	213	4,022
EMB170	RJ	4,621	288	4,539	370	9,818
EMB175	RJ	3,946	126	3,861	211	8,143
LEAR35	RJ	21	6	22	5	54
Commercial Jets Subtotal		**119,899**	**24,934**	**124,652**	**20,181**	**289,666**
Commercial Non-Jet						
BEC58P	Non-jet	17,245	295	17,414	126	35,080
CNA182	Non-jet	2	0	2	0	4
CNA208	Non-jet	210	2	210	2	424
DHC8	Non-jet	1,519	13	1,519	13	3,063
DHC830	Non-jet	2,224	147	2,152	220	4,743
DO328	Non-jet	10	0	10	0	19
SF340	Non-jet	2,183	8	2,186	5	4,382
Commercial Non-Jet Operations Subtotal		**23,392**	**465**	**23,492**	**366**	**47,715**
Commercial Aircraft Total		**143,291**	**25,400**	**148,143**	**20,547**	**337,381**
General Aviation						
74720B	Heavy Jet A	1	1	2	0	4
DC870	Heavy Jet A	8	0	8	0	15
767300	Heavy Jet B	1	1	2	0	4
7878R	Heavy Jet B	8	0	8	0	15
727EM1	Light Jet A	4	0	3	1	9
727EM2	Light Jet A	1	2	0	3	6
737400	Light Jet B	4	1	5	0	11
737700	Light Jet B	26	0	23	2	51
737800	Light Jet B	13	15	21	7	55
757PW	Light Jet B	3	1	4	0	9
MD83	Light Jet B	6	2	7	1	17
1900D	Non-jet	2	0	2	0	4
BEC58P	Non-jet	480	22	476	26	1,004

Table H-1a	2014 Annual Modeled Operations					
		Arrivals		Departures		
INM Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
CNA172	Non-jet	84	0	83	1	168
CNA182	Non-jet	59	0	59	0	117
CNA206	Non-jet	97	0	95	2	193
CNA208	Non-jet	1,140	109	1,172	82	2,503
CNA20T	Non-jet	3	1	4	0	8
CNA441	Non-jet	566	76	563	80	1,285
DHC8	Non-jet	7	0	7	0	14
DHC830	Non-jet	12	1	12	1	27
DO228	Non-jet	430	38	442	29	938
DO328	Non-jet	8	0	8	0	16
GASEPF	Non-jet	8	0	8	0	16
GASEPV	Non-jet	512	36	526	23	1,096
PA28	Non-jet	20	2	23	0	45
PA30	Non-jet	1	0	1	0	2
PA31	Non-jet	54	3	54	2	113
SF340	Non-jet	14	0	14	0	29
CIT3	RJ	48	4	50	2	105
CL600	RJ	1,079	83	1,079	85	2,326
CL601	RJ	1,067	84	1,092	61	2,304
CNA500	RJ	72	6	70	8	156
CNA510	RJ	53	7	50	10	121
CNA525C	RJ	346	36	340	42	764
CNA55B	RJ	212	22	215	19	466
CNA560E	RJ	526	44	539	31	1,140
CNA560U	RJ	137	8	129	15	289
CNA560XL	RJ	969	81	987	69	2,107
CNA680	RJ	493	34	498	31	1,055
CNA750	RJ	522	45	539	28	1,133
CRJ9-ER	RJ	3	0	3	0	6
ECLIPSE500	RJ	31	4	33	2	70
EMB145	RJ	71	10	73	8	162
F10062	RJ	484	57	504	40	1,084
GII	RJ	4	0	4	0	8
GIIB	RJ	17	1	16	2	37
GIV	RJ	539	51	542	48	1,181
GV	RJ	737	68	748	57	1,610
IA1125	RJ	91	2	90	3	187
LEAR25	RJ	6	0	5	1	12
LEAR35	RJ	1,349	127	1,355	120	2,950
MU3001	RJ	553	42	554	41	1,191

Table H-1a 2014 Annual Modeled Operations

		Arrivals		Departures		
INM Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
ECLIPSE500	RJ	30	2	31	1	64
EMB145	RJ	74	15	74	15	177
F10062	RJ	455	47	470	32	1,004
GIIB	RJ	23	2	25	1	51
GIV	RJ	692	70	700	62	1,524
GV	RJ	686	78	690	74	1,528
IA1125	RJ	125	12	127	10	273
LEAR25	RJ	4	0	4	0	9
LEAR35	RJ	1,423	159	1,427	155	3,163
MU3001	RJ	537	38	542	33	1,149
General Aviation Total		**12,110**	**1,099**	**12,198**	**1,010**	**26,417**
Grand Total		**155,401**	**26,499**	**160,341**	**21,557**	**363,799**

Source: HMMH, 2014.
Notes: BEC58P is the AEDT substitution for the Cessna 402.
The CRJ9-ER in the RJ category is the CRJ700 aircraft.
Annual operations modeled in the 2014 Annual contour.
Some totals may not match due to rounding.

Table H-1b 2015 Annual Modeled Operations

		Arrivals		Departures		
INM Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
Commercial Jet						
74720B	Heavy Jet A	1	0	0	1	2
747400	Heavy Jet A	1,260	33	862	431	2,586
7478	Heavy Jet A	156	0	150	5	311
A340-211	Heavy Jet A	564	6	191	379	1,139
A340-642	Heavy Jet A	350	0	230	120	701
767300	Heavy Jet B	976	489	824	641	2,931
767400	Heavy Jet B	282	3	252	33	570
767CF6	Heavy Jet B	69	7	49	27	151
767JT9	Heavy Jet B	95	28	19	104	245
777200	Heavy Jet B	583	110	578	116	1,387
7773ER	Heavy Jet B	581	66	129	518	1,293
7878R	Heavy Jet B	870	0	747	123	1,739
A300-622R	Heavy Jet B	182	448	314	316	1,259
A310-304	Heavy Jet B	240	18	58	200	517
A330-301	Heavy Jet B	1,399	9	1,050	359	2,817
A330-343	Heavy Jet B	553	7	395	165	1,119
DC1010	Heavy Jet B	217	186	218	185	806
DC1030	Heavy Jet B	64	50	53	60	227
MD11GE	Heavy Jet B	32	9	27	15	82
MD11PW	Heavy Jet B	12	12	9	15	48
717200	Light Jet A	3,814	656	3,892	579	8,942
727EM2	Light Jet A	0	2	2	0	4
MD9025	Light Jet A	1,129	114	1,172	72	2,487
MD9028	Light Jet A	554	44	569	30	1,197
737300	Light Jet B	1,963	353	1,939	377	4,633
7373B2	Light Jet B	127	27	128	26	308
737400	Light Jet B	27	14	26	15	82
737500	Light Jet B	0	0	0	0	0
737700	Light Jet B	6,690	2,432	7,468	1,657	18,247
737800	Light Jet B	13,986	5,609	16,305	3,289	39,188
757300	Light Jet B	558	290	615	233	1,696
757PW	Light Jet B	2,193	550	2,392	352	5,487
757RR	Light Jet B	2,677	473	2,670	480	6,300
A319-131	Light Jet B	9,100	2,030	9,717	1,413	22,260
A320-211	Light Jet B	3,809	1,085	4,255	639	9,788
A320-232	Light Jet B	16,664	5,833	19,778	2,719	44,994
A321-232	Light Jet B	2,704	877	2,975	607	7,163
EMB190	Light Jet B	27,031	3,582	26,711	3,908	61,232
EMB195	Light Jet B	1,720	198	1,732	186	3,836
MD82	Light Jet B	15	0	15	0	30

Table H-1b	2015 Annual Modeled Operations					
		Arrivals		**Departures**		
INM Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
MD83	Light Jet B	992	33	974	51	2,049
CL600	Light Jet B	2	0	2	0	4
CL601	RJ	4,713	266	4,805	176	9,960
CNA680	RJ	1	3	4	0	9
CRJ9-ER	RJ	3,650	192	3,510	331	7,683
CRJ9-LR	RJ	1,610	75	1,509	176	3,369
EMB145	RJ	114	1	114	1	229
EMB14L	RJ	2,124	14	2,088	49	4,275
EMB170	RJ	2,458	111	2,445	124	5,138
EMB175	RJ	3,744	54	3,695	103	7,595
F10062	RJ	9	0	9	0	17
GV	RJ	1	0	1	0	1
LEAR35	RJ	14	1	13	2	30
Commercial Jets Subtotal		**122,677**	**26,398**	**127,682**	**21,403**	**298,160**
Commercial Non-Jet						
BEC58P	Non-jet	17,650	308	17,864	172	35,994
CNA208	Non-jet	227	0	222	5	454
DHC8	Non-jet	970	2	960	13	1,944
DHC830	Non-jet	2,081	150	2,002	229	4,463
DO228	Non-jet	1	0	1	0	2
SF340	Non-jet	1,873	0	1,875	0	3,747
Commercial Non-Jet Operations Subtotal		**22,801**	**461**	**22,923**	**419**	**46,604**
Commercial Aircraft Total		**145,479**	**26,858**	**150,605**	**21,822**	**344,764**
General Aviation						
74720B	Heavy Jet A	2	2	2	2	8
777200	Heavy Jet B	1	0	1	0	2
A330-301	Heavy Jet B	3	0	2	1	6
DC93LW	Light Jet A	0	1	1	0	2
737700	Light Jet B	12	2	12	1	27
757PW	Light Jet B	10	0	6	4	21
757RR	Light Jet B	3	3	4	1	10
A319-131	Light Jet B	3	2	5	0	10
EMB195	Light Jet B	0	2	1	1	4
MD81	Light Jet B	4	3	4	3	14
MD83	Light Jet B	6	2	7	1	17
1900D	Non-jet	2	0	2	0	4

Table H-1b 2015 Annual Modeled Operations

		Arrivals		Departures		
INM Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
BEC58P	Non-jet	480	22	476	26	1,004
CNA172	Non-jet	84	0	83	1	168
CNA182	Non-jet	59	0	59	0	117
CNA206	Non-jet	97	0	95	2	193
CNA208	Non-jet	1,140	109	1,172	82	2,503
CNA20T	Non-jet	3	1	4	0	8
CNA441	Non-jet	566	76	563	80	1,285
DHC8	Non-jet	7	0	7	0	14
DHC830	Non-jet	12	1	12	1	27
DO228	Non-jet	430	38	442	29	938
DO328	Non-jet	8	0	8	0	16
GASEPF	Non-jet	8	0	8	0	16
GASEPV	Non-jet	512	36	526	23	1,096
PA28	Non-jet	20	2	23	0	45
PA30	Non-jet	1	0	1	0	2
PA31	Non-jet	54	3	54	2	113
SF340	Non-jet	14	0	14	0	29
CIT3	RJ	48	4	50	2	105
CL600	RJ	1,079	83	1,079	85	2,326
CL601	RJ	1,067	84	1,092	61	2,304
CNA500	RJ	72	6	70	8	156
CNA510	RJ	53	7	50	10	121
CNA525C	RJ	346	36	340	42	764
CNA55B	RJ	212	22	215	19	466
CNA560E	RJ	526	44	539	31	1,140
CNA560U	RJ	137	8	129	15	289
GV	RJ	737	68	748	57	1,610
IA1125	RJ	91	2	90	3	187
LEAR25	RJ	6	0	5	1	12
LEAR35	RJ	1,349	127	1,355	120	2,950
MU3001	RJ	553	42	554	41	1,191
General Aviation Total		**12,951**	**1,122**	**13,110**	**983**	**28,166**
Grand Total		**158,430**	**27,980**	**163,715**	**22,805**	**372,930**

Source: HMMH, 2016.

Notes: BEC58P is the AEDT substitution for the Cessna 402.
The CRJ9-ER in the RJ category is the CRJ700 aircraft
Annual operations modeled in the 2015 Annual contour.
Some totals may not match due to rounding.

Runway Use

RealContours™ determines which runway was used by each aircraft type and whether it was a daytime or nighttime operation directly from the radar data. The summary of daytime and nighttime runway usages presented here is broken into six representative aircraft groups listed below with example aircraft types from each group, grouped in this format to allow comparison with prior years (see **Tables H-2a** and **H-2b**):

- Heavy Jet A – B747s, A340s, DC-8s;
- Heavy Jet B – B767s, B777s, A300s, A310s, A330s, DC-10s, L1011s, MD-11s;
- Light Jet A – B717s, B727s, DC-9s, F100s, MD-90s;
- Light Jet B – B737s, B757s, A319s, A320s, B-146s, MD-80s, E190;
- Regional Jet (RJ) – E135, E145, E170, CRJ2, CRJ7, CRJ9, J328 and Corporate Jets; and
- Turboprops and Piston Aircraft (non-jets).

Table H-2a shows the runway use that was used to model the 2014 noise conditions. **Table H-2b** shows the runway used to model the 2015 noise conditions. As described above, turbojet aircraft in the table were grouped into different categories for reporting purposes. Because the 2014 and 2015 contours developed using RealContours™ reflect the individual use of the runways by each INM aircraft type, they accurately represent Logan Airport's noisiest aircraft by modeling them on the actual runways that they used during the year. The modeled runway use for each particular aircraft type may be different from the overall group runway use presented in **Table H-2a** for 2014 and **Table H-2b** for 2015.

Comparing **Table H-2b** (2015) with the similar **Table H-2a** (2014) in this *2015 EDR*, the largest change was a 15 percent decrease in the share of nighttime arrivals of the Heavy Jet A group on Runway 22L. These operations shifted to Runway 33L, with an increase of 14 percent, and Runway 4R, with an increase of 3 percent.

Departures on Runway 15R and 22R showed the broadest increases. Heavy Jet departures from Runway 15R had increased shares for both nighttime and daytime operations. The shares of Runway 22R departures increased mainly in the Light Jet and Regional Jet categories, again for both nighttime and daytime operations.

The share of operations on Runway 4R fell broadly across all aircraft groups, with the largest decrease (7 percent) among Heavy Jet A aircraft.

Table H-2a 2014 Modeled Runway Use Percentages by Aircraft Group

	Heavy Jet A		Heavy Jet B		Light Jet A		Light Jet B		Regional Jets		Turboprops	
ARRIVALS												
Runway	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**
04L	0.11	0.00	0.21	0.07	2.83	0.70	4.53	0.62	11.28	2.60	23.60	6.42
04R	40.88	26.86	41.56	24.41	32.38	24.16	32.33	22.47	25.78	25.15	13.56	25.24
09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00
15R	1.86	0.00	2.38	3.74	2.61	1.90	1.90	2.17	2.00	1.30	2.33	1.18
22L	28.13	45.31	23.90	26.43	17.89	32.24	22.86	34.61	22.27	34.95	25.98	34.13
22R	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.03	0.05	3.65	3.25
27	10.94	3.83	16.91	6.02	27.65	16.29	24.43	11.80	20.16	11.97	7.56	8.19
32	0.10	0.00	0.00	0.00	0.00	0.00	0.99	0.00	4.73	0.10	9.36	0.17
33L	17.98	24.01	15.04	39.33	16.63	24.72	12.94	28.33	13.75	23.89	10.32	19.15
33R	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.26	2.28
Total	100.0	100.00	100.00	100.0	100.00	100.00	100.00	100.00	100.00	100.00	100.0	100.0
DEPARTURES												
Runway	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**
04L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.67	14.30
04R	16.59	10.98	14.53	5.83	3.10	4.24	5.07	5.02	1.08	3.01	6.63	3.00
09	9.72	4.55	16.94	16.95	33.52	26.64	31.62	19.14	38.20	24.12	10.51	4.67
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00
15L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
15R	18.12	30.27	10.20	17.22	2.28	10.92	2.67	17.31	1.07	13.51	2.37	13.52
22L	8.65	5.36	7.35	1.83	0.26	0.45	1.86	1.48	0.12	0.19	1.00	1.25
22R	22.13	22.42	22.20	28.73	27.07	24.51	28.75	26.62	29.76	28.75	35.28	36.17
27	0.93	3.43	7.34	6.78	16.55	28.40	12.17	18.70	12.87	19.30	4.84	5.15
32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33L	23.86	22.99	21.45	22.65	17.21	4.83	17.87	11.72	16.89	11.13	16.59	21.94
33R	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
Total	100.0	100.0	100.00	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Massport, HMMH. 2015.
Notes: Night for noise modeling is defined as 10:00 PM to 7:00 AM.
Nighttime runway restrictions are from 11:00 PM to 6:00 AM.
Values may not add to 100 percent due to rounding.

Table H-2b 2015 Modeled Runway Use by Aircraft Group												
	Heavy Jet A		**Heavy Jet B**		**Light Jet A**		**Light Jet B**		**Regional Jets**		**Turboprops**	
ARRIVALS												
Runway	**Day (%)**	**Nigh t (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**
04L	0.12	0.00	0.37	0.14	4.38	0.48	4.01	0.24	12.19	0.88	26.03	6.79
04R	38.22	30.12	37.97	20.64	30.88	21.47	32.03	19.12	24.13	22.54	10.80	18.79
09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
15L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00
15R	2.02	2.12	1.61	0.76	1.51	2.29	1.39	2.27	1.22	2.11	0.77	1.21
22L	31.61	29.97	26.64	30.61	17.68	37.07	21.87	35.96	22.52	35.94	29.28	38.31
22R	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.06	0.00	3.65	0.97
27	9.80	0.00	17.55	3.06	30.12	19.26	26.60	12.85	22.50	12.41	7.66	7.61
32	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.00	3.95	0.13	8.19	0.27
33L	18.23	37.80	15.85	44.79	15.40	19.43	13.22	29.57	13.43	25.99	8.43	21.20
33R	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	4.68	4.85
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
DEPARTURES												
Runway	**Day (%)**	**Nigh t (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Nigh t (%)**
04L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	19.75	12.19
04R	9.75	7.64	12.31	4.25	1.15	1.25	5.14	3.99	0.94	1.47	4.29	3.61
09	9.02	4.93	15.79	12.78	34.53	25.65	29.41	18.12	36.19	22.01	16.78	11.35
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00
15L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
15R	26.50	34.25	11.91	23.69	1.64	8.72	3.02	18.45	1.05	15.88	2.29	10.86
22L	11.42	4.33	9.34	3.09	0.32	0.15	2.61	1.66	0.06	0.50	0.81	0.32
22R	22.96	23.00	24.48	26.77	33.76	31.56	32.52	25.63	35.84	30.20	35.20	33.48
27	1.09	0.22	6.46	1.59	16.00	27.38	11.55	19.68	11.79	17.18	5.12	7.31
32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00
33L	19.27	25.63	19.71	27.83	12.59	5.28	15.76	12.45	14.12	12.76	15.53	20.88
33R	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Massport, HMMH. 2016.
Notes: Night for noise modeling is defined as 10:00 PM to 7:00 AM.
Nighttime runway restrictions are from 11:00 PM to 6:00 AM.
Values may not add to 100 percent due to rounding.

While **Tables H-2a** and **H-2b** present runway use by aircraft groups, **Tables H-3a** and **H-3b** present the total runway use (jets and non-jets) by runway and time of day. The first section of the table displays the operations by runway and time of day for an average day. The second section displays the same information for the year and the last section displays the percent that each runway is used by operation type and time of day. **Table H-3a** shows that on an average day in 2014, Runway 22R had the most departures (146.62 per day) and Runway 4R had the most arrivals (137.42 per day). At night, Runway 22R had the most departures (16.03 per night) but Runway 22L had the most arrivals (24.81 per night). **Table H-3b** shows that on an average day in 2015 Runway 22R had the most departures (165.6 per day) and Runway 4R had the most arrivals (134.85 per day). At night, Runway 22R had the most departures (16.5 per night) but Runway 22L had the most arrivals (27.42 per night).

Table H-3a Summary of Jet and Non-Jet Aircraft Runway Use: 2014

	Runway												
	4L	**4R**	**9**	**14[2]**	**15L**	**15R**	**22L**	**22R**	**27**	**32**	**33L**	**33R**	**Total**
2014 Daily Operations													
Dep Day	16.2	21.4	126.9	0.1	0.0	11.6	6.8	130.6	48.3	0.0	77.4	0.0	439.3
Dep Night	0.2	3.0	11.0	0.0	0.0	10.2	0.9	16.0	9.8	0.0	8.0	0.0	59.1
Arr Day	37.3	120.8	0.1	0.0	0.2	8.6	99.0	2.7	86.8	13.0	55.0	2.3	425.8
Arr Night	0.7	16.6	0.0	0.0	0.0	1.6	24.8	0.1	8.4	0.0	20.5	0.0	72.6
Total Daily Operations	54.4	161.9	138.0	0.1	0.2	32.0	131.6	149.3	153.2	13.0	160.8	2.4	996.7
2014 Annual Operations													
Dep Day	5,901	7,820	46,322	21	3	4,244	2,498	47,667	17,620	0	28,239	6	160,341
Dep Night	83	1,095	4,005	0	0	3,705	327	5,852	3,560	0	2,930	0	21,557
Arr Day	13,630	44,096	40	0	63	3,149	36,146	970	31,680	4,727	20,055	846	155,402
Arr Night	236	6,064	0	0	0	569	9,056	23	3,057	3	7,475	16	26,499
Total Annual Operations	19,850	59,075	50,367	21	65	11,668	48,026	54,511	55,917	4,730	58,699	868	363,797
2014 Percentage Operations													
Dep Day	4%	5%	29%	<1%	<1%	3%	2%	30%	11%	<1%	18%	<1%	100%
Dep Night	<1%	5%	19%	<1%	<1%	17%	2%	27%	17%	<1%	14%	<1%	100%
Arr Day	9%	28%	<1%	<1%	<1%	2%	23%	1%	20%	3%	13%	1%	100%
Arr Night	1%	23%	<1%	<1%	<1%	2%	34%	<1%	12%	<1%	28%	<1%	100%

Source: Massport Noise Office and HMMH 2015.

Notes: The data reflect actual percentages of aircraft operations on each runway end. They should not be confused with effective runway use, which is used by the Preferential Runway Advisory System (PRAS) to derive recommendations for use of a particular runway.
Runway 14-32 is unidirectional.
Values may not add to 100 percent due to rounding.

Table H-3b Summary of Jet and Non-Jet Aircraft Runway Use: 2015

	Runway												
	4L	**4R**	**9**	**14[2]**	**15L**	**15R**	**22L**	**22R**	**27**	**32**	**33L**	**33R**	**Total**
2015 Daily Operations													
Dep Day	14.3	19.7	126.1	0.1	0.0	13.4	9.3	149.0	46.9	0.0	69.4	0.1	448.4
Dep Night	0.2	2.4	10.8	0.0	0.0	11.9	1.1	16.5	10.2	0.0	9.4	0.0	62.5
Arr Day	38.7	118.9	0.1	0.0	0.3	5.6	101.6	2.8	96.6	11.1	55.2	3.4	434.2
Arr Night	0.4	14.9	0.0	0.0	0.0	1.7	27.4	0.0	9.5	0.0	22.7	0.1	76.7
Total Daily Operations	53.6	156.0	137.0	0.1	0.3	32.5	139.4	168.4	163.2	11.1	156.7	3.5	1021.7
2015 Annual Operations													
Dep Day	5,228	7,200	46,028	24	6	4,878	3,405	54,397	17,134	0	25,343	17	163,660
Dep Night	82	889	3,927	0	0	4,347	406	6,022	3,713	0	3,418	0	22,804
Arr Day	14,135	43,410	33	0	106	2,027	37,065	1,033	35,259	4,038	20,146	1,233	158,485
Arr Night	126	5,445	0	0	0	602	10,007	8	3456	4	8,295	36	27,979
Total Annual Operations	19,571	56,944	49,988	24	112	11,854	50,884	61,460	59,562	4,042	57,201	1,287	372,930
2015 Percentage Operations													
Dep Day	3%	4%	28%	<1%	<1%	3%	2%	33%	10%	<1%	15%	<1%	100%
Dep Night	<1%	4%	17%	<1%	<1%	19%	2%	26%	16%	<1%	15%	<1%	100%
Arr Day	9%	27%	<1%	<1%	<1%	1%	23%	1%	22%	3%	13%	1%	100%
Arr Night	<1%	19%	<1%	<1%	<1%	2%	36%	<1%	12%	<1%	30%	<1%	100%

Source: Massport Noise Office and HMMH 2016.

Notes: The data reflect actual percentages of aircraft operations on each runway end. They should not be confused with effective runway use, which is used by the Preferential Runway Advisory System (PRAS) to derive recommendations for use of a particular runway.
Runway 14-32 is unidirectional.
Values may not add to 100 percent due to rounding.

Runway use can also be presented in terms of percent of total operations as shown in **Table H-4** for 2014 and 2015. **Tables H-2a** and **H-2b** total the runway use by aircraft group and time of day. **Tables H-3a** and **H-3b** total the runway use by operation type and time of day. **Table H-4** presents the 2014 and 2015 runway use for all operations which use Logan Airport.

In 2014, Runway 4R was the runway with the highest activity (primarily by jet arrivals) with Runway 33L a very close second (primarily by jet departures), whereas in 2015, Runway 22R was the runway with the highest activity (primarily jet departures) with Runway 27 a very close second (primarily by jet arrivals).

Each year, non-jet activity makes up approximately 8.0 percent of the arrivals and 8.0 percent of the departures at Logan Airport.

Table H-4 Total 2014 and 2015 Modeled Runway Use by All Operations

	Jet Arrivals		Non-Jet Arrivals		Jet Departures		Non-Jet		All Operations
	Day	Night	Day	Night	Day	Night	Day	Night	
Runway				**2014 Operations**					
04L	2.1%	<0.1%	1.7%	<0.1%	0.0%	0.0%	1.6%	<0.1%	5.5%
04R	11.2%	1.6%	1.0%	<0.1%	1.7%	<0.1%	<0.1%	<0.1%	16.2%
9	0.0%	0.0%	<0.1%	0.0%	12.0%	1.1%	0.8%	<0.1%	13.8%
14	0.0%	0.0%	0.0%	0.0%	<0.1%	0.0%	<0.1%	0.0%	<0.1%
15L	0.0%	0.0%	<0.1%	0.0%	0.0%	0.0%	<0.1%	0.0%	<0.1%
15R	0.7%	<0.1%	<0.1%	<0.1%	1.0%	1.0%	<0.1%	<0.1%	3.2%
22L	8.1%	2.4%	1.9%	<0.1%	0.6%	<0.1%	<0.1%	<0.1%	13.2%
22R	<0.1%	<0.1%	<0.1%	<0.1%	10.6%	1.6%	2.5%	<0.1%	15.0%
27	8.2%	0.8%	0.5%	<0.1%	4.5%	1.0%	<0.1%	<0.1%	15.4%
32	0.6%	<0.1%	0.7%	<0.1%	0.0%	0.0%	0.0%	0.0%	1.3%
33L	4.8%	2.0%	0.7%	<0.1%	6.6%	0.8%	1.2%	<0.1%	16.1%
33R	0.0%	<0.1%	<0.1%	<0.1%	0.0%	0.0%	<0.1%	0.0%	<0.1%
Total	35.6%	7.1%	7.1%	<0.1%	36.9%	5.8%	7.2%	<0.1%	100.0%
Runway				**2015 Operations**					
04L	2.0%	<0.1%	1.8%	<0.1%	<0.1%	<0.1%	1.4%	<0.1%	5.2%
04R	10.9%	1.4%	0.8%	<0.1%	1.6%	<0.1%	<0.1%	<0.1%	15.3%
9	0.0%	0.0%	<0.1%	0.0%	11.2%	1.0%	1.2%	<0.1%	13.4%
14	0.0%	0.0%	<0.1%	0.0%	<0.1%	0.0%	<0.1%	0.0%	<0.1%
15L	0.0%	0.0%	<0.1%	0.0%	0.0%	0.0%	<0.1%	0.0%	<0.1%
15R	<0.1%	<0.1%	<0.1%	<0.1%	1.1%	1.1%	<0.1%	<0.1%	3.2%
22L	7.9%	2.6%	2.1%	<0.1%	0.9%	<0.1%	<0.1%	<0.1%	13.6%
22R	<0.1%	<0.1%	<0.1%	<0.1%	12.1%	1.6%	2.5%	<0.1%	16.5%
27	8.9%	0.9%	0.5%	<0.1%	4.2%	1.0%	<0.1%	<0.1%	16.0%
32	0.5%	<0.1%	0.6%	<0.1%	0.0%	0.0%	<0.1%	0.0%	1.1%
33L	4.8%	2.2%	0.6%	<0.1%	5.7%	0.9%	1.1%	<0.1%	15.3%
33R	<0.1%	0.0%	<0.1%	<0.1%	0.0%	0.0%	<0.1%	0.0%	<0.1%
Total	35.4%	7.3%	7.1%	<0.1%	36.8%	5.9%	7.1%	<0.1%	100.0%

Flight Tracks

RealContours™ converts each radar track to an INM model track and then models the scaled aircraft operation on that track. This method keeps the lateral and vertical dispersion of the aircraft types consistent with the radar data, and ensures that anomalies in the departure paths are captured in the RealContours™ system. **Table H-5** lists the number of flight tracks used in the RealContours™ modeling system for 2014 and 2015. Flight tracks from October 2015 are displayed in **Figures 6-3** through **6-9** in Chapter 6, *Noise Abatement*.

Table H-5 Total Count of Flight Tracks Modeled in RealContours™ (2014 and 2015)

	Runway											
	4L	**4R**	**9**	**14**	**15L**	**15R**	**22L**	**22R**	**27**	**32**	**33L**	**33R**
2014												
Departures	5,984	8,915	50,327	21	3	7,950	2,825	53,518	21,180	0	31,169	6
Arrivals	13,866	50,160	39	0	63	3,718	45,201	993	34,736	4,730	27,530	862
2015												
Departures	5,310	8,089	49,955	24	6	9,225	3,811	60,419	20,847	0	28,761	17
Arrivals	14,261	48,855	33	0	106	2,629	47,073	1,041	38,715	4,042	28,440	1,269

Source: HMMH, 2014/2015; Harris NOMS data.

Flight Profiles

To enhance the results from RealContours™, Massport elected to use the companion RealProfiles™ software. By using the actual radar information along with the equations developed for the INM, RealProfiles™ develops an altitude profile for each aircraft operation. This profile is then modeled in the RealContours™ system. As a result, the modeled aircraft follows both the actual radar track on the ground and the actual radar altitude profile in the sky.

RealProfiles™ provides several advantages over the standard INM profile modeling. The standard INM modeling uses a "Stagelength" to identify an aircraft's departure weight and then models a standard departure profile for that Stagelength. Using RealProfiles™, the RealContours™ system selects a weight similar to the standard modeling but then develops a profile to allow the INM aircraft to follow the actual path flown for that route. For example, if aircraft departing from a particular runway are required to remain level at 3,000 feet for a certain distance, RealProfiles™ will develop a profile that remains level for that distance along the track. In contrast, the standard modeling would use the standard INM profile and would not model the level segment.

For 2014, RealProfiles™ was able to compute profiles based on the actual radar data for 98.6 percent of the available departure tracks and 94.8 percent of the available arrivals. For 2015, RealProfiles™ was able to compute profiles based on the actual radar data for 56.3 percent of the available departure tracks and 53.2 percent of the available arrivals. RealProfiles™ uses the INM supplied aircraft performance database to develop its unique profiles; however, for several aircraft in the INM database the aircraft performance data are not available. For those profiles, the INM database contains fixed profiles, which are not modified and are used as supplied with the INM data.

Fleet Mix

As in the past, operations by aircraft types have been summarized into several key categories: commercial (passenger and cargo) operations, Stage 2 or Stage 3 jet aircraft, and turboprop and propeller (non-jet) aircraft. In addition, the operations are split into daytime and nighttime periods, where nighttime hours are defined as 10:00 PM to 7:00 AM, consistent with the definition of DNL. **Table H-6** summarizes the numbers of operations by categories of aircraft operating at Logan Airport from 1990 through 2015. General aviation (GA) operations were not included in the noise modeling prior to 1998 and commercial jet operations were not separated until 1999.

Table H-6 Modeled Daily Operations by Commercial and General Aviation (GA) Aircraft[1] – 1990 to 2015

(Data for the years 2000 to 2015 are shown on the subsequent pages)

		1990	1992	1993	1994	1995	1996	1997	1998	1999
Commercial Aircraft										
Stage 2 Jets[2]	Day	312.40	228.89	203.34	189.40	156.90	132.40	108.46	84.93	83.30
	Night	19.99	13.13	7.44	10.10	5.50	4.79	7.75	5.92	6.66
	Total	**332.39**	**242.02**	**210.78**	**199.50**	**162.40**	**137.19**	**116.21**	**90.85**	**89.96**
Stage 3 Jets	Day	288.89	384.49	418.99	425.70	429.40	439.81	505.08	541.43	597.28
	Night	57.25	58.29	65.47	62.80	69.00	80.16	85.06	95.54	98.59
	Total	**346.14**	**442.78**	**484.46**	**488.50**	**498.40**	**519.97**	**590.14**	**636.97**	**695.87**
Air Carrier	Day	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	569.18
	Night	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	96.21
	Total	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	**665.39**
Regional Jets	Day	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	28.10
	Night	N/A[3]	NA[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	2.38
	Total	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	**30.48**
Non-Jets	Day	444.41	411.84	598.16	541.97	526.85	505.31	514.70	552.56	448.82
	Night	11.72	69.32	46.84	13.59	11.14	13.73	27.27	21.86	16.63
	Total	**456.13**	**481.16**	**645.00**	**555.56**	**537.99**	**519.04**	**541.97**	**574.42**	**465.45**
Total Commercial										
Operations	Day	1045.70	1025.22	1220.49	1157.07	1113.15	1077.52	1128.24	1178.92	1129.90
	Night	88.96	140.74	119.75	86.49	85.64	98.68	120.08	123.32	121.88
	Total	**1134.6**	**1165.9**	**1340.2**	**1243.5**	**1198.7**	**1176.2**	**1248.3**	**1302.2**	**1251.7**
GA Aircraft										
Stage 2 Jets[2]	Day	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	5.25	9.89
	Night	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	0.40	0.74
	Total	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	**5.65**	**10.63**
Stage 3 Jets	Day	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	30.54	48.46
	Night	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	4.21	6.55
	Total	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	**34.75**	**55.01**
Non-Jets	Day	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	37.29	19.36
	Night	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	16.28	18.89
	Total	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	**53.57**	**38.25**
Total GA										
Operations	Day	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	73.08	77.71
	Night	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	20.89	26.17
	Total	NA[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	**93.97**	**103.88**
Total	Day	1045.70	1025.22	1220.49	1157.07	1113.15	1077.52	1128.24	1252.00	1207.61
	Night	88.96	140.74	119.75	86.49	85.64	98.68	120.08	144.21	148.05
	Total[3]	**1134.6**	**1165.9**	**1340.2**	**1243.5**	**1198.7**	**1176.2**	**1248.3**	**1396.2**	**1355.6**

Table H-6 Modeled Daily Operations by Commercial and General Aviation (GA) Aircraft[1] – 1990 to 2015

(Data for the years 1990 to 1999 are shown on the prior page)

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Commercial Aircraft											
Stage 2 Jets[2]	Day	5.13	1.18	0.05	0.08	0.03	0.05	0.03	0.03	0.01	0.00
		0.26	0.05	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00
	Total	**5.39**	**1.23**	**0.05**	**0.08**	**0.05**	**0.06**	**0.03**	**0.04**	**0.02**	**0.00**
Stage 3 Jets	Day	727.09	756.24	740.75	717.85	772.39	765.76	767.55	748.13	699.39	668..32
	Night	103.66	109.77	97.04	92.69	113.24	113.66	114.81	118.29	114.30	103.11
	Total	**830.75**	**866.01**	**837.79**	**810.54**	**885.63**	**879.42**	**882.36**	**866.42**	**813.69**	**771.43**
Air Carrier Jets	Day	648.95	569.99	500.70	461.06	518.96	505.48	490.63	472.39	443.15	421.51
	Night	99.79	101.30	83.52	72.69	89.24	91.99	92.71	96.28	89.89	82.19
	Totals	**748.74**	**671.29**	**584.22**	**533.75**	**608.20**	**597.47**	**583.34**	**568.66**	**533.04**	**503.70**
Regional Jets	Day	78.14	186.25	240.05	256.80	253.43	260.34	276.95	275.77	256.24	246.81
	Night	3.87	8.47	13.52	19.99	24.00	21.68	22.11	22.03	24.40	20.93
	Total	**82.01**	**194.72**	**253.57**	**276.79**	**277.43**	**282.01**	**299.06**	**297.80**	**280.64**	**267.73**
Non-Jets	Day	409.62	317.62	165.45	135.18	133.24	148.77	140.81	145.27	132.52	136.45
	Night	21.58	10.97	3.45	2.41	3.03	3.02	3.26	3.47	4.00	5.54
	Total	**431.20**	**328.58**	**168.89**	**137.59**	**136.28**	**151.79**	**144.07**	**148.73**	**136.52**	**141.99**
Total Commercial											
Operations	Day	1141.8	1075.0	906.25	853.10	905.66	914.59	908.41	893.43	831.92	804.77
	Night	125.51	120.79	100.49	95.10	116.29	116.68	118.09	121.77	118.31	108.65
	Total	**1267.35**	**1195.82**	**1006.7**	**948.20**	**1021.9**	**1031.2**	**1026.5**	**1015.1**	**950.23**	**913.42**
GA Aircraft											
Stage 2 Jets[2]	Day	7.29	5.15	3.65	2.84	0.94	2.29	1.90	1.24	0.36	0.09
	Night	0.64	0.50	0.41	0.26	0.14	0.25	0.17	0.19	0.03	0.01
	Total	**7.93**	**5.65**	**4.08**	**3.10**	**1.08**	**2.54**	**2.07**	**1.43**	**0.38**	**0.10**
Stage 3 Jets	Day	40.08	34.23	37.83	46.21	53.72	58.84	61.08	54.82	43.98	22.31
	Night	3.21	3.28	6.42	6.98	8.37	9.33	6.57	6.39	4.52	2.28
	Total	**43.29**	**37.51**	**44.25**	**53.19**	**62.09**	**68.16**	**67.65**	**61.21**	**48.49**	**23.59**
Non-Jets	Day	34.57	37.31	17.36	17.81	16.95	14.00	15.05	11.98	15.13	8.19
	Night	1.83	1.92	4.45	4.40	5.20	4.75	1.39	3.61	1.08	0.74
	Total	**36.40**	**39.23**	**21.81**	**22.21**	**22.14**	**18.75**	**16.44**	**15.58**	**16.20**	**8.93**
Total GA											
Operations	Day	81.94	76.68	58.84	66.88	71.60	75.12	78.03	68.04	59.46	30.46
	Night	5.68	5.71	11.29	11.64	13.71	14.33	8.13	10.19	5.62	3.08
	Total	**87.62**	**82.39**	**70.13**	**78.52**	**85.31**	**89.46**	**86.15**	**78.22**	**65.05**	**33.54**
Total	Day	1223.7	1151.7	965.09	919.98	977.27	989.71	986.43	961.46	891.39	834.33
	Night	131.19	126.50	111.78	106.74	130.00	131.02	126.22	131.96	123.93	111.70
	Total[3]	**1354.9**	**1278.2**	**1076.8**	**1026.7**	**1107.2**	**1120.7**	**1112.6**	**1093.4**	**1015.3**	**946.03**

Table H-6	Modeled Daily Operations by Commercial and General Aviation (GA) Aircraft[1] – 1990 to 2015							
		(Data for the years 1990 to 2009 are shown on the prior pages)						
		2010	**2011**	**2012**	**2013**	**2014**	**2015**	**Change 2014 to 2015**
Commercial Aircraft								
Stage 2 Jets[2]	Day	0.01	0.01	0.01	0.01	0.00	0.00	0.00
	Night	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	Total	**0.02**	**0.01**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**
Stage 3 Jets (All)	Day	674.25	684.19	649.22	667.65	670.00	685.92	15.91
	Night	107.92	109.38	106.55	115.91	123.60	130.96	7.36
	Total	**782.17**	**793.57**	**755.77**	**783.56**	**793.61**	**816.88**	**23.27**
Air Carrier Jets	Day	521.64	571.03	530.76	546.27	556.59	585.55	28.96
	Night	93.98	99.17	98.68	107.17	115.84	126.36	10.53
	Totals	**615.62**	**670.20**	**629.44**	**653.44**	**672.43**	**711.92**	**39.49**
Regional Jets	Day	152.61	113.16	118.46	121.38	113.41	100.36	-13.05
	Night	13.94	10.21	7.87	8.74	7.77	4.60	-3.17
	Total	**166.55**	**123.37**	**126.33**	**130.12**	**121.18**	**104.96**	**-16.22**
Non-Jets	Day	138.53	135.18	133.92	132.33	128.45	125.27	-3.18
	Night	5.21	4.73	3.06	3.21	2.28	2.41	0.13
	Total	**143.74**	**139.91**	**136.98**	**135.54**	**130.73**	**127.68**	**-3.04**
Total Commercial								
Operations	Day	812.78	819.39	783.14	799.99	798.45	811.19	12.74
	Night	113.13	114.11	109.62	119.12	125.88	133.37	7.49
	Total	**925.91**	**933.50**	**892.76**	**919.12**	**924.33**	**944.56**	**20.23**
GA Aircraft								
Stage 2 Jets[2]	Day	0.27	0.08	0.25	0.31	0.00	0.28	0.28
	Night	0.04	0.00	0.04	0.02	0.00	0.02	0.02
	Total	**0.30**	**0.08**	**0.29**	**0.33**	**0.00**	**0.30**	**0.30**
Stage 3 Jets	Day	27.80	52.51	52.93	51.21	52.64	51.82	-0.82
	Night	3.21	5.35	7.20	5.10	4.65	4.28	-0.37
	Total	**31.01**	**57.87**	**60.13**	**56.31**	**57.29**	**56.10**	**-1.19**
Non-Jets	Day	8.19	18.18	15.16	13.06	13.95	19.31	5.35
	Night	0.72	1.29	1.29	1.15	1.13	1.46	0.33
	Total	**8.92**	**19.48**	**16.45**	**14.22**	**15.08**	**20.77**	**5.69**
Total GA								
Operations	Day	36.26	70.78	68.35	64.58	66.59	71.40	4.81
	Night	3.97	6.65	8.52	6.28	5.78	5.77	-0.01
	Total	**40.22**	**77.43**	**76.86**	**70.85**	**72.37**	**77.17**	**4.79**
Total	Day	849.03	890.16	851.49	864.57	865.05	882.59	17.54
	Night	117.10	120.76	118.13	125.40	131.66	139.14	7.48
	Total[3]	**966.13**	**1,010.92**	**969.61**	**989.97**	**996.70**	**1,021.73**	**25.02**

Source: Massport's Noise Monitoring System and Revenue Office numbers, HMMH 2015.

Notes: Data from 1991 not available.

1 Includes scheduled and unscheduled operations.

2 Stage 2 aircraft are exempt from meeting newer federal Stage 3 noise limits when their maximum gross takeoff weight is less than or equal to 75,000 pounds.

3 RJ operations were not tracked separately prior to 1999.

4 Totals prior to 1998 do not include GA operations.

5 The definition of RJ for the EDR changed between 2009 and 2010. A RJ in 2010 is a jet in commercial service with less than 80 seats. Prior to 2010, a RJ was a jet in commercial service with 100 seats or less.

Commercial Jet Aircraft by Part 36 Stage Category

The FAA categorizes jet aircraft currently operating at Logan Airport into three groups: Stage 2, Stage 3, and Stage 4. As described in Chapter 6, *Noise Abatement*, the designation refers to a noise classification specified in Federal Aviation Regulation Part 36 that sets noise emission standards at three measurement locations – takeoff, landing, and sideline – based on an aircraft's maximum certificated weight. The heavier the aircraft, the more noise it is permitted to make within limits. Aircraft are allowed to be recertificated to the higher standard when modifications are made to the aircraft engine or design. Because of the substantial differences in noise between Stage 2, recertificated Stage 3, Stage 3, and Stage 4 aircraft, Massport tracks operations by these separate categories to follow their trends. **Table H-7** shows the percentage of commercial jet operations by stage category from 1999 through 2015. One of the most significant changes occurring after the economic downturn in 2001 was the almost immediate retirement of the re-certificated aircraft from airlines' fleets due to their high operating costs. This type of accelerated retirement is not as prevalent during the 2008 to 2009 economic downturn since it is no longer the major airlines operating these aircraft. However, these aircraft still have high operating costs and are being replaced wherever possible.

Table H-7	Percentage of Commercial Jet Operations by Part 36 Stage Category – 1999 to 2015				
	Stage 4 Requirements[3]	**Certificated Stage 3[1]**	**Recertificated Stage 3[2]**	**Stage 2**	**Total**
1999	N/A	70.0%	21.0%	9.0%	100%
2000	N/A	75.0%	24.0%	1.0%	100%
2001	N/A	86.3%	13.6%	0.1%	100%
2002	N/A	92.8%	7.2%	0.0%	100%
2003	N/A	95.8%	4.1%	0.0%	100%
2004	N/A	97.8%	2.2%	0.0%	100%
2005	N/A	98.0%	2.0%	0.0%	100%
2006	N/A	98.6%	1.4%	0.0%	100%
2007	N/A	98.9%	1.1%	0.0%	100%
2008	N/A	99.1%	0.9%	0.0%	100%
2009	N/A	99.1%	0.9%	0.0%	100%
2010	93.2%[4]	98.9%	1.1%	0.0%	100%
2011	95.5%[4]	99.5%	0.5%	0.0%	100%
2012	95.8%[4]	99.9%	0.1%	0.0%	100%
2013	97.4%[4]	100.0%	<0.1%	<0.1%	100%
2014	97.4%[4]	100.0%	<0.1%	0.0%	100%
2015	96.7%[4]	100.0%	<0.1%	<0.1%	100%

Source: Massport and FAA radar data.
Notes:
1 New Stage 3 aircraft are aircraft originally manufactured as a certified Stage 3 aircraft under Federal Regulation Part 36.
2 Recertificated Stage 3 aircraft are aircraft originally manufactured as a certified Stage 1 or 2 aircraft under Federal Regulation Part 36, which either have been treated with hushkits or have been re-engineered to meet Stage 3 requirements.
3 Aircraft that meet Stage 4 requirements are aircraft that are certificated Stage 4 or would qualify if recertificated. Certificated Stage 4 aircraft were not available until 2006 and the level of aircraft that meet Stage 4 requirements has not been determined prior to 2010.
4 All aircraft listed as meeting Stage 4 requirements are also listed as Stage 3 aircraft.

Nighttime Operations

Massport tracks flights that operate between the broader DNL nighttime periods of 10:00 PM to 7:00 AM, when each flight is penalized 10 dB in calculations of noise exposure. **Table H-8** shows this nighttime activity by different groups of aircraft. Nighttime flights by commercial jet operators increased by 6 percent in 2015, following increases of 8.8 percent in 2013 and 6.6 percent in 2014. Commercial non-jet operations increased by 5.7 percent in 2015 following increases of 4.9 percent in 2013 and 29 percent in 2014. GA traffic was essentially unchanged in 2015, falling by 0.25 percent, following decreases of 26.4 percent in 2013 and 8 percent in 2014. Overall, nighttime operations at Logan Airport increased by 5.7 percent in 2015, after increasing 6.2 percent in 2013 and 5.0 percent in 2014. The majority of nighttime operations (between 10:00 PM and 7:00 AM) occurred either before midnight or after 5:00 AM.

Table H-8	Modeled Nighttime Operations at Logan Airport – 1990 to 2014			
	Commercial Jets	**Commercial Non-Jets**	**General Aviation**	**Total**
1990	77.24	11.72	NA	88.96
1991	NA	NA	NA	NA
1992	71.42	69.32	NA	140.74
1993	72.91	46.84	NA	119.75
1994	72.90	13.59	NA	86.49
1995	74.50	11.14	NA	85.64
1996	84.95	13.73	NA	98.68
1997	92.81	27.27	NA	120.08
1998	101.46	21.86	NA	123.32
1999	105.25	16.63	26.17	148.05
2000	103.92	21.58	5.68	131.19
2001	109.82	10.97	5.71	126.50
2002	97.04	3.45	11.29	111.78
2003	92.69	2.41	11.64	106.74
2004	113.26	3.03	13.71	130.00
2005	113.67	3.02	14.33	131.02
2006	114.81	3.26	8.13	126.22
2007	118.30	3.47	10.19	131.96
2008	114.31	4.00	5.62	123.93
2009	103.05	5.56	3.08	111.70
2010	107.93	5.21	3.97	117.10
2011	109.38	4.73	6.65	120.76
2012	106.55	3.06	8.52	118.13
2013	115.91	3.21	6.28	125.40
2014	123.60	2.28	5.78	131.66
2015	130.96	2.41	5.77	139.14
Change (2014 to 2015)	**7.36**	**0.13**	**-0.01**	**7.48**
Percent Change	**5.96%**	**5.70%**	**-0.25%**	**5.68%**

Source: Massport, HMMH, 2015.
Note: NA = Not available.

Jet Runway Use

Table H-9 presents a summary of runway use by jets. Since 2009, the radar data have been analyzed with Massport's Harris Noise and Operational Monitoring System (NOMS), data from 2001 through 2008 was compiled with Massport's PreFlight™ software. PreFlight™ was an analysis package used to compile fleet, day/night splits, and runway use information from radar data. Data prior to 2001 were derived from Massport's original noise monitoring system, supplemented with field records. Note that Logan Airport Noise Rules prevent arrivals to Runway 22R and departures from Runway 4L by jet aircraft.

Table H-9	Summary of Jet Aircraft Runway Use – 1990 to 2015									
Runway	**4L**	**4R**	**9**	**14[1]**	**15R**	**22L**	**22R**	**27**	**32[1]**	**33L**
1990										
Departures	0%[2]	3%	21%	NA	10%	2%	36%	20%	NA	7%
Arrivals	1%	25%	0%	NA	2%	14%	0%	28%	NA	29%
1992[2]										
Departures	0%	6%	31%	NA	7%	2%	38%	10%	NA	6%
Arrivals	1%	37%	0%	NA	3%	12%	0%	30%	NA	17%
1993										
Departures	0%	9%	33%	NA	7%	3%	40%	4%	NA	4%
Arrivals	2%	44%	0%	NA	1%	11%	0%	28%	NA	15%
1994										
Departures	0%	9%	33%	NA	4%	3%	32%	12%	NA	5%
Arrivals	3%	42%	0%	NA	1%	8%	0%	27%	NA	19%
1995										
Departures	0%	8%	36%	NA	5%	5%	29%	11%	NA	5%
Arrivals	3%	41%	0%	NA	2%	8%	0%	27%	NA	17%
1996										
Departures	0%	8%	32%	NA	5%	6%	33%	12%	NA	5%
Arrivals	2%	38%	0%	NA	2%	11%	0%	29%	NA	18%
1997										
Departures	0%	8%	30%	NA	5%	6%	31%	15%	NA	5%
Arrivals	2%	36%	0%	NA	2%	9%	0%	30%	NA	20%
1998										
Departures	0%	8%	35%	NA	6%	5%	28%	14%	NA	5%
Arrivals	2%	41%	0%	NA	2%	7%	0%	28%	NA	19%
1999										
Departures	0%	8%	31%	NA	5%	4%	30%	15%	NA	6%
Arrivals	3%	37%	0%	NA	2%	10%	0%	28%	NA	21%
2000										
Departures	0%	8%	35%	NA	4%	3%	30%	15%	NA	6%
Arrivals	4%	40%	0%	NA	1%	7%	0%	28%	NA	20%
2001										
Departures	0%	7%	34%	NA	4%	3%	35%	12%	NA	5%
Arrivals	5%	36%	0%	NA	1%	8%	0%	32%	NA	18%

Table H-9	Summary of Jet Aircraft Runway Use – 1990 to 2015									
Runway	**4L**	**4R**	**9**	**14[1]**	**15R**	**22L**	**22R**	**27**	**32[1]**	**33L**
2002										
Departures	0%	4%	31%	NA	6%	3%	35%	16%	NA	6%
Arrivals	6%	31%	0%	NA	1%	12%	0%	30%	NA	21%
2003										
Departures	0%	4%	33%	NA	7%	2%	34%	14%	NA	6%
Arrivals	7%	33%	0%	NA	1%	14%	0%	28%	NA	18%
2004										
Departures	0%	5%	34%	NA	10%	4%	24%	18%	NA	6%
Arrivals	6%	34%	0%	NA	1%	12%	0%	24%	NA	23%
2005										
Departures	0%	5%	36%	NA	7%	1%	31%	13%	NA	7%
Arrivals	8%	33%	0%	NA	1%	11%	0%	29%	NA	17%
2006										
Departures	0%	4%	33%	0%	3%	1%	40%	13%	-	6%
Arrivals	7%	29%	0%	-	1%	14%	0%	33%	0.2%	16%
2007										
Departures	0%	5%	31%	0%	4%	1%	33%	7%	-	19%
Arrivals	5%	31%	0%	-	1%	15%	0%	36%	2%	11%
2008										
Departures	0%	6%	33%	<1%	3%	<1%	36%	6%	-	16%
Arrivals	6%	30%	-	-	2%	17%	-	33%	2%	11%
2009										
Departures	0%	7%	32%[3]	0%	3%	2%	34%	6%[3]	-	16%
Arrivals	7%	31%	-	-	3%	17%	0%	30%[3]	1%	11%
2010										
Departures	0%	4%	28%	<1%	8%	2%	31%	10%	-	17%
Arrivals	5%	28%	-	-	1%	15%	0%	32%	1%	16%
2011										
Departures	0%	6%	36%	<1%	5%[4]	2%	36%	7%	-	7%[4]
Arrivals	7%	37%	-	-	<1%[4]	16%	0%	28%	1%	11%[4]
2012										
Departures	0%	6%	33%	<1%	5%[4]	3%	38%	6%	-	9%[4]
Arrivals	6%	34%	-	-	1%[4]	16%	0%	33%	<1%	9%[4]

Table H-9	Summary of Jet Aircraft Runway Use – 1990 to 2015									
Runway	**4L**	**4R**	**9**	**14[1]**	**15R**	**22L**	**22R**	**27**	**32[1]**	**33L**
2013										
Departures	<1%	5%	30%	<1%	5%	2%	35%	12%	--	12%
Arrivals	6%	29%	--	--	1%	16%	<1%	32%	1%	15%
2014										
Departures	0%	5%	31%	<1%	5%	2%	28%	13%	-	17%
Arrivals	5%	30%	0%	-	2%	25%	<1%	21%	1%	16%
2015										
Departures	<1%	4%	29%	<1%	5%	2%	32%	12%	-	15%
Arrivals	5%	29%	0%	-	2%	25%	<1%	23%	1%	16%

Source: HMMH 2015, Massport Noise Office.

Notes: The data reflect actual percentages of jet aircraft operations on each runway end. They should not be confused with effective runway use, which is used by the PRAS to derive recommendations for use of a particular runway. Effective runway percentages include a factor of 10 applied to nighttime operations so that use of a runway at night more closely reflects its effect on total noise exposure.

Jet aircraft are not able to use Runway 15L or 33R due to its length of only 2,557 feet.

Values may not add to 100 percent due to rounding.

NA = Not available.

1 Runway 14-32 opened in late November 2006. (Runway 14-32 is unidirectional with no arrivals to Runway 14 and no departures from Runway 32).

2 The *1990 Final Generic Environmental Impact Report* was published and submitted to the Secretary of Environmental Affairs in July 1993. It included modeled operations and resulting noise contours for 1987, 1990, and a 1996-forecast year. The *1993 Annual Update* published in July 1994 included operations and contours for 1992 and 1993. 1991 data are not available.

3 Runway 9-27 had extended weekend closings for resurfacing during 2009.

4 Runway 15R-33L was closed for 3 months in 2011 and in 2012.

Annual Model Results and Status of Mitigation Programs

Noise Exposed Population

Table H-10 presents the noise-exposed population by community through 2014. This table includes population within the DNL 60 to 65 dB contours, although a DNL of 65 dB is the federally-defined noise criterion used as a guideline to identify when residential land use is considered incompatible with aircraft noise.

Table H-10 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
BOSTON[2]							
1990	1980	0	0	1,778	28,970	30,748	NA
1992	1980	0	0	800	4,316	5,116	NA
1993	1980	0	0	264	2,820	3,084	NA
1994	1990	0	106	265	7,698	8,069	30,895
1995	1990	0	106	851	8,815	9,772	33,765
1996	1990	0	106	374	8,775	9,255	40,992
1997	1990	0	106	719	13,857	14,682	54,804
1998	1990	0	58	580	10,877	11,515	52,201
1999[3]	1990	0	58	364	11,632	12,054	45,948
2000[3]	1990	0	58	183	7,880	8,121	32,474
2000[3]	2000	0	0	234	9,014	9,248	35,785
2001[3]	2000	0	0	315	6,515	6,700	27,778
2002[3]	2000	0	0	132	2,625	2,757	23,225
2003[3]	2000	0	0	164	1,730	1,894	21,763
2004[3,4]	2000	0	65	192	4,142	4,399	24,473
2005[3,4]	2000	0	65	104	2,020	2,189	17,661
2006[4]	2000	0	65	99	1,054	1,218	14,866
2007 (INMv7.0a)[4]	2000	0	0	169	4,094	4,263	21,446
2008 (INMv7.0b)[4]	2000	0	5	0	3,487	3,492	18,890
2009 (INMv7.0b)[4]	2000	0	5	67	937	1,009	12,284
2010 (INMv7.0b)[4]	2000	0	0	67	644	711	14,900
2010 (INMv7.0b)[4]	2010	0	0	0	689	689	17,646
2011 (INMv7.0c)[4]	2010	0	0	0	331	331	11,600
2012 (INMv7.0c)[4]	2010	0	0	0	439	439	12,076
2012 (INMv7.0d)[4]	2010	0	0	0	421	421	11,037
2013 (INMv7.0d)[4]	2010	0	0	0	612	612	14,835
2014 (INMv7.0d)[4]	2010	0	0	34	4,151	4,185	23,343
2015 (INMv7.0d)[4]	2010	0	0	110	7,225	7,365	32,309
CHELSEA							
1990	1980	0	0	0	4,813	4,813	NA
1992	1980	0	0	0	3,952	3,952	NA
1993	1980	0	0	0	0	0	NA

Table H-10 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
1994	1990	0	0	0	0	0	8,510
1995	1990	0	0	0	95	95	9,750
1996	1990	0	0	0	0	0	8,744
1997	1990	0	0	0	0	0	10,001
1998	1990	0	0	0	0	0	9,222
1999	1990	0	0	0	95	95	9,249
2000	1990	0	0	0	0	0	5,622
2000	2000	0	0	0	0	0	7,361
2001	2000	0	0	0	0	0	4,508
2002	2000	0	0	0	0	0	3,995
2003	2000	0	0	0	0	0	3,591
2004[4]	2000	0	0	0	0	0	7,756
2005[4]	2000	0	0	0	0	0	5,772
2006[4]	2000	0	0	0	0	0	2,477
2007 (INMv7.0a)[4]	2000	0	0	0	0	0	9,774
2008 (INMv7.0b)[4]	2000	0	0	0	0	0	7,793
2009 (INMv7.0b)[4]	2000	0	0	0	0	0	5,462
2010 (INMv7.0b)[4]	2000	0	0	0	0	0	4,880
2010 (INMv7.0b)[4]	2010	0	0	0	0	0	4,897
2011 (INMv7.0c)[4]	2010	0	0	0	0	0	0
2012 (INMv7.0c)[4]	2010	0	0	0	0	0	0
2012 (INMv7.0d)[4]	2010	0	0	0	0	0	0
2013 (INMv7.0d)[4]	2010	0	0	0	0	0	3,485
2014 (INMv7.0d)[4]	2010	0	0	0	0	0	9,236
2015 (INMv7.0d)[4]	2010	0	0	0	0	0	0
EVERETT							
1990	1980	0	0	0	0	0	NA
1992	1980	0	0	0	0	0	NA
1993	1980	0	0	0	0	0	NA
1994	1990	0	0	0	0	0	0
1995	1990	0	0	0	0	0	0
1996	1990	0	0	0	0	0	0
1997	1990	0	0	0	0	0	0
1998	1990	0	0	0	0	0	0

Table H-10 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
1999[3]	1990	0	0	0	0	0	0
2000[3]	1990	0	0	0	0	0	0
2000[3]	2000	0	0	0	0	0	0
2001[3]	2000	0	0	0	0	0	0
2002[3]	2000	0	0	0	0	0	0
2003[3]	2000	0	0	0	0	0	0
2004[3,4]	2000	0	0	0	0	0	0
2005[3,4]	2000	0	0	0	0	0	0
2006[4]	2000	0	0	0	0	0	0
2007 (INMv7.0a)[4]	2000	0	0	0	0	0	0
2008 (INMv7.0b)[4]	2000	0	0	0	0	0	0
2009 (INMv7.0b)[4]	2000	0	0	0	0	0	0
2010 (INMv7.0b)[4]	2000	0	0	0	0	0	0
2010 (INMv7.0b)[4]	2010	0	0	0	0	0	0
2011 (INMv7.0c)[4]	2010	0	0	0	0	0	0
2012 (INMv7.0c)[4]	2010	0	0	0	0	0	0
2012 (INMv7.0d)[4]	2010	0	0	0	0	0	0
2013 (INMv7.0d)[4]	2010	0	0	0	0	0	0
2014 (INMv7.0d)[4]	2010	0	0	0	0	0	0
2015 (INMv7.0d)[4]	2010	0	0	0	0	0	0
MEDFORD							
1990	1980	0	0	0	0	0	NA
1992	1980	0	0	0	0	0	NA
1993	1980	0	0	0	0	0	NA
1994	1990	0	0	0	0	0	0
1995	1990	0	0	0	0	0	0
1996	1990	0	0	0	0	0	0
1997	1990	0	0	0	0	0	0
1998	1990	0	0	0	0	0	0
1999	1990	0	0	0	0	0	0
2000	1990	0	0	0	0	0	0
2000	2000	0	0	0	0	0	0
2001	2000	0	0	0	0	0	0
2002	2000	0	0	0	0	0	0

Table H-10 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
2003	2000	0	0	0	0	0	0
2004[4]	2000	0	0	0	0	0	0
2005[4]	2000	0	0	0	0	0	0
2006[4]	2000	0	0	0	0	0	0
2007 (INMv7.0a)[4]	2000	0	0	0	0	0	0
2008 (INMv7.0b)[4]	2000	0	0	0	0	0	0
2009 (INMv7.0b)[4]	2000	0	0	0	0	0	0
2010 (INMv7.0b)[4]	2000	0	0	0	0	0	0
2010 (INMv7.0b)[4]	2010	0	0	0	0	0	0
2011 (INMv7.0c)[4]	2010	0	0	0	0	0	0
2012 (INMv7.0c)[4]	2010	0	0	0	0	0	0
2012 (INMv7.0d)[4]	2010	0	0	0	0	0	0
2013 (INMv7.0d)[4]	2010	0	0	0	0	0	0
2014 (INMv7.0d)[4]	2010	0	0	0	0	0	0
2015 (INMv7.0d)[4]	2010	0	0	0	0	0	0
QUINCY							
1990	1980	0	0	0	0	0	NA
1992	1980	0	0	0	0	0	NA
1993	1980	0	0	0	0	0	NA
1994	1990	0	0	0	0	0	0
1995	1990	0	0	0	0	0	0
1996	1990	0	0	0	0	0	0
1997	1990	0	0	0	0	0	0
1998	1990	0	0	0	0	0	0
1999	1990	0	0	0	0	0	0
2000	1990	0	0	0	0	0	0
2000	2000	0	0	0	0	0	636
2001	2000	0	0	0	0	0	610
2002	2000	0	0	0	0	0	610
2003	2000	0	0	0	0	0	610
2004[4]	2000	0	0	0	0	0	610
2005[4]	2000	0	0	0	0	0	610
2006[4]	2000	0	0	0	0	0	610
2007 (INMv7.0a)[4]	2000	0	0	0	0	0	0

Table H-10 Noise-Exposed Population by Community							
Year	**Census Data**	**80+ dB DNL**	**75+ dB DNL**	**70-75 dB DNL**	**65-70 dB DNL[1]**	**Total (65+)**	**60-65 dB DNL**
2008 (INMv7.0b)[4]	2000	0	0	0	0	0	0
2009 (INMv7.0b)[4]	2000	0	0	0	0	0	0
2010 (INMv7.0b)[4]	2000	0	0	0	0	0	0
2010 (INMv7.0b)[4]	2010	0	0	0	0	0	0
2011 (INMv7.0c)[4]	2010	0	0	0	0	0	0
2012 (INMv7.0c)[4]	2010	0	0	0	0	0	0
2012 (INMv7.0d)[4]	2010	0	0	0	0	0	0
2013 (INMv7.0d)[4]	2010	0	0	0	0	0	0
2014 (INMv7.0d)4	2010	0	0	0	0	0	0
2015 (INMv7.0d)[4]	2010	0	0	0	0	0	0
REVERE							
1990	1980	0	0	0	4,274	4,274	NA
1992	1980	0	0	0	3,848	3,848	NA
1993	1980	0	0	0	4,617	4,617	NA
1994	1990	0	0	0	3,569	3,569	2,099
1995	1990	0	0	0	3,364	3,364	2,304
1996	1990	0	0	172	3,292	3,464	2,505
1997	1990	0	0	0	3,293	3,293	2,047
1998	1990	0	0	0	3,168	3,168	2,132
1999	1990	0	0	128	3,165	3,293	2,047
2000	1990	0	0	0	2,552	2,552	2,386
2000	2000	0	0	0	2,496	2,496	3,100
2001	2000	0	0	0	2,496	2,496	3,100
2002	2000	0	0	0	2,822	2,822	2,399
2003	2000	0	0	0	2,994	2,994	2,227
2004[4]	2000	0	0	82	2,969	3,051	2,678
2005[4]	2000	0	0	82	2,540	2,622	2,731
2006[4]	2000	0	0	82	2,540	2,622	2,698
2007 (INMv7.0a)[4]	2000	0	0	0	2,450	2,450	2,853
2008 (INMv7.0b)[4]	2000	0	0	0	2,434	2,434	1,802
2009 (INMv7.0b)[4]	2000	0	0	0	2,512	2,512	1,452
2010 (INMv7.0b)[4]	2000	0	0	0	2,505	2,505	1,385
2010 (INMv7.0b)[4]	2010	0	0	0	2,413	2,413	2,473

Table H-10 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
2011 (INMv7.0c)[4]	2010	0	0	0	2,547	2,547	3,123
2012 (INMv7.0c)[4]	2010	0	0	0	2,772	2,772	3,236
2012 (INMv7.0d)[4]	2010	0	0	0	2,762	2,762	3,191
2013 (INMv7.0d)[4]	2010	0	0	0	2,505	2,505	2,791
2014 (INMv7.0d)[4]	2010	0	0	0	2,832	2,832	3,829
2015 (INMv7.0d)[4]	2010	0	0	0	3,789	3,789	3,385
WINTHROP							
1990	1980	0	676	1,211	2,420	4,307	NA
1992	1980	0	626	1,146	2,488	4,262	NA
1993	1980	0	648	1,211	1,773	3,632	NA
1994	1990	0	417	1,343	5,154	6,914	7,512
1995	1990	0	482	1,611	5,757	7,850	7,077
1996	1990	0	417	1,376	5,930	7,723	7,333
1997	1990	0	417	1,659	6,386	8,462	6,839
1998	1990	0	519	1,522	6,572	8,613	6,507
1999	1990	0	353	1,408	5,946	7,707	7,135
2000	1990	0	277	991	5,240	6,508	7,296
2000	2000	0	247	1,070	4,684	6,001	7,776
2001	2000	0	244	683	4,123	5,050	8,104
2002	2000	0	2	481	2,247	2,730	7,921
2003	2000	0	0	339	1,956	2,295	7,386
2004[4]	2000	0	2	337	1,649	1,988	6,508
2005[4]	2000	0	39	347	1,280	1,666	6,353
2006[4]	2000	0	39	416	1,288	1,743	6,845
2007 (INMv7.0a)[4]	2000	0	0	247	1,139	1,386	6,749
2008 (INMv7.0b)[4]	2000	0	0	244	1,409	1,653	6,547
2009 (INMv7.0b)[4]	2000	0	0	171	643	814	4,221
2010 (INMv7.0b)[4]	2000	0	0	131	523	654	3,960
2010 (INMv7.0b)[4]	2010	0	0	130	598	728	3,720
2011 (INMv7.0c)[4]	2010	0	0	130	939	1069	4,303
2012 (INMv7.0c)[4]	2010	0	0	200	1,325	1,525	5,564
2012 (INMv7.0d)[4]	2010	0	0	200	1,186	1,386	5,305

Table H-10 Noise-Exposed Population by Community							
Year	**Census Data**	**80+ dB DNL**	**75+ dB DNL**	**70-75 dB DNL**	**65-70 dB DNL[1]**	**Total (65+)**	**60-65 dB DNL**
2013 (INMv7.0d)[4]	2010	0	0	130	1,060	1,190	5,466
2014 (INMv7.0d)[4]	2010	0	0	130	1,775	1,905	6,456
2015 (INMv7.0d)[4]	2010	0	0	320	2,623	2,943	6,375
All Communities							
1990	1980	0	676	2,989	40,477	44,142	NA
1992	1980	0	628	2,352	14,604	17,584	NA
1993	1980	0	648	1,475	9,210	11,333	NA
1994	1990	0	523	1,608	16,421	18,552	49,016
1995	1990	0	588	2,462	18,031	21,081	52,896
1996	1990	0	523	1,922	17,997	20,442	59,574
1997	1990	0	523	2,378	23,536	26,437	73,691
1998	1990	0	577	2,102	20,617	23,296	70,062
1999	1990	0	411	1,900	20,838	23,149	64,379
2000	1990	0	335	1,174	15,672	17,181	47,778
2000	2000	0	247	1,304	16,194	17,745	54,190
2001	2000	0	244	998	13,004	14,246	43,616
2002	2000	0	2	613	7,694	8,309	38,150
2003	2000	0	0	503	6,680	7,183	35,577
2004[4]	2000	0	67	611	8,760	9,438	41,975
2005[4]	2000	0	104	533	5,840	6,477	33,127
2006[4]	2000	0	104	597	4,882	5,583	27,496
2007(INMv7.01)[4]	2000	0	0	416	7,683	8,099	40,822
2008(INMv7.0b)[4]	2000	0	5	244	7,330	7,579	35,122
2009 (INMv7.0b)[4]	2000	0	5	238	4,092	4,335	23,419
2010 (INMv7.0b)[4]	2000	0	0	198	3,672	3,870	25,125
2010 (INMv7.0b)[4]	2010	0	0	130	3,700	3,830	28,736
2011 (INMv7.0c)[4]	2010	0	0	130	3,817	3,947	19,026

Table H-10 Noise-Exposed Population by Community

Year	Census Data	80+ dB DNL	75+ dB DNL	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
All Communities							
2012 (INMv7.0c)[4]	2010	0	0	200	4,536	4,736	20,876
2012(INMv7.0d)[4]	2010	0	0	200	4,369	4,569	19,533
2013(INMv7.0d)[4]	2010	0	0	130	4,177	4,307	26,577
2014(INMv7.0d)[4]	2010	0	0	164	8,758	8,922	42,864
2015 (INMv7.0d)[4]	2010	0	0	430	13,667	14,097	52,748

Source: Data prepared for Massport by HMMH 2015.
Notes: South End is included in Boston totals.
NA Not available.
1 65 dB DNL is the federally-defined noise criterion.
2 Portions of Dorchester, East Boston, Roxbury, South Boston
3 Boston population by community changed in 1999 due to employment of more accurate hill effects methodology and reporting change.
4 All results since 2004 are from the RealContours™ modeling system.

Residential Sound Insulation Program (RSIP)

In 2015, no new dwelling units received sound insulation from Massport, leaving totals of 5,467 residential buildings and 11,515 dwelling units that have been sound insulated since 1986 when the program was first implemented. **Table H-11** lists the yearly progress of this mitigation effort.

Following the FAA's approval of model adjustments based on the effects of terrain (discussed in the *1999 ESPR*), Massport submitted, and the New England Region of the FAA approved, a new sound insulation program. The revised contour, approved for a two-year period beginning in 1999, included dwelling units in East Boston, South Boston, and Winthrop that previously had not been eligible for insulation. Massport received notice of FAA funding for $5 million. Subsequently, Massport updated its program contour, first with the *2001 EDR* contour and more recently with the Logan Airside Improvements Project approved contour. These updates have allowed Massport to continue the program with additional funds every year since 1999. This latest update takes into account runway use changes due to the new Runway 14-32 which opened in late November 2006. This update expands the focus of the sound insulation program into Chelsea to satisfy the mitigation commitments made in the Airside Improvements Program Record of Decision (ROD). Massport has also utilized a program where they have contacted properties that are still eligible within the RSIP boundaries that had previously declined to participate. They have been offered a second chance to participate in the program.

Table H-11 Residential Sound Insulation Program (RSIP) Status (1986-2015)

Construction Year	Residential Buildings[1]	Dwelling Units[2]
1986	4	8
1987	43	51
1988	102	159
1989	94	133
1990	121	200
1991	175	360
1992	197	354
1993	318	654
1994	310	542
1995	372	753
1996	323	577
1997	364	808
1998	328	806
1999	330	718
2000	195	601
2001	260	278
2002	205	354
2003	230	468
2004	320	791
2005	314	471
2006	286	827
2007	160	548
2008	94	388
2009	111	287
2010	56	83
2011	62	114
2012[3]	0	0
2013	45	76
2014	48	106
2015	0	0
Total	**5,467**	**11,515**

Source: Massport, 2015.
Notes:
1 Includes multiple units.
2 Individual units.
3 Federal funding was delayed in 2012

Table H-12 provides a list of all schools that have been treated under Massport's sound insulation program. To date, Massport has provided sound insulation to 36 schools at a cost of over $8 million.

Table H-12 Schools Treated Under Massport Sound Insulation Program	
Boston:	
East Boston	**Winthrop**
East Boston High	Winthrop Jr. High School
St. Mary's Star of the Sea	E. B. Newton
St. Dominic Savio High	A. T. Cummings (Ctr.) School
St. Lazarus	3 Total Winthrop Schools
James Otis	
Samuel Adams	
Curtis Guild	**Revere**
Dante Alighieri	Beachmont School
P.J. Kennedy	1 Total Revere School
Donald McKay	
Hugh Roe O'Donnell	
E Boston Central Catholic	**Chelsea**
Manassah Bradley	Shurtleff School
13 East Boston Schools	Williams School
	St. Rose Elementary
South Boston	St. Stanislaus
St. Augustine	Chelsea High School
Cardinal Cushing	5 Total Chelsea Schools
Patrick Gavin	
St. Bridgid's	**36 Total Schools**
Oliver Hazard Perry	
Condon School	
6 South Boston Schools	
Roxbury and Dorchester	
Samuel Mason	
Dearborn Middle	
Ralph Waldo Emerson	
Lewis Middle	
Nathan Hale Elem.	
Phillis Wheatley Elem.	
Davis Ellis Elem.	
Henry L. Higginson	
8 Roxbury and Dorchester Schools	
27 Total Boston Schools	

Source: Massport, 2015.

Noise Complaints

Table H-13 presents a detailed list by community of the total complaints made in 2014 and 2015, which can be filed either on Massport's Noise Complaint Line, through a form on Massport's website or through the PublicVue flight track portal. The Noise Complaint Line provides individuals the ability to express their concerns about aviation noise (activities) or to ask questions regarding noise at Logan Airport. Callers ask a range of questions such as "Why is this runway in use?"; "What times do the planes stop flying?" and "Was that aircraft off-course?"

The Noise Abatement Office (NAO) staff documents noise line complaints by obtaining information from the caller about the nature of the complaint, time of the occurrence, location of caller's residence, and the activity that was disturbed. The NAO uses the collected information to determine the probable activity responsible for the complaint and writes a letter report to the complainant. The letter includes the original complaint, a response that identifies the activity responsible for the call (arrivals, departures, run-up, etc.), meteorological information at the time of the call (a major factor in aviation activities), runways in use at the time of the call, and a notice that the FAA will receive a copy of the report.

In 2015, Massport received 17,685 noise complaints from 82 communities (**Figure H-13**), an increase of 37.6 percent compared to 2014. The number of individual complainants, however, declined by 9 percent (from 2,084 individuals in 2014 to 1,903 individuals in 2015), indicating that noise annoyance is growing among a concentrated population rather than spreading to a larger population. This is consistent with a recent survey of U.S. airports that finds noise complaints concentrated among relatively small numbers of complainants.[15] This research, completed by George Mason University, shows that a small number of people account for a disproportionately high share of the total number of noise complaints (the full article is included at the end of this appendix).

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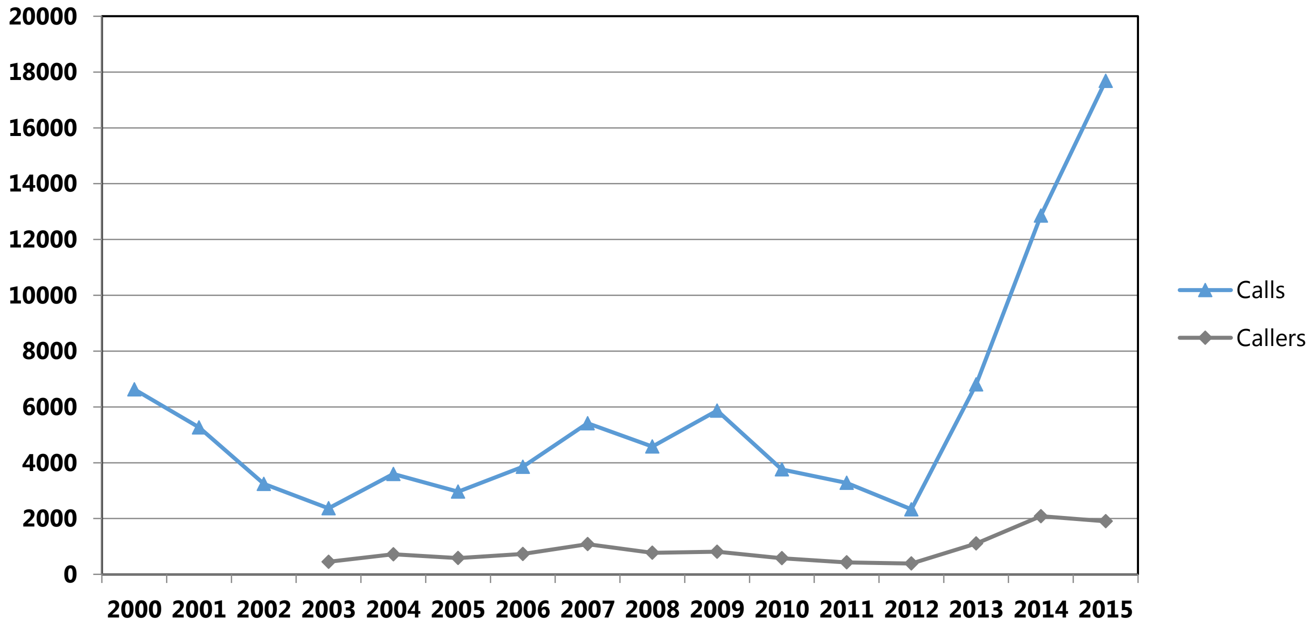
15 Dourado, E. and Russell, R. October 2016. *Airport Noise NIMBYism: An Empirical Investigation.* Mercatus Center at George Mason University. https://www.mercatus.org/system/files/dourado-airport-noise-mop-v1.pdf. Accessed December 10, 2016.

Figure H-13 Number of Callers and Complaints between 2000 and 2015



Source: Massport, HMMH 2015.
Notes: Number of callers is not available before 2003.

Massport's website, (www.massport.com/environment/environmental-reporting/noise-abatement/noise-complaints/), provides for additional general questions and answers regarding the Noise Complaint Line.

Table H-13 Noise Complaint Line Summary

Town	2014		2015		Change 2014 to 2015
	Calls	Callers	Calls	Callers	
Arlington	332	106	1,851	92	1,519
Athol	1	1	0	0	-1
Auburndale	0	0	2	1	2
Belmont	1,658	116	715	95	-943
Berkley	0	0	1	1	1
Beverly	2	2	1	1	-1
Boston	136	17	120	10	-16
Boxford	0	0	1	1	1
Braintree	2	2	2	2	0
Brighton	1	1	0	0	-1
Brockton	1	1	3	1	2

Table H-13	Noise Complaint Line Summary				
Town	**2014**		**2015**		**Change 2014 to 2015**
	Calls	**Callers**	**Calls**	**Callers**	
Brookline	3	2	5	3	2
Burlington	3	2	0	0	-3
Cambridge	585	71	1,697	136	1,112
Canton	21	4	10	2	-11
Charlestown	5	3	6	3	1
Chelsea	66	36	116	37	50
Cohasset	46	14	110	12	64
Danvers	0	0	8	2	8
Dartmouth	1	1	0	0	-1
Dedham	24	5	10	5	-14
Dorchester	38	17	115	20	77
Duxbury	1	1	1	1	0
East Boston	354	106	250	69	-104
East Bridgewater	0	0	1	1	1
Essex	27	1	0	0	-27
Everett	270	54	114	30	-156
Fitchburg	0	0	1	1	1
Framingham	25	2	19	2	-6
Gloucester	5	1	4	1	-1
Hamilton	2	1	5	2	3
Hanover	1	1	1	1	0
Harvard	1	1	0	0	-1
Hingham	86	17	55	16	-31
Hull	1,855	332	1,136	152	-719
Hyde Park	50	16	28	7	-22
Jamaica Plain	268	89	288	60	20
Kingston	1	1	1	1	0
Leominster	2	2	1	1	-1
Lexington	1	1	0	0	-1
Littleton	0	0	6	1	6
Lunenburg	3	2	2	2	-1
Lynn	482	5	424	13	-58

Table H-13	Noise Complaint Line Summary				
Town	**2014**		**2015**		**Change 2014 to 2015**
	Calls	**Callers**	**Calls**	**Callers**	
Lynnfield	2	1	4	3	2
Malden	8	5	36	6	28
Manchester	2	2	0	0	-2
Marblehead	61	3	10	5	-51
Marshfield	7	6	2	1	-5
Mattapan	1	1	6	1	5
Medford	742	154	508	116	-234
Medway	1	1	0	0	-1
Melrose	1	1	8	4	7
Middleton	3	2	1	1	-2
Millis	0	0	1	1	1
Milton	2,669	189	4,991	343	2,322
Nahant	109	20	50	19	-59
Natick	3	2	7	1	4
Needham	0	0	7	2	7
Newton	12	6	20	7	8
Norton	0	0	1	1	1
Norwell	3	2	4	3	1
Peabody	30	11	64	12	34
Pembroke	0	0	1	1	1
Quincy	27	17	89	11	62
Randolph	6	2	1	1	-5
Reading	2	2	0	0	-2
Revere	86	29	57	25	-29
Roslindale	127	27	285	55	158
Roxbury	113	9	129	11	16
Ruxbury	2	2	0	0	-2
Salem	20	13	7	6	-13
Saugus	0	0	1	1	1
Scituate	4	4	3	3	-1
Sharon	0	0	9	2	9
Shirley	6	2	12	6	6

Table H-13	Noise Complaint Line Summary				
Town	**2014**		**2015**		**Change 2014 to 2015**
	Calls	**Callers**	**Calls**	**Callers**	
Somerville	938	239	1,910	191	972
South Boston	67	26	263	48	196
South Easton	1	1	0	0	-1
South End	272	35	216	38	-56
Southborough	0	0	1	1	1
Stoneham	0	0	7	2	7
Stoughton	1	1	2	2	1
Swampscott	5	3	3	3	-2
Tewksbury	0	0	1	1	1
Wakefield	1	1	0	0	-1
Waltham	5	3	1	1	-4
Watertown	541	72	298	34	-243
Wayland	0	0	1	1	1
Wellesley	1	1	0	0	-1
Wenham	3	2	285	2	282
West Roxbury	24	9	205	28	181
Weston	1	1	0	0	-1
Weymouth	83	7	41	6	-42
Wilmington	1	1	0	0	-1
Winchendon	1	1	0	0	-1
Winchester	246	31	733	24	487
Winthrop	237	98	242	74	5
Woburn	8	3	33	10	25
Grand Total	**12,855**	**2,084**	**17,685**	**1,903**	**4,830**

Source: Massport, HMMH 2015

Cumulative Noise Index (CNI)

Massport reports total annual fleet noise at Logan Airport, defined in the Logan Airport Noise Rules by a metric referred to as the CNI. The CNI is a single number representing the sum of the entire set of single-event noise levels experienced at the Airport over a full year of operation, weighted similarly to DNL so that activity occurring at night is penalized by adding an extra 10 dB to each event. This penalty is mathematically equivalent to multiplying the number of nighttime events by each aircraft by a factor of 10. The Logan Airport Noise Rules define CNI in terms of Effective Perceived Noise Level (EPNL) and require that the index be computed for the fleet of commercial aircraft operating at Logan Airport throughout the year. In addition, in EDRs and ESPRs, Massport reports partial CNI values of noise at Logan Airport, so that various subsets of the fleet (cargo, night operations, passenger jets, etc.) are identified (see **Table H-14**).

The Noise Rules, adopted by Massport following public hearings held in February 1986, established a CNI limit of 156.5 Effective Perceived Noise Decibels (EPNdB). The CNI generally has decreased since 1990, remaining below that cap, with changes from year to year on the order of a few tenths of a decibel. The 2015 CNI remains well below the cap of 156.5 EPNL.

Table H-14	Cumulative Noise Index (EPNL) – 1990 to 2015 (limit 156.5)									
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Full CNI (Entire Commercial Jet Fleet)	**156.4**	**155.8**	**155.5**	**155.3**	**155.4**	**155.3**	**155.1**	**154.8**	**154.7**	**154.9**
Total Passenger Jets	155.2	154.8	154.6	154.4	154.4	154.2	154.1	153.9	153.7	153.9
Total Cargo Jets	150.1	148.9	148.0	147.9	148.3	148.8	148.6	147.5	147.9	148.0
Total Daytime	152.5	152.1	152.4	152.1	152.1	151.6	151.2	150.8	150.4	150.4
Total Nighttime	154.4	153.4	152.6	152.4	152.6	152.9	152.9	152.5	152.7	153.1
Total Stage 2 Jets	NA	NA	NA	NA	151.0	150.2	149.4	149.2	147.7	147.1
Total Stage 3 Jets	NA	NA	NA	NA	153.4	153.8	153.8	153.4	153.8	154.2
Daytime Stage 2	NA	NA	NA	NA	149.0	148.5	147.6	146.5	145.2	144.1
Nighttime Stage 2	NA	NA	NA	NA	146.7	145.1	144.8	145.8	144.1	144.0
Daytime Stage 3	NA	NA	NA	NA	149.1	148.8	148.7	148.8	148.9	149.2
Nighttime Stage 3	NA	NA	NA	NA	151.4	152.1	152.2	151.5	152.1	152.5
Passenger Jet Stage 2	NA	NA	NA	NA	150.5	149.9	149.2	148.9	147.5	146.8
Passenger Jet Stage 3	NA	NA	NA	NA	152.2	152.3	152.3	152.2	152.6	153.0
Cargo Jet Stage 2	NA	NA	NA	NA	141.5	137.4	136.8	137.4	139.0	134.5
Cargo Jet Stage 3	NA	NA	NA	NA	147.3	148.5	148.3	147.0	147.3	147.9
Daytime Passenger	NA	152.0	152.2	152.0	152.0	151.5	151.1	150.6	150.1	150.1
Nighttime Passenger	NA	151.6	150.9	150.6	150.8	151.0	151.0	151.1	151.2	151.6
Daytime Cargo	137.1	137.1	137.6	135.2	136.1	138.0	136.7	136.2	138.0	138.2
Nighttime Cargo	149.9	148.6	147.6	147.6	148.0	148.4	148.3	147.1	147.5	147.6
Daytime Passenger Stage 2	NA	NA	NA	NA	148.9	148.4	147.6	146.5	145.0	143.9
Daytime Passenger Stage 3	NA	NA	NA	NA	149.0	148.5	148.4	148.5	148.6	149.0
Nighttime Passenger Stage 2	NA	NA	NA	NA	149.0	148.5	148.4	148.5	142.8	143.7
Nighttime Passenger Stage 3	NA	NA	NA	NA	149.4	149.9	150.1	149.8	150.5	150.8
Daytime Cargo Stage 2	NA	NA	NA	NA	128.3	126.7	124.6	126.4	131.6	131.5
Daytime Cargo Stage 3	NA	NA	NA	NA	135.3	137.7	136.4	135.7	136.9	137.1
Nighttime Cargo Stage 2	NA	NA	NA	NA	141.3	137.0	136.5	137.0	138.2	131.5
Nighttime Cargo Stage 3	NA	NA	NA	NA	147.0	148.1	148.0	146.6	146.9	147.5

Table H-14 Cumulative Noise Index (EPNL) – 1990 to 2015 (limit 156.5)										
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Full CNI (Entire Commercial Jet Fleet)	**154.7**	**154.1**	**153.2**	**152.7**	**153.4**	**153.2**	**152.6**	**152.7**	**152.9**	**152.3**
Total Passenger Jets	153.6	152.9	151.8	151.3	152.2	152.1	151.4	151.5	151.9	151.1
Total Cargo Jets	148.2	147.8	147.4	147.1	147.0	146.6	146.5	146.4	146.1	145.9
Total Daytime	149.5	149.0	148.5	148.0	148.5	148.2	147.5	147.2	147.6	147.1
Total Nighttime	153.1	152.4	151.3	150.9	151.7	151.6	151.0	151.2	151.4	150.7
Total Stage 2 Jets	124.7	121.5	114.3	114.1	118.1	NA	NA	NA	NA	NA
Total Stage 3 Jets	154.7	154.1	153.2	152.7	153.4	153.2	152.6	152.7	152.9	152.3
Daytime Stage 2	122.6	119.3	111.2	113.7	109.4	NA	NA	NA	NA	NA
Nighttime Stage 2	120.5	117.3	111.4	103.2	117.5	NA	NA	NA	NA	NA
Daytime Stage 3	149.5	149.0	148.5	148.0	148.5	148.2	147.5	147.2	147.6	147.1
Nighttime Stage 3	153.1	152.4	151.3	150.9	151.7	151.6	151.0	151.2	151.4	150.7
Passenger Jet Stage 2	124.2	116.3	NA	NA	NA	NA	NA	NA	NA	NA
Passenger Jet Stage 3	153.6	152.9	151.8	151.3	152.2	152.1	151.4	151.5	151.9	151.1
Cargo Jet Stage 2	114.8	119.9	114.3	114.1	118.1	NA	NA	NA	NA	NA
Cargo Jet Stage 3	148.2	147.8	147.4	147.1	147.0	146.6	146.5	146.4	146.1	145.9
Daytime Passenger	149.3	148.7	148.2	147.7	148.2	147.9	147.2	146.9	147.3	146.8
Nighttime Passenger	151.6	150.8	149.4	148.8	150.0	150.1	149.3	149.7	150.0	149.1
Daytime Cargo	137.5	137.1	137.0	136.2	135.7	135.8	135.5	135.8	135.8	135.2
Nighttime Cargo	147.8	147.4	147.0	146.8	146.7	146.2	146.1	146.0	145.6	145.5
Daytime Passenger Stage 2	122.3	115.0	NA	NA	NA	NA	NA	NA	NA	NA
Daytime Passenger Stage 3	149.2	148.7	148.2	147.7	148.2	147.9	147.2	146.9	147.3	146.8
Nighttime Passenger Stage 2	119.8	110.2	NA	NA	NA	NA	NA	NA	NA	NA
Nighttime Passenger Stage 3	151.6	150.8	149.4	148.8	150.0	150.1	149.3	149.7	150.0	149.1
Daytime Cargo Stage 2	111.1	117.3	111.2	113.7	109.4	NA	NA	NA	NA	NA
Daytime Cargo Stage 3	137.5	137.0	137.0	136.1	135.7	135.8	135.5	135.8	135.8	135.2
Nighttime Cargo Stage 2	112.3	116.4	111.4	103.2	117.5	NA	NA	NA	NA	NA
Nighttime Cargo Stage 3	147.8	147.4	147.0	146.8	146.7	146.2	146.1	146.0	145.6	145.5

Table H-14 Cumulative Noise Index (EPNL) – 1990 to 2015 (limit 156.5)							
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**Change 2014 to 2015**
Full CNI (Entire Commercial Jet Fleet)	**151.9**	**152.1**	**152.2**	**152.3**	**152.9**	**152.7**	**-0.2**
Total Passenger Jets	150.9	150.6	151.3	151.4	152.2	152.0	-0.2
Total Cargo Jets	145.1	146.7	144.9	145.1	144.5	144.2	-0.3
Total Daytime	146.8	146.9	147	147.0	147.5	147.2	-0.3
Total Nighttime	150.3	150.6	150.6	150.8	151.3	151.2	-0.1
Total Stage 2 Jets	113.6	110.8	104.9	111.3	NA	NA	NA
Total Stage 3 Jets	151.9	152.1	152.2	152.3	152.9	152.7	-0.2
Daytime Stage 2	103.6	NA	104.9	101.4	NA	NA	NA
Nighttime Stage 2	113.1	110.8	NA	110.8	NA	NA	NA
Daytime Stage 3	146.8	146.9	147	147.0	147.5	147.2	-0.3
Nighttime Stage 3	150.3	150.6	150.6	150.8	151.3	151.2	-0.1
Passenger Jet Stage 2	NA	NA	104.9	101.4	NA	NA	NA
Passenger Jet Stage 3	150.9	150.6	151.3	151.4	152.2	152.0	-0.2
Cargo Jet Stage 2	113.6	110.8	NA	110.8	NA	NA	NA
Cargo Jet Stage 3	145.1	146.7	144.9	145.1	144.5	144.2	-0.3
Daytime Passenger	146.6	146.5	146.8	146.8	147.3	147.0	-0.3
Nighttime Passenger	149.0	148.5	149.4	149.6	150.5	150.3	-0.2
Daytime Cargo	134.5	136.6	134	133.6	134.9	134.4	-0.5
Nighttime Cargo	144.7	146.3	144.5	144.8	144.0	143.7	-0.3
Daytime Passenger Stage 2	NA	NA	104.9	101.4	NA	NA	NA
Daytime Passenger Stage 3	146.6	146.5	146.8	146.8	147.3	147.0	-0.3
Nighttime Passenger Stage 2	NA	NA	NA	NA	NA	NA	NA
Nighttime Passenger Stage 3	149.0	148.5	149.4	149.6	150.5	150.3	-0.2
Daytime Cargo Stage 2	103.6	NA	NA	NA	NA	NA	NA
Daytime Cargo Stage 3	134.4	136.6	134	133.6	134.9	134.4	-0.5
Nighttime Cargo Stage 2	113.1	110.8	NA	110.8	NA	NA	NA
Nighttime Cargo Stage 3	144.7	146.3	144.5	144.8	144.0	143.7	-0.3

Source: HMMH, 2015.
Notes: GA and non-jet aircraft are not included in the calculation.
NA = Not available.

Flight Track Monitoring Report

As part of its ongoing commitment to mitigate noise at Logan Airport, Massport has undertaken evaluating the flight tracks of turbojet aircraft engaged in the implementation of established FAA noise abatement procedures. As is true for any airport operator, however, Massport has no authority to control where individual aircraft actually fly. That remains the responsibility of the FAA, while the individual pilots are responsible for safely executing the FAA's instructions. The flight procedures, which are used by the Air Traffic Control (ATC) staff at Boston Tower to achieve desired noise abatement tracks, are contained in the FAA's Tower Order (BOS TWR 7040.1).

This is the thirteenth annual report for flight track monitoring. Prior to 2002, Massport had issued semi-annual reports, an outgrowth of the Flight Track Monitoring Program study. That study was contained in the *Generic Environmental Impact Report* filed with Massachusetts Environmental Policy Act (MEPA) in July 1996, and was the subject of two Community Working Group workshops in September and October 1996. The thirteenth annual report was published in Appendix H, *Noise Abatement* in the *2014 EDR*. The information for 2014 is repeated in this report for reference. The period covered by this *2015 EDR* is January 1, 2015 through December 31, 2015.

The purpose of the ongoing monitoring program is to identify any systematic changes in flight tracks that may occur and to reduce flight track dispersion, where appropriate. The next report will cover the period January 1, 2016 through December 31, 2016, and will be included in the *2016 ESPR*.

FAA Air Traffic Control (ATC) Procedures

FAA Tower Order BOS TWR 7040.1 entitled "Noise Abatement" describes the series of noise abatement policies, rules, regulations, and the procedures to be followed by the FAA air traffic controllers in meeting their designated responsibilities to be "a good neighbor, while meeting our operational objectives/ responsibilities to the National Airspace System." Section 7.a.3 of the Order, subtitled "Turbojet Departure Noise Abatement Procedures," states that all turbojet departures shall be issued the Standard Instrument Departure (SID) procedure appropriate for the departure runway. They are paraphrased from the LOGAN NINE SID[16] below.

Note in the descriptions that follow that terms such as "BOS 2 DME" are used frequently. Here, BOS refers to an aid to navigation known as the BOSTON VORTAC, a radio beacon physically located on Logan Airport near the eastern shoreline between the ends of Runways 27 and 33L (see **Figure H-14**). DME refers to "Distance Measuring Equipment," a co-located aid to navigation that provides pilots with a cockpit display of the number of nautical miles that the aircraft is from the designated radio beacon. Thus, BOS 2 DME means an aircraft should be two nautical miles away from the BOS. The term "vectored" means the pilot is assigned to fly a magnetic heading given by and at the discretion of the FAA air traffic controller to maintain the safe separation of aircraft. "MSL" is defined as feet above mean sea level and is the indicator of aircraft altitude used both by the pilot in the cockpit and the air traffic controller on the ground.

16 Accessed 04/07/2016

During 2010, several of the conventional-only (or radar vector) and RNAV procedures from the Boston Logan Airport Noise Study Categorical Exclusion (CATEX)[17] were implemented. There are eight new RNAV procedures for departures from Logan Airport. These eight procedures are used by aircraft departing Runways 4R, 9, 15R, 22L, 22R, 27, and 33L (Runways 27 and 33L were added in 2014). These procedures primarily affected departures flying over the North and South shores and were designed to increase the amount of jet traffic crossing back over land above 6,000 feet to minimize noise impacts to communities. A ninth RNAV procedure, which is used by Runway 27, has been in use at the Airport and has been modified several times.

For departures, the conventional procedures (flown by non-RNAV equipped aircraft) from the LOGAN NINE SID are:

- For Runway 4R, climb heading 036 degrees to BOS 4 DME, then turn right to a heading of 090 degrees, and then expect radar vectors to assigned route/navaid/fix. Aircraft that are initially vectored over water can expect to cross the coastline above 6,000 MSL before proceeding on course.
- For Runway 9, climb heading 093 degrees, and then expect radar vectors to assigned route/navaid/fix. Aircraft that are initially vectored over water can expect to cross the coastline above 6,000 MSL before proceeding on course.
- For Runway 14, climb heading 142 degrees to BOS 1 DME, then turn left to heading 120 degrees, then expect radar vectors to assigned route/navaid/fix. Aircraft that are initially vectored over water can expect to cross the coastline above 6,000 MSL before proceeding on course.
- For Runway 15R, climb heading 151 degrees to BOS 1 DME then turn left to 120 degrees, then expect radar vectors to assigned route/navaid/fix. Aircraft that are initially vectored over water can expect to cross the coastline above 6,000 MSL before proceeding on course.
- For Runways 22R and 22L, climbing left turn to a heading of 140 degrees, then expect radar vectors to assigned route/navaid/fix. Aircraft that are initially vectored over water can expect to cross the coastline above 6,000 MSL before proceeding on course.
- For Runway 33L, climb heading 331 degrees to BOS 2 DME then turn left to 316 degrees, then expect radar vectors to assigned route/navaid/fix.
- For Runway 27, climb heading 273 to BOS 2.2 DME, then turn left heading 235 degrees, then expect radar vectors to assigned route/navaid/fix.

The RNAV procedures (used only by Turbojets)[18] and the runways they serve:

- BLZZR THREE – Runways 4L, 9, 15R, 22L, 22R, 27, and 33L: This procedure directs most jet traffic in a well-defined flight corridor over the ocean and crossing back over the South Shore near Cohasset and Scituate.
- BRUWN FOUR – Runways 4L, 9, 15R, 22L, 22R, 27, and 33L: This procedure directs most jet traffic in a well-defined flight corridor over the ocean towards Cape Cod.

17 Federal Aviation Administration (FAA) Boston Logan Airport Noise Study Categorical Exclusion Record of Decision (CATEX ROD), Issued October 16, 2007

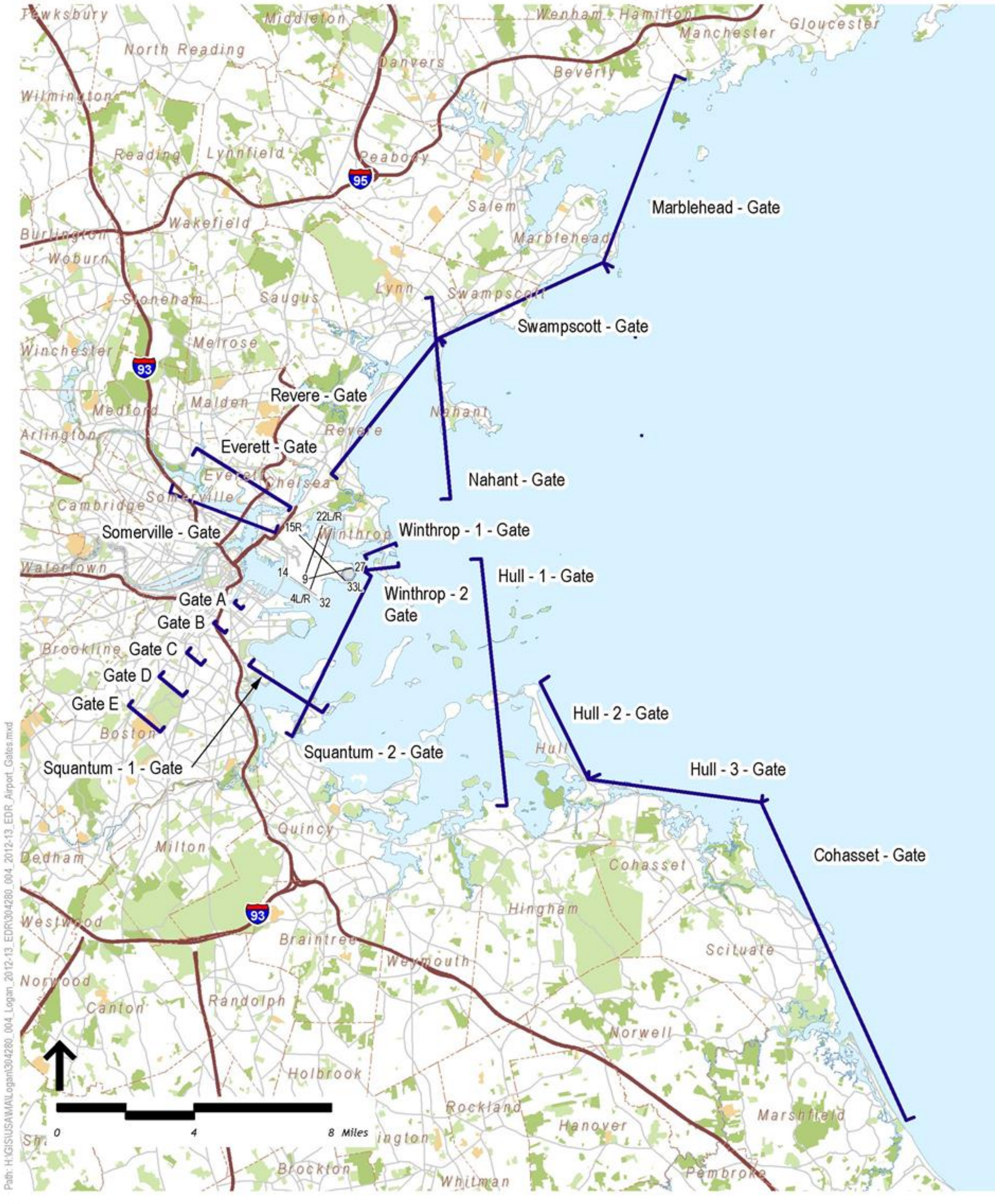
18 These are the procedures as defined on April 7, 2016. Procedures may be adjusted at points throughout the year.

- CELTK FOUR – Runways 4L, 9, 15R, 22L, 22R, 27, and 33L: This procedure directs most jet traffic in a well-defined flight corridor over the ocean.
- HYLND FOUR – 4L, 9, 15R, 22L, 22R, 27, and 33L: This procedure directs most jet traffic in a well-defined flight corridor over the ocean and crossing back over the North Shore near Beverly.
- LBSTA FOUR – 4L, 9, 15R, 22L, 22R, 27, 33L: This procedure directs most jet traffic in a well-defined flight corridor over the ocean and crossing back over the North Shore near Manchester and Gloucester.
- PATSS FOUR – 4L, 9, 15R, 22L, 22R, 27, 33L: This procedure directs most jet traffic in a well-defined flight corridor over the ocean and crossing back over the South Shore near Cohasset and Scituate.
- REVSS THREE – 4L, 9, 15R, 22L, 22R, 27, 33L: This procedure directs most jet traffic in a well-defined flight corridor over the ocean and crossing back over the South Shore near Cohasset and Scituate.
- SSOXS FOUR – 4L, 9, 15R, 22L, 22R, 27, 33L: This procedure directs most jet traffic in a well-defined flight corridor over the ocean and crossing back over the South Shore over Marshfield.
- WYLYY TWO – 27: This procedure directs most jet traffic in a well-defined flight corridor on a heading of 273 degrees then a turn to 235 degrees over South Boston.

These brief procedural statements form the basis of the verbal instructions and flight clearances that are passed from controller to pilot to achieve reduced noise in the communities surrounding Logan Airport while also maintaining the safe and efficient flow of aircraft in and out of the Airport. However, consistency with which these procedures are used varies due to air traffic demands, controller workloads, weather conditions, and other operational factors, as noted in the Flight Track Monitoring Program Study.

Figure H-14 presents the gates used in the analysis for the Flight Track Monitoring Report. These gates are virtual vertical planes, which are used in the analysis to capture the aircraft flight paths. The gates are defined using a geographic coordinate for each end of the gate along with a floor and a ceiling altitude. The gates also capture direction of flights (in or out). The edges of each gate in **Figure H-14** point in the direction that the aircraft is coming from. This information is used to evaluate the performance of the flight procedures off each runway end and is presented below. **Figure H-14** also displays the BOS location, which is used for the distance measurements for the conventional procedures.

The RNAV procedures are still captured by the original flight track monitoring gates. Traffic crossing over the North Shore passes through the Marblehead Gate and traffic passing over the South Shore passes through the Hull 2, Hull 3, and Cohasset Gates. Turbojets departing Runway 27 on the RNAV pass through the Runway 27 gates and the new Runway 33L RNAV flight tracks still pass between the Somerville and Everett gates as expected.



Source: HMMH, MassGIS, USDA NAIP 2010

Logan Airport Flight Track Monitor Gates

Logan Flight Gates

Boston VOR/DME

Figure H-14

Statistical Analyses of Flight Tracks - Runway 4R

The Nahant Gate (**Figure H-14**) monitors aircraft after the first turn at 4 DME. The Swampscott and Marblehead Gates monitor northbound shoreline crossings, while the Hull 2, Hull 3, and Cohasset Gates monitor southbound shoreline crossings.

Tables H-15a and **H-15b** show that Runway 4R departures for 2015 were concentrated, with 99.2 percent "over the Causeway," and about 0.3 percent over the south end of the gate compared to 99.0 percent over the Causeway in 2014 and 0.2 percent over the south end of the gate. Departures through the north end of the gate decreased from 0.8 percent in 2014 to 0.5 percent in 2015.

Table H-15a Runway 4R Nahant Gate Summary for 2014

	Number of Tracks Through Gate Segment	Total Number of Tracks Through Gate	Percentage of Tracks Through Gate Segment
North End of Gate	54	6,787	0.8%
Over Causeway	6,717	6,787	99.0%
South End of Gate	16	6,787	0.2%
Total	**6,787**	**6,787**	**100.00%**

Source: Massport, HMMH 2014.

Table H-15b Runway 4R Nahant Gate Summary for 2015

	Number of Tracks Through Gate Segment	Total Number of Tracks Through Gate	Percentage of Tracks Through Gate Segment
North End of Gate	35	6,851	0.5%
Over Causeway	6,797	6,851	99.2%
South End of Gate	19	6,851	0.3%
Total	**6,851**	**6,851**	**100.00%**

Source: Massport, HMMH 2015.

Table H-16a and **H-16b** show how many of the shoreline crossings from Runway 4R were above 6,000 feet. For 2015, 97.2 percent of the flights were above 6,000 feet compared to 96.9 percent in 2014. The Swampscott gate had 23.3 percent of flights above 6,000 feet in 2015 compared to 24.2 percent in 2014. The number of flights through the Swampscott gate decreased in 2015 (124 in 2014, down to 116 in 2015). The crossing percentage for this gate is historically lower than most gates due to its proximity to the Nahant gate itself. As seen in **Figure H-14**, the Swampscott gate is adjacent to the Nahant gate and aircraft would have to climb very quickly to be above 6,000 feet when crossing the Swampscott gate.

Table H-16a Runway 4R Shoreline Crossings Above 6,000 Feet for 2014

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	124	30	24.2%
Marblehead Gate	2,856	2,817	98.6%
Hull 2 Gate	280	280	100.0%
Hull 3 Gate	856	855	99.9%
Cohasset Gate	181	181	100.0%
Total	**4,297**	**4,163**	**96.9%**

Source: Massport, HMMH 2014.

Table H-16b Runway 4R Shoreline Crossings Above 6,000 Feet for 2015

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	116	27	23.3%
Marblehead Gate	2,770	2,735	98.7%
Hull 2 Gate	345	345	100.0%
Hull 3 Gate	1,034	1,033	99.9%
Cohasset Gate	196	196	100.0%
Total	**4,461**	**4,336**	**97.2%**

Source: Massport, HMMH 2015.

Statistical Analyses of Flight Tracks - Runway 9

The Winthrop 1 and Winthrop 2 gates (**Figure H-14**) monitor early turns for departures off Runway 9. The Revere, Swampscott, or Marblehead gates monitor northbound shoreline crossings, while the Hull 2, Hull 3, or Cohasset gates monitor southbound shoreline crossings.

Tables H-17a and **H-17b** show how many tracks turned prior to the BOS 2 DME. Northbound turns before BOS 2 DME pass through the Winthrop 1 Gate. Southbound traffic would pass through the Winthrop 2 Gate. In 2015, between both gates there were a total of 44 such turns, 0.1 percent. In 2014, 52 tracks or 0.1 percent of the total also crossed these gates.

Table H-17a Runway 9 Gate Summary — Winthrop Gates 1 and 2 for 2014

	Number of Departure Tracks	Number of Tracks Through Gate	Percent Turning Before BOS 2 DME
Winthrop 1 Gate	44,979	27	0.1%
Winthrop 2 Gate	44,979	25	0.1%
Total	**44,979**	**52**	**0.1%**

Source: Massport, HMMH 2014.

Table H-17b Runway 9 Gate Summary — Winthrop Gates 1 and 2 for 2015

	Number of Departure Tracks	Number of Tracks Through Gate	Percent Turning Before BOS 2 DME
Winthrop 1 Gate	45,371	20	<0.1%
Winthrop 2 Gate	45,371	24	0.1%
Total	**45,371**	**44**	**0.1%**

Source: Massport, HMMH 2015.

Table H-18a and **H-18b** indicate that 99.3 percent of Runway 9 departures were above 6,000 feet when crossing the shoreline in 2015, compared with 98.5 percent in 2014. The number of Runway 9 departures crossing back over the South Shore increased from 31,370 in 2014 to 33,807 in 2015.

An increase in the percentage above 6,000 feet occurred at the Revere gate (46.7 percent in 2014 to 60.6 percent in 2014) and a slight increase at the Hull 2 gate (99.0 percent in 2014 to 99.4 percent in 2015).

The number of crossings increased for the Revere gate (45 in 2014 to 60 in 2015) and increased at the Swampscott gate (316 in 2014 to 435 in 2015). The Marblehead gate had an increase in crossings (from 10,596 in 2014 to 11,333 in 2015), and an increase in the percent above 6,000 feet (from 99.6 percent in 2014 to 99.7 percent in 2015). Both the Hull 2 and Hull 3 gates had an increase in crossings compared to 2014. Hull 2 increased from 1,939 in 2014 to 2,120 in 2015 and Hull 3 increased from 4,318 in 2014 to 4,834 in 2014. The Hull 2 crossing percentage increased slightly from 99.0 percent in 2014 to 99.4 percent in 2015, and the Hull 3 gate crossings increased from 95.6 percent to 98.1 percent. The crossings through the Cohasset gate increased (from 14,156 in 2014 to 15,019 in 2015) and the percent above 6,000 feet increased slightly from 98.9 percent in 2014 to 99.8 percent in 2015.

Table H-18a Runway 9 Shoreline Crossings Above 6,000 Feet for 2014

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Revere Gate	45	21	46.7%
Swampscott Gate	316	278	88.0%
Marblehead Gate	10,596	10,552	99.6%
Hull 2 Gate	1,939	1,920	99.0%
Hull 3 Gate	4,318	4,126	95.6%
Cohasset Gate	14,156	13,994	98.9%
Total	**31,370**	**30,891**	**98.5%**

Source: Massport, HMMH 2014

Table H-18b Runway 9 Shoreline Crossings Above 6,000 Feet for 2015

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Revere Gate	66	40	60.6%
Swampscott Gate	435	398	91.5%
Marblehead Gate	11,333	11,298	99.7%
Hull 2 Gate	2,120	2,108	99.4%
Hull 3 Gate	4,834	4,742	98.1%
Cohasset Gate	15,019	14,993	99.8%
Total	**33,807**	**33,579**	**99.3%**

Source: Massport, HMMH 2015.

Statistical Analyses of Flight Tracks - Runway 15R

After takeoff, Runway 15R departures turn left approximately 30 degrees to avoid Hull, head out over Boston Harbor, and return back over the shore through the Swampscott and Marblehead Gates (**Figure H-14**) to the north, or through the Hull 2, Hull 3, and Cohasset Gates to the south. **Tables H-19a** and **H-19b** indicate that 99.4 percent of Runway 15R departures were above 6,000 feet when crossing the shoreline in 2015, compared with 98.2 percent in 2014. At 98.3 percent, the percent above 6,000 feet for the Swampscott Gate decreased in 2015, from 99.2 percent in 2014. The Marblehead gate had an increase in crossings (from 1,638 in 2014 to 2,025 in 2015) and achieved 100 percent compliance above 6,000 feet. The Hull 2 gate percentage remained at 100 percent in 2015, and the Hull 3 gate increased from 83.2 percent in 2014 to 94.3 percent in 2015. The Cohasset gate had an increasein crossings (from 2,207 in 2014 to 2,554 in 2015) and the percent above 6,000 feet increased from 98.1 percent to 99.6 percent.

Table H-19a Runway 15R Shoreline Crossings Above 6,000 Feet for 2014

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	120	119	99.2%
Marblehead Gate	1,638	1,636	99.9%
Hull 2 Gate	4	4	100.0%
Hull 3 Gate	191	159	83.2%
Cohasset Gate	2,207	2,166	98.1%
Total	**4,160**	**4,084**	**98.2%**

Source: Massport, HMMH 2014.

Table H-19b Runway 15R Shoreline Crossings Above 6,000 Feet for 2015

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	179	176	98.3%
Marblehead Gate	2,025	2,025	100.0%
Hull 2 Gate	14	14	100.0%
Hull 3 Gate	282	266	94.3%
Cohasset Gate	2,554	2,544	99.6%
Total	**5,054**	**5,025**	**99.4%**

Source: Massport, HMMH 2015.

Statistical Analyses of Flight Tracks - Runways 22R and 22L

The Squantum 2 and Hull 1 Gates (**Figure H-14**) are used to monitor the turn to 140 degrees over Boston Harbor and north of Hull. The shoreline gates are used to monitor shoreline crossings, as for Runways 4R, 9, and 15R above.

Tables H-20a and **H-20b** show the dispersion of the jet departures from Runways 22R and 22L as they pass through the Squantum 2 Gate. The first segment of the gate is the northernmost segment and is primarily over Boston Harbor. The other segments extend southward toward Quincy. The percentage of tracks passing through the first two segments of this gate decreased from 89.5 percent in 2014 to 89.2 percent in 2015.

Table H-20a Runways 22R and 22L Squantum 2 Gate Summary for 2014

	Number of Tracks Through Gate Segment	Total Number of Tracks Through All Gate Segments	Percentage of Tracks Through Gate Segment
0 - 12,000 ft	2,297	44,093	5.2%
12,000 - 14,000 ft	37,161	44,093	84.3%
14,000 - 21,000 ft	4,594	44,093	10.4%
21,000 - 27,000 ft	41	44,093	0.1%
Total	**44,093**	**44,093**	**100.0%**

Source: Massport, HMMH 2014.

Note: Percentages sum to more than 100 percent due to rounding.

Table H-20b Runways 22R and 22L Squantum 2 Gate Summary for 2015

	Number of Tracks Through Gate Segment	Total Number of Tracks Through All Gate Segments	Percentage of Tracks Through Gate Segment
0 - 12,000 ft	3,183	53,958	5.9%
12,000 - 14,000 ft	44,923	53,958	83.3%
14,000 - 21,000 ft	5,806	53,958	10.8%
21,000 - 27,000 ft	46	53,958	0.1%
Total	**53,958**	**53,958**	**100.0%**

Source: Massport, HMMH 2015.

Note: Percentages sum to more than 100 percent due to rounding.

Tables H-21a and **H-21b** show that the percent of tracks crossing north of the Hull peninsula as they passed through the Hull 1 Gate was 98.9 percent in 2014 and 98.8 percent in 2015.

Table H-21a Runways 15R, 22R, and 22L Hull 1 Gate Summary – North of Hull Peninsula for 2014

	Number of Tracks Through Gate Segment	Total Number of Tracks Through Gate	Percentage of Tracks Through Gate Segment
North of Hull Peninsula	50,327	50,909	98.9%
Over Hull	582	50,909	1.1%
Total	**50,909**	**50,909**	**100.0%**

Source: Massport, HMMH 2014

Table H-21b	Runways 15R, 22R, and 22L Hull 1 Gate Summary – North of Hull Peninsula for 2015		
	Number of Tracks Through Gate Segment	**Total Number of Tracks Through Gate**	**Percentage of Tracks Through Gate Segment**
North of Hull Peninsula	61,537	62,259	98.8%
Over Hull	722	62,259	1.2%
Total	**62,259**	**62,259**	**100.0%**

Source: Massport, HMMH 2015.

Tables H-22a and **H-22b** indicate that 99.7 percent of Runway 22R/22L departures were above 6,000 feet when crossing the shoreline in 2015, compared with 98.9 percent in 2014. For the Revere gate, the percent above 6,000 feet increased from 95.9 percent in 2014 to 97.6 percent in 2015. The Swampscott gate increased from 99.1 percent in 2014 to 100 percent in 2015. The Marblehead gate had an increasein crossings (from 11,027 in 2014 to 13,932 in 2015) and the percent above 6,000 feet remained the same as 2011 at 100 percent. The Hull 2 gate decreased in percent above 6,000 feet from 96.3 percent in 2013 to 91.3 percent in 2014. The Hull 3 gate decreased in percent above 6,000 feet from 91.3 percent in 2014 to 87.5 percent in 2015. The number of crossings for the Cohasset gate increased (17,117 in 2014 to 20,704 in 2015) and the percentage slightly increased from 98.9 percent in 2014 to 99.7 percent in 2015.

Table H-22a	Runways 22R and 22L Shoreline Crossings Above 6,000 Feet for 2014		
	Number of Tracks Through Gate	**Number Above 6,000 ft**	**Percentage Above 6,000 ft**
Revere Gate	73	70	95.9%
Swampscott Gate	444	440	99.1%
Marblehead Gate	11,027	11,021	99.9%
Hull 2 Gate	23	21	91.3%
Hull 3 Gate	1,318	1227	93.1%
Cohasset Gate	17,117	16,904	98.8%
Total	**30,002**	**29,683**	**98.9%**

Source: Massport, HMMH 2014.

Table H-22b	Runways 22R and 22L Shoreline Crossings Above 6,000 Feet for 2015		
	Number of Tracks Through Gate	**Number Above 6,000 ft**	**Percentage Above 6,000 ft**
Revere Gate	127	124	97.6%
Swampscott Gate	1114	1114	100.0%
Marblehead Gate	13,932	13,929	100.0%
Hull 2 Gate	32	28	87.5%
Hull 3 Gate	2,119	2057	97.1%
Cohasset Gate	20,704	20,651	99.7%
Total	**38,028**	**37,903**	**99.7%**

Source: Massport, HMMH 2015.

Runway 27

On September 15, 1996, the FAA implemented a new departure procedure for Runway 27 called the WYLYY RNAV procedure. In accordance with the provisions of the ROD issued for the Runway 27 Environmental Impact Statement, Massport has been providing on-going radar flight track data and analysis to the FAA with respect to the procedure.

In 2012, for the first time since 1997 when flight track monitoring began, each gate (Gates A through E) averaged over 68 percent for every month the Airport had all runways open and for the annual average. The percent of flight tracks through all gates (a number tracked but not required per the 1996 ROD) rounded up to 68 percent for the last two months of 2011 and continued for all of 2012. The FAA had discussed these data internally and concluded that acceptable flight track dispersion had been achieved and that no subsequent action by FAA is required per the 1996 ROD requirements.[19]

Massport will continue to provide **Tables H-23a** and **H-23b** in the subsequent annual reports. **Table H-23a** presents the conformance results for the Runway 27 corridor for 2013 and **Table H-23b** for 2014. The average percentage of tracks through the corridor was 76.8 percent for 2014 and 83.7 percent for 2015.

Each gate is further from the runway and falls along the procedure. The gates also increase in width as the distance is increased along the flight path and they form a noise abatement corridor. A consistent percentage of traffic through each gate means that flights are not entering the corridor late or exiting the corridor too early. The average percent through each gate was 92.2 percent in 2014 and 95.1 percent in 2015, which means that the majority of the traffic remained in the corridor.

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Table H-23a	Runway 27 Corridor Percent of Tracks Through Each Gate for 2014								
Month	**Total # of Tracks**	**Total # of Tracks Through All Gates**	**Percent of Tracks Through All Gates**	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Average Percent Through Each Gate**
				1,400[1]	**2,200[1]**	**2,900[1]**	**4,700[1]**	**6,300[1]**	
January	1,841	1,396	75.8%	78.0%	91.6%	95.8%	97.7%	97.3%	92.1%
February	2,132	1591	74.6%	78.0%	90.9%	95.2%	97.1%	96.1%	91.4%
March	1,461	1,134	77.6%	80.4%	92.0%	96.9%	98.0%	97.0%	92.9%
April	1,609	1,237	76.9%	80.1%	91.9%	95.3%	96.7%	96.1%	92.0%
May	1301	1045	80.3%	82.5%	93.4%	97.7%	98.6%	98.1%	94.1%
June	1135	863	76.0%	78.4%	91.0%	95.2%	97.4%	97.1%	91.8%
July	1192	876	73.5%	75.5%	89.1%	94.1%	96.5%	95.6%	90.2%
August	1033	770	74.5%	76.7%	89.5%	96.1%	98.4%	97.6%	91.6%
Septembe r	1381	1117	80.9%	83.1%	91.8%	94.7%	96.0%	95.9%	92.3%
October	1,836	1373	74.8%	78.2%	91.1%	95.0%	97.3%	96.2%	91.6%
November	2,797	2,194	78.4%	81.3%	92.8%	96.1%	97.6%	97.0%	92.9%
December	1,410	1,100	78.0%	80.6%	92.8%	96.8%	98.2%	97.3%	93.1%
Average	**1,594**	**1,225**	**76.8%**	**79.4%**	**91.5%**	**95.7%**	**97.5%**	**96.8%**	**92.2%**

Source: Massport, HMMH 2014.
Notes: Gray shading indicates the percentage rounds up to 68 percent or greater.
1 Width of each gate in feet.

Month	Total # of Tracks	Total # of Tracks Through All Gates	Percent of Tracks Through All Gates	Gate A 1,400[1]	Gate B 2,200[1]	Gate C 2,900[1]	Gate D 4,700[1]	Gate E 6,300[1]	Average Percent Through Each Gate
January	2,586	2,118	81.9%	2,212	2,435	2,524	2,560	2,538	94.9%
February	3,142	2604	82.9%	2,725	2,944	3,059	3,111	3,076	94.9%
March	2,706	2,207	81.6%	2,314	2,547	2,633	2,675	2,642	94.7%
April	1,245	1,059	85.1%	1,100	1,189	1,222	1,235	1,224	95.9%
May	685	539	78.7%	581	647	649	657	640	92.7%
June	772	642	83.2%	681	727	747	760	753	95.0%
July	1005	837	83.3%	868	954	975	995	989	95.1%
August	996	861	86.4%	891	940	968	984	980	95.6%
September	855	721	84.3%	742	809	834	846	840	95.2%
October	1,821	1569	86.2%	1,604	1,736	1,794	1,806	1,793	95.9%
November	1,868	1,612	86.3%	1,650	1,789	1,826	1,848	1,831	95.8%
December	1,634	1,379	84.4%	1,410	1,563	1,603	1,611	1,592	95.2%
Average	**1,610**	**1,346**	**83.7%**	**1,398**	**1,523**	**1,570**	**1,591**	**1,575**	**95.1%**

Table H-23b Runway 27 Corridor Percent of Tracks Through Each Gate for 2015

Source: Massport, HMMH 2015.
Notes: Gray shading indicates the percentage rounds up to 68 percent or greater.
1 Width of each gate in feet.

Statistical Analyses of Flight Tracks — Runway 33L

The Somerville and Everett Gates (**Figure H-14**) extend from BOS 2 DME to BOS 5 DME and are used to monitor the departure procedure for Runway 33L. Turns to the left prior to the BOS 5 DME would pass through the Somerville Gate. Turns to the right prior to the BOS 5 DME would pass through the Everett Gate.

Tables H-24a and **H-24b** indicate the percentage of tracks turning before BOS 5 DME decreases from 2.0 percent in 2014 to 1.7 percent in 2015. The total number of tracks decreased from 25,412 in 2014 to 24,203 in 2015.

Table H-24a Runway 33L Gates — Passages Below 3,000 Feet for 2015

	Number of Departure Tracks	Number of Tracks Turning Before BOS 5 DME	Percentage of Tracks Turning Before BOS 5 DME
Everett Gate	25,412	229	0.9%
Somerville Gate	25,412	285	1.1%
Total	**25,412**	**514**	**2.0%**

Source: Massport, HMMH 2015.

Table H-24b Runway 33L Gates — Passages Below 3,000 Feet for 2015

	Number of Departure Tracks	Number of Tracks Turning Before BOS 5 DME	Percentage of Tracks Turning Before BOS 5 DME
Everett Gate	24,203	205	0.8%
Somerville Gate	24,203	197	0.8%
Total	**24,203**	**402**	**1.7%**

Source: Massport, HMMH 2015.

Table H-25 provides the level of traffic off each runway end in 2014 and 2015. These percent's represent the amount of activity experienced off each runway end for a given year.

Table H-25 Runway Usage by Runway End

		2014		2015	
By Runway End	**Operations(s)**	**Total Flights**	**% of Total**	**Total Flights**	**% of Total**
04L	R4L A + R22R D	67,385	18.5%	74,695	20.0%
04R	R4R A + R22L D	52,984	14.6%	52,664	14.1%
09	R9 A + R27 D	21,220	5.8%	20,892	5.6%
14	N/A	0	0.0%	0	0.0%
15L	R15L A + R33R D	69	0.0%	123	0.0%
15R	R15R A + R33L D	34,887	9.6%	31,388	8.4%
22L	R22L A + R4R D	54,116	14.9%	55,164	14.8%
22R	R22R A + R4L D	6,977	1.9%	6,312	1.7%
27	R27 A + R9 D	85,064	23.4%	88,683	23.8%
32	R32 A + R14 D	4,751	1.3%	4,066	1.1%
33L	R33L A + R15R D	35,480	9.8%	37,667	10.1%
33R	R33R A + R15L D	865	0.2%	1,275	0.3%
All		**363,797**	**100.0%**	**372,930**	**100.0%**

Notes: A=Arrivals
1 D=Departures

2015 DNL Levels for Census Block Group Locations

Table H-26 reports the DNL value for each Census block group down to the DNL 50 dB.

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB

U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250250203021	Back Bay	1,181	721	48.2	48.2
250250202001	Back Bay	1,266	897	47.6	47.6
250250703001	Back Bay	1,065	804	49.0	49.0
250173521012	Cambridge	1,473	1,187	46.8	46.8
250250408012	Charlestown	828	263	53.1	53.1
250250408013	Charlestown	2,011	1,296	50.6	50.6
250250402001	Charlestown	775	304	50.6	50.6
250250408011	Charlestown	1,061	530	50.0	50.0
250250402002	Charlestown	831	423	49.4	49.4
250250403001	Charlestown	739	334	49.7	49.7
250250403004	Charlestown	617	320	49.3	49.3
250250403003	Charlestown	657	366	48.8	48.8
250250401001	Charlestown	958	555	48.6	48.6
250250403002	Charlestown	1,247	662	48.7	48.7
250250406001	Charlestown	863	491	48.7	48.7
250250406002	Charlestown	1,581	843	48.7	48.7
250250401002	Charlestown	1,210	684	48.1	48.1
250250403005	Charlestown	622	355	48.3	48.3
250250404011	Charlestown	1,689	766	47.8	47.8
250250404012	Charlestown	750	456	47.6	47.6
250251602003	Chelsea	1,497	494	63.0	63.0
250251601015	Chelsea	1,025	261	62.7	62.7
250251602002	Chelsea	1,210	374	61.6	61.6
250251601013	Chelsea	1,730	568	59.9	59.9
250251601011	Chelsea	1,332	353	59.9	59.9
250251603002	Chelsea	596	366	62.5	62.5
250251604002	Chelsea	1,783	683	59.9	59.9
250251602001	Chelsea	1,336	357	59.1	59.1
250251603001	Chelsea	1,469	913	59.9	59.9
250251604001	Chelsea	933	345	58.4	58.4
250251601012	Chelsea	1,372	438	56.9	56.9
250251605022	Chelsea	1,359	477	52.1	52.1
250251601014	Chelsea	2,092	539	55.7	55.7

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB					
U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250251605021	Chelsea	1,703	624	51.9	51.9
250251605013	Chelsea	774	233	54.5	54.5
250251605023	Chelsea	1,398	488	52.5	52.5
250251605012	Chelsea	1,231	396	52.8	52.8
250251605014	Chelsea	754	392	53.2	53.2
250251605015	Chelsea	748	304	52.0	52.0
250251605011	Chelsea	2,097	646	52.6	52.6
250251606011	Chelsea	2,158	1,005	49.9	49.9
250251606012	Chelsea	1,905	565	50.7	50.7
250251606024	Chelsea	780	271	48.6	48.6
250251606025	Chelsea	985	409	49.0	49.0
250251606021	Chelsea	1,290	470	50.1	50.1
250251606022	Chelsea	795	304	48.1	48.1
250251606023	Chelsea	825	346	47.1	47.1
250251006032	Dorchester	598	284	58.1	58.1
250251007002	Dorchester	1,027	527	57.5	57.5
250251006031	Dorchester	1,306	556	55.6	55.6
250251007003	Dorchester	672	290	55.9	55.9
250250907004	Dorchester	651	302	53.6	53.6
250250909012	Dorchester	2,103	1,034	52.8	52.8
250250913002	Dorchester	1,131	388	52.7	52.7
250251007001	Dorchester	1,050	484	54.0	54.0
250250913001	Dorchester	1,368	480	51.3	51.3
250250907002	Dorchester	1,253	644	51.1	51.1
250250914001	Dorchester	1,672	584	50.5	50.5
250251008004	Dorchester	1,117	666	51.4	51.4
250251007004	Dorchester	856	371	52.4	52.4
250250907003	Dorchester	1,153	526	50.2	50.2
250250912003	Dorchester	742	296	50.2	50.2
250250921013	Dorchester	729	321	50.7	50.7
250251006011	Dorchester	1,094	488	51.7	51.7
250251007005	Dorchester	717	303	51.9	51.9
250250912001	Dorchester	1,081	451	50.0	50.0
250250907001	Dorchester	1,218	518	50.0	50.0
250250921011	Dorchester	1,113	467	50.3	50.3
250250910013	Dorchester	682	335	49.6	49.6

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB

U.S. Census 2010 Block Group

Block Group ID	Name	Population	Housing units	Average Block DNL	DNL at centroid
250250912002	Dorchester	1,411	492	49.0	49.0
250250915002	Dorchester	1,494	547	48.7	48.7
250250911005	Dorchester	817	297	49.2	49.2
250250909011	Dorchester	1,627	606	50.3	50.3
250250915001	Dorchester	1,978	744	49.0	49.0
250251006012	Dorchester	898	382	50.1	50.1
250251008003	Dorchester	899	412	49.9	49.9
250250918003	Dorchester	933	357	48.6	48.6
250250918001	Dorchester	1,517	517	48.8	48.8
250250919001	Dorchester	1,042	329	48.4	48.4
250250918002	Dorchester	1,002	340	48.8	48.8
250250911001	Dorchester	1,395	625	49.0	49.0
250250203031	Downtown Boston	878	693	47.8	47.8
250250203033	Downtown Boston	1,179	789	47.5	47.5
250250701011	Downtown Boston	850	529	54.2	54.2
250250702002	Downtown Boston	1,133	444	52.9	52.9
250250303001	Downtown Boston	1,757	1,283	51.6	51.6
250250305001	Downtown Boston	704	442	50.2	50.2
250250305002	Downtown Boston	1,025	687	50.4	50.4
250250305003	Downtown Boston	809	527	50.0	50.0
250250701018	Downtown Boston	449	246	52.1	52.1
250250702001	Downtown Boston	1,460	599	52.3	52.3
250250304001	Downtown Boston	1,519	994	50.2	50.2
250250303002	Downtown Boston	1,262	709	50.7	50.7
250250301001	Downtown Boston	1,053	790	49.3	49.3
250250304002	Downtown Boston	932	665	50.0	50.0
250250701017	Downtown Boston	1,102	701	51.9	51.9
250250301002	Downtown Boston	901	587	49.2	49.2
250250302001	Downtown Boston	1,665	1,103	49.4	49.4
250250303004	Downtown Boston	548	465	50.4	50.4
250250701012	Downtown Boston	303	90	50.5	50.5
250250702003	Downtown Boston	2,625	647	51.0	51.0
250250303003	Downtown Boston	1,305	503	49.4	49.4
250250701016	Downtown Boston	366	325	50.4	50.4
250250701015	Downtown Boston	451	161	50.1	50.1
250250701013	Downtown Boston	494	390	49.6	49.6

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB					
U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250250203032	Downtown Boston	1,343	365	48.2	48.2
250250701014	Downtown Boston	1,887	941	49.7	49.7
250250703002	Downtown Boston	733	449	50.0	50.0
250250203012	Downtown Boston	1,673	1,209	47.1	47.1
250250203011	Downtown Boston	350	205	47.0	47.0
250250509011	Eagle Hill East Boston	1,283	420	65.8	65.8
250250509013	Eagle Hill East Boston	918	309	63.6	63.6
250250509012	Eagle Hill East Boston	1,964	717	64.1	64.1
250250507003	Eagle Hill East Boston	1,476	505	60.5	60.5
250250502004	Eagle Hill East Boston	1,055	349	61.4	61.4
250250502003	Eagle Hill East Boston	836	283	61.3	61.3
250250507002	Eagle Hill East Boston	1,344	484	58.7	58.7
250250501011	Eagle Hill East Boston	1,713	534	60.3	60.3
250250507001	Eagle Hill East Boston	1,684	617	56.3	56.3
250250501013	Eagle Hill East Boston	1,930	684	59.2	59.2
250250502001	Eagle Hill East Boston	2,189	757	57.4	57.4
250250502002	Eagle Hill East Boston	1,151	445	55.8	55.8
250250501012	Eagle Hill East Boston	1,472	632	57.8	57.8
250173424004	Everett	1,348	517	56.6	56.6
250173424002	Everett	1,132	480	56.8	56.8
250173424003	Everett	905	346	56.7	56.7
250173424001	Everett	1,878	847	55.1	55.1
250173425003	Everett	2,200	970	54.5	54.5
250173423003	Everett	2,137	858	52.9	52.9
250173426002	Everett	904	347	52.0	52.0
250173423004	Everett	1,807	805	51.4	51.4
250173424005	Everett	792	363	51.5	51.5
250173426003	Everett	2,336	941	51.1	51.1
250173425002	Everett	2,169	870	51.1	51.1
250173426001	Everett	1,125	395	50.0	50.0
250173423002	Everett	1,555	596	50.5	50.5
250173421014	Everett	943	362	47.9	47.9
250173423001	Everett	1,327	495	49.7	49.7
250235001012	Hull	819	452	51.0	51.0
250235001011	Hull	1,502	836	53.7	53.7
250251202013	Jamaica Plain	451	221	49.6	49.6

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB

U.S. Census 2010 Block Group

Block Group ID	Name	Population	Housing units	Average Block DNL	DNL at centroid
250251202012	Jamaica Plain	1,841	894	49.7	49.7
250251202011	Jamaica Plain	1,147	611	48.6	48.6
250251204002	Jamaica Plain	676	363	48.1	48.1
250251201041	Jamaica Plain	516	252	47.0	47.0
250250512002	Jefferies Point	1,548	692	56.1	56.1
250250512001	Jefferies Point	32	19	54.9	54.9
250250512003	Jefferies Point	799	449	55.0	55.0
250092072001	Lynn	1,212	391	56.2	56.2
250092070002	Lynn	1,235	456	56.6	56.6
250092072002	Lynn	1,727	789	56.7	56.7
250092071002	Lynn	992	307	56.8	56.8
250092061002	Lynn	2,051	665	56.6	56.6
250092055002	Lynn	2,552	961	56.2	56.2
250092060001	Lynn	1,443	478	55.8	55.8
250092071001	Lynn	1,446	444	55.4	55.4
250092062002	Lynn	2,267	786	55.3	55.3
250092061001	Lynn	1,793	797	54.9	54.9
250092052004	Lynn	1,435	511	55.3	55.3
250092060002	Lynn	1,916	642	54.5	54.5
250092052002	Lynn	714	277	54.7	54.7
250092052005	Lynn	854	385	52.4	52.4
250092051005	Lynn	637	264	54.4	54.4
250092071003	Lynn	1,075	342	54.4	54.4
250092052003	Lynn	1,510	564	54.2	54.2
250092051004	Lynn	1,527	556	53.4	53.4
250092052001	Lynn	806	410	52.7	52.7
250092062003	Lynn	1,859	573	53.7	53.7
250092062001	Lynn	1,128	327	53.4	53.4
250092051003	Lynn	919	361	53.1	53.1
250092070001	Lynn	963	585	53.6	53.6
250092058002	Lynn	1,089	342	52.2	52.2
250092063004	Lynn	1,040	367	52.3	52.3
250092058001	Lynn	1,044	362	51.8	51.8
250092059001	Lynn	1,743	598	51.9	51.9
250092068002	Lynn	1,792	915	51.6	51.6
250092063001	Lynn	712	250	51.3	51.3

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB

U.S. Census 2010 Block Group

Block Group ID	Name	Population	Housing units	Average Block DNL	DNL at centroid
250092055001	Lynn	2,054	736	51.3	51.3
250092059002	Lynn	1,262	443	51.0	51.0
250092051002	Lynn	1,077	413	51.0	51.0
250092051001	Lynn	1,192	534	50.6	50.6
250092058003	Lynn	1,179	435	50.4	50.4
250092063003	Lynn	1,030	379	50.3	50.3
250173412003	Malden	1,070	451	52.4	52.4
250173412004	Malden	978	383	52.2	52.2
250173414005	Malden	769	389	51.3	51.3
250173412005	Malden	1,693	713	51.0	51.0
250173412006	Malden	976	362	50.4	50.4
250173412002	Malden	976	386	49.8	49.8
250259811004	Mattapan	400	128	49.1	49.1
250250924004	Mattapan	1,142	413	49.2	49.2
250251001001	Mattapan	167	61	48.5	48.5
250173398012	Medford	617	263	55.3	55.3
250173398011	Medford	2,101	1,369	55.7	55.7
250173398021	Medford	1,308	586	54.6	54.6
250173398013	Medford	808	375	55.3	55.3
250173397001	Medford	552	280	52.7	52.7
250173398022	Medford	2,498	1,096	53.6	53.6
250173398014	Medford	884	363	54.2	54.2
250173397003	Medford	785	357	52.5	52.5
250173397002	Medford	1,678	670	52.1	52.1
250173398023	Medford	751	294	52.4	52.4
250173396002	Medford	813	371	51.7	51.7
250173396003	Medford	757	369	51.3	51.3
250173399001	Medford	1,651	719	52.7	52.7
250173396004	Medford	827	363	51.3	51.3
250173396001	Medford	797	392	51.5	51.5
250173397004	Medford	863	377	51.5	51.5
250173399002	Medford	950	380	52.4	52.4
250173396005	Medford	885	377	51.0	51.0
250173399004	Medford	759	346	51.8	51.8
250173395002	Medford	1,312	547	51.0	51.0
250173396006	Medford	945	443	50.6	50.6

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB

U.S. Census 2010 Block Group

Block Group ID	Name	Population	Housing units	Average Block DNL	DNL at centroid
250173395004	Medford	736	307	49.7	49.7
250173399003	Medford	939	425	51.8	51.8
250173399005	Medford	872	342	51.6	51.6
250173400003	Medford	713	303	51.3	51.3
250173391003	Medford	1,169	691	50.8	50.8
250173400001	Medford	1,033	435	51.3	51.3
250173401004	Medford	1,483	609	50.9	50.9
250173395001	Medford	2,710	553	50.1	50.1
250173400002	Medford	848	377	50.9	50.9
250173391002	Medford	1,460	603	50.4	50.4
250173391004	Medford	1,797	1,041	49.8	49.8
250173395003	Medford	641	283	49.6	49.6
250173401006	Medford	826	310	50.2	50.2
250173391001	Medford	617	243	48.3	48.3
250173391005	Medford	1,399	446	48.9	48.9
250214164007	Milton	1,002	386	53.4	53.4
250214164001	Milton	789	302	54.6	54.6
250214164005	Milton	1,028	348	54.7	54.7
250214164006	Milton	978	357	52.7	52.7
250214161012	Milton	1,969	732	53.6	53.6
250214164004	Milton	797	281	49.6	49.6
250214164002	Milton	664	267	49.0	49.0
250092011001	Nahant	629	319	46.9	46.9
250250511013	Orient Heights	1,537	621	61.4	61.4
250250511011	Orient Heights	1,602	598	57.1	57.1
250250511012	Orient Heights	1,949	741	54.8	54.8
250250511014	Orient Heights	1,005	385	60.4	60.4
250259813002	Other East Boston	389	245	63.3	63.3
250250510001	Other East Boston	2,039	855	61.4	61.4
250250510003	Other East Boston	1,088	467	61.2	61.2
250250510002	Other East Boston	962	462	56.1	56.1
250250505001	Other East Boston	1,857	702	56.0	56.0
250250506001	Other East Boston	1,248	494	55.5	55.5
250250506002	Other East Boston	815	312	54.4	54.4
250250504002	Other East Boston	1,735	797	54.1	54.1
250250504001	Other East Boston	637	238	53.5	53.5

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB

U.S. Census 2010 Block Group

Block Group ID	Name	Population	Housing units	Average Block DNL	DNL at centroid
250250503001	Other East Boston	727	282	53.3	53.3
250250503002	Other East Boston*	1,524	759	52.6	52.6
250251805002	Point Shirley Winthrop	572	271	64.1	64.1
250251805004	Point Shirley Winthrop	882	459	65.6	65.6
250251805003	Point Shirley Winthrop	1,156	671	57.7	57.7
250251805001	Point Shirley Winthrop	1,273	613	52.9	52.9
250214173001	Quincy	1,781	1,180	53.4	53.4
250214174001	Quincy	1,125	485	46.6	46.6
250214173002	Quincy	900	630	52.5	52.5
250214172001	Quincy	2,743	1,256	52.4	52.4
250214175023	Quincy	887	337	50.5	50.5
250214176021	Quincy**	1,328	585	41.6	41.6
250251708002	Revere	1,359	577	63.0	63.0
250251708003	Revere	967	419	62.8	62.8
250251708001	Revere	1,815	797	63.5	63.5
250251707012	Revere	1,311	622	61.3	61.3
250251708004	Revere	977	424	63.2	63.2
250251705022	Revere	1,684	998	58.6	58.6
250251705021	Revere	1,134	550	58.2	58.2
250259815021	Revere	9	3	54.5	54.5
250251705012	Revere	1,501	814	54.9	54.9
250251705011	Revere	1,934	1,113	54.8	54.8
250251707025	Revere	1,391	553	55.6	55.6
250251707011	Revere	788	431	56.6	56.6
250251707022	Revere	1,474	509	54.8	54.8
250251706012	Revere	1,413	573	49.9	49.9
250251707021	Revere	1,146	352	53.3	53.3
250251707024	Revere	959	358	52.7	52.7
250251707023	Revere	1,658	547	51.2	51.2
250251706014	Revere	954	380	49.9	49.9
250251706013	Revere	1,387	497	48.6	48.6
250251701003	Revere	773	320	48.6	48.6
250251701007	Revere	1,335	498	47.9	47.9
250251701002	Revere	1,012	384	48.2	48.2
250251701001	Revere	1,671	769	47.4	47.4
250251706011	Revere	1,351	557	48.3	48.3

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB

U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250251704002	Revere	1,151	506	49.4	49.4
250251702002	Revere	1,395	499	47.2	47.2
250251702001	Revere	1,228	542	46.9	46.9
250251703007	Revere	729	300	46.4	46.4
250251701004	Revere	727	290	47.1	47.1
250251704003	Revere	1,101	431	47.9	47.9
250251701005	Revere	1,320	514	46.8	46.8
250251703006	Revere	1,209	517	46.7	46.7
250251704004	Revere	2,025	910	46.9	46.9
250251703005	Revere	1,692	659	45.6	45.6
250251704001	Revere	1,102	485	50.0	50.0
250251702004	Revere	1,335	533	45.8	45.8
250251703004	Revere	1,609	637	45.4	45.4
250251702003	Revere	606	240	46.0	46.0
250251703002	Revere	899	344	45.2	45.2
250251701006	Revere	722	289	46.3	46.3
250251703003	Revere	946	338	44.8	44.8
250259811003	Roslindale	6	6	50.4	50.4
250251101031	Roslindale	568	325	50.3	50.3
250251103012	Roslindale	1,271	552	49.6	49.6
250251101036	Roslindale	583	271	49.6	49.6
250251101035	Roslindale	1,440	666	49.5	49.5
250251103011	Roslindale	1,134	403	49.3	49.3
250251101034	Roslindale	620	289	49.3	49.3
250251101033	Roslindale	653	241	48.7	48.7
250251102011	Roslindale	2,051	874	48.6	48.6
250251104011	Roslindale	2,011	733	48.9	48.9
250250801001	Roxbury	2,612	450	55.2	55.2
250250906001	Roxbury	1,094	351	54.4	54.4
250250801002	Roxbury	738	294	54.6	54.6
250250906002	Roxbury	1,254	442	54.2	54.2
250250818002	Roxbury	921	442	54.2	54.2
250250904004	Roxbury	870	294	53.9	53.9
250250818003	Roxbury	820	369	53.6	53.6
250250818001	Roxbury	1,157	577	53.9	53.9
250250820003	Roxbury	841	414	53.3	53.3

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB

U.S. Census 2010 Block Group

Block Group ID	Name	Population	Housing units	Average Block DNL	DNL at centroid
250250904003	Roxbury	763	254	53.3	53.3
250250817002	Roxbury	893	430	53.5	53.5
250250820002	Roxbury	682	298	53.0	53.0
250250820001	Roxbury	1,292	566	52.9	52.9
250250803001	Roxbury	1,769	791	53.7	53.7
250250821003	Roxbury	2,244	1,012	52.8	52.8
250250819001	Roxbury	906	453	53.1	53.1
250250904001	Roxbury	871	311	52.9	52.9
250250817001	Roxbury	619	225	53.2	53.2
250250821001	Roxbury	1,228	526	52.4	52.4
250250904002	Roxbury	1,155	435	52.6	52.6
250250819002	Roxbury	617	259	52.5	52.5
250250819004	Roxbury	992	428	52.3	52.3
250250819003	Roxbury	600	257	52.5	52.5
250250821002	Roxbury	1,553	579	52.1	52.1
250250903003	Roxbury	978	422	52.1	52.1
250250817003	Roxbury	780	291	52.1	52.1
250250914002	Roxbury	1,069	355	51.8	51.8
250259803001	Roxbury	338	2	51.3	51.3
250250817004	Roxbury	887	355	52.2	52.2
250250804011	Roxbury	1,265	526	52.2	52.2
250250903002	Roxbury	1,310	513	50.9	50.9
250250901001	Roxbury	1,631	660	51.2	51.2
250250902003	Roxbury	934	308	51.2	51.2
250250817005	Roxbury	641	298	51.9	51.9
250250813001	Roxbury	1,661	806	51.0	51.0
250250815002	Roxbury	1,346	554	51.1	51.1
250250902002	Roxbury	626	278	50.5	50.5
250251203013	Roxbury	1,543	554	50.5	50.5
250250903001	Roxbury	891	333	50.9	50.9
250251203012	Roxbury	855	331	50.6	50.6
250250901003	Roxbury	693	303	50.3	50.3
250250901002	Roxbury	531	237	49.9	49.9
250250902001	Roxbury	673	244	49.8	49.8
250250815001	Roxbury	788	351	50.1	50.1
250250806013	Roxbury	459	242	50.2	50.2

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB

U.S. Census 2010 Block Group

Block Group ID	Name	Population	Housing units	Average Block DNL	DNL at centroid
250250804012	Roxbury	1,445	723	49.9	49.9
250250814001	Roxbury	1,067	558	49.6	49.6
250250924005	Roxbury	721	276	49.1	49.1
250250901004	Roxbury	1,099	414	49.0	49.0
250251203014	Roxbury	1,231	567	49.1	49.1
250250924003	Roxbury	1,688	711	49.1	49.1
250251203011	Roxbury	1,166	443	49.2	49.2
250250813002	Roxbury	1,749	690	49.1	49.1
250250901005	Roxbury	617	249	48.4	48.4
250250813003	Roxbury	1,350	615	48.6	48.6
250092081021	Saugus	752	301	48.3	48.3
250173501032	Somerville	1,210	520	52.4	52.4
250173504001	Somerville	1,006	368	50.9	50.9
250173501042	Somerville	2,584	947	51.4	51.4
250173504005	Somerville	849	392	50.5	50.5
250173504002	Somerville	1,232	565	50.1	50.1
250173503003	Somerville	849	390	50.0	50.0
250173501041	Somerville	2,119	793	50.4	50.4
250173504003	Somerville	1,017	462	49.4	49.4
250173501044	Somerville	1,384	673	49.8	49.8
250173509001	Somerville	803	398	49.0	49.0
250173501043	Somerville	1,188	485	49.1	49.1
250173503002	Somerville	627	304	48.8	48.8
250173502001	Somerville	1,376	586	49.0	49.0
250173503001	Somerville	965	454	49.6	49.6
250173502006	Somerville	1,044	502	49.0	49.0
250173510005	Somerville	1,056	484	48.3	48.3
250173514031	Somerville	763	309	48.5	48.5
250173502005	Somerville	749	315	48.5	48.5
250173510001	Somerville	1,236	595	47.8	47.8
250173514033	Somerville	587	321	47.8	47.8
250173502004	Somerville	1,410	594	47.9	47.9
250173514035	Somerville	619	288	47.6	47.6
250173514032	Somerville	1,017	391	47.8	47.8
250173514034	Somerville	1,042	369	48.0	48.0
250173502003	Somerville	1,385	533	47.7	47.7

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB

U.S. Census 2010 Block Group

Block Group ID	Name	Population	Housing units	Average Block DNL	DNL at centroid
250173511002	Somerville	912	465	47.5	47.5
250173502002	Somerville	603	233	47.6	47.6
250173514041	Somerville	1,147	448	46.8	46.8
250173504004	Somerville	1,464	721	49.8	49.8
250173506001	Somerville	1,656	2	50.6	50.6
250173506004	Somerville	1,164	487	50.4	50.4
250173510004	Somerville	1,813	870	47.1	47.1
250173510006	Somerville	1,018	523	47.2	47.2
250173506002	Somerville	939	371	50.0	50.0
250173511005	Somerville	1,146	540	46.9	46.9
250173505002	Somerville	811	382	50.1	50.1
250173505001	Somerville	818	390	50.1	50.1
250173511001	Somerville	1,601	747	46.9	46.9
250173506003	Somerville	813	231	49.7	49.7
250173514042	Somerville	1,335	527	46.9	46.9
250173514043	Somerville	1,026	396	46.7	46.7
250250606001	South Boston	2,357	1,530	59.6	59.6
250250612001	South Boston	1,702	1,188	58.4	58.4
250250601011	South Boston	881	441	59.5	59.5
250250607001	South Boston	741	253	57.9	57.9
250250601013	South Boston	981	496	59.0	59.0
250250601012	South Boston	633	350	58.8	58.8
250250607002	South Boston	1,152	383	57.3	57.3
250250601014	South Boston	721	397	58.7	58.7
250250612002	South Boston	627	383	55.4	55.4
250250608003	South Boston	886	470	55.9	55.9
250250608004	South Boston	1,666	943	55.4	55.4
250250605014	South Boston	631	295	56.5	56.5
250250608002	South Boston	757	396	54.7	54.7
250250605015	South Boston	656	333	54.8	54.8
250250602001	South Boston	821	419	55.7	55.7
250250608001	South Boston	655	333	54.2	54.2
250250605013	South Boston	717	431	54.2	54.2
250250605011	South Boston	699	375	54.7	54.7
250250605012	South Boston	868	508	54.0	54.0
250250612003	South Boston	911	470	53.1	53.1

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB

U.S. Census 2010 Block Group

Block Group ID	Name	Population	Housing units	Average Block DNL	DNL at centroid
250250602002	South Boston	1,095	580	54.9	54.9
250250610001	South Boston	1,033	544	53.2	53.2
250250604005	South Boston	960	336	53.2	53.2
250250610002	South Boston	1,164	471	52.7	52.7
250250610003	South Boston	901	393	52.7	52.7
250250603013	South Boston	1,092	561	53.8	53.8
250250604001	South Boston	1,021	542	52.7	52.7
250250611011	South Boston	617	278	52.2	52.2
250250603011	South Boston	1,285	741	53.6	53.6
250250603012	South Boston	699	345	53.3	53.3
250250604002	South Boston	988	530	52.6	52.6
250250604004	South Boston	1,093	669	52.1	52.1
250250604003	South Boston	842	466	52.2	52.2
250250611012	South Boston	1,615	766	51.4	51.4
250250712011	South End	1,899	819	54.7	54.7
250250711012	South End	1,424	750	53.1	53.1
250250712012	South End	1,232	580	53.7	53.7
250250711011	South End	1,498	928	53.9	53.9
250250704021	South End	1,723	680	53.5	53.5
250250711013	South End	831	507	52.6	52.6
250250705001	South End	1,700	1,018	52.3	52.3
250250705003	South End	1,393	803	51.7	51.7
250250705002	South End	999	524	51.1	51.1
250250705004	South End	1,368	721	51.1	51.1
250250709001	South End	2,166	1,231	50.6	50.6
250250703004	South End	1,119	746	50.3	50.3
250250805002	South End	2,020	863	49.9	49.9
250250709002	South End	1,163	567	50.1	50.1
250250706001	South End	1,127	667	50.2	50.2
250250703003	South End	992	707	49.6	49.6
250250706002	South End	1,113	642	49.5	49.5
250251802004	Winthrop	1,343	549	59.0	59.0
250251802001	Winthrop	1,471	610	58.1	58.1
250251802003	Winthrop	648	336	55.5	55.5
250251804002	Winthrop	839	347	55.3	55.3
250251802002	Winthrop	647	299	54.0	54.0

Table H-26 2015 DNL Levels for Census Block Group Locations within the DNL 50 dB

U.S. Census 2010 Block Group

Block Group ID	Name	Population	Housing units	Average Block DNL	DNL at centroid
250251804001	Winthrop	876	435	54.9	54.9
250251801013	Winthrop	2,344	1,194	52.6	52.6
250251801011	Winthrop	1,207	584	50.9	50.9
250251801012	Winthrop	1,215	724	49.7	49.7
250251803014	Winthrop Court Rd	760	297	61.4	61.4
250251803012	Winthrop Court Rd	778	322	58.3	58.3
250251803011	Winthrop Court Rd	652	258	57.2	57.2
250251803013	Winthrop Court Rd	834	351	57.4	57.4

Note: * Centriod location on the Airport, the Block Group includes area off airport property.
** Centriod location displaced over Quincy Bay
Block group boundaries were modified to only include Land areas.
Noise levels reported do not include aircraft or helicopters not arriving to or departing from Logan Airport.
Only Census Blocks with population were used to compute the average.
Only locations within the 2015 EDR modeling were used.
Bold highlighted Groups Indicate Census Block Group Centroid is below 50dB, while census block centroid average is above 50 dB

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MERCATUS ON POLICY

Airport Noise NIMBYism: An Empirical Investigation

Eli Dourado and Raymond Russell

October 2016

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Every growing city encounters criticism from residents who will settle for little else but the status quo. Local governments intent on building or expanding infrastructure must contend with citizens opposed to the inconvenience and nuisance of increased construction, more neighbors, and heavier traffic. This hostility to expansion, called "NIMBYism" (not in my backyard), can be a barrier to denser development, lower housing prices, and ultimately economic growth.

But NIMBYism extends beyond opposition to urban development, and its consequences can hinder economic growth in nonobvious ways. In this policy brief, we explore a particular category of NIMBY complaints surrounding airport noise. Airport noise can be a nuisance, but it is also necessary for economic activity in the modern world. We evaluate noise complaint data from a selection of US airports to quantify opposition to airport noise. We find that the source of airport noise complaints is highly concentrated in a few dedicated complainers.

Airport noise policy must strike a reasonable balance between noise abatement and the economic benefits associated with noisy airplane takeoffs and landings. However, because the majority of noise complaints come from a small number of loud objectors, there is a danger that this balance has been tilted too far in the direction of noise abatement.[1] We hope that increasing awareness of the lopsided distribution of noise complaints can help promote noise standards that strike an appropriate balance and facilitate the advancement of faster and cheaper commercial flight.

MANY COMPLAINTS COME FROM A SMALL NUMBER OF CALLERS

Most airports in the United States allow the public to submit noise complaints through dedicated hotlines and online portals. Nearly all of the country's largest airports publish data on the calls they receive, but this information varies in thoroughness. Some airport authorities, such as the Port of Seattle, allow public access to each complainant's name, their personal information, and a summary of the call. Others, like Boston's Massport, only publish the number of complaints received and the number of unique callers. But even this summary information is useful; data from Massport on Boston Logan International Airport still illustrate the distribution and origin of complaints.

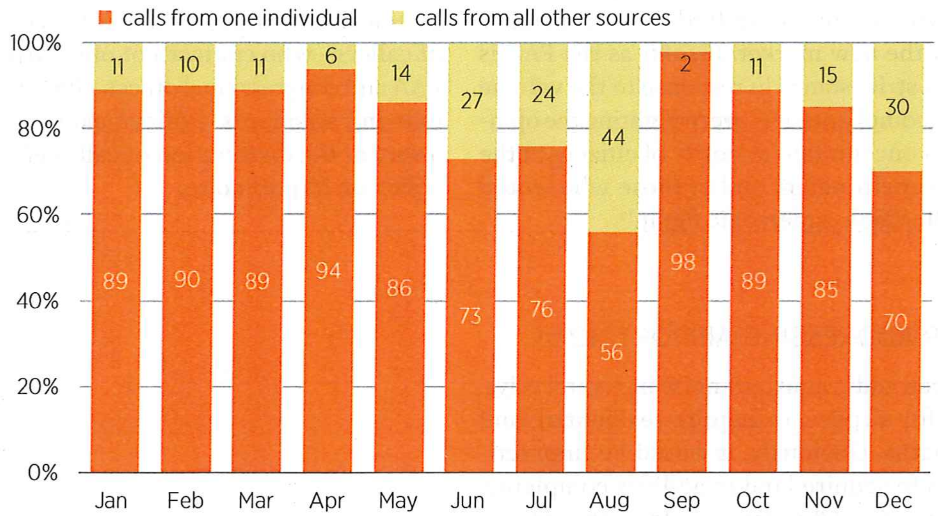
Generally, a very small number of people account for a disproportionately high share of the total number of noise complaints. In 2015, for example, 6,852 of the 8,760 complaints submitted to Ronald Reagan Washington National Airport originated from one residence in the affluent Foxhall neighborhood of northwest Washington, DC.[2] The residents of that particular house called Reagan National to express irritation about aircraft noise an average of almost 19 times per day during 2015. Other major airports report similar trends. In Seattle's detailed call-by-call lists, one individual complains so frequently that her grievances are not transcribed in full but simply tallied at the end of the month. While airport employees provide summaries of other calls, the description of this particular individual's calls is, "Same complaint over and over. Records a/c flying over."[3]

Relative to other large US airports, San Francisco International Airport receives an enormous number of complaints each year. In 2015, it registered 890,376 complaints. Predictably, we find that these complaints were not lodged by a correspondingly large number of people; rather, hundreds of thousands of calls came from just 9,561 callers. Even if calls were uniformly distributed among these callers, each would still have had to place 93 calls. But as with other US airports, San Francisco's complaint records show a high degree of concentration among a very small subset of total callers. In October 2015, 53 Portola Valley, CA, residents placed 25,259 calls to the airport—nearly 477 per person. Similarly, three residents of Daly City placed 1,034 calls in December 2015, and six Woodside callers complained 2,432 times in November.

TABLE 1. SUMMARY OF AIRPORT NOISE COMPLAINTS

Airport	Time period covered	Total number of complaints	Evidence of concentration
Ronald Reagan Washington National Airport (DCA)	2015	8,760	2 individuals at 1 residence in NW DC accounted for 6,852 complaints (78 percent).[4]
Denver International Airport (DEN)	2015	4,870	1 individual in Strasburg, CO, 30 miles from the airport, accounted for 3,555 complaints (73 percent). 4 callers accounted for 4,653 complaints (96 percent). A total of 42 households complained.[5]
Washington Dulles International Airport (IAD)	2015	1,223	1 individual in Poolesville, MD, 13 miles away from the airport, accounted for 1,024 complaints (84 percent).[6]
Las Vegas McCarran International Airport (LAS)	2015	3,963	1 individual accounted for 450 calls in September 2015 (98 percent of monthly total).[7]
Los Angeles International Airport (LAX)	2015	8,862	1 individual in Monterey Park, CA, accounted for 489 complaints during June 2015 (50 percent of monthly total). The top 3 callers accounted for 88 percent of June complaints.[8]
Portland International Airport (PDX)	2015	688	5 individuals accounted for 420 complaints (61 percent).[9]
Phoenix Sky Harbor International Airport (PHX)	2015	24,247	1,338 households in total lodged complaints. While data is not available by household, the airport received 3,814 complaints from 13 households in zip code 85258, for an average of 293 calls per household.[10]
Seattle-Tacoma International Airport (SEA)	2014	1,006	3 individuals accounted for 648 complaints (64 percent). Top caller accounted for 42 percent of total.[11]
San Francisco International Airport (SFO)	2015	890,376	53 Portola Valley, CA, individuals accounted for 25,259 complaints during the month of October 2015, for an average of 477 calls per person in that month.[12]

FIGURE 1. CONCENTRATION OF NOISE COMPLAINTS AT LAS VEGAS MCCARRAN INTERNATIONAL AIRPORT (LAS), 2015



Source: McCarran International Airport, "Noise Complaint Reports."

Table 1 summarizes the concentration of noise complaints registered at several large US airports. Figure 1 shows the monthly concentration of noise complaints over the course of 2015 at McCarran International Airport in Las Vegas.

SMALL NUMBER OF CALLERS HAVE DISPROPORTIONATE IMPACT

Airport noise complaint data paints a startling picture. A handful of individuals are responsible for most of the noise complaints at most airports we examine. Some of these individuals do not appear to live particularly close to the airports to which they are complaining. For example, one individual in Strasburg, CO, 30 miles from Denver International Airport, complained 3,555 times in 2015, an average of 9.7 times per day. One individual in La Selva Beach, CA, about *55 miles* from San Francisco International Airport, complained about airport noise 186 times during October 2015.

There are worrisome signs that this small, frustrated minority of citizens is affecting aviation policy. In recent decades, the Federal Aviation Administration (FAA) has imposed progressively more stringent noise standards on aircraft operating in US airspace.[13] While noise abatement is desirable, it can have significant costs—particularly on the fuel efficiency of aircraft—resulting not only in higher carbon emissions but also in higher ticket prices. It is troubling that a tiny but vocal group is potentially driving policy. While we do not have data on grievances lodged directly to the FAA or to members of Congress, it is probable that those airport noise complaints follow a similar pattern.

AIRPORT NOISE AND FUEL EFFICIENCY

Airport noise is entangled with fuel efficiency in at least two ways. First, the FAA's NextGen airspace modernization program will enable aircraft to travel along denser and more direct routes, particularly on approach for landing. NextGen will remove much of the need for circling above the airport in holding patterns, and it allows aircraft to descend more gradually, saving valuable fuel. However, denser and more gradual approaches also correspond to more noise on the ground under approach paths to the airport. Airports undergoing NextGen implementation have experienced a significant uptick in noise complaints.[14]

Second, airport noise standards are very important for fuel efficiency gains on potential new supersonic aircraft. Aircraft are more fuel efficient when they can take off at full throttle, and these gains in efficiency are of particular importance when aircraft are climbing to the high cruise speeds and altitudes of supersonic planes. Yet in the FAA's most recent policy statement on supersonics, the agency said it "would propose that any future supersonic airplane produce no greater noise impact on a community than a subsonic airplane."[15] Subsonic noise type certification requirements are quite strict, and they will become stricter still in 2018. Holding supersonic aircraft to subsonic noise standards would hamper the viability of the new market. Insofar as the FAA is adopting such a strict stance in response to the volume of airport noise complaints, it is overweighting the opinions of a small, concentrated minority of citizens at the expense of the environment and of those who would benefit from affordable supersonic flight.[16]

OPTIONS FOR ADDRESSING AIRPORT NOISE

Policymakers can address airport noise in several ways. One option is for airports to acquire residential land below flight paths. Obviously, it would be impractical for airports to acquire land to address complaints originating from up to 50 miles away from the airport. Nevertheless, numerous airports have bought up nearby land to reduce the effect of noise on people nearby. A second approach is to make noise standards more severe, creating mandatory retirement of the existing fleet of airplanes. This was done in the 1990s as the Stage 2 noise standard was replaced with Stage 3. Economist Stephen A. Morrison and his coauthors estimate that the benefits of the phaseout, in terms of property values for homeowners, were $5 billion less than the costs to airlines, in terms of the reduced life of their capital.[17]

A third approach is to subsidize and otherwise support the installation of more and better insulation in homes affected by airport noise. Aerospace engineer Philip J. Wolfe and his coauthors estimate that this is more cost-effective than land acquisition or mandatory retirement.[18] There are a number of insulation programs run by airports around the country.[19]

Finally, a noise tax could help to efficiently discourage the production of noise without outright banning it, and revenues could be used to fund insulation programs. This is a better strategy than existing FAA policy of continuing to increase noise standards, perhaps in response to a high volume of complaints.

CONCLUSION

It would be a mistake to allow the preferences of a vocal but minuscule minority of citizens, however sympathetic their circumstances, to impede much-needed improvements in aviation. Airport noise standards are already quite strict, and they create real economic and environmental costs associated with lower aircraft fuel efficiency. While our analysis cannot recommend a precise noise standard, we are concerned that a handful of callers—who contact not only airports but also the FAA and congressional offices—have unduly influenced existing standards. Policymakers should be acutely aware of the distribution of calls before taking further action on airport noise.

NOTES

1. In other words, airport noise complaints could be a classic case of concentrated benefits and diffused costs. Mancur Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups*, 2nd ed. (Cambridge, MA: Harvard University Press, 1971).

2. Metropolitan Washington Airports Authority, "2015 Annual Aircraft Noise Report," accessed August 18, 2016.

3. Port of Seattle, "Public Records Request: Request #16-34," January 27, 2016.

4. Ibid.

5. Denver International Airport, "DEN Noise Report: January 1, 2015–December 31, 2015," accessed August 19, 2016.

6. Metropolitan Washington Airports Authority, "2015 Annual Aircraft Noise Report."

7. McCarran International Airport, "Noise Complaint Reports," July through September 2015 Noise Complaint Reports, October 22, 2015.

8. Los Angeles World Airports, "June 2015 ANCR Report," July 31, 2015.

9. Port of Portland, "2015 Year in Review," accessed August 19, 2016.

10. City of Phoenix Aviation Department, "Annual Noise Report 2015," accessed August 18, 2016.

11. Port of Seattle, "Public Records Request: Request #16-122," April 6, 2016.

12. San Francisco International Airport, "Noise Abatement Data," accessed August 19, 2016.

13. Federal Aviation Administration, "Details on FAA Noise Levels, Stages, and Phaseouts," June 10, 2016.

14. Pia Bergqvist, "NextGen Flight Paths Give Rise to Noise Complaints," *Flying Magazine*, June 23, 2016. Entire websites also exist to coordinate noise complaints against NextGen. See NextGenNoise, accessed September 26, 2016, http://nextgennoise.org/.

15. Federal Aviation Administration, Civil Supersonic Airplane Noise Type Certification Standards and Operating Rules, 73 Fed. Reg. 205 (October 22, 2008).

16. For subsonic aircraft, noise standards have in fact become stricter over time. In 2000, so-called Stage 3 noise requirements became mandatory. In 2006, the FAA stopped certifying aircraft under Stage 3 in favor of the more restrictive Stage 4 standards. In 2018, new Stage 5 standards will be required for certification. This continuous one-way ratchet in noise standards is at least circumstantial evidence that noise complaints are effective.

17. Steven A. Morrison, Clifford Winston, and Tara Watson, "Fundamental Flaws of Social Regulation: The Case of Airplane Noise," *Journal of Law and Economics* 42, no. 2 (1999): 723–44.

18. Philip J. Wolfe et al., "Costs and Benefits of US Aviation Noise Land-Use Policies," *Transportation Research Part D: Transport and Environment* 44 (2016): 147–56.

19. Jon Hilkevitch, "Midway-Area Homes to Get $10 Million More for Soundproofing," *Chicago Tribune*, August 5, 2015; Massachusetts Port Authority, "Sound Insulation Program," accessed August 19, 2016; Community Development Commission of the County of Los Angeles, "Residential Sound Insulation Program (RSIP)," accessed August 19, 2016.

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I

Air Quality/Emissions Reduction

This appendix provides the following detailed information and data tables in support of Chapter 7, *Air Quality/ Emissions Reduction*:

- Fundamentals of Air Quality
  - Table I-1 National Ambient Air Quality Standards
  - Table I-2 Airport-Related Sources of Air Emissions
  - Table I-3 Attainment, Nonattainment, and Maintenance Areas
- Aircraft Fleet and Operational Data Used in EDMS v5.1.4.1
  - Table I-4 2015 Fleet Mix, Annual Landing-and-Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode by Aircraft Type
- Ground Service Equipment (GSE)/Alternative Fuels Conversion
  - Table I-5 Ground Service Equipment Alternative Fuel Conversion Summary (kg/day)
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  - Table I-11 Estimated VOC Emissions (in kg/day) at Logan Airport 2002-2009
  - Table I-12 Estimated VOC Emissions (in kg/day) at Logan Airport 2010
  - Table I-13 Estimated NO_X Emissions (in kg/day) at Logan Airport 1993-2001

- Table I-14 Estimated NO_X Emissions (in kg/day) at Logan Airport 2002-2009
- Table I-15 Estimated NO_X Emissions (in kg/day) at Logan Airport 2010
- Table I-16 Estimated CO Emissions (in kg/day) at Logan Airport 1993-2001
- Table I-17 Estimated CO Emissions (in kg/day) at Logan Airport 2002-2009
- Table I-18 Estimated CO Emissions (in kg/day) at Logan Airport 2010
- Table I-19 Estimated $PM_{10}/PM_{2.5}$ Emissions (in kg/day) at Logan Airport 2005-2010

- Greenhouse Gas (GHG) Emissions Inventory for 2015
  - Table I-20 Logan Airport Greenhouse Gas (GHG) Inventory Input Data and Information for 2015
  - Table I-21 Greenhouse Gas (GHG) Emission Factors for 2015
  - Table I-22 Greenhouse Gas (GHG) Emissions (MMT CO_2eq) for 2015
  - Table I-23 Logan Airport Greenhouse Gas (GHG) Emissions Compared to Massachusetts Totals
  - Table I-24 Comparison of Estimated Total Greenhouse Gas (GHG) Emissions (MMT of CO_2eq) at Logan Airport – 2007 through 2015
- Measured NO_2 Concentrations
  - Table I-25 Massport and MassDEP Annual NO_2 Concentration Monitoring Results (µg/m^3)

Fundamentals of Air Quality

This section contains a general summary of air quality and air emissions with a particular emphasis on airport-related emissions where appropriate. This material is intended to supplement and provide background information for the materials contained in Chapter 7, *Air Quality/Emissions Reduction*.

Pollutant Types and Standards

The United States (U.S.) Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for a select group of "criteria air pollutants" designed to protect public health, the environment, and the quality of life from the detrimental effects of air pollution. Listed alphabetically, these pollutants are briefly described below:

- **Carbon monoxide (CO)** is a colorless, odorless, tasteless gas. It may temporarily accumulate, especially in cool, calm weather conditions, when fuel use reaches a peak and CO is chemically most stable due to the low temperatures. CO from natural sources usually dissipates quickly, posing no threat to human health. Transportation sources (e.g., motor vehicles), energy generation, and open burning are among the predominant anthropogenic (i.e., man-made) sources of CO.

- **Lead (Pb)** in the atmosphere is generated from industrial sources including waste oil and solid waste incineration, iron and steel production, lead smelting, and battery and lead manufacturing. The lead content of motor vehicle emissions, which was the major source of lead in the past, has significantly declined with the widespread use of unleaded fuel. Low-lead fuel used in some general aviation (GA) aircraft is still a source of airport-related lead.

- **Nitrogen dioxide (NO_2)**, nitric oxide (NO), and the nitrate radical (NO_3) are collectively called oxides of nitrogen (NO_x). These three compounds are interrelated, often changing from one form to another in chemical reactions, and NO_2 is the compound commonly measured for comparison to the NAAQS. NO_x is generally emitted in the form of NO, which is oxidized to NO_2. The principal man-made source of NO_x is fuel combustion in motor vehicles and power plants – aircraft engines are also a source. Reactions of NO_x with other atmospheric chemicals can lead to formation of ozone (O_3) and acidic precipitation.

- **Ozone (O_3)** is a secondary pollutant, formed from daytime reactions of NO_x and volatile organic compounds (VOCs) in the presence of sunlight. VOCs, which are a subset of hydrocarbons (HC) and have no NAAQS, are released in industrial processes and from evaporation of gasoline and solvents. Sources of NO_x are discussed above.

- **Particulate matter (PM)** comprises very small particles of dirt, dust, soot, or liquid droplets called aerosols. The NAAQS for PM is segregated by sizes (i.e., less than 10 and less than 2.5 microns as PM_{10} and $PM_{2.5}$, respectively). PM is formed as an exhaust product in the internal combustion engine or can be generated from the breakdown and dispersion of other solid materials (e.g., fugitive dust).

- **Sulfur oxides (SO_x)** are primarily composed of sulfur dioxide (SO_2) which is emitted in natural processes and by man-made sources such as combustion of sulfur-containing fuels and sulfuric acid manufacturing.

The NAAQS for these criteria pollutants are subdivided into the Primary Standards (designed to protect human health) and the Secondary Standards (designed to protect the environment and human welfare) and are listed below in **Table I-1**. Exceedances of these values constitute violations of the NAAQS.

Table I-1 National Ambient Air Quality Standards

Pollutants	Averaging Time	Concentration	Condition of Violation
Ozone (O_3)	8-hour	0.070 ppm	3-year average of the fourth-highest daily maximum 8-hour average.
Carbon Monoxide (CO)	8-hour	9 ppm	No more than once per year.
	1-hour	35 ppm	
Nitrogen Dioxide (NO_2)	Annual Average	53 ppb	Annual mean.
	1-hour	100 ppb	3-year average of the 98th percentile of the daily maximum 1-hour average.
Sulfur Dioxide (SO_2)	3-hour	0.5 ppm	No more than once per year.
	1-hour	75 ppb	Three-year average of the 99th percentile of 1-hour daily maximum concentrations.
Particulate Matter (PM_{10})	24-hour	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years.
Particulate Matter ($PM_{2.5}$)	Annual (primary)	12 $\mu g/m^3$	Annual mean, averaged over 3 years.
	Annual (secondary)	15 $\mu g/m^3$	Annual mean, averaged over 3 years.
	24-hour	35 $\mu g/m^3$	3-year average of the 98th percentile.
Lead (Pb)	Rolling 3 month average	0.15 $\mu g/m^3$	Not to be exceeded.

Source: U.S. EPA, 2016, http://www.epa.gov/air/criteria.html
Note: ppm - parts per million; ppb – parts per billion; µg/m3 - micrograms per cubic meter

Sources of Airport Air Emissions

Almost all large metropolitan airports generate air emissions from the following general source categories: aircraft, ground service equipment (GSE), and motor vehicles traveling to, from, and moving about the airport; fuel storage and transfer facilities; a variety of stationary sources (e.g., steam boilers, back-up generators, snow melters, etc.); an assortment of aircraft maintenance activities (e.g., painting, cleaning, repair, etc.); routine airfield, roadway, and building maintenance activities (e.g., painting, cleaning, repair, etc.); and periodic construction activities for new projects or improvements to existing facilities. **Table I-2** provides a summary listing of these sources of air emissions, the pollutants, and their characteristics.

Table I-2 Airport-related Sources of Air Emissions

Sources	Emissions	Characteristics
Aircraft	CO NO_2 PM SO_2 VOCs	Exhaust products of fuel combustion that vary depending on aircraft engine type, number of engines, power setting, and period of operation. Emissions are also emitted by an aircraft's auxiliary power unit (APU).
Motor vehicles	CO NO_2 PM SO_2 VOCs	Exhaust products of fuel combustion from patron and employee traffic approaching, departing, and moving about the airport site. Emissions vary depending on vehicle type, distance traveled, operating speed, and ambient conditions.
Ground service equipment	CO NO_2 PM SO_2 VOCs	Exhaust products of fuel combustion from service trucks, tow tugs, belt loaders, and other portable equipment.
Fuel storage and transfer	VOCs	Formed from the evaporation and vapor displacement of fuel from storage tanks and fuel transfer facilities. Emissions vary with fuel usage, type of storage tank, refueling method, fuel type, vapor recovery, climate, and ambient temperature.
Stationary sources	CO NO_2 PM SO_2 VOCs	Exhaust products of fossil fuel combustion from boilers dedicated to indoor heating requirements and emissions from incinerators used for waste reduction. Emissions are generally well controlled with operational techniques and post-burn collection methods. Sources include boilers and hot water generators, emergency generators, incinerators, paint booth and surface coating operations, welding operations, and firefighting facilities.
Construction Activities	CO NO_2 PM SO_2 VOCs	Construction projects may have associated emissions from dust generated during excavation and land clearing, exhaust emissions from construction equipment and motor vehicles, and evaporative emissions from asphalt paving and painting. The amount of particulate emissions varies with the material type, the amount of area exposed, and meteorology. The construction of airport and airfield improvement projects at airports represents temporary sources of emissions.

Notes: CO - Carbon monoxide; VOC - Volatile organic compounds; PM - Particulate matter; NO_2 - Nitrogen dioxide; SO_2 - Sulfur dioxide.

The U.S. EPA, state, and local air quality agencies maintain outdoor air monitoring networks to measure air quality conditions and gauge compliance with the NAAQS. Based upon the data collected by these agencies, all areas throughout the country are designated by the U.S. EPA with respect to their compliance with the NAAQS. **Table I-3** provides the definitions of each of these designations.

Table I-3 Attainment, Nonattainment, and Maintenance Areas

Attainment/Nonattainment Designations			
Attainment	**Attainment/Maintenance**	**Nonattainment Area**	**Unclassifiable**
Any area that meets the NAAQS established for all of the criteria air pollutants.	Any area that is in transition from formerly being a nonattainment area to an attainment area (also called Maintenance).	Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) one or more of the NAAQS.	Any area that cannot be classified on the basis of available information as meeting or not meeting the NAAQS.

Source: U.S. EPA

For O_3, CO, PM_{10}, and $PM_{2.5}$, the nonattainment designations are further classified by the severity, or degree, of the violation of the NAAQS. For example, in the case of O_3, these classifications range from highest to lowest as extreme, severe, serious, marginal, and moderate.

The nonattainment designation of an area has a bearing on the emission control measures required and the time periods allotted by which a State Implementation Plan (SIP) must demonstrate attainment of the NAAQS. It is also important to note that the degree of nonattainment determines the thresholds of emissions that are considered to be "*de minimis,*" or levels below (i.e., within) which a formal General Conformity determination is not required.

Finally, the boundaries of nonattainment areas are generally determined based on Core Based Statistical Areas (CBSA) as defined by U.S. census data (air monitoring station locations and contributing emission sources also play a role). However, nonattainment areas for localized pollutants such as lead and CO typically only comprise a partial CBSA or a local "hot-spot." By comparison, regional pollutants such as O_3 can encompass multiple CBSAs and can extend across state lines.

State Implementation Plans (SIP)

For the purposes of this summary explanation of SIPs, it is sufficient to characterize SIPs as the principal instrument by which a state formulates and implements its strategies for bringing nonattainment or maintenance areas into compliance with the NAAQS. In equally broad terms, the SIP contains the necessary emission limitations, control measures and timetables for achieving this objective. Therefore, the SIP development process is delegated to state air quality agencies that may in turn rely on regional, county, and local agencies to help prepare emission inventories that include airport-related emissions.

Aircraft Fleet and Operational Data used in EDMS Version 5.1.4.1

The Federal Aviation Administration (FAA) Emissions Dispersion System (EDMS) is the EPA-preferred and the FAA-required model for conducting airport air quality analyses. The most recent version of EDMS, Version 5.1.4.1 (EDMS v5.1.4.1), was used in support of the 2015 air quality analysis.

Table I-4 contains the data that were used in EDMS v5.1.4.1 to represent actual conditions at Logan Airport in 2015. These data include aircraft type, engine, landing takeoff cycles (LTOs), and taxi times. The aircraft are divided into four categories: air carrier (AC), cargo (CA), commuter (CO), and GA.

Table I-4 2015 Fleet Mix, Annual Landing-and-Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode by Aircraft Type

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Air Carrier Aircraft				
Airbus A319-100 Series	CFM56-5B6/P	4,337	AC AAL	25.89
Airbus A320-200 Series	V2527-A5	1,169	AC AAL	25.89
Airbus A321-100 Series	V2533-A5	2,663	AC AAL	25.89
Boeing 737-800 Series	CFM56-7B26 (8CM051)	8,747	AC AAL	25.89
Boeing 757-200 Series	RB211-535E4B Phase 5	1,760	AC AAL	25.89
Boeing 767-300 Series	CF6-80C2B6 1862M39	38	AC AAL	25.89
Boeing 777-200 Series	Trent 892	14	AC AAL	25.89
Boeing MD-82	JT8D-217	15	AC AAL	25.89
Boeing MD-83	JT8D-219 Environmental Kit (E_Kit)	13	AC AAL	25.89
Embraer ERJ190	CF34-10E6 SAC	5,421	AC AAL	25.89
Airbus A319-100 Series	CFM56-5A5	20	AC ACA	25.89
Embraer ERJ170	CF34-8E5 LEC (8GE108)	839	AC ACA	25.89
Airbus A330-200 Series	CF6-80E1A3	68	AC AFR	25.89
Airbus A340-300 Series	CFM56-5C2	8	AC AFR	25.89
Boeing 747-400 Series	PW4056 Reduced smoke	237	AC AFR	25.89
Boeing 777-200 Series	GE90-90B DAC I	127	AC AFR	25.89
Boeing 777-200 Series	GE90-90B DAC I	15	AC AFR	25.89
Boeing 737-700 Series	CFM56-7B22	159	AC AMX	25.89
Boeing 737-800 Series	CFM56-7B26 (8CM051)	12	AC AMX	25.89
Boeing 787-8 Dreamliner	GEnx-1B64 TAPS (11GE136)	1	AC AMX	25.89
Boeing 737-800 Series	CFM56-7B24	709	AC ASA	25.89
Boeing 737-900 Series	CFM56-7B27	805	AC ASA	25.89

Table I-4 2015 Fleet Mix, Annual Landing-and-Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Air Carrier Aircraft (Cont'd.)				
Airbus A319-100 Series	CFM56-5B6/P	1,516	AC AWE	25.89
Airbus A320-200 Series	CFM56-5B4/P	393	AC AWE	25.89
Airbus A321-100 Series	CFM56-5B3/P	697	AC AWE	25.89
Airbus A330-200 Series	Trent 772 Improved traverse	1	AC AWE	25.89
Boeing 757-200 Series	RB211-535E4 (3RR028)	4	AC AWE	25.89
Embraer ERJ190	CF34-10E6 SAC	1,811	AC AWE	25.89
Boeing 717-200 Series	BR700-715A1-30	9	AC AWI	25.89
Airbus A330-200 Series	CF6-80E1A4 Low emissions	281	AC AZA	25.89
Boeing 747-400 Series	RB211-524H	711	AC BAW	25.89
Boeing 777-200 Series	GE90-90B DAC I	513	AC BAW	25.89
Boeing 777-300 ER	GE90-115B	65	AC BAW	25.89
Boeing 737-400 Series	CFM56-3B-2	11	AC BSK	25.89
Boeing 737-800 Series	CFM56-7B26 (8CM051)	14	AC BSK	25.89
Boeing 787-8 Dreamliner	GEnx-1B64 TAPS (11GE136)	372	AC CHH	25.89
Airbus A320-200 Series	V2527-A5	5	AC CMP	25.89
Boeing 737-700 Series	CFM56-7B24	193	AC CMP	25.89
Boeing 737-800 Series	CFM56-7B26 (8CM051)	125	AC CMP	25.89
Boeing 777-300 ER	GE90-115B	139	AC CPA	25.89
Airbus A319-100 Series	CFM56-5A5	2,349	AC DAL	25.89
Airbus A320-200 Series	CFM56-5A3	2,613	AC DAL	25.89
Airbus A330-300 Series	PW4168A Talon II	379	AC DAL	25.89
Boeing 717-200 Series	BR700-715A1-30	4,451	AC DAL	25.89
Boeing 737-800 Series	CFM56-7B26 (8CM051)	1,486	AC DAL	25.89
Boeing 737-900 Series	CFM56-7B26 (8CM051)	238	AC DAL	25.89
Boeing 757-200 Series	PW2037 (4PW072)	1,957	AC DAL	25.89
Boeing 767-300 Series	CF6-80A2	344	AC DAL	25.89
Boeing 767-400 ER	CF6-80C2B7F 1862M39	285	AC DAL	25.89
Boeing MD-88	JT8D-219 Environmental Kit (E_Kit)	1,012	AC DAL	25.89
Boeing MD-90	V2525-D5	1,842	AC DAL	25.89
Airbus A330-300 Series	PW4168A Talon II	94	AC DLH	25.89

Table I-4 2015 Fleet Mix, Annual Landing-and-Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Air Carrier Aircraft (Cont'd.)				
Airbus A340-300 Series	CFM56-5C4/P	99	AC DLH	25.89
Airbus A340-600 Series	Trent 556-61 Phase5 Tiled (6RR041)	204	AC DLH	25.89
Boeing 747-400 Series	CF6-80C2B1F 1862M39	291	AC DLH	25.89
Boeing 747-8	GEnx-2B67 TAPS (8GENX1)	156	AC DLH	25.89
Airbus A330-200 Series	CF6-80E1A2 1862M39	169	AC EIN	25.89
Airbus A330-300 Series	CF6-80E1A4 Standard	486	AC EIN	25.89
Boeing 757-200 Series	PW2040 (4PW073)	239	AC EIN	25.89
Boeing 767-200 Series	CF6-80A	64	AC EIN	25.89
Boeing 767-300 Series	CF6-80C2B6 1862M39	29	AC EIN	25.89
Boeing 767-300 Series	PW4060 Reduced smoke	76	AC ELY	25.89
Airbus A330-300 Series	CF6-80E1A4 Standard	122	AC IBE	25.89
Airbus A340-300 Series	CFM56-5C4/P	29	AC IBE	25.89
Airbus A340-600 Series	Trent 556-61 Phase5 Tiled (6RR041)	17	AC IBE	25.89
Boeing 757-200 Series	RB211-535E4 (3RR028)	683	AC ICE	25.89
Boeing 787-8 Dreamliner	GEnx-1B64 TAPS (11GE136)	364	AC JAL	25.89
Airbus A320-200 Series	V2527-A5	18,473	AC JBU	25.89
Embraer ERJ190	CF34-10E6 SAC	24,445	AC JBU	25.89
Boeing 737-400 Series	CFM56-3B-2	25	AC NA	25.89
Boeing 777-200 Series	GE90-90B DAC I	27	AC NA	25.89
Boeing 737-800 Series	CFM56-7B26 (8CM051)	18	AC NAX	25.89
Airbus A319-100 Series	V2522-A5	1,498	AC NKS	25.89
Airbus A320-200 Series	V2527-A5	950	AC NKS	25.89
Bombardier Learjet 45	TFE731-2-2B	14	AC RAX	25.89
Airbus A310-200 Series	CF6-80C2A2 1862M39	268	AC RZO	25.89
Boeing 767-300 Series	CF6-80C2B6 1862M39	3	AC RZO	25.89
Boeing 737-700 Series	CFM56-7B22	274	AC SCX	25.89
Boeing 737-800 Series	CFM56-7B27	433	AC SCX	25.89
Boeing 737-300 Series	CFM56-3-B1	2,469	AC SWA	25.89
Boeing 737-700 Series	CFM56-7B24	7,532	AC SWA	25.89
Boeing 737-800 Series	CFM56-7B26 (8CM051)	756	AC SWA	25.89

Table I-4 2015 Fleet Mix, Annual Landing-and-Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Air Carrier Aircraft (Cont'd.)				
Boeing 737-400 Series	CFM56-3B-2	23	AC SWQ	25.89
Airbus A330-300 Series	Trent 772 Improved traverse	230	AC SWR	25.89
Airbus A340-300 Series	CFM56-5C4	125	AC SWR	25.89
Boeing 757-200 Series	PW2037 (4PW072)	30	AC TCV	25.89
Airbus A330-300 Series	Trent 772 Improved traverse	59	AC THY	25.89
Airbus A340-300 Series	CFM56-5C2	305	AC THY	25.89
Boeing 717-200 Series	BR700-715A1-30	14	AC TRS	25.89
Boeing 777-200 Series	GE90-110B1	108	AC UAE	25.89
Boeing 777-300 ER	GE90-115B	350	AC UAE	25.89
Airbus A319-100 Series	V2522-A5	1,171	AC UAL	25.89
Airbus A320-200 Series	V2527-A5	2,313	AC UAL	25.89
Boeing 737-700 Series	CFM56-7B24	961	AC UAL	25.89
Boeing 737-800 Series	CFM56-7B26 (8CM051)	2,734	AC UAL	25.89
Boeing 737-900 Series	CFM56-7B26 (8CM051)	3,523	AC UAL	25.89
Boeing 757-200 Series	PW2037 (4PW072)	765	AC UAL	25.89
Boeing 757-300 Series	RB211-535E4B Phase 5	845	AC UAL	25.89
Boeing 767-300 Series	PW4060 Reduced smoke	3	AC UAL	25.89
Boeing 767-400 ER	CF6-80C2B8FA	1	AC UAL	25.89
Boeing 777-200 Series	PW4077	6	AC UAL	25.89
Airbus A330-300 Series	Trent 772 Improved traverse	47	AC VIR	25.89
Airbus A340-600 Series	Trent 556-61 Phase5 Tiled (6RR041)	128	AC VIR	25.89
Boeing 747-400 Series	CF6-80C2B1F 1862M39	45	AC VIR	25.89
Boeing 787-9 Dreamliner	Trent 1000-A Phase5 Tiled (11RR049)	131	AC VIR	25.89
Airbus A319-100 Series	CFM56-5B6/P	242	AC VRD	25.89
Airbus A320-200 Series	V2527-A5	1471	AC VRD	25.89
Airbus A321-100 Series	V2533-A5	223	AC WOW	25.89
Total Air Carrier Aircraft LTOs		**127,153**		
Cargo Aircraft				
Boeing 767-200 Series	CF6-80A	3	CA ABX	25.89

Table I-4 2015 Fleet Mix, Annual Landing-and-Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Cargo Aircraft (Cont'd.)				
Boeing 757-200 Series	PW2037 (4PW072)	129	CA ATN	25.89
Boeing 767-200 Series	JT9D-7R4D, -7R4D1	22	CA ATN	25.89
Airbus A300F4-600 Series	CF6-80C2A5F	206	CA FDX	25.89
Airbus A310-200 Series	JT9D-7R4E, -7R4E1	22	CA FDX	25.89
Boeing 757-200 Series	RB211-535E4 (3RR028)	242	CA FDX	25.89
Boeing 767-300 Series	CF6-80C2B6 1862M39	711	CA FDX	25.89
Boeing DC-10-10 Series	CF6-6D	517	CA FDX	25.89
Boeing MD-11	CF6-80C2D1F 1862M39	64	CA FDX	25.89
Boeing 767-200 Series	JT9D-7R4D, -7R4D1	109	CA GTI	25.89
Cessna 208 Caravan	PT6A-114	5	CA MTN	25.89
Airbus A300F4-600 Series	PW4158	423	CA UPS	25.89
Boeing 757-200 Series	PW2040 (4PW073)	88	CA UPS	25.89
Boeing 767-300 ER	CF6-80C2B6F	258	CA UPS	25.89
Cessna 208 Caravan	PT6A-114	222	CA WIG	25.89
Total Cargo Aircraft LTOs		**3,021**		
Commuter Aircraft				
Bombardier CRJ-700	CF34-8C1	214	CO ASH	25.89
Embraer ERJ170	CF34-8E5 LEC (8GE108)	5	CO ASH	25.89
Bombardier CRJ-700	CF34-8C1	961	CO ASQ	25.89
Embraer ERJ145	AE3007A1P Type 3 (reduced emissions)	875	CO ASQ	25.89
Embraer ERJ145-XR	AE3007A1E	625	CO ASQ	25.89
Bombardier CRJ-200	CF34-3B	2,490	CO AWI	25.89
Bombardier CRJ-900	CF34-8C5 LEC (8GE110)	3,642	CO FLG	25.89
Bombardier CRJ-700	CF34-8C5 LEC (8GE110)	305	CO GJS	25.89
Bombardier CRJ-900	CF34-8C5 LEC (8GE110)	350	CO GJS	25.89
Bombardier CRJ-700	CF34-8C1	3	CO JIA	25.89
Bombardier CRJ-200	CF34-3B	2,518	CO JZA	25.89
Bombardier de Havilland Dash 8 Q400	PW150A	601	CO JZA	25.89

Table I-4 2015 Fleet Mix, Annual Landing-and-Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode by Aircraft Type (Continued)

Aircraft Types	Engine	LTOs	Description (Airlines)	Taxi Times
Commuter Aircraft Cont'd.				
Cessna 402	TIO-540-J2B2	17,997	CO KAP	25.89
Bombardier de Havilland Dash 8 Q100	PW120A	390	CO PDT	25.89
Saab 340-B-Plus	CT7-9B	1,874	CO PEN	25.89
Bombardier de Havilland Dash 8 Q400	PW150A	2,046	CO POE	25.89
Bombardier de Havilland Dash 8 Q400	PW150A	167	CO RPA	25.89
Embraer ERJ170	CF34-8E5 LEC (8GE108)	2,314	CO RPA	25.89
Embraer ERJ190	CF34-10E6 SAC	21	CO RPA	25.89
Embraer ERJ170	CF34-8E5 LEC (8GE108)	1,892	CO SKV	25.89
Bombardier CRJ-700	CF34-8C5 LEC (8GE110)	22	CO SKW	25.89
Embraer ERJ170	CF34-8E5 LEC (8GE108)	252	CO SKW	25.89
Embraer ERJ145	AE3007A1E	752	CO TCF	25.89
Embraer ERJ170	CF34-8E5 LEC (8GE108)	1,893	CO TCF	25.89
Total Commuter LTO		**42,209**		
General Aviation Aircraft				
Pilatus PC-12	PT6A-67B	873	GA CNS	25.89
Raytheon Beechjet 400	JT15D-5, -5A, -5B	3	GA CNS	25.89
Cessna 560 Citation XLS	JT15D-5, -5A, -5B	955	GA EJA	25.89
Cessna 680 Citation Sovereign	PW308C	404	GA EJA	25.89
Cessna 750 Citation X	AE3007C Type 2	400	GA EJA	25.89
Dassault Falcon 2000	PW308C	310	GA EJA	
Raytheon Hawker 800	TFE731-3	280	GA EJA	25.89
Bombardier Challenger 300	AE3007A1 Type 2	39	GA EJM	25.89
Bombardier Global Express	BR700-710A2-20	43	GA EJM	25.89
Bombardier Learjet 45	TFE731-2-2B	45	GA EJM	25.89
Gulfstream G400	TAY Mk611-8	73	GA EJM	25.89
Gulfstream G500	BR700-710A1-10 (4BR008)	42	GA EJM	25.89
Cessna 525 CitationJet	JT15D-1 series	5	GA GPD	25.89

Table I-4 2015 Fleet Mix, Annual Landing-and-Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
General Aviation Aircraft (Cont'd.)				
Cessna 525 CitationJet	JT15D-1 series	1	GA GPD	25.89
EADS Socata TBM-700	PT6A-64	1	GA GPD	25.89
Pilatus PC-12	PT6A-67B	166	GA GPD	25.89
Bombardier Challenger 300	AE3007A1 Type 2	212	GA LXJ	25.89
Bombardier Challenger 600	CF34-3B	16	GA LXJ	25.89
Bombardier Challenger 600	CF34-3B	15	GA LXJ	25.89
Bombardier Learjet 40	TFE731-2-2B	14	GA LXJ	25.89
Bombardier Learjet 45	TFE731-2-2B	83	GA LXJ	25.89
Bombardier Challenger 300	AE3007A1 Type 2	579	GA NA	25.89
Bombardier Challenger 600	CF34-3B	548	GA NA	25.89
Cessna 560 Citation Excel	JT15D-5, -5A, -5B	721	GA NA	25.89
Cirrus SR22	TIO-540-J2B2	667	GA NA	25.89
Dassault Falcon 2000	PW308C	1,007	GA NA	25.89
Gulfstream G400	TAY Mk611-8	1,210	GA NA	25.89
Gulfstream G500	BR700-710A1-10 (4BR008)	1,093	GA NA	25.89
Raytheon Hawker 800	TFE731-3	961	GA NA	25.89
Raytheon Super King Air 200	PT6A-42	1,082	GA NA	25.89
Raytheon Super King Air 300	PT6A-60A	773	GA NA	25.89
Cessna 172 Skyhawk	TSIO-360C	66	GA NGF	25.89
Mooney M20-K	TSIO-360C	33	GA NGF	25.89
Piper PA-32 Cherokee Six	TIO-540-J2B2	49	GA NGF	25.89
Raytheon Beech Baron 58	TIO-540-J2B2	48	GA NGF	25.89
Raytheon Beech Bonanza 36	TIO-540-J2B2	79	GA NGF	25.89
Cessna 560 Citation V	PW530	106	GA OPT	25.89
Cessna 750 Citation X	AE3007C Type 2	56	GA OPT	25.89
Embraer ERJ135	AE3007A1/3 Type 3 (reduced emissions)	29	GA OPT	25.89
Raytheon Beechjet 400	JT15D-5, -5A, -5B	65	GA OPT	25.89
Bombardier Learjet 60	TFE731-2/2A	7	GA TFF	25.89
Raytheon Beechjet 400	JT15D-5, -5A, -5B	7	GA TFF	25.89

Table I-4 2015 Fleet Mix, Annual Landing-and-Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
General Aviation Aircraft (Cont'd.)				
Raytheon Hawker 4000 Horizon	PW308A	160	GA TFF	25.89
Raytheon Hawker 800	TFE731-3	9	GA TFF	25.89
Raytheon Super King Air 300	PT6A-60A	8	GA TFF	25.89
Bombardier Challenger 600	CF34-3B	8	GA TMC	25.89
Bombardier Challenger 600	CF34-3B	9	GA TMC	25.89
Raytheon Beechjet 400	JT15D-5, -5A, -5B	348	GA TMC	25.89
Raytheon Hawker 800	TFE731-3	168	GA TMC	25.89
Bombardier Challenger 300	AE3007A1 Type 2	114	GA XOJ	25.89
Cessna 750 Citation X	AE3007C Type 2	95	GA XOJ	25.89
Total General Aviation Aircraft LTOs		**14,085**		
Total Fleet LTOs		**186,468**		

Ground Service Equipment/Alternative Fuels Conversion

For the 2015 analyses, GSE emissions were calculated using EDMS emission factors which are based on the EPA NONROAD2005 model in combination with the GSE time-in-mode survey and the GSE fuel types obtained from the Logan Airport Vehicle Aerodrome Permit Application as part of the *2011 ESPR*. In this way, the most up-to-date GSE fleet operational, conversion, and emissions characteristics are used.

Table I-5 Ground Service Equipment Alternative Fuel Conversion Summary (kg/day)

Year	Pollutant	Percent Reduction	Calculated Emissions without Reduction	Reduction from AFVs	Calculated Emissions with Reduction
2000	Volatile Organic Compounds (VOCs)	13.72%	178	24	154
	Oxides of Nitrogen (NO_x)	9.87%	369	36	333
	Carbon Monoxide (CO)	12.88%	6,124	789	5,335
2001	VOCs	13.72%	166	23	143

Table I-5	Ground Service Equipment Alternative Fuel Conversion Summary (kg/day) (Continued)				
Year	**Pollutant**	**Percent Reduction**	**Calculated Emissions without Reduction**	**Reduction from AFVs**	**Calculated Emission with Reduction**
2001 (Cont'd.)	NO_x	9.87%	338	33	305
	CO	12.88%	5,960	768	5,193
2002	VOCs	13.6%	286	39	247
	NO_x	8.0%	350	28	322
	CO	16.3%	6,174	1,004	5,170
2003	VOCs	13.8%	263	36	227
	NO_x	8.0%	316	25	291
	CO	16.4%	5,692	934	4,758
2004	VOCs	11.9%	212	25	187
	NO_x	6.6%	357	24	333
	CO	15.4%	4,236	650	3,586
2005	VOCs	12.2%	203	25	178
	NO_x	6.9%	335	23	312
	CO	15.4%	4,175	643	3,531
	$PM_{10}/PM_{2.5}$	9.9%	11	1	10
2006	VOCs	10.7%	86	9	77
	NO_x	7.5%	324	24	300
	CO	13.8%	1,841	255	1,586
	$PM_{10}/PM_{2.5}$	10.8%	10	1	9
2007	VOCs	8.2%	85	7	78
	NO_x	5.1%	315	16	299
	CO	10.4%	2,124	220	1,904
	$PM_{10}/PM_{2.5}$	5.9%	10	<1	10
2008	VOCs	8.3%	72	6	66
	NO_x	4.8%	270	13	257

Table I-5 Ground Service Equipment Alternative Fuel Conversion Summary (kg/day) (Continued)

Year	Pollutant	Percent Reduction	Calculated Emissions without Reduction	Reduction from AVFs	Calculated Emission with Reduction
2008 (Cont'd)	CO	10.2%	1,792	183	1,609
	$PM_{10}/PM_{2.5}$	5.6%	16	<1	15
2009	VOCs	8.2%	61	5	56
	NO_x	4.8%	230	11	219
	CO	10.0%	1,516	152	1,364
	$PM_{10}/PM_{2.5}$	3.5%	14	<1	14
2010	VOCs	7.5%	53	4	49
	NO_x	3.9%	206	8	198
	CO	8.5%	1,335	113	1,222
	$PM_{10}/PM_{2.5}$	2.5%	13	<1	13
2011	VOCs	13.2%	38	5	33
	NO_x	7.5%	188	14	173
	CO	16.7%	834	139	694
	$PM_{10}/PM_{2.5}$	5.5%	14	1	13
2012	VOCs	11.8%	34	4	30
	NO_x	6.8%	176	12	164
	CO	16.3%	738	120	618
	$PM_{10}/PM_{2.5}$	4.9%	13	<1	13
2013	VOCs	10.3%	29	3	26
	NO_x	6.5%	155	10	145
	CO	15.9%	634	101	533
	$PM_{10}/PM_{2.5}$	5.0%	12	<1	12
2014	VOCs	11.5%	26	3	23
	NO_x	5.6%	142	8	134
	CO	15.4%	572	88	484

Table I-5 Ground Service Equipment Alternative Fuel Conversion Summary (kg/day) (Continued)

Year	Pollutant	Percent Reduction	Calculated Emissions	Reduction from AVFs	Calculated Emissions with Reduction
2014 (Cont'd.)	$PM_{10}/PM_{2.5}$	4.8%	12	<1	12
2015	VOCs	4.5%	22	1	21
	NO_x	5.2%	135	7	128
	CO	15.2%	521	79	442
	$PM_{10}/PM_{2.5}$	14.3%	14	2	12

Source: KBE and Massport.
Notes: 2000 and 2001 analyses used EDMS v4.03. 2002 and 2003 analyses used EDMS v4.11, which used updated emission factors from the NONROAD2002 Model. 2004 analyses used EDMS v4.21, which again used emission factors from the EPA NONROAD2002 Model. 2005 analysis used EDMS v4.5, which used emission factors from the EPA NONROAD2002 Model. 2006 analysis used EDMS v5.0.1, which used emission factors from the EPA NONROAD2005 Model. 2007 analysis used EDMS v5.0.2, which used emission factors from the EPA NONROAD2005 Model. 2008 analysis used EDMS v5.1, which used emission factors from the EPA NONROAD2005 Model. 2009 analysis used EDMS v5.1.2, which used emission factors from the EPA NONROAD2005 Model. 2010, 2011, and 2012 analysis used EDMS v5.1.3, which used emission factors from the EPA NONROAD2005 Model. 2013, 2014, and 2015 used EDMS v5.1.4.1, which used emission factors from the EPA NONROAD2005 Model.

Motor Vehicle Emissions

For the 2015 analysis, the motor vehicle emission factor model MOVES2014a was used. The resultant emission factors were multiplied by average daily vehicle miles to calculate daily emissions. The on-Airport traffic data are summarized in the vehicle miles traveled (VMT) analyses of Appendix G, *Ground Access*. Due to the new roadway configuration of the Ted Williams Tunnel, through-traffic no longer traverses Airport property. Therefore, as of 2003, emissions from these vehicles are no longer included as part of the Logan Airport emissions inventory. Further, MOVES2014a was used to obtain vehicle emissions at idle to estimate parking and curbside motor vehicle emissions. Idling emissions are determined for a unit of time and multiplied by total idling time to reach the associated emissions. The input and output files of MOVES2014a are included as **Tables I-6** and **I-7.**

Table I-6 MOVES2014a Sample Input File for 2015


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<runspec version="MOVES2014a-20151201">
    <description><![CDATA[BOS 2015 EDR - Summer (July)
Passenger Car/Passenger Truck
(Ethanol, Diesel, Gasoline)
at idle 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 mph]]></description>
    <models>
        <model value="ONROAD"/>
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    <modelscale value="Inv"/>
    <modeldomain value="PROJECT"/>
    <geographicselections>
        <geographicselection type="COUNTY" key="25025" description="MASSACHUSETTS - Suffolk County"/>
    </geographicselections>
    <timespan>
        <year key="2015"/>
        <month id="7"/>
        <day id="5"/>
        <beginhour id="16"/>
        <endhour id="16"/>
        <aggregateBy key="Hour"/>
    </timespan>
    <onroadvehicleselections>
        <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="21" sourcetypename="Passenger Car"/>
        <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="31" sourcetypename="Passenger Truck"/>
        <onroadvehicleselection fueltypeid="5" fueltypedesc="Ethanol (E-85)" sourcetypeid="21" sourcetypename="Passenger Car"/>
        <onroadvehicleselection fueltypeid="5" fueltypedesc="Ethanol (E-85)" sourcetypeid="31" sourcetypename="Passenger Truck"/>
        <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="21" sourcetypename="Passenger Car"/>
        <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="31" sourcetypename="Passenger Truck"/>
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    <offroadvehicleselections>
    </offroadvehicleselections>
    <offroadvehiclesccs>
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    <roadtypes separateramps="false">
        <roadtype roadtypeid="1" roadtypename="Off-Network" modelCombination="M1"/>
        <roadtype roadtypeid="5" roadtypename="Urban Unrestricted Access" modelCombination="M1"/>
    </roadtypes>
    <pollutantprocessassociations>
        <pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="1" processname="Running
Exhaust"/>
        <pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="2" processname="Start Exhaust"/>
        <pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="90" processname="Extended Idle
Exhaust"/>
        <pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="91" processname="Auxiliary
Power Exhaust"/>
        <pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="1" processname="Running
Exhaust"/>
```

<pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="91" processname="Auxiliary Power Exhaust"/>
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<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="16" processname="Crankcase Start Exhaust"/>
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<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="91" processname="Auxiliary Power Exhaust"/>
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<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="1" processname="Running Exhaust"/>
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<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="90" processname="Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="91" processname="Auxiliary Power Exhaust"/>
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<pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="2" processname="Start Exhaust"/>
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<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="2" processname="Start Exhaust"/>
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<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="90" processname="Extended Idle Exhaust"/>
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<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="90" processname="Extended Idle Exhaust"/>
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<pollutantprocessassociation pollutantkey="106" pollutantname="Primary PM10 - Brakewear Particulate" processkey="9" processname="Brakewear"/>
<pollutantprocessassociation pollutantkey="107" pollutantname="Primary PM10 - Tirewear Particulate" processkey="10" processname="Tirewear"/>
<pollutantprocessassociation pollutantkey="116" pollutantname="Primary PM2.5 - Brakewear Particulate" processkey="9" processname="Brakewear"/>
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<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="2" processname="Start Exhaust"/>
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<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="2" processname="Start Exhaust"/>
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<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="11" processname="Evap Permeation"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="13" processname="Evap Fuel Leaks"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="11" processname="Evap Permeation"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="13" processname="Evap Fuel Leaks"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="90" processname="Extended Idle Exhaust"/>
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<databaseselection servername="" databasename="MassLEV" description=""/>
</databaseselections>
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useParameters No

]]></internalcontrolstrategy>
</internalcontrolstrategies>
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<geographicoutputdetail description="LINK"/>
<outputemissionsbreakdownselection>
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<fueltype selected="false"/>
<fuelsubtype selected="false"/>
<emissionprocess selected="false"/>
<onroadoffroad selected="true"/>
<roadtype selected="false"/>
<sourceusetype selected="true"/>
<movesvehicletype selected="false"/>

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			<estimateuncertainty selected="false" numberOfIterations="2" keepSampledData="false" keepIterations="false"/>
			<sector selected="false"/>
			<engtechid selected="false"/>
			<hpclass selected="false"/>
			<regclassid selected="false"/>
		</outputemissionsbreakdownselection>
		<outputdatabase servername="" databasename="out_BOS2015s_PCPT" description=""/>
		<outputtimestep value="Hour"/>
		<outputvmtdata value="true"/>
		<outputsho value="true"/>
		<outputsh value="true"/>
		<outputshp value="true"/>
		<outputshidling value="true"/>
		<outputstarts value="true"/>
		<outputpopulation value="true"/>
		<scaleinputdatabase servername="localhost" databasename="in_bos2015s_pcpt" description=""/>
		<pmsize value="0"/>
		<outputfactors>
			<timefactors selected="true" units="Hours"/>
			<distancefactors selected="true" units="Miles"/>
			<massfactors selected="true" units="Grams" energyunits="Million BTU"/>
		</outputfactors>
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		</savedata>

		<donotexecute>

		</donotexecute>

		<generatordatabase shouldsave="false" servername="" databasename="" description=""/>
			<donotperformfinalaggregation selected="false"/>
		<lookuptableflags scenarioid="" truncateoutput="true" truncateactivity="true" truncatebaserates="true"/>
	</runspec>
```


Source: KBE and Massport.

Table I-7 MOVES2014a Sample Output File for 2015

MasterKey	MOVESRunID	iterationID	yearID	monthID	dayID	hourID	stateID	countyID	zoneID	linkID	pollutantID	processID	sourceTypeID	regClassId	fuelTypeID	modelYearID	roadTypeID	SCC	emissionQuant	activityTypeID	activity	emissionRate	massUnits	distanceUnits
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	119	NULL	31	0	0	0	0	0	0	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	119	NULL	21	0	0	0	0	0	0	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	118	NULL	31	0	0	0	0	0	0.035492402	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	118	NULL	21	0	0	0	0	0	0.033338599	1	0	NULL	g	mi

"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	118	NULL	31	0	0	0	0	0	0.00334407	1	1	0.00334407	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	118	NULL	31	0	0	0	0	0	0.00339481	1	1	0.00339481	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	118	NULL	31	0	0	0	0	0	0.00355537	1	1	0.00355537	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	118	NULL	31	0	0	0	0	0	0.00382075	1	1	0.00382075	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	118	NULL	31	0	0	0	0	0	0.00417303	1	1	0.00417303	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	118	NULL	31	0	0	0	0	0	0.00468412	1	1	0.00468412	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	118	NULL	31	0	0	0	0	0	0.00583307	1	1	0.00583307	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	118	NULL	31	0	0	0	0	0	0.0066116	1	1	0.0066116	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	118	NULL	31	0	0	0	0	0	0.00749131	1	1	0.00749131	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	118	NULL	31	0	0	0	0	0	0.0101304	1	1	0.0101304	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	118	NULL	21	0	0	0	0	0	0.00285559	1	1	0.00285559	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	118	NULL	21	0	0	0	0	0	0.00286061	1	1	0.00286061	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	118	NULL	21	0	0	0	0	0	0.00297983	1	1	0.00297983	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	118	NULL	21	0	0	0	0	0	0.00320164	1	1	0.00320164	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	118	NULL	21	0	0	0	0	0	0.0034701	1	1	0.0034701	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	118	NULL	21	0	0	0	0	0	0.00375349	1	1	0.00375349	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	118	NULL	21	0	0	0	0	0	0.00470792	1	1	0.00470792	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	118	NULL	21	0	0	0	0	0	0.00540682	1	1	0.00540682	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	118	NULL	21	0	0	0	0	0	0.00627302	1	1	0.00627302	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	118	NULL	21	0	0	0	0	0	0.00887159	1	1	0.00887159	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	117	NULL	31	0	0	0	0	0	0	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	117	NULL	21	0	0	0	0	0	0	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	117	NULL	31	0	0	0	0	0	0.00124421	1	1	0.00124421	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	117	NULL	31	0	0	0	0	0	0.00134041	1	1	0.00134041	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	117	NULL	31	0	0	0	0	0	0.00144464	1	1	0.00144464	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	117	NULL	31	0	0	0	0	0	0.00155601	1	1	0.00155601	g	mi

"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	117	NULL	31	0	0	0	0	0	0.00167651	1	1	0.00167651	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	117	NULL	31	0	0	0	0	0	0.00180606	1	1	0.00180606	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	117	NULL	31	0	0	0	0	0	0.00194579	1	1	0.00194579	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	117	NULL	31	0	0	0	0	0	0.00209661	1	1	0.00209661	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	117	NULL	31	0	0	0	0	0	0.00225859	1	1	0.00225859	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	117	NULL	31	0	0	0	0	0	0.00243373	1	1	0.00243373	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	117	NULL	21	0	0	0	0	0	0.001229	1	1	0.001229	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	117	NULL	21	0	0	0	0	0	0.001324	1	1	0.001324	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	117	NULL	21	0	0	0	0	0	0.001427	1	1	0.001427	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	117	NULL	21	0	0	0	0	0	0.001537	1	1	0.001537	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	117	NULL	21	0	0	0	0	0	0.001656	1	1	0.001656	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	117	NULL	21	0	0	0	0	0	0.001784	1	1	0.001784	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	117	NULL	21	0	0	0	0	0	0.001922	1	1	0.001922	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	117	NULL	21	0	0	0	0	0	0.002071	1	1	0.002071	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	117	NULL	21	0	0	0	0	0	0.002231	1	1	0.002231	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	117	NULL	21	0	0	0	0	0	0.002404	1	1	0.002404	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	116	NULL	31	0	0	0	0	0	0	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	116	NULL	21	0	0	0	0	0	0	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	116	NULL	31	0	0	0	0	0	0.0014	1	1	0.0014	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	116	NULL	31	0	0	0	0	0	0.00219603	1	1	0.00219603	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	116	NULL	31	0	0	0	0	0	0.00307423	1	1	0.00307423	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	116	NULL	31	0	0	0	0	0	0.00413246	1	1	0.00413246	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	116	NULL	31	0	0	0	0	0	0.00553236	1	1	0.00553236	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	116	NULL	31	0	0	0	0	0	0.00732577	1	1	0.00732577	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	116	NULL	31	0	0	0	0	0	0.00826577	1	1	0.00826577	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	116	NULL	31	0	0	0	0	0	0.0098568	1	1	0.0098568	g	mi

"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	116	NULL	31	0	0	0	0	0	0.0130534	1	1	0.0130534	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	116	NULL	31	0	0	0	0	0	0.022643	1	1	0.022643	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	116	NULL	21	0	0	0	0	0	0.00128294	1	1	0.00128294	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	116	NULL	21	0	0	0	0	0	0.00198081	1	1	0.00198081	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	116	NULL	21	0	0	0	0	0	0.00275537	1	1	0.00275537	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	116	NULL	21	0	0	0	0	0	0.00369192	1	1	0.00369192	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	116	NULL	21	0	0	0	0	0	0.00493551	1	1	0.00493551	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	116	NULL	21	0	0	0	0	0	0.00655265	1	1	0.00655265	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	116	NULL	21	0	0	0	0	0	0.00745541	1	1	0.00745541	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	116	NULL	21	0	0	0	0	0	0.00888721	1	1	0.00888721	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	116	NULL	21	0	0	0	0	0	0.0117074	1	1	0.0117074	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	116	NULL	21	0	0	0	0	0	0.0201681	1	1	0.0201681	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	115	NULL	31	0	0	0	0	0	0.00283361	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	115	NULL	21	0	0	0	0	0	0.00128888	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	115	NULL	31	0	0	0	0	0	0.000164972	1	1	0.000164972	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	115	NULL	31	0	0	0	0	0	0.000166561	1	1	0.000166561	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	115	NULL	31	0	0	0	0	0	0.000173325	1	1	0.000173325	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	115	NULL	31	0	0	0	0	0	0.000184918	1	1	0.000184918	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	115	NULL	31	0	0	0	0	0	0.000201542	1	1	0.000201542	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	115	NULL	31	0	0	0	0	0	0.000230983	1	1	0.000230983	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	115	NULL	31	0	0	0	0	0	0.000286238	1	1	0.000286238	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	115	NULL	31	0	0	0	0	0	0.000333302	1	1	0.000333302	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	115	NULL	31	0	0	0	0	0	0.000400591	1	1	0.000400591	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	115	NULL	31	0	0	0	0	0	0.000602453	1	1	0.000602453	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	115	NULL	21	0	0	0	0	0	0.000109485	1	1	0.000109485	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	115	NULL	21	0	0	0	0	0	0.000109651	1	1	0.000109651	g	mi

"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	115	NULL	21	0	0	0	0	0	0.000114126	1	1	0.000114126	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	115	NULL	21	0	0	0	0	0	0.000122469	1	1	0.000122469	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	115	NULL	21	0	0	0	0	0	0.000132612	1	1	0.000132612	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	115	NULL	21	0	0	0	0	0	0.000143529	1	1	0.000143529	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	115	NULL	21	0	0	0	0	0	0.00017957	1	1	0.00017957	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	115	NULL	21	0	0	0	0	0	0.00020633	1	1	0.00020633	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	115	NULL	21	0	0	0	0	0	0.000239994	1	1	0.000239994	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	115	NULL	21	0	0	0	0	0	0.000340988	1	1	0.000340988	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	112	NULL	31	0	0	0	0	0	0.0152367	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	112	NULL	21	0	0	0	0	0	0.00568479	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	112	NULL	31	0	0	0	0	0	0.00134584	1	1	0.00134584	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	112	NULL	31	0	0	0	0	0	0.00132137	1	1	0.00132137	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	112	NULL	31	0	0	0	0	0	0.001322	1	1	0.001322	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	112	NULL	31	0	0	0	0	0	0.00134173	1	1	0.00134173	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	112	NULL	31	0	0	0	0	0	0.00139631	1	1	0.00139631	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	112	NULL	31	0	0	0	0	0	0.0016041	1	1	0.0016041	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	112	NULL	31	0	0	0	0	0	0.00190981	1	1	0.00190981	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	112	NULL	31	0	0	0	0	0	0.0021524	1	1	0.0021524	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	112	NULL	31	0	0	0	0	0	0.00247849	1	1	0.00247849	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	112	NULL	31	0	0	0	0	0	0.00345676	1	1	0.00345676	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	112	NULL	21	0	0	0	0	0	0.000486863	1	1	0.000486863	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	112	NULL	21	0	0	0	0	0	0.000487719	1	1	0.000487719	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	112	NULL	21	0	0	0	0	0	0.000508046	1	1	0.000508046	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	112	NULL	21	0	0	0	0	0	0.000545864	1	1	0.000545864	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	112	NULL	21	0	0	0	0	0	0.000591638	1	1	0.000591638	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	112	NULL	21	0	0	0	0	0	0.00063996	1	1	0.00063996	g	mi

"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	112	NULL	21	0	0	0	0	0	0.000802691	1	1	0.000802691	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	112	NULL	21	0	0	0	0	0	0.000921862	1	1	0.000921862	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	112	NULL	21	0	0	0	0	0	0.00106957	1	1	0.00106957	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	112	NULL	21	0	0	0	0	0	0.00151268	1	1	0.00151268	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	110	NULL	31	0	0	0	0	0	0.0507292	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	110	NULL	21	0	0	0	0	0	0.039023399	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	110	NULL	31	0	0	0	0	0	0.00468991	1	1	0.00468991	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	110	NULL	31	0	0	0	0	0	0.00471618	1	1	0.00471618	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	110	NULL	31	0	0	0	0	0	0.00487737	1	1	0.00487737	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	110	NULL	31	0	0	0	0	0	0.00516248	1	1	0.00516248	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	110	NULL	31	0	0	0	0	0	0.00556934	1	1	0.00556934	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	110	NULL	31	0	0	0	0	0	0.00628822	1	1	0.00628822	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	110	NULL	31	0	0	0	0	0	0.00774288	1	1	0.00774288	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	110	NULL	31	0	0	0	0	0	0.00876401	1	1	0.00876401	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	110	NULL	31	0	0	0	0	0	0.00996981	1	1	0.00996981	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	110	NULL	31	0	0	0	0	0	0.0135872	1	1	0.0135872	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	110	NULL	21	0	0	0	0	0	0.00334246	1	1	0.00334246	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	110	NULL	21	0	0	0	0	0	0.00334833	1	1	0.00334833	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	110	NULL	21	0	0	0	0	0	0.00348787	1	1	0.00348787	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	110	NULL	21	0	0	0	0	0	0.0037475	1	1	0.0037475	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	110	NULL	21	0	0	0	0	0	0.00406174	1	1	0.00406174	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	110	NULL	21	0	0	0	0	0	0.00439345	1	1	0.00439345	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	110	NULL	21	0	0	0	0	0	0.00551061	1	1	0.00551061	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	110	NULL	21	0	0	0	0	0	0.00632868	1	1	0.00632868	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	110	NULL	21	0	0	0	0	0	0.00734258	1	1	0.00734258	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	110	NULL	21	0	0	0	0	0	0.0103843	1	1	0.0103843	g	mi

"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	107	NULL	31	0	0	0	0	0	0	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	107	NULL	21	0	0	0	0	0	0	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	107	NULL	31	0	0	0	0	0	0.00829476	1	1	0.00829476	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	107	NULL	31	0	0	0	0	0	0.00893611	1	1	0.00893611	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	107	NULL	31	0	0	0	0	0	0.00963101	1	1	0.00963101	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	107	NULL	31	0	0	0	0	0	0.0103735	1	1	0.0103735	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	107	NULL	31	0	0	0	0	0	0.0111768	1	1	0.0111768	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	107	NULL	31	0	0	0	0	0	0.0120405	1	1	0.0120405	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	107	NULL	31	0	0	0	0	0	0.012972	1	1	0.012972	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	107	NULL	31	0	0	0	0	0	0.0139774	1	1	0.0139774	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	107	NULL	31	0	0	0	0	0	0.0150573	1	1	0.0150573	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	107	NULL	31	0	0	0	0	0	0.016225001	1	1	0.016225001	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	107	NULL	21	0	0	0	0	0	0.00819337	1	1	0.00819337	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	107	NULL	21	0	0	0	0	0	0.00882671	1	1	0.00882671	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	107	NULL	21	0	0	0	0	0	0.00951337	1	1	0.00951337	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	107	NULL	21	0	0	0	0	0	0.0102467	1	1	0.0102467	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	107	NULL	21	0	0	0	0	0	0.01104	1	1	0.01104	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	107	NULL	21	0	0	0	0	0	0.0118934	1	1	0.0118934	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	107	NULL	21	0	0	0	0	0	0.0128134	1	1	0.0128134	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	107	NULL	21	0	0	0	0	0	0.0138067	1	1	0.0138067	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	107	NULL	21	0	0	0	0	0	0.0148734	1	1	0.0148734	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	107	NULL	21	0	0	0	0	0	0.0160267	1	1	0.0160267	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	106	NULL	31	0	0	0	0	0	0	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	106	NULL	21	0	0	0	0	0	0	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	106	NULL	31	0	0	0	0	0	0.0112	1	1	0.0112	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	106	NULL	31	0	0	0	0	0	0.017568201	1	1	0.017568201	g	mi

"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	106	NULL	31	0	0	0	0	0	0.0245938	1	1	0.0245938	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	106	NULL	31	0	0	0	0	0	0.033059701	1	1	0.033059701	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	106	NULL	31	0	0	0	0	0	0.0442589	1	1	0.0442589	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	106	NULL	31	0	0	0	0	0	0.058606099	1	1	0.058606099	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	106	NULL	31	0	0	0	0	0	0.066126198	1	1	0.066126198	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	106	NULL	31	0	0	0	0	0	0.078854397	1	1	0.078854397	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	106	NULL	31	0	0	0	0	0	0.104427002	1	1	0.104427002	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	106	NULL	31	0	0	0	0	0	0.181143999	1	1	0.181143999	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	106	NULL	21	0	0	0	0	0	0.0102635	1	1	0.0102635	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	106	NULL	21	0	0	0	0	0	0.0158465	1	1	0.0158465	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	106	NULL	21	0	0	0	0	0	0.022043001	1	1	0.022043001	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	106	NULL	21	0	0	0	0	0	0.029535299	1	1	0.029535299	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	106	NULL	21	0	0	0	0	0	0.039484099	1	1	0.039484099	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	106	NULL	21	0	0	0	0	0	0.052421201	1	1	0.052421201	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	106	NULL	21	0	0	0	0	0	0.059643298	1	1	0.059643298	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	106	NULL	21	0	0	0	0	0	0.071097702	1	1	0.071097702	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	106	NULL	21	0	0	0	0	0	0.093659498	1	1	0.093659498	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	106	NULL	21	0	0	0	0	0	0.161345005	1	1	0.161345005	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	100	NULL	31	0	0	0	0	0	0.055997901	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	100	NULL	21	0	0	0	0	0	0.0441023	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	100	NULL	31	0	0	0	0	0	0.00525542	1	1	0.00525542	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	100	NULL	31	0	0	0	0	0	0.00528447	1	1	0.00528447	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	100	NULL	31	0	0	0	0	0	0.00546541	1	1	0.00546541	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	100	NULL	31	0	0	0	0	0	0.00578579	1	1	0.00578579	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	100	NULL	31	0	0	0	0	0	0.00624195	1	1	0.00624195	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	100	NULL	31	0	0	0	0	0	0.00704379	1	1	0.00704379	g	mi

"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	100	NULL	31	0	0	0	0	0	0.00867345	1	1	0.00867345	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	100	NULL	31	0	0	0	0	0	0.00980757	1	1	0.00980757	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	100	NULL	31	0	0	0	0	0	0.0111328	1	1	0.0111328	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	100	NULL	31	0	0	0	0	0	0.0151086	1	1	0.0151086	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	100	NULL	21	0	0	0	0	0	0.00377733	1	1	0.00377733	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	100	NULL	21	0	0	0	0	0	0.00378396	1	1	0.00378396	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	100	NULL	21	0	0	0	0	0	0.00394165	1	1	0.00394165	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	100	NULL	21	0	0	0	0	0	0.00423504	1	1	0.00423504	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	100	NULL	21	0	0	0	0	0	0.00459016	1	1	0.00459016	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	100	NULL	21	0	0	0	0	0	0.00496505	1	1	0.00496505	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	100	NULL	21	0	0	0	0	0	0.00622772	1	1	0.00622772	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	100	NULL	21	0	0	0	0	0	0.0071523	1	1	0.0071523	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	100	NULL	21	0	0	0	0	0	0.00829819	1	1	0.00829819	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	100	NULL	21	0	0	0	0	0	0.0117358	1	1	0.0117358	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	98	NULL	31	0	0	0	0	0	4848.779785	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	98	NULL	21	0	0	0	0	0	3692.48999	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	98	NULL	31	0	0	0	0	0	431.9710083	1	1	431.9710083	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	98	NULL	31	0	0	0	0	0	441.1530151	1	1	441.1530151	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	98	NULL	31	0	0	0	0	0	453.0669861	1	1	453.0669861	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	98	NULL	31	0	0	0	0	0	468.6489868	1	1	468.6489868	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	98	NULL	31	0	0	0	0	0	494.8770142	1	1	494.8770142	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	98	NULL	31	0	0	0	0	0	555.3829956	1	1	555.3829956	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	98	NULL	31	0	0	0	0	0	621.3400269	1	1	621.3400269	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	98	NULL	31	0	0	0	0	0	722.8280029	1	1	722.8280029	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	98	NULL	31	0	0	0	0	0	920.7750244	1	1	920.7750244	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	98	NULL	31	0	0	0	0	0	1514.609985	1	1	1514.609985	g	mi

"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	98	NULL	21	0	0	0	0	0	316.6390076	1	1	316.6390076	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	98	NULL	21	0	0	0	0	0	324.3880005	1	1	324.3880005	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	98	NULL	21	0	0	0	0	0	335.2009888	1	1	335.2009888	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	98	NULL	21	0	0	0	0	0	349.7869873	1	1	349.7869873	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	98	NULL	21	0	0	0	0	0	372.2829895	1	1	372.2829895	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	98	NULL	21	0	0	0	0	0	417.131012	1	1	417.131012	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	98	NULL	21	0	0	0	0	0	471.1919861	1	1	471.1919861	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	98	NULL	21	0	0	0	0	0	551.9030151	1	1	551.9030151	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	98	NULL	21	0	0	0	0	0	707.7290039	1	1	707.7290039	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	98	NULL	21	0	0	0	0	0	1175.199951	1	1	1175.199951	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	91	NULL	31	0	0	0	0	0	0.063898131	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	91	NULL	21	0	0	0	0	0	0.048683487	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	91	NULL	31	0	0	0	0	0	0.005691746	1	1	0.005691746	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	91	NULL	31	0	0	0	0	0	0.005812716	1	1	0.005812716	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	91	NULL	31	0	0	0	0	0	0.005969655	1	1	0.005969655	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	91	NULL	31	0	0	0	0	0	0.006174905	1	1	0.006174905	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	91	NULL	31	0	0	0	0	0	0.006520423	1	1	0.006520423	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	91	NULL	31	0	0	0	0	0	0.007317726	1	1	0.007317726	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	91	NULL	31	0	0	0	0	0	0.008186826	1	1	0.008186826	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	91	NULL	31	0	0	0	0	0	0.009524235	1	1	0.009524235	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	91	NULL	31	0	0	0	0	0	0.012133006	1	1	0.012133006	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	91	NULL	31	0	0	0	0	0	0.019959226	1	1	0.019959226	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	91	NULL	21	0	0	0	0	0	0.004174423	1	1	0.004174423	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	91	NULL	21	0	0	0	0	0	0.004276608	1	1	0.004276608	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	91	NULL	21	0	0	0	0	0	0.00441914	1	1	0.00441914	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	91	NULL	21	0	0	0	0	0	0.004611405	1	1	0.004611405	g	mi

"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	91	NULL	21	0	0	0	0	0	0.004907958	1	1	0.004907958	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	91	NULL	21	0	0	0	0	0	0.005499254	1	1	0.005499254	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	91	NULL	21	0	0	0	0	0	0.006211955	1	1	0.006211955	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	91	NULL	21	0	0	0	0	0	0.007276088	1	1	0.007276088	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	91	NULL	21	0	0	0	0	0	0.009330605	1	1	0.009330605	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	91	NULL	21	0	0	0	0	0	0.015494156	1	1	0.015494156	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	90	NULL	31	0	0	0	0	0	4848.029785	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	90	NULL	21	0	0	0	0	0	3691.919922	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	90	NULL	31	0	0	0	0	0	431.848999	1	1	431.848999	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	90	NULL	31	0	0	0	0	0	441.0280151	1	1	441.0280151	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	90	NULL	31	0	0	0	0	0	452.9370117	1	1	452.9370117	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	90	NULL	31	0	0	0	0	0	468.5119934	1	1	468.5119934	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	90	NULL	31	0	0	0	0	0	494.7309875	1	1	494.7309875	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	90	NULL	31	0	0	0	0	0	555.2260132	1	1	555.2260132	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	90	NULL	31	0	0	0	0	0	621.1640015	1	1	621.1640015	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	90	NULL	31	0	0	0	0	0	722.6329956	1	1	722.6329956	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	90	NULL	31	0	0	0	0	0	920.552002	1	1	920.552002	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	90	NULL	31	0	0	0	0	0	1514.300049	1	1	1514.300049	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	90	NULL	21	0	0	0	0	0	316.572998	1	1	316.572998	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	90	NULL	21	0	0	0	0	0	324.321991	1	1	324.321991	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	90	NULL	21	0	0	0	0	0	335.131012	1	1	335.131012	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	90	NULL	21	0	0	0	0	0	349.7109985	1	1	349.7109985	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	90	NULL	21	0	0	0	0	0	372.2000122	1	1	372.2000122	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	90	NULL	21	0	0	0	0	0	417.0419922	1	1	417.0419922	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	90	NULL	21	0	0	0	0	0	471.0899963	1	1	471.0899963	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	90	NULL	21	0	0	0	0	0	551.789978	1	1	551.789978	g	mi

"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	90	NULL	21	0	0	0	0	0	707.5960083	1	1	707.5960083	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	90	NULL	21	0	0	0	0	0	1175.01001	1	1	1175.01001	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	87	NULL	31	0	0	0	0	0	0.966842115	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	87	NULL	21	0	0	0	0	0	1.127281189	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	87	NULL	31	0	0	0	0	0	0.122033991	1	1	0.122033991	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	87	NULL	31	0	0	0	0	0	0.124843739	1	1	0.124843739	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	87	NULL	31	0	0	0	0	0	0.12878935	1	1	0.12878935	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	87	NULL	31	0	0	0	0	0	0.134125128	1	1	0.134125128	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	87	NULL	31	0	0	0	0	0	0.141135737	1	1	0.141135737	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	87	NULL	31	0	0	0	0	0	0.150427505	1	1	0.150427505	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	87	NULL	31	0	0	0	0	0	0.163756236	1	1	0.163756236	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	87	NULL	31	0	0	0	0	0	0.181615949	1	1	0.181615949	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	87	NULL	31	0	0	0	0	0	0.214739546	1	1	0.214739546	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	87	NULL	31	0	0	0	0	0	0.314108014	1	1	0.314108014	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	87	NULL	21	0	0	0	0	0	0.136501253	1	1	0.136501253	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	87	NULL	21	0	0	0	0	0	0.138646752	1	1	0.138646752	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	87	NULL	21	0	0	0	0	0	0.142272323	1	1	0.142272323	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	87	NULL	21	0	0	0	0	0	0.147505865	1	1	0.147505865	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	87	NULL	21	0	0	0	0	0	0.154280096	1	1	0.154280096	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	87	NULL	21	0	0	0	0	0	0.162807047	1	1	0.162807047	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	87	NULL	21	0	0	0	0	0	0.175537661	1	1	0.175537661	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	87	NULL	21	0	0	0	0	0	0.19367075	1	1	0.19367075	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	87	NULL	21	0	0	0	0	0	0.22809726	1	1	0.22809726	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	87	NULL	21	0	0	0	0	0	0.33137688	1	1	0.33137688	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	79	NULL	31	0	0	0	0	0	0.91345495	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	79	NULL	21	0	0	0	0	0	1.057322145	1	0	NULL	g	mi

"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	79	NULL	31	0	0	0	0	0	0.114606999	1	1	0.114606999	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	79	NULL	31	0	0	0	0	0	0.117340498	1	1	0.117340498	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	79	NULL	31	0	0	0	0	0	0.121218599	1	1	0.121218599	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	79	NULL	31	0	0	0	0	0	0.126484305	1	1	0.126484305	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	79	NULL	31	0	0	0	0	0	0.1333808	1	1	0.1333808	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	79	NULL	31	0	0	0	0	0	0.142417192	1	1	0.142417192	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	79	NULL	31	0	0	0	0	0	0.155404896	1	1	0.155404896	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	79	NULL	31	0	0	0	0	0	0.172516599	1	1	0.172516599	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	79	NULL	31	0	0	0	0	0	0.204036996	1	1	0.204036996	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	79	NULL	31	0	0	0	0	0	0.298599303	1	1	0.298599303	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	79	NULL	21	0	0	0	0	0	0.125293702	1	1	0.125293702	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	79	NULL	21	0	0	0	0	0	0.127287105	1	1	0.127287105	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	79	NULL	21	0	0	0	0	0	0.130736604	1	1	0.130736604	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	79	NULL	21	0	0	0	0	0	0.135752201	1	1	0.135752201	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	79	NULL	21	0	0	0	0	0	0.142226398	1	1	0.142226398	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	79	NULL	21	0	0	0	0	0	0.150297806	1	1	0.150297806	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	79	NULL	21	0	0	0	0	0	0.162451804	1	1	0.162451804	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	79	NULL	21	0	0	0	0	0	0.179591298	1	1	0.179591298	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	79	NULL	21	0	0	0	0	0	0.212012202	1	1	0.212012202	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	79	NULL	21	0	0	0	0	0	0.309274495	1	1	0.309274495	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	31	NULL	31	0	0	0	0	0	0.095086403	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	31	NULL	21	0	0	0	0	0	0.073296003	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	31	NULL	31	0	0	0	0	0	0.0084658	1	1	0.0084658	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	31	NULL	31	0	0	0	0	0	0.00864562	1	1	0.00864562	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	31	NULL	31	0	0	0	0	0	0.00887834	1	1	0.00887834	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	31	NULL	31	0	0	0	0	0	0.00918234	1	1	0.00918234	g	mi

"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	31	NULL	31	0	0	0	0	0	0.00969481	1	1	0.00969481	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	31	NULL	31	0	0	0	0	0	0.01088	1	1	0.01088	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	31	NULL	31	0	0	0	0	0	0.0121742	1	1	0.0121742	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	31	NULL	31	0	0	0	0	0	0.0141666	1	1	0.0141666	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	31	NULL	31	0	0	0	0	0	0.018053301	1	1	0.018053301	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	31	NULL	31	0	0	0	0	0	0.0297135	1	1	0.0297135	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	31	NULL	21	0	0	0	0	0	0.00628296	1	1	0.00628296	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	31	NULL	21	0	0	0	0	0	0.00643677	1	1	0.00643677	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	31	NULL	21	0	0	0	0	0	0.00665134	1	1	0.00665134	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	31	NULL	21	0	0	0	0	0	0.00694078	1	1	0.00694078	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	31	NULL	21	0	0	0	0	0	0.0073872	1	1	0.0073872	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	31	NULL	21	0	0	0	0	0	0.00827727	1	1	0.00827727	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	31	NULL	21	0	0	0	0	0	0.0093501	1	1	0.0093501	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	31	NULL	21	0	0	0	0	0	0.010952	1	1	0.010952	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	31	NULL	21	0	0	0	0	0	0.0140446	1	1	0.0140446	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	31	NULL	21	0	0	0	0	0	0.0233227	1	1	0.0233227	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	5	NULL	31	0	0	0	0	0	0.030278549	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	5	NULL	21	0	0	0	0	0	0.023221483	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	5	NULL	31	0	0	0	0	0	0.004959182	1	1	0.004959182	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	5	NULL	31	0	0	0	0	0	0.005064816	1	1	0.005064816	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	5	NULL	31	0	0	0	0	0	0.005259523	1	1	0.005259523	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	5	NULL	31	0	0	0	0	0	0.005547877	1	1	0.005547877	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	5	NULL	31	0	0	0	0	0	0.005913299	1	1	0.005913299	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	5	NULL	31	0	0	0	0	0	0.006344683	1	1	0.006344683	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	5	NULL	31	0	0	0	0	0	0.007124707	1	1	0.007124707	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	5	NULL	31	0	0	0	0	0	0.007873956	1	1	0.007873956	g	mi

"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	5	NULL	31	0	0	0	0	0	0.009044121	1	1	0.009044121	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	5	NULL	31	0	0	0	0	0	0.012554659	1	1	0.012554659	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	5	NULL	21	0	0	0	0	0	0.002695806	1	1	0.002695806	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	5	NULL	21	0	0	0	0	0	0.00270092	1	1	0.00270092	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	5	NULL	21	0	0	0	0	0	0.002830357	1	1	0.002830357	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	5	NULL	21	0	0	0	0	0	0.003071414	1	1	0.003071414	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	5	NULL	21	0	0	0	0	0	0.003354953	1	1	0.003354953	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	5	NULL	21	0	0	0	0	0	0.003587049	1	1	0.003587049	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	5	NULL	21	0	0	0	0	0	0.004115268	1	1	0.004115268	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	5	NULL	21	0	0	0	0	0	0.004612972	1	1	0.004612972	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	5	NULL	21	0	0	0	0	0	0.005380244	1	1	0.005380244	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	5	NULL	21	0	0	0	0	0	0.007682066	1	1	0.007682066	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	3	NULL	31	0	0	0	0	0	2.334285498	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	3	NULL	21	0	0	0	0	0	1.471556664	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	3	NULL	31	0	0	0	0	0	0.297543466	1	1	0.297543466	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	3	NULL	31	0	0	0	0	0	0.29189527	1	1	0.29189527	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	3	NULL	31	0	0	0	0	0	0.288305283	1	1	0.288305283	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	3	NULL	31	0	0	0	0	0	0.285791397	1	1	0.285791397	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	3	NULL	31	0	0	0	0	0	0.287514806	1	1	0.287514806	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	3	NULL	31	0	0	0	0	0	0.312439442	1	1	0.312439442	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	3	NULL	31	0	0	0	0	0	0.33231917	1	1	0.33231917	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	3	NULL	31	0	0	0	0	0	0.360608876	1	1	0.360608876	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	3	NULL	31	0	0	0	0	0	0.414301038	1	1	0.414301038	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	3	NULL	31	0	0	0	0	0	0.575376689	1	1	0.575376689	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	3	NULL	21	0	0	0	0	0	0.192107379	1	1	0.192107379	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	3	NULL	21	0	0	0	0	0	0.188965231	1	1	0.188965231	g	mi

"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	3	NULL	21	0	0	0	0	0	0.189977273	1	1	0.189977273	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	3	NULL	21	0	0	0	0	0	0.194275454	1	1	0.194275454	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	3	NULL	21	0	0	0	0	0	0.202715814	1	1	0.202715814	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	3	NULL	21	0	0	0	0	0	0.225827828	1	1	0.225827828	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	3	NULL	21	0	0	0	0	0	0.239990458	1	1	0.239990458	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	3	NULL	21	0	0	0	0	0	0.257899255	1	1	0.257899255	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	3	NULL	21	0	0	0	0	0	0.290321738	1	1	0.290321738	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	3	NULL	21	0	0	0	0	0	0.38758713	1	1	0.38758713	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	2	NULL	31	0	0	0	0	0	6.922605038	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	2	NULL	21	0	0	0	0	0	7.144999981	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	2	NULL	31	0	0	0	0	0	2.764748096	1	1	2.764748096	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	2	NULL	31	0	0	0	0	0	2.80517292	1	1	2.80517292	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	2	NULL	31	0	0	0	0	0	2.913474798	1	1	2.913474798	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	2	NULL	31	0	0	0	0	0	3.087763309	1	1	3.087763309	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	2	NULL	31	0	0	0	0	0	3.289238214	1	1	3.289238214	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	2	NULL	31	0	0	0	0	0	3.456769228	1	1	3.456769228	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	2	NULL	31	0	0	0	0	0	4.159496307	1	1	4.159496307	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	2	NULL	31	0	0	0	0	0	4.661911488	1	1	4.661911488	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	2	NULL	31	0	0	0	0	0	5.268093586	1	1	5.268093586	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	2	NULL	31	0	0	0	0	0	7.086639881	1	1	7.086639881	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	2	NULL	21	0	0	0	0	0	2.010581017	1	1	2.010581017	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	2	NULL	21	0	0	0	0	0	2.056927919	1	1	2.056927919	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	2	NULL	21	0	0	0	0	0	2.197807789	1	1	2.197807789	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	2	NULL	21	0	0	0	0	0	2.429258347	1	1	2.429258347	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	2	NULL	21	0	0	0	0	0	2.686214447	1	1	2.686214447	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	2	NULL	21	0	0	0	0	0	2.828671694	1	1	2.828671694	g	mi

"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	2	NULL	21	0	0	0	0	0	3.40225482	1	1	3.40225482	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	2	NULL	21	0	0	0	0	0	3.83739996	1	1	3.83739996	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	2	NULL	21	0	0	0	0	0	4.39722538	1	1	4.39722538	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	2	NULL	21	0	0	0	0	0	6.076691628	1	1	6.076691628	g	mi
"2,1,2015,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	22	1	NULL	31	0	0	0	0	0	0.943414986	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,21,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	21	1	NULL	21	0	0	0	0	0	1.080242157	1	0	NULL	g	mi
"2,1,2015,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	20	1	NULL	31	0	0	0	0	0	0.119505495	1	1	0.119505495	g	mi
"2,1,2015,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	19	1	NULL	31	0	0	0	0	0	0.122343495	1	1	0.122343495	g	mi
"2,1,2015,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	18	1	NULL	31	0	0	0	0	0	0.126414001	1	1	0.126414001	g	mi
"2,1,2015,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	17	1	NULL	31	0	0	0	0	0	0.131964594	1	1	0.131964594	g	mi
"2,1,2015,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	16	1	NULL	31	0	0	0	0	0	0.139222205	1	1	0.139222205	g	mi
"2,1,2015,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	15	1	NULL	31	0	0	0	0	0	0.148684904	1	1	0.148684904	g	mi
"2,1,2015,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	14	1	NULL	31	0	0	0	0	0	0.162443489	1	1	0.162443489	g	mi
"2,1,2015,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	13	1	NULL	31	0	0	0	0	0	0.180296198	1	1	0.180296198	g	mi
"2,1,2015,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	12	1	NULL	31	0	0	0	0	0	0.212974995	1	1	0.212974995	g	mi
"2,1,2015,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	11	1	NULL	31	0	0	0	0	0	0.311011314	1	1	0.311011314	g	mi
"2,1,2015,7,5,16,25,25025,250250,10,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	10	1	NULL	21	0	0	0	0	0	0.127954796	1	1	0.127954796	g	mi
"2,1,2015,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	9	1	NULL	21	0	0	0	0	0	0.129953295	1	1	0.129953295	g	mi
"2,1,2015,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	8	1	NULL	21	0	0	0	0	0	0.133530408	1	1	0.133530408	g	mi
"2,1,2015,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	7	1	NULL	21	0	0	0	0	0	0.138784096	1	1	0.138784096	g	mi
"2,1,2015,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	6	1	NULL	21	0	0	0	0	0	0.145538107	1	1	0.145538107	g	mi
"2,1,2015,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	5	1	NULL	21	0	0	0	0	0	0.1538385	1	1	0.1538385	g	mi
"2,1,2015,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	4	1	NULL	21	0	0	0	0	0	0.166514009	1	1	0.166514009	g	mi
"2,1,2015,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	3	1	NULL	21	0	0	0	0	0	0.184144899	1	1	0.184144899	g	mi
"2,1,2015,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	2	1	NULL	21	0	0	0	0	0	0.217322901	1	1	0.217322901	g	mi
"2,1,2015,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00"	2	1	2015	7	5	16	25	25025	250250	1	1	NULL	21	0	0	0	0	0	0.316857487	1	1	0.316857487	g	mi

Source: KBE and Massport.

Fuel Storage and Handling

As in previous years, VOC emissions from fuel storage and handling were calculated using methods based on EPA's AP-42[1] document. Calculations account for evaporative emissions from breathing losses, working losses, and spillage from aboveground storage tanks, underground storage tanks, and aircraft refueling. In 2003, additional information became available on the fire training fuel, Tek-Flame®. Emissions of VOCs from this fuel were estimated by EDMS. **Table I-8** presents Logan Airport's fuel throughput by category.

Stationary Sources

Stationary sources include the Central Heating and Cooling Plant, emergency generators, snow melters, space heaters, and boilers. Emission factors from EPA's AP-42 or NO_x Reasonably Available Control Technology (RACT) compliance testing were combined with the actual 2015 fuel throughput of the stationary sources to obtain emissions of VOCs, NO_X, CO, and PM with a diameter of less than or equal to 10 micrograms or 2.5 micrograms (PM_{10}/$PM_{2.5}$).

Title V of the 1990 Clean Air Act (CAA) Amendments requires facilities with air emissions to document their emissions and obtain a single permit combining all sources. The permitting program ensures that all emission sources are accounted for, the proper permits have been received, and permit conditions are being followed. A Title V Air Operating Permit covers all of the stationary sources at Logan Airport including boilers, emergency generators, snow melters, fire training, cooling towers, paint booths, deicing facilities, and storage tanks. **Table I-9** presents Logan Airport's stationary source fuel throughput by fuel category.

1 Compilation of Air Pollutant Emission Factors, AP-42, Office of Air Quality Planning and Standards, EPA, Fifth Edition, 1995.

Table I-8 Fuel Throughput by Fuel Category (gallons)

Fuel Category	1999	2000	2001	2002	2003	2004	2005	2006	2007
Jet Fuel	354,095,516	441,901,932	416,748,819	358,190,362	319,439,910	373,996,141	368,645,392	364,450,864	367,585,187
Fire Training Fuel[1]	NA	NA	NA	NA	13,719	12,227	8,105	5,000	8,631
Aviation Gas	99,726	90,922	60,691	35,111	32,515	34,717	52,487	35,098	29,067
Auto Gas	7,200,000	7,569,206	6,181,472	5,754,740	5,436,322	5,803,442	5,903,424	6,028,931	6,022,237
Diesel	768,106	839,751	1,239,904	1,067,847	1,030,185	1,078,665	1,567,688	1,164,493	1,141,335
Heating Oil No.2	480,733	494,500	582,283	340,492	370,903	381,852	367,899	259,768	423,181
Heating Oil No.62	1,600,893	1,555,527	1,641,693	1,079,283	1,122,975	2,940,752	3,098,126	1,396,529	1,073,260

Fuel Category	2008	2009	2010	2011	2012	2013	2014	2015
Jet Fuel	345,631,788	327,358,619	335,693,997	340,421,373	343,731,127	349,397,940	370,222,342	374,985,216
Fire Training Fuel[1]	5,971	3,510	800	3,810	2,587	5,400	3,753	7,619
Aviation Gas	25,037	18,238	15,268	14,064	12,306	14,422	12,514	10,225
Auto Gas	5,693,178	5,736,724	5,696,505	5,487,952	6,694,626	6,800,936	7,007,591	7,432,165
Diesel	1,071,707	1,121,241	1,168,761	1,099,720	878,499	1,094,714	1,178,805	1,473,720
Heating Oil No.2	303,143	409,049	319,727	384,906	210,794	289,665	289,956	294,704
Heating Oil No.6[2]	16,385	368,690	9,010	11,285	6,786	17,721	77,146	0

Source: Massport, 2015.

1 Fire Training Fuel used in 1999-2002 was Jet A Fuel while in 2003 through 2014 it was Tek-Flame®. 2012 includes 100 gallons of avgas, 2013 includes 400 gallons of avgas, 2014 includes 338 gallons of avgas, and 2015 includes 742 gallons of avgas.

2 Effective November 2014, Massport no longer uses No. 6 heating oil at the CHP and was replaced with No. 2 heating oil.

NA Not available.

Table I-9 Stationary Source Fuel Throughput by Fuel Category (gallons)

Fuel Category	1999	2000	2001	2002	2003	2004	2005	2006	2007
Natural Gas (ft^3)	183,943,000	283,720,049	199,500,000	268,359,282	201,714,114	62,610,000	92,460,000	112,390,000	338,430,000
Heating Oil No. 2	480,733	494,500	582,283	340,492	370,903	381,852	367,899	259,768	423,181
Heating Oil No. 6[1]	1,600,893	1,555,527	1,641,693	1,079,283	1,122,975	2,940,752	3,098,126	1,396,529	1,073,260
Diesel Fuel[2]	57,441	NA	NA	NA	NA	67,198	77,848	77,848	258,606
Fire Training Fuel[3]	23,000	NA	NA	NA	13,719	12,227	8,105	5,000	8,631

Fuel Category	2008	2009	2010	2011	2012	2013	2014	2015
Natural Gas (ft^3)	458,680,000	430,810,000	449,640,000	479,830,000	360,523,000	402,496,000	418,805,000	463,170,000
Heating Oil No. 2	303,143	409,050	319,727	384,906	210,794	289,665	289,956	294,704
Heating Oil No. 6[1]	16,385	368,690	9,010	11,285	6,786	17,721	77,146	0
Diesel Fuel[2]	146,718	145,778	116,511	218,081	42,109	231,130	124,480	381,581
Fire Training Fuel[3]	5,971	3,510	800	3,810	2,587	5,400	3,753	7,619

Source: Massport, 2015.
NA Not available.
1 Effective November 2014, Massport no longer uses No. 6 heating oil at the CHP and was replaced with No. 2 heating oil.
2 Diesel fuel was from the stationary snow melter usage. Starting in 2007, portable snow melter usage was also included.
3 Fire Training Fuel used in 1999-2002 was Jet A Fuel while in 2003 through 2015 it was Tek-Flame®. 2012 includes 100 gallons of avgas, 2013 includes 400 gallons of avgas, 2014 includes 338 gallons of avgas, and 2015 includes 742 gallons of avgas.

Tables I-10 through **I-19** contain the 1993 through 2010 Emissions Inventory summary tables for Logan Airport.

1993 Through 2010 Emissions Inventories

Table I-10 Estimated VOC Emissions (in kg/day) at Logan Airport 1993-2001[1]

Aircraft/GSE Model:	**Logan Dispersion Modeling System (LDMS)**					**EDMS v3.22**	**EDMS v4.21**	**EDMS v4.03**	
Motor Vehicle Model:	**MOBILE5a**					**MOB5a_h**	**MOB 6.2.03**	**MOBILE 6.0**	
Year:	1993	1994	1995	1996	1997	1998	1999[2]	2000	2001
Aircraft Sources									
Air carriers	1,958	1,554	1,407	1,390	1,227	736	653	514	374
Commuter aircraft	943	543	531	622	498	154	196	140	113
Cargo aircraft	89	244	236	214	207	43	318	207	149
General aviation	51	48	36	24	27	13	141	42	43
Total aircraft sources	3,041	2,389	2,210	2,250	1,959	946	1,308	903	679
Ground Service Equipment[3]	636	533	521	497	530	145	243	153	143
Motor Vehicles									
Ted Williams Tunnel through-traffic	NA	NA	NA	NA	NA	NA	15	12	10
Parking/curbside	173	148	127	102	102	118	101	89	77
On-airport vehicles[4]	238	215	179	223	205	258	256	206	170
Total motor vehicle sources	411	363	306	325	307	376	372	307	257
Other Sources									
Fuel storage/handling	408	434	318	356	381	372	352	412	372
Miscellaneous sources[5]	5	5	5	6	6	2	16	2	2
Total other sources	413	439	323	362	387	374	368	414	374
Total Airport Sources	4,501	3,724	3,360	3,434	3,183	1,841	2,291	1,777	1,453

Source: KBE and Massport.
kg/day kilograms per day. 1 kg/day is approximately equivalent to 0.40234 tons per year (tpy).
NA Not available.
MOB MOBILE model for motor vehicle emissions (MOB5a_h=MOBILE5a_h, MOB6.2.03=MOBILE6.2 version .03)
1 The emissions inventory for 1990 is shown in Chapter 7. Emission inventories for 1991 and 1992 were not prepared.
2 Year 1999 emissions were last re-calculated using EDMS v4.21 in the 2004 ESPR Air Quality Analysis.
3 Beginning in 1996 and later, emissions include vehicles and equipment converted to alternative fuels. APU emissions are also included.
4 1999 emissions inventory include reductions attributable to CNG shuttle buses.
5 Includes the Central Heating and Cooling Plant, emergency electricity generation, and other stationary sources. Fire Training emissions were included in 1999. Diesel snow melter usage was added in 1999.

Table I-11 Estimated VOC Emissions (in kg/day) at Logan Airport 2002-2009

Aircraft/GSE Model:	**EDMS v4.11**		**EDMS v4.21**	**EDMS v4.5**		**EDMS v5.0.1**		**EDMS v5.0.2**		**EDMS v5.1**		**EDMS v5.1.2**
Motor Vehicle Model:	**MOBILE 6.0**	**MOB 6.2.01**	**MOBILE 6.2.03**									
Year:	**2002**	**2003**	**2004**	**2005**	**2006**		**2007**		**2008**		**2009**	
Aircraft Sources												
Air carriers	248	208	292	271	227	511	435	381	324	286	237	235
Commuter aircraft	75	95	127	140	125	371	479	409	253	176	131	133
Cargo aircraft	127	94	110	41	19	46	129	112	107	70	71	71
General aviation	52	61	127	147	147	236	226	206	201	171	78	78
Total aircraft sources	502	458	656	599	518	1,164[1]	1,269	1,108	885	703	517	517
Ground Service Equipment[2]	247	227	187	178	167	77	78	78	66	66	56	56
Motor Vehicles												
Ted Williams Tunnel through-traffic	9	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]
Parking/curbside[4]	51	45	38	37	33	33	31	31	25	25	22	22
On-airport vehicles	152	135	129	118	106	106	104	104	82	82	71	71
Total motor vehicle sources	212	180	167	155	139	139	135	135	107	107	93	93
Other Sources												
Fuel storage/handling	329	297	341	340	336	336	338	338	320	320	307	307
Miscellaneous sources[5]	2	3	9	13	8	8	14	14	13	12	7	7
Total other sources	331	300	350	353	344	344	352	352	333	332	314	314
Total Airport Sources	1,292	1,165	1,360	1,285	1,168	1,724	1,834	1,673	1,391	1,208	980	980

Source: KBE and Massport
Notes: Years 2006 to 2009 were computed with previous years EDMS version to provide for a common basis of comparison.
kg/day kilograms per day. 1 kg/day is equivalent to approximately 0.40234 tons per year (tpy).
1 The 2006 increase in aircraft VOC emissions is largely attributable to the addition of aircraft main engine startup emissions.
2 GSE emissions include aircraft APUs as well as vehicles and equipment converted to alternative fuels.
3 Due to the new roadway configuration and opening of the Ted Williams Tunnel there was no Ted Williams Tunnel through- traffic at Logan Airport beginning in 2003.
4 Parking/curbside is based on VMT analysis.
5 Includes the Central Heating and Cooling Plant, emergency electricity generation, snow melter usage, and other stationary sources.

Table I-12 Estimated VOC Emissions (in kg/day) at Logan Airport 2010		
Aircraft/GSE Model:	**EDMS v5.1.2**	**EDMS v5.1.3**
Motor Vehicle Model:	**MOBILE 6.2.03**	
Year:	**2010**	
Aircraft Sources		
Air carriers	292	292
Commuter aircraft	129	125
Cargo aircraft	70	70
General aviation	81	81
Total aircraft sources	572	568
Ground Service Equipment[1]	49	49
Motor Vehicles		
Ted Williams Tunnel through-traffic	–[2]	–[2]
Parking/curbside[3]	20	20
On-airport vehicles	68	68
Total motor vehicle sources	88	88
Other Sources		
Fuel storage/handling	311	311
Miscellaneous sources[4]	5	5
Total other sources	316	316
Total Airport Sources	1,025	1,021

Source: KBE and Massport
kg/day kilograms per day. 1 kg/day is equivalent to approximately 0.40234 tons per year (tpy).
1 GSE emissions include aircraft APUs as well as vehicles and equipment converted to alternative fuels.
2 Due to the new roadway configuration and opening of the Ted Williams Tunnel there was no Ted Williams Tunnel through-traffic at Logan Airport beginning in 2003.
3 Parking/curbside is based on VMT analysis.
4 Includes the Central Heating and Cooling Plant, emergency electricity generation, snow melter usage, and other stationary sources.

Table I-13 Estimated NO_X Emissions (in kg/day) at Logan Airport 1993-2001[1]

Aircraft/GSE Model:	**Logan Dispersion Modeling System (LDMS)**					**EDMS v3.22**	**EDMS v4.21**	**EDMS v4.03**	
Motor Vehicle Model:	**MOBILE5a**					**MOB5a_h**	**MOB 6.2.03**	**MOBILE 6.0**	
Year:	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999[2]**	**2000**	**2001**
Aircraft Sources									
Air carriers	4,271	4,317	3,861	3,781	4,150	4,471	4,183	4,202	3,707
Commuter aircraft	202	158	192	137	159	203	166	125	233
Cargo aircraft	213	257	332	363	262	254	286	284	267
General aviation	13	13	17	18	21	5	12	49	34
Total aircraft sources	4,699	4,745	4,402	4,299	4,592	4,933	4,647	4,660	4,241
Ground Service Equipment[3]	722	617	607	588	622	317	444	333	305
Motor Vehicles									
Ted Williams Tunnel through-traffic	NA	NA	NA	NA	NA	NA	28	26	22
Parking/curbside	25	24	24	24	24	37	39	52	46
On-airport vehicles[4]	240	239	229	257	244	372	449	425	369
Total motor vehicle sources	265	263	253	281	268	409	516	503	437
Other Sources									
Fuel storage/handling[5]	0	0	0	0	0	0	0	0	0
Miscellaneous sources[6]	278	330	320	275	244	284	165	211	185
Total other sources	278	330	320	275	244	284	165	211	185
Total Airport Sources	5,964	5,955	5,582	5,443	5,726	5,943	5,772	5,707	5,168

Source: KBE and Massport.
Kg/day kilograms per day. 1 kg/day is approximately equivalent to 0.40234 tons per year (tpy).
NA Not available.
MOB MOBILE model for motor vehicle emissions (MOB5a_h=MOBILE5a_h, MOB6.2.03=MOBILE6.2 version .03)
1 The emissions inventory for 1990 is shown in Chapter 7. Emission inventories for 1991 and 1992 were not prepared.
2 Year 1999 emissions were last re-calculated using EDMS v4.21 in the 2004 ESPR Air Quality Analysis.
3 Beginning in 1996 and later, emissions include vehicles and equipment converted to alternative fuels. APU emissions are also included.
4 1999 emissions inventory include reductions attributable to CNG shuttle buses.
5 Fuel storage and handling facilities are not sources of NOx emissions.
6 Includes the Central Heating and Cooling Plant, emergency electricity generation, and other stationary sources. Fire Training emissions were included in 1999. Diesel snow melter usage was added in 1999.

Table I-14 Estimated NO_X Emissions (in kg/day) at Logan Airport 2002-2009												
Aircraft/GSE Model:	**EDMS v4.11**		**EDMS v4.21**	**EDMS v4.5**		**EDMS v5.0.1**		**EDMS v5.0.2**		**EDMS v5.1**		**EDMS v5.1.2**
Motor Vehicle Model:	**MOBILE 6.0**	**MOB 6.2.01**	**MOBILE 6.2.03**									
Year:	**2002**	**2003**	**2004**	**2005**	**2006**		**2007**		**2008**		**2009**	
Aircraft Sources												
Air carriers	2,721	2,479	2,949	2,880	2,849	3,044	3,120	3,121	3,031	3,031	2,944	2,952
Commuter aircraft	208	185	245	225	195	256	353	354	319	319	309	234
Cargo aircraft	246	213	215	211	192	125	248	248	233	233	215	204
General aviation	38	45	49	50	49	60	56	56	43	43	27	23
Total aircraft sources	3,213	2,922	3,458	3,366	3,285	3,485	3,777	3,779	3,626	3,626	3,495	3,413
Ground Service Equipment[1]	322	291	333	312	280	300	299	299	257	257	219	219
Motor Vehicles												
Ted Williams Tunnel through-traffic	20	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]
Parking/curbside[3]	32	28	21	22	19	19	18	18	15	15	13	13
On-airport vehicles	341	302	267	269	238	238	233	233	182	182	153	153
Total motor vehicle sources	393	330	288	291	257	257	251	251	197	197	166	166
Other Sources												
Fuel storage/handling[4]	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous sources[5]	175	151	211	218	109	109	128	128	124	124	181	181
Total other sources	175	151	211	218	109	109	128	128	124	124	181	181
Total Airport Sources	4,103	3,694	4,290	4,187	3,931	4,151	4,455	4,457	4,204	4,204	4,061	3,979

Source: KBE and Massport

Notes: Years 2006 to 2009 were computed with previous years EDMS version to provide for a common basis of comparison.

Kg/day kilograms per day. 1 kg/day is approximately equivalent to 0.40234 tons per year (tpy).

1 GSE emissions include APUs as well as vehicles and equipment converted to alternative fuels.

2 Due to the new roadway configuration and opening of the Ted Williams Tunnel there was no Ted Williams Tunnel through-traffic at Logan Airport beginning in 2003.

3 Parking/curbside data is based on VMT analysis.

4 Fuel storage/handling facilities are not a source of NOx emissions.

5 Includes the Central Heating and Cooling Plant, emergency electricity generation, snow melter usage, and other stationary sources.

Table I-15 Estimated NO_X Emissions (in kg/day) at Logan Airport 2010

Aircraft/GSE Model:	**EDMS v5.1.2**	**EDMS v5.1.3**
Motor Vehicle Model:	**MOBILE 6.2.03**	
Year:	**2010**	
Aircraft Sources		
Air carriers	3,031	3,037
Commuter aircraft	203	204
Cargo aircraft	197	197
General aviation	29	26
Total aircraft sources	3,460	3,464
Ground Service Equipment[1]	198	198
Motor Vehicles		
Ted Williams Tunnel through-traffic	–[2]	–[2]
Parking/curbside[3]	12	12
On-airport vehicles	144	144
Total motor vehicle sources	156	156
Other Sources		
Fuel storage/handling[4]	0	0
Miscellaneous sources[5]	166	166
Total other sources	166	166
Total Airport Sources	3,980	3,984

Source: KBE and Massport
Kg/day kilograms per day. 1 kg/day is approximately equivalent to 0.40234 tons per year (tpy).
1 GSE emissions include APUs as well as vehicles and equipment converted to alternative fuels.
2 Due to the new roadway configuration and opening of the Ted Williams Tunnel there was no Ted Williams Tunnel through-traffic at Logan Airport beginning in 2003.
3 Parking/curbside data is based on VMT analysis.
4 Fuel storage/handling facilities are not a source of NOx emissions.
5 Includes the Central Heating and Cooling Plant, emergency electricity generation, snow melter usage, and other stationary sources.

Table I-16 Estimated CO Emissions (in kg/day) at Logan Airport 1993-2001[1]

Aircraft/GSE Model:	**Logan Dispersion Modeling System (LDMS)**					**EDMS v3.22**	**EDMS v4.21**	**EDMS v4.03**	
Motor Vehicle Model:	**MOBILE5a**					**MOB5a_h**	**MOB 6.2.03**	**MOBILE 6.0**	
Year:	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999[2]**	**2000**	**2001**
Aircraft Sources									
Air carriers	5,663	4,660	4,691	4,812	4,698	3,079	3,754	2,994	2,475
Commuter aircraft	1,309	927	934	859	770	482	1,404	1,188	1,072
Cargo aircraft	344	572	598	580	514	218	503	400	323
General aviation	353	356	339	549	654	269	940	295	407
Total aircraft sources	7,669	6,515	6,562	6,800	6,636	4,048	6,601	4,877	4,277
Ground Service Equipment[3]	7,482	6,187	6,029	5,740	6,098	5,113	4,532	5,335	5,193
Motor Vehicles									
Ted Williams Tunnel through-traffic	NA	NA	NA	NA	NA	NA	151	133	121
Parking/curbside	952	820	650	644	586	772	437	495	440
On-airport vehicles[4]	1,575	1,451	1,087	1,514	1,283	1,883	2,547	2,245	2,001
Total motor vehicle sources	2,527	2,271	1,737	2,158	1,869	2,655	3,135	2,873	2,562
Other Sources									
Fuel storage/handling[5]	0	0	0	0	0	0	0	0	0
Miscellaneous sources[6]	26	30	29	39	37	37	168	27	24
Total other sources	26	30	29	39	37	37	168	27	24
Total Airport Sources	17,704	15,003	14,357	14,737	14,640	11,853	14,436	13,112	12,056

Source: KBE and Massport.
Kg/day kilograms per day. 1 kg/day is approximately equivalent to 0.40234 tons per year (tpy).
NA Not available.
MOB MOBILE model for motor vehicle emissions (MOB5a_h=MOBILE5a_h, MOB6.2.03=MOBILE6.2 version .03)
1 The emissions inventory for 1990 is shown in Chapter 7. Emission inventories for 1991 and 1992 were not prepared.
2 Year 1999 emissions were last re-calculated using EDMS v4.21 in the 2004 ESPR Air Quality Analysis.
3 Beginning in 1996 and later, emissions include vehicles and equipment converted to alternative fuels. APU emissions are also included.
4 1999 emission inventory include reductions attributable to CNG shuttle buses.
5 Fuel storage and handling facilities are not sources of CO emissions.
6 Includes the Central Heating and Cooling Plant, emergency electricity generation, and other stationary sources. Fire Training emissions were included in 1999. Diesel snow melter usage was added in 1999.

Table I-17 Estimated CO Emissions (in kg/day) at Logan Airport 2002-2009

Aircraft/GSE Model:	**EDMS v4.11**		**EDMS v4.21**	**EDMS v4.5**		**EDMS v5.0.1**		**EDMS v5.0.2**		**EDMS v5.1**		**EDMS v5.1.2**
Motor Vehicle Model:	**MOBILE 6.0**	**MOB 6.2.01**	**MOBILE 6.2.03**									
Year:	**2002**	**2003**	**2004**	**2005**	**2006**		**2007**		**2008**		**2009**	
Aircraft Sources												
Air carriers	2,156	2,128	2,985	2,895	2,828	3,167	2,973	2,973	2,710	2,710	2,460	2,448
Commuter aircraft	783	846	1,010	1,010	950	1,587	2,484	2,484	2,436	2,436	2,364	2,795
Cargo aircraft	285	209	229	174	138	158	241	241	255	255	256	266
General aviation	256	276	416	437	398	442	401	403	345	345	145	150
Total aircraft sources	3,480	3,459	4,640	4,516	4,314	5,354	6,099	6,101	5,746	5,746	5,225	5,659
Ground Service Equipment[1]	5,170	4,758	3,586	3,531	3,409	1,586	1,904	1,904	1,609	1,609	1,364	1,364
Motor Vehicles												
Ted Williams Tunnel through-traffic	112	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]
Parking/curbside[3]	295	253	180	179	144	144	139	139	117	117	107	107
On-airport vehicles	1,872	1,685	1,412	1,290	1,036	1,036	1,038	1,038	834	834	740	740
Total motor vehicle sources	2,279	1,938	1,592	1,469	1,180	1,180	1,177	1,177	951	951	847	847
Other Sources												
Fuel storage/handling[4]	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous sources[5]	23	22	33	40	24	24	51	51	55	55	55	55
Total other sources	23	22	33	40	24	24	51	51	55	55	55	55
Total Airport Sources	10,952	10,177	9,851	9,556	8,927	8,144	9,231	9,233	8,361	8,361	7,491	7,925

Source: KBE and Massport
Notes: Years 2006 to 2009 were computed with previous years EDMS version to provide for a common basis of comparison.
Kg/day kilograms per day. 1 kg/day is approximately equivalent to 0.40234 tons per year (tpy).
1 GSE emissions include APUs as well as vehicles and equipment converted to alternative fuels.
2 Due to the new roadway configuration and opening of the Ted Williams Tunnel there was no Ted Williams Tunnel through-traffic at Logan Airport beginning in 2003.
3 Parking/curbside information is based on VMT analysis.
4 Fuel storage/handling facilities are not a source of CO emissions.
5 Includes the Central Heating and Cooling Plant, emergency electricity generation, snow melter usage, and other stationary sources.

Table I-18 Estimated CO Emissions (in kg/day) at Logan Airport 2010

Aircraft/GSE Model:	**EDMS v5.1.2**	**EDMS v5.1.3**
Motor Vehicle Model:	**MOBILE 6.2.03**	
Year:	**2010**	
Aircraft Sources		
Air carriers	2,531	2,531
Commuter aircraft	2,629	2,086
Cargo aircraft	248	259
General aviation	177	173
Total aircraft sources	5,585	5,049
Ground Service Equipment[1]	1,222	1,222
Motor Vehicles		
Ted Williams Tunnel through-traffic	–[2]	–[2]
Parking/curbside[3]	106	106
On-airport vehicles	726	726
Total motor vehicle sources	832	832
Other Sources		
Fuel storage/handling[4]	0	0
Miscellaneous sources[5]	53	53
Total other sources	53	53
Total Airport Sources	7,692	7,156

Source: KBE and Massport
Kg/day kilograms per day. 1 kg/day is approximately equivalent to 0.40234 tons per year (tpy).
1 GSE emissions include APUs as well as vehicles and equipment converted to alternative fuels.
2 Due to the new roadway configuration and opening of the Ted Williams Tunnel there was no Ted Williams Tunnel through-traffic at Logan Airport beginning in 2003.
3 Parking/curbside information is based on VMT analysis.
4 Fuel storage/handling facilities are not a source of CO emissions.
5 Includes the Central Heating and Cooling Plant, emergency electricity generation, snow melter usage, and other stationary sources.

Table I-19 Estimated PM_{10}/$PM_{2.5}$ Emissions (in kg/day) at Logan Airport, 2005-2010[1,2]

Aircraft/GSE Model:	**EDMS v4.5**		**EDMS v5.0.1**		**EDMS v5.0.2**		**EDMS v5.1**		**EDMS v5.1.2**		**EDMS v5.1.3**
Motor Vehicle Model:	**MOBILE 6.2.03**										
Year:	**2005**	**2006**		**2007**		**2008**		**2009**		**2010**	
Aircraft Sources											
Air carriers	25	25	38	35	67	63	42	43	36	34	34
Commuter aircraft	1	1	2	6	14	11	6	5	5	4	4
Cargo aircraft	2	3	2	3	6	5	4	4	3	3	3
General aviation	2	2	2	2	5	5	4	2	2	2	2
Total aircraft sources	30	31	44	46	92	84	56	54	46	43	43
Ground Service Equipment[3]	11	9	9	10	10	8	15	14	14	13	13
Motor Vehicles											
Parking/curbside[4]	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
On-airport vehicles	8	8	8	9	9	7	7	6	6	6	6
Total motor vehicle sources	9	9	9	9	9	7	7	6	6	6	6
Other Sources											
Fuel storage/handling[5]	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous sources[6]	34	16	16	17	17	3	3	5	5	2	2
Total other sources	34	16	16	17	17	3	3	5	5	2	2
Total Airport Sources	84	65	78	82	128	102	81	79	71	64	64

Source: KBE and Massport
Notes: Years 2006 to 2010 were computed with previous years EDMS version to provide for a common basis of comparison.
Kg/day kilograms per day. 1 kg/day is approximately equivalent to 0.40234 tons per year (tpy); PM – particulate matter
1 It is assumed that all PM are less than 2.5 microns in diameter (PM2.5).
2 2005 is the first year that PM10/PM2.5 emissions were included in the Logan Airport ESPR/EDR emission inventories.
3 GSE emissions include APUs as well as vehicles and equipment converted to alternative fuels.
4 Parking/curbside is based on VTM analysis.
5 Fuel storage and handling facilities are not sources of PM emissions.
6 Includes the Central Heating and Cooling Plant, emergency electricity generation, fire training, snow melters, and other stationary sources.

Greenhouse Gas Emissions Inventory for 2015

The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) has published the *MEPA Greenhouse Gas Emissions Policy and Protocol*.[2] These guidelines require that certain projects undergoing review under the Massachusetts Environmental Policy Act (MEPA) quantify the greenhouse gas (GHG) emissions generated by proposed projects, and identify measures to avoid, minimize, or mitigate such emissions.[3] Even though the *2015 EDR* does not assess any proposed projects and is therefore not subject to the GHG policy, Massport has voluntarily prepared an emission inventory of GHG emissions directly and indirectly associated with Logan Airport.

In April 2009, the Transportation Research Board Airport Cooperative Research Program (ACRP); published the *Guidebook on Preparing Airport Greenhouse Gas Emission Inventories (ACRP Report 11)*, which provides recommended instructions to airport operators on how to prepare an airport-specific GHG emissions inventory.[4] The 2015 GHG emissions estimates include aircraft (within the ground taxi/delay and up to 3,000 feet), GSE, APU, motor vehicles, a variety of stationary sources, and electricity usage. Aircraft cruise emissions over the 3,000-foot level were not included. This work was accomplished following the EEA guidelines and uses widely-accepted emission factors that are considered appropriate for this application, including International Organization for Standardization New England electricity-based values.

Methodology

Airport GHG emissions are calculated in much the same way as criteria pollutants,[5] through the use of input data such as activity levels or material throughput rates (i.e., fuel usage, VMT, electrical consumption) that are applied to appropriate emission factors (i.e., in units of GHG emissions per gallon of fuel).

In this case, the input data were either based on Massport records, or data and information derived from the latest version of the FAA EDMS (EDMS v5.1.4.1). Table I-20 summarizes the data and information used in the 2015 GHG inventory.

Massport will update the GHG Emissions Inventory for Logan Airport annually.

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2 Revised MEPA Greenhouse Gas Emissions Policy and Protocol, Massachusetts Executive Office of Energy and Environmental Affairs, effective May 10, 2010.

3 These GHGs are comprised primarily of carbon dioxide (CO2), methane (CH4), nitrous oxides (N2O), and three groups of fluorinated gases (i.e., sulfur hexafluoride [SF6], hydrofluorocarbons [HFCs], and perfluorocarbons [PFCs]). GHG emission sources associated with airports are generally limited to CO2, CH4, and N2O.

4 Transportation Research Board, Airport Cooperative Research Panel, ACRP Report 11, Project 02-06, Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories (in production). See http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_011.pdf for the full report.

5 Criteria pollutants are pollutants for which there are National Ambient Air Quality Standards (i.e., carbon monoxide, sulfur dioxide, nitrogen dioxide, etc.).

Table I-20 Logan Airport Greenhouse Gas (GHG) Inventory Input Data and Information for 2015

Activity	Fuel Type	Usage	Units	Source
Aircraft				
Aircraft Taxi	Jet A[1]	21,219,609	gallons	EDMS v5.1.4
	AvGas[2]	579	gallons	EDMS v5.1.4
Engine Startup	Jet A	220,102	gallons	EDMS v5.1.4
Aircraft Ground up to 3,000 feet	Jet A[1]	18,069,246	gallons	EDMS v5.1.4
	AvGas[2]	493	gallons	EDMS v5.1.4
Aircraft Support Equipment				
GSE	Diesel	791,156	gallons	Massport
	Gasoline	652,773	gallons	Massport
	Propane	1,782	gallons	EDMS v5.1.4
	CNG	428,058	ft^3	EDMS v5.1.4
APU	Jet A	841,860	gallons	EDMS v5.1.4
Motor Vehicles				
On-airport Vehicles	Composite[3]	61,608,547	VMT	Massport
On-airport Parking/Curbsides	Composite[3]	1,429,516	Idle hours	Massport
Massport Shuttle Bus	CNG	259,011	GEG	Massport
	Diesel	Defleeted 2014	gallons	Massport
Massport Express Bus	Diesel	342,328	gallons	Massport
Massport Fire Rescue	Diesel	20,000	gallons	Massport
Agricultural Equipment	Diesel	134,123	gallons	Massport
Massport Fleet Vehicles (Honda Civic)	CNG	3,467	GEG	Massport
Massport Fleet Vehicles (Fueled Onsite)	Gasoline	143,331	gallons	Massport
Massport Fleet Vehicles (Fueled Offsite)	Gasoline	83,683	gallons	Massport
Massport Fleet Vehicles (Fueled Onsite)	Diesel	134,272	gallons	Massport
Off-airport Vehicles (Public)	Composite[3]	165,068,635	VMT	Massport
Off-airport Vehicles (Airport Employees)	Composite[3]	3,785,210	VMT	Massport
Off-airport Vehicles (Tenant Employees)	Composite[3]	51,125,676	VMT	Massport
Stationary and Portable Sources				
Boilers and Space Heaters	No 2 Oil	298,804	gallons	Massport
	No 6 Oil	0	gallons	Massport
	Natural Gas	467	million ft^3	Massport
Generators	Diesel	64,315	gallons	Massport

Table I-20 Logan Airport Greenhouse Gas (GHG) Inventory Input Data and Information for 2015 (Continued)

Activity	Fuel Type	Usage	Units	Source
Aircraft Support Equipment (Cont'd.)				
Snow melters	ULSD	381,581	gallons	Massport
	CNG	4.83	million ft^3	Massport
Fire Training Facility	Tekflame	6,877	gallons	Massport
	AvGas	742	gallons	Massport
Electrical Consumption – Massport	-	18,467,839	kWh	Massport
Electrical Consumption – Tenent/Common Area	-	166,686,391	kWh	Massport

Sources: Massport and KBE.
Notes: APU – Auxiliary power units; CNG – compressed natural gas; GEG – gasoline equivalent gallons; GSE – ground support equipment; kWh – kilowatt hours; VMT – vehicle miles traveled; ULSD – ultra low sulfur diesel.
1 Jet A density of 6.84 pounds per gallon.
2 AvGas density of 6.0 pounds per gallon.
3 Composite means gasoline, diesel, CNG, and liquefied petroleum gas (LPG) fueled motor vehicles.

Emission factors were obtained from the U.S. Energy Information Administration, the International Panel on Climate Change (IPCC), EPA's MOVES, and the most recent version of EPA's GHG Emission Factors Hub (April 2014).[6,7,8,9] **Table I-21** presents emission factors for CO_2, nitrous oxide (N_2O), and methane (CH_4) for 2015.

6 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, 2006, www.ipcc-nggip.iges.or.jp/public/2006gl/index.html.

7 U.S. Energy Information Administration, *Voluntary Reporting of Greenhouse Gases Program. Fuel and Energy Source Codes and Emission Coefficients,* www.eia.doe.gov/oiaf/1605/coefficients.html.

8 U.S. Environmental Protection Agency, GHG Emissions Factors Hub (April 2014), www.epa.gov/climateleadership/inventory/ghg-emissions.html. The most recent version of the Emission Factors Hub includes updates to emission factors for stationary and mobile combustion sources, new electricity emission factors from EPA's Emissions & Generation Resource Integrated Database (eGRID) and the IPCC Fourth and Fifth Assessment Report (AR4/AR5).

9 U.S. Environmental Protection Agency, MOVES Emissions Model, http://www.epa.gov/otaq/models/moves/.

Table I-21 Greenhouse Gas (GHG) Emission Factors for 2015

Sources	Fuel	CO_2	N_2O	CH_4	Units
Aircraft[1]	Jet A	21.5	0.00066	-[5]	lb/gallon
	AvGas	18.3	0.00024	0.01556	lb/gallon
Ground Support Equipment/ Auxiliary Power Units[1]	Diesel	22.5	0.00057	0.00126	lb/gallon
	Gasoline	19.4	0.00049	0.00110	lb/gallon
	CNG	120.0	0.00023	0.00226	lb/1000 ft^3
	Propane	12.6	0.00011	0.00060	lb/gallon
	Jet A	21.5	0.00066	-[5]	lb/gallon
Motor Vehicles[1,2]	Composite	486	0.00010	0.00490	g/mile
	Composite	4,270	0.00030	0.02580	g/hour
	CNG	120.0	0.00023	0.00226	lb/1000 ft^3
	Diesel	22.5	0.00057	0.00126	lb/gallon
	Gasoline	19.4	0.00018	0.0008	lb/gallon
Stationary and Portable[1]	No. 2 Oil	22.5	0.00018	0.00090	lb/gallon
	No. 6 Oil	24.8	0.00020	0.00099	lb/gallon
	Natural Gas	120.0	0.00023	0.00226	lb/1000 ft^3
	ULSD	22.5	0.00018	0.00090	lb/gallon
Fire Training Facility[1]	Tekflame[3]	12.6	0.00011	0.00060	lb/gallon
	AvGas	18.3	0.00024	0.01556	lb/gallon
Electrical Consumption[4]	-	0.72	0.000013	0.00007	lb/kW-hr

Sources: Massport and KBE.

Notes: CH4 – methane; CNG – compressed natural gas; CO2 – carbon dioxide; g- grams; kWh – kilowatt hour; lb – pound; N2O – nitrous oxides; ULSD – Ultra Low Sulfur Diesel.

1 Environmental Protection Agency, GHG Emissions Factors Hub (April 2014), www.epa.gov/climateleadership/inventory/ghg-emissions.html.

2 Environmental Protection Agency, MOVES2014, http://www.epa.gov/otaq/models/moves/.

3 As propane.

4 Environmental Protection Agency, Emissions & Generation Resource Integrated Database (eGRID) 9th edition Version 1.0, February 2014, http://www.epa.gov/climateleadership/documents/emission-factors.pdf.

5 Contributions of CH4 emissions from commercial aircraft are reported as zero. Years of scientific measurement campaigns conducted at the exhaust exit plane of commercial aircraft gas turbine engines have repeatedly indicated that CH4 emissions are consumed over the full emission flight envelope [Reference: Aircraft Emissions of Methane and Nitrous Oxide during the Alternative Aviation Fuel Experiment, Santoni et al., Environ. Sci. Technol., July 2011, Volume 45, pp. 7075-7082]. As a result, the EPA published that: "...methane is no longer considered to be an emission from aircraft gas turbine engines burning Jet A at higher power settings and is, in fact, consumed in net at these higher powers." [Reference: EPA, Recommended Best Practice for Quantifying Speciated Organic Gas Emissions from Aircraft Equipped with Turbofan, Turbojet, and Turboprop Engines, May 27, 2009 [EPA-420-R-09-901], http://www.epa.gov/otaq/aviation.htm]. In accordance with the following statements in the 2006 IPCC Guidelines (IPCC 2006), the FAA does not calculate CH4 emissions for either the domestic or international bunker commercial aircraft jet fuel emissions inventories. "Methane (CH4) may be emitted by gas turbines during idle and by older technology engines, but recent data suggest that little or no CH4 is emitted by modern engines." "Current scientific understanding does not allow other gases (e.g., N2O and CH4) to be included in calculation of cruise emissions." (IPCC 1999).

Results

Table I-22 presents the results of the 2015 GHG emissions inventory for Logan Airport by emission source (i.e., aircraft, GSE, motor vehicles, and stationary sources) and compound (i.e., CO_2, N_2O, and CH_4), respectively.

Table I-22 Greenhouse Gas (GHG) Emissions (MMT CO2 Eq)[1] for 2015

Activity	CO_2	N_2O	CH_4	Total
Aircraft Sources				
Aircraft Taxi	0.21	<0.01	-[2]	0.21
Engine Startup	<0.01	<0.01	<0.01	<0.01
Aircraft AGL to 3,000 feet	0.18	<0.01	<0.01	0.18
Aircraft Support Equipment				
GSE	0.02	<0.01	<0.01	0.02
APU	0.01	<0.01	-[2]	0.01
Motor Vehicles				
On-airport Vehicles	0.03	<0.01	<0.01	0.03
On-airport Parking/Curbsides	0.01	<0.01	<0.01	0.01
Massport Shuttle Buses	0.01	<0.01	<0.01	0.01
Massport Fleet Vehicles	0.01	<0.01	<0.01	0.01
Off-airport Vehicles (Public)	0.05	<0.01	<0.01	0.05
Off-airport Vehicles (Airport Employees)	<0.01	<0.01	<0.01	<0.01
Off-airport Vehicles (Tenant Employees)	0.02	<0.01	<0.01	0.02
Stationary Sources				
Boilers	0.03	<0.01	<0.01	0.03
Generators, Snow melters, etc.	<0.01	<0.01	<0.01	<0.01
Fire Training Facility	<0.01	<0.01	<0.01	<0.01
Electrical Consumption	0.06	<0.01	<0.01	0.06

Sources: Massport and KBE.

1 Units expressed as million metric tons of CO2 equivalent (MMT CO2 Eq): 1 metric ton = 1.1 short tons.

2 Contributions of CH4 emissions from commercial aircraft are reported as zero. Years of scientific measurement campaigns conducted at the exhaust exit plane of commercial aircraft gas turbine engines have repeatedly indicated that CH4 emissions are consumed over the full emission flight envelope [Reference: Aircraft Emissions of Methane and Nitrous Oxide during the Alternative Aviation Fuel Experiment, Santoni et al., Environ. Sci. Technol., July 2011, Volume 45, pp. 7075-7082]. As a result, the EPA published that: "…methane is no longer considered to be an emission from aircraft gas turbine engines burning Jet A at higher power settings and is, in fact, consumed in net at these higher powers." [Reference: EPA, Recommended Best Practice for Quantifying Speciated Organic Gas Emissions from Aircraft Equipped with Turbofan, Turbojet, and Turboprop Engines, May 27, 2009 [EPA-420-R-09-901],http://www.epa.gov/otaq/aviation.htm]. In accordance with the following statements in the 2006 IPCC Guidelines (IPCC 2006), the FAA does not calculate CH4 emissions for either the domestic or international bunker commercial aircraft jet fuel emissions inventories. "Methane (CH4) may be emitted by gas turbines during idle and by older technology engines, but recent data suggest that little or no CH4 is emitted by modern engines." "Current scientific understanding does not allow other gases (e.g., N2O and CH4) to be included in calculation of cruise emissions." (IPCC 1999).

Table I-23 compares the total GHG emission from Logan Airport in 2015 to the total GHG emissions for Massachusetts.

Table I-23 Logan Airport Greenhouse Gas (GHG) Emissions Compared to Massachusetts Totals[1]

	CO_2	N_2O	CH_4	Totals
Logan Airport Emissions (2015)[2]	0.63	<0.01	<0.01	0.63
Massachusetts[3]	68.7	0.8	1.1	70.6
Percent of Logan Airport to Massachusetts[4]	<1%	<1%	<1%	<1%

Sources: Massport and KBE.
1 Units expressed as million metric tons of CO_2 equivalents (MMT CO_2 Eq): 1 metric ton = 1.1 short tons.
2 Total from Massport, tenants, and public categories.
3 Climate Analysis Indicators Tool (CAIT US) Version 4.0. (Washington, DC: World Resources Institute, 2012)
4 Percentages represent the relative amount Logan-related emissions compared to the state totals.

Table I-24 provides a comparison between Airport-related GHG emissions from 2007 through 2015. Total GHG emissions in 2015 were slightly higher (13 percent) than 2010 levels. To equally compare to previous years, the 2015 emissions are summarized in a manner similar to previous years.

Table I-24 Comparison of Estimated Total Greenhouse Gas (GHG) Emissions (MMT of CO_2eq) at Logan Airport – 2007 through 2015

Source	2007	2008	2009	2010	2011	2012	2013	2014	2015
Direct Emissions[2]									
Aircraft[3]	0.22	0.21	0.19	0.18	0.19	0.19	0.19	0.20	0.21
GSE/APUs	0.08	0.08	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Motor vehicles[4]	0.03	0.03	0.03	0.03	0.04	0.03	0.05	0.05	0.05
Other sources[5]	0.04	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03
Total Direct Emissions	0.37	0.35	0.27	0.27	0.28	0.26	0.29	0.29	0.32
Indirect Emissions[6]									
Aircraft[7]	0.18	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.18
Motor vehicles[8]	0.05	0.05	0.05	0.05	0.06	0.05	0.08	0.07	0.08
Electrical consumption[9]	0.09	0.08	0.07	0.07	0.08	0.08	0.06	0.06	0.06
Total Indirect Emissions	0.32	0.30	0.29	0.29	0.30	0.30	0.31	0.30	0.32
Total Emissions[10]	0.69	0.65	0.56	0.56	0.58	0.57	0.60	0.60	0.63
Percent of State Totals[11]	<1	<1	<1	<1	<1	<1	<1	<1	<1

Sources: Massport and KBE.

1 MMT – million metric tons of CO_2 equivalents (1 MMT = 1.1M Short Tons). CO_2 equivalents (CO_2eq) are bases for reporting the three primary GHGs (e.g., CO_2, N_2O and CH_4) in common units. Quantities are reported as "rounded" and truncated values for ease of addition.

2 Direct emissions are those that occur in areas located within the Airport's geographic boundaries.

3 Direct aircraft emissions based engine start-up, taxi-in, taxi-out and ground-based delay emissions.

4 Direct motor vehicle emissions based on on-site vehicle miles traveled (VMT).

5 Other sources include Central Heating and Cooling Plant, emergency generators, snow melters and live fire training facility.

6 Indirect emissions are those that occur off the Airport site.

7 Indirect aircraft emissions are based on take-off, climb-out and landing emissions which occur up to an altitude of 3,000 ft., the limits of the landing/take-off (LTO) cycle

8 Indirect motor vehicle emissions based on off-site Airport-related VMT and an average round trip distance of approximately 60 miles.

9 Electrical consumption emissions occur off-airport at power generating plants.

10 Total Emissions = Direct +Indirect.

11 Percentage based on relative amount of Airport total of direct emissions to statewide total from World Resources Institute (cait.wri.org).

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Measured NO_2 Concentrations

This section presents the results of Massport's long-term ambient (i.e., outdoor) air quality monitoring program for NO_2 – a pollutant associated with aircraft activity and other fuel combustion sources. Between 1982 and 2011, Massport collected NO_2 concentration data at numerous locations both on the Airport and in neighboring residential communities. The purpose of this monitoring program was to track long-term trends in NO_2 levels and to compare the results to the NAAQS for this pollutant. In 2011, Massport determined that the Logan NO_2 Monitoring Program had achieved its objectives with the significant and stable decrease in NO_2 emissions since 1999 and thus discontinued the program in 2011.

When it was operational, this monitoring program used passive diffusion tube technology for a period of one week each month for 12 months of the year at each of the monitoring stations. The samples of NO_2, along with Quality Assurance/Quality Control (QA/QC) samples, were then analyzed in a laboratory.

Table I-25 presents the final year NO_2 monitoring data (i.e., 2011). For comparative purposes, historical data from 1999 are similarly shown in **Table I-25**. The table also includes NO_2 data collected under a separate effort by MassDEP using continuous monitors at four Boston-area locations.

As shown on **Table I-25**, the 2011 NO_2 levels were somewhat higher than in 2010. However, this occurrence is consistent with the cyclical trend of the average levels over the past several years[10]. Importantly, there remains a long-term trend of decreasing NO_2 concentrations at both the Massport and MassDEP monitoring sites since 1999. Other notable observations of the 2011 data reveal the following:

- Annual NO_2 concentrations at all Massport and MassDEP monitoring locations were below the annual NO_2 NAAQS of 100 micrograms per cubic meter ($\mu g/m^3$) in 2011.
- The Massport-collected data compare relatively closely with data collected by the MassDEP. The average of all Massport monitoring sites was 29.8 $\mu g/m^3$ compared to 32.3 $\mu g/m^3$ for the four MassDEP Boston-area monitors.
- The highest NO_2 concentrations in 2011 from the Massport program occurred in areas characterized by high levels of motor vehicle traffic (i.e., Main Terminal Area [Site 8] and Maverick Square [Site 12]).

10 Spatial and temporal changes in measured NO_2 levels from year to year are typical and should not be used to define short-term results. Rather, NO_2 levels are better assessed by looking at the trends over several years.

Table I-25 Massport and MassDEP Annual NO_2 Concentration Monitoring Results ($\mu g/m^3$)

Monitoring Site	Site No.	Year												
		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Massport Monitoring Sites														
Runway 9	1	61.0	58.2	41.6	45.8	33.9	30.1	35.0	31.9	17.3	31.3	32.2	32.3	38.7
Runway 4R	2	55.6	44.6	41.4	36.9	32.5	30.9	30.7	29.0	17.2	20.2	19.2	21.9	25.7
Runway 33L	3	47.7	42.6	39.4	33.3	30.8	25.4	24.5	26.3	24.2	21.6	16.9	25.0	29.8
Runway 27	4	42.9	37.8	35.8	30.3	25.5	24.1	22.7	22.3	16.9	18.3	17.6	19.4	23.3
Runaway 22L	5	47.5	39.8	38.2	33.8	27.8	23.7	22.1	24.9	17.1	21.3	20.1	21.9	29.0
Runway 22R	6	60.6	59.2	51.6	45.0	32.3	29.7	32.9	25.1	24.8	29.7	27.8	33.1	30.6
Runway 15R	7	47.0	43.4	44.3	42.6	40.8	28.7	27.7	28.7	20.5	24.2	23.9	26.7	29.7
Main Terminal Area	8	70.8	87.0	80.7	69.3	44.3	44.7	46.2	43.5	29.5	41.7	37.7	43.9	49.0
Webster St., Jeffries Point	11	52.4	45.5	43.4	39.1	32.5	28.3	31.3	31.3	22.7	25.2	23.9	27.0	30.1
Maverick Square, E. Bos	12	81.2	72.2	68.5	61.3	47.9	46.5	41.4	45.6	36.0	41.3	38.2	42.5	43.5
Bremen St., E. Boston	13	59.1	52.6	52.0	46.2	39.1	35.7	37.6	37.1	27.8	30.1	28.6	31.9	35.3
Shore St. E. Boston	14	45.7	38.5	38.8	35.0	27.2	24.0	24.9	22.4	18.1	19.7	18.3	20.7	26.7
Orient Heights Yacht Club	15	45.1	46.9	47.7	43.1	29.4	25.2	25.5	25.1	19.6	21.1	18.3	22.5	26.7
Bayswater St. E. Boston	16	45.2	45.5	48.3	41.2	28.4	22.8	30.4	23.1	18.4	20.2	17.8	21.0	25.9
Annavoy St. E. Boston	17	40.8	39.2	44.4	33.7	24.7	21.4	23.3	21.0	18.2	19.6	17.3	20.9	25.8
Pleasant St. Winthrop	18	42.0	39.3	37.8	32.3	27.9	22.6	23.4	21.4	17.8	20.2	17.7	20.1	24.4
Court Road, Winthrop	19	40.0	36.1	33.8	27.4	24.0	19.2	22.3	21.0	16.3	17.1	16.7	18.4	22.7
Cottage Park Yacht Club	20	37.1	50.9	45.9	36.7	22.5	19.1	27.7	21.4	16.3	18.4	17.8	17.8	22.5
Winthrop, Point Shirley	21	33.1	37.7	38.6	24.4	22.7	17.4	17.2	20.2	15.7	15.6	14.9	17.5	21.6
Deer Island	22	36.3	31.9	33.8	33.1	21.3	17.8	16.9	17.8	13.0	17.0	14.7	16.7	20.7
Runway 4R–9	23	42.2	66.0	42.3	33.4	28.6	24.1	27.1	26.3	19.2	22.4	21.2	21.6	26.5
Runway 33L–4R	24	44.3	41.7	41.8	33.5	28.1	24.3	22.3	25.7	20.9	25.2	20.0	23.6	26.2
Runway 22R–33L	25	62.4	50.3	49.4	42.2	33.8	31.7	29.4	34.5	22.9	25.1	25.3	29.5	34.9

Table I-25 Massport and MassDEP Annual NO2 Concentration Monitoring Results (µg/m3) (Continued)

Monitoring Site	Site No.	Year												
		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Jeffries Point Park/Marginal St.	26	68.6	49.8	45.0	42.0	35.2	30.5	32.5	31.7	24.4	27.0	25.6	28.6	33.1
Harborwalk	27	54.3	48.5	47.4	43.5	35.6	35.5	29.3	34.2	24.2	26.1	24.5	28.3	34.9
Logan Athletic Fields	29	NA	69.1	67.6	54.9	41.9	40.2	37.5	37.0	24.6	28.8	26.8	30.8	37.8
Brophy Park, Jeffries Point	30	NA	48.0	45.2	41.0	36.5	31.2	32.9	31.3	24.8	26.6	24.6	26.8	30.8
Average of all Monitoring Sites		50.5	50.5	47.5	40.0	31.7	28.0	28.7	28.7	21.0	24.3	22.5	25.6	29.8
MassDEP Monitoring Sites[1]														
Long Island Road	A	20.7	24.4	22.6	22.6	16.9	12.6	13.2	13.2	13.2	13.2	11.3	13.6	13.4
Harrison Avenue	B	NA	45.1	47.0	45.1	43.2	37.4	35.8	35.8	37.7	37.7	33.9	32.1	33.1
Kenmore Square	C	56.4	54.5	56.8	47.0	47.0	51.7	43.3	43.3	39.6	41.5	37.7	36.0	38.4
East First Street	D	39.5	37.6	43.2	39.5	39.5	36.8	33.9	39.6	37.7	30.2	28.3	24.0	25.4

Notes: The NAAQS is 100 µg/m^3.
Massport determined that the Logan NO_2 Monitoring Program had achieved its objectives with the significant and stable decrease in NO_2 emissions since 1999 and thus discontinued the program in 2011.

µg/m^3 micrograms/cubic meter.

NA Not available.

1 NO_2 monitoring sites operated by the MassDEP.

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J

Water Quality/Environmental Compliance and Management

This appendix provides detailed information in support of Chapter 8, *Water Quality/Environmental Compliance and Management*:

- Table J-1 Logan Airport National Pollutant Discharge Elimination System (NPDES) Permit (No. MA0000787) Stormwater Outfall Monitoring Requirements (2007)
- Table J-2 Fire Training Facility NPDES Permit (No. MA0032751) Stormwater Outfall Monitoring Requirements (2006)
- Table J-3 Logan Airport 2015 Monthly Monitoring Results for First Quarter — North, West, and Maverick Street Stormwater Outfalls
- Table J-4 Logan Airport 2015 Monthly Monitoring Results for First Quarter — Porter Street Stormwater Outfall
- Table J-5 Logan Airport 2015 Monthly Monitoring Results for Second Quarter — North, West, and Maverick Street Stormwater Outfalls
- Table J-6 Logan Airport 2015 Monthly Monitoring Results for Second Quarter — Porter Street Stormwater Outfall
- Table J-7 Logan Airport 2015 Monthly Monitoring Results for Third Quarter — North, West, and Maverick Street Stormwater Outfalls
- Table J-8 Logan Airport 2015 Monthly Monitoring Results for Third Quarter — Porter Street Stormwater Outfall
- Table J-9 Logan Airport 2015 Monthly Monitoring Results for Fourth Quarter — North, West, and Maverick Street Stormwater Outfalls
- Table J-10 Logan Airport 2015 Monthly Monitoring Results for Fourth Quarter — Porter Street Stormwater Outfall
- Table J-11 Logan Airport 2015 Quarterly Wet Weather Monitoring Results — North, West, Maverick Street, and Porter Street Stormwater Outfalls
- Table J-12 Logan Airport 2015 Quarterly Wet Weather Monitoring Results – Northwest and Runway/Perimeter Stormwater Outfalls

- Table J-13 Logan Airport January 2015 Wet Weather Deicing Monitoring Results – North, West, Porter Street, and Runway/Perimeter Stormwater Outfalls
- Table J-14 Logan Airport April 2015 Wet Weather Deicing Monitoring Results – North, West Porter Street, and Runway/Perimeter Stormwater Outfalls
- Table J-15 Logan Airport Stormwater Outfall NPDES Water Quality Monitoring Results – 1993 to 2015
- Table J-16 Logan Airport Oil and Hazardous Material Spills and Jet Fuel Handling – 1990 to 2015
- Table J-17 Type and Quantity of Oil and Hazardous Material Spills at Logan Airport – 1999 to 2015
- Table J-18 MCP Activities Status of Massport Sites at Logan Airport
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Table J-1 Logan Airport NPDES Permit (No. MA0000787) Stormwater Outfall Monitoring Requirements (2007)

Monitoring Event	North Outfall 001		West Outfall 002		Maverick Outfall 003	
	Field Measurement	**Laboratory Analysis**	**Field Measurement**	**Laboratory Analysis**	**Field Measurement**	**Laboratory Analysis**
Monthly Dry Weather	Not Required	Oil and Grease TSS[1] Benzene Surfactant Fecal Coliform *Enterococcus*	Not Required	Oil and Grease TSS[1] Benzene Surfactant Fecal Coliform *Enterococcus*	Not Required	Oil and Grease TSS[1] Benzene Surfactant Fecal Coliform *Enterococcus*
Monthly Wet Weather	pH Flow Rate[6]	Oil and Grease TSS[1] Benzene[2] Surfactant Fecal Coliform *Enterococcus*	pH Flow Rate[6]	Oil and Grease TSS[1] Benzene[2] Surfactant Fecal Coliform *Enterococcus*	pH Flow Rate[6]	Oil and Grease TSS[1] Benzene[2] Surfactant Fecal Coliform *Enterococcus*
Quarterly Wet Weather	pH Flow Rate[6]	PAHs[3]: - Benzo(a)anthracene - Benzo(a)pyrene - Benzo(b)fluoranthene - Benzo(k)fluoranthene - Chrysene -Dibenzo(a,h)anthracene - Indeno(1,2,3-cd)pyrene - Naphthalene	pH Flow Rate[6]	PAHs[3]: - Benzo(a)anthracene - Benzo(a)pyrene - Benzo(b)fluoranthene - Benzo(k)fluoranthene - Chrysene -Dibenzo(a,h)anthracene - Indeno(1,2,3-cd)pyrene - Naphthalene	pH Flow Rate[6]	PAHs[3]: - Benzo(a)anthracene - Benzo(a)pyrene - Benzo(b)fluoranthene - Benzo(k)fluoranthene - Chrysene -Dibenzo(a,h)anthracene - Indeno(1,2,3-cd)pyrene - Naphthalene
Deicing Episode (2/Deicing Season)	Not Required	Ethylene Glycol Propylene Glycol BOD5[4] COD[5] Total Ammonia Nitrogen Nonylphenol Tolyltriazole	Not Required	Ethylene Glycol Propylene Glycol BOD5[4] COD[5] Total Ammonia Nitrogen Nonylphenol Tolyltriazole	Not Required	Not Required
Whole Effluent Toxicity (1st and 3rd Year Deicing Season)	Not Required	Menidia beryllina Arbacia punctulata	Not Required	Menidia beryllina Arbacia punctulata	Not Required	Not Required
Treatment System Sampling (Internal Outfalls)[7]	pH Quantity, Gallons	Oil and Grease TSS[1] Benzene[2]	Not Required	Not Required	Not Required	Not Required

Table J-1 Logan Airport NPDES Permit (No. MA0000787) Stormwater Outfall Monitoring Requirements (2007) (Continued)

Monitoring Event	Northwest Outfall 005		Porter Outfall 003 (3 upstream locations)		Select Runway/Perimeter Outfalls	
	Field Measurement	Laboratory Analysis	Field Measurement	Laboratory Analysis	Field Measurement	Laboratory Analysis
Monthly Dry Weather	Not Required	Not Required	Not Required	Oil and Grease TSS[1] Benzene Surfactant Fecal Coliform *Enterococcus*	Not Required	Not Required
Monthly Wet Weather	Not Required	Not Required	pH Flow Rate	Oil and Grease TSS[1] Benzene[2] Surfactant Fecal Coliform *Enterococcus*	Not Required	Not Required
Quarterly Wet Weather	pH Flow Rate[6]	Oil and Grease TSS[1] Benzene[2]	pH Flow Rate[6]	PAHs[3]: - Benzo(a)anthracene - Benzo(a)pyrene - Benzo(b)fluoranthene - Benzo(k)fluoranthene - Chrysene -Dibenzo(a,h)anthracene - Indeno(1,2,3-cd)pyrene - Naphthalene	pH	Oil and Grease TSS[1] Benzene[2]
Deicing Episode (2/Deicing Season)	Not Required	Not Required	Not Required	Ethylene Glycol Propylene Glycol BOD5[4] COD[5] Total Ammonia Nitrogen Nonylphenol Tolytriazole	Not Required	Ethylene Glycol Propylene Glycol BOD5[4] COD[5] Total Ammonia Nitrogen Nonylphenol Tolytriazole
Whole Effluent Toxicity (1st and 3rd Year Deicing Season)	Not Required	Not Required	Not Required	Menidia beryllina Arbacia punctulata	Not Required	Not Required
Treatment System Sampling (Internal Outfalls)[7]	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required

Source: Massport

Notes: Requirements are from NPDES Permit MA0000787, issued July 31, 2007.

1 TSS - Total Suspended Solids
2 Benzene must be collected with HDPE bailer.
3 PAH - Polycyclic Aromatic Hydrocarbons
4 BOD - Biological Oxygen Demand
5 COD - Chemical Oxygen Demand
6 Flow Rate will be estimated based on measured precipitation and the hydraulic model developed for the Logan Airport drainage system.
7 Outfalls 001D and 001E samples collected by Swissport.

Table J-2 Fire Training Facility NPDES Permit (No. MA0032751) Stormwater Outfall Monitoring Requirements (2006)

Monitoring Event	**Outfall Serial Number 001**	
	Field Measurement	**Laboratory Analysis**
Each Discharge Event[1]	Flow Rate[2] pH	TSS[3] Oil and Grease[4] Total BTEX[5] Toluene Benzene Ethylbenzene Xylene PAHs[5,6]
Whole Effluent Toxicity (once per year during discharge event)	Not Required	Acute Toxicity[7]

Source: Massport

Notes: Requirements are from NPDES Permit MA0032751, issued November 1, 2006.

All samples, except for wet testing, shall be collected after treatment and prior to discharge from above ground holding tank.

1 Flows from more than one training session may be held in treatment train for several weeks. Treatment and subsequent discharge through Outfall 001 is usually triggered by tank levels. Sampling will be conducted during each discharge event with the sampling point after the GAC unit and prior to discharge from the above ground holding tank. Each sample shall be a composite of three equally weighted (same volume) grab samples taken at the bottom, middle, and top of the above ground tank.

2 Total flow volume shall be reported monthly in gallons and the maximum flow rate in gallons per minute shall be reported for each month.

3 TSS - Total Suspended Solids

4 Oil and grease is measured using EPA Method 1664.

5 BTEX and PAH compounds shall be analyzed using EPA approved methods. Testing method used and method detection level for each parameter will be included in each DMR submittal.

6 PAH - Polycyclic Aromatic Hydrocarbons

7 The permittee shall conduct one acute toxicity test per year. The test results shall be submitted by the last day of the full month following completion of the test in accordance with protocols defined in the permit.

Table J-3 Logan Airport 2015 Monthly Monitoring Results for First Quarter — North, West, and Maverick Street Stormwater Outfalls

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactant (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)	*Klebsiella* (cfu/100mL)
001A – North Outfall	1/30/2015	Wet Weather	3.44	0.58	6.04	5.8	23	2.3	0.310	70	350	NA
002A – West Outfall	1/30/2015	Wet Weather	13.53	1.95	6.56	10	32	<1.0	0.240	280	10	NA
004A – Maverick Street Outfall	1/30/2015	Wet Weather	0.90	0.12	NS	NS	NS	NS	NS	NS	NS	NS
001C – North Outfall	1/8/2015	Dry Weather				<4.0	18	<1.0	0.110	<10	10	NA
002C – West Outfall	1/8/2015	Dry Weather				<4.0	28	<1.0	0.110	60	10	NA
004C – Maverick Street Outfall	1/8/2015	Dry Weather				<4.0	23	<1.0	0.090	50	20	NA
001A – North Outfall	-	Wet Weather	1.80	0.77	NS	NS	NS	NS	NS	NS	NS	NS
002A – West Outfall	-	Wet Weather	10.87	2.06	NS	NS	NS	NS	NS	NS	NS	NS
004A – Maverick Street Outfall	-	Wet Weather	0.95	0.13	NS	NS	NS	NS	NS	NS	NS	NS
001C – North Outfall	2/13/2015	Dry Weather				**18**	42	<1.0	0.280	<10	160	NA
002C – West Outfall	2/13/2015	Dry Weather				NS	NS	NS	NS	NS	NS	NS
004C – Maverick Street Outfall	2/13/2015	Dry Weather				NS	NS	NS	NS	NS	NS	NS
001A – North Outfall	3/26/2015	Wet Weather	2.9	0.6	6.60	<4.0	24	<1.0	0.300	10	150	NA
002A – West Outfall	3/26/2015	Wet Weather	10.4	2.1	6.44	<4.0	30	<1.0	0.290	150	<10	NA
004A – Maverick Street Outfall	3/26/2015	Wet Weather	0.7	0.1	6.35	<4.0	32	<1.0	0.170	10	<10	NA
001C – North Outfall	3/11/2015	Dry Weather				<4.0	10	<1.0	0.280	90	100	NA
002C – West Outfall	3/11/2015	Dry Weather				<4.0	32	<1.0	0.250	20	60	NA
004C – Maverick Street Outfall	3/11/2015	Dry Weather				<4.0	25	<1.0	0.150	80	40	NA
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.												
Discharge Limitations												
Maximum Daily			Report	Report	6.0 to 8.5	15 mg/L	100 mg/L	Report	Report	Report	Report	
Average Monthly			Report	Report	6.0 to 8.5	—	Report	Report	Report	Report	Report	

Source: Massport.

Notes: Bold values exceed maximum daily discharge limitation.
Flow rates were estimated for outfalls 001, 002, and 004 by using the SWMM model developed for Logan Airport.
For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit. For geometric mean calculations (fecal coliform and *Enterococcus*) a value of 1 was employed for those results measured below the laboratory detection limit.

1 *Klebsiella* is an indication of non-fecal coliform bacteria and is tested for at the North Outfall when fecal coliform concentration exceeds 5,000 cfu/100ml.

NA Not Analyzed.

TSS Total Suspended Solids.

NS Not Sampled. A wet weather sampling event was not conducted during the month of February 2015 due to snow cover. In January 2015, a sample could not be collected from the Maverick Street outfalls due to snow cover. In February 2015, a sample could not be collected from the West or Maverick Street Outfalls due to snow cover.

Table J-4 Logan Airport 2015 Monthly Monitoring Results for First Quarter — Porter Street Stormwater Outfall

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactant (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)
003 - Porter Street Outfall 1	1/30/2015	Wet Weather	-	-	6.22	<4.0	63	<1.0	0.210	10	<10
003 - Porter Street Outfall 2	1/30/2015	Wet Weather	-	-	6.53	9.6	28	<1.0	0.170	10	20
003 - Porter Street Outfall 3	1/30/2015	Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall Average		Wet Weather	2.33	0.34	6.38	4.8	46	0.0	0.190	10	4.5
003 - Porter Street Outfall 1	1/82015	Dry Weather				9.7	8.6	<1.0	0.160	<10	60
003 - Porter Street Outfall 2	1/8/2015	Dry Weather				<4.0	29	<1.0	<0.050	<10	20
003 - Porter Street Outfall 3	1/8/2015	Dry Weather				<4.0	24	<1.0	0.140	<10	<10
003 - Porter Street Outfall Average		Dry Weather				3.2	20.5	0.0	0.100	1.0	11
003 - Porter Street Outfall 1		Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 2		Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 3		Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall Average		Wet Weather	2.19	0.37	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 1	2/13/2015	Dry Weather				NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 2	2/13/2015	Dry Weather				NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 3	2/13/2015	Dry Weather				NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall Average		Dry Weather				NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 1	3/26/2015	Wet Weather	-	-	6.37	13	870	<1.0	0.160	70	320
003 - Porter Street Outfall 2	3/26/2015	Wet Weather	-	-	6.01	20	85	<1.0	0.140	<10	<10
003 - Porter Street Outfall 3	3/26/2015	Wet Weather	-	-	7.45	<4.4	28	<1.0	0.360	80	50
003 - Porter Street Outfall Average		Wet Weather	2.0	0.3	6.61	11.0	328	0.0	0.220	18	25
003 - Porter Street Outfall 1	3/11/2015	Dry Weather				6.7	400	<1.0	0.180	10	10
003 - Porter Street Outfall 2	3/11/2015	Dry Weather				39	90	<5.0	0.420	100	10
003 - Porter Street Outfall 3	3/11/2015	Dry Weather				8.7	48	<1.0	0.140	<10	<10
003 - Porter Street Outfall Average		Dry Weather				18.1	179	0.0	0.247	10	4.6
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.											
Discharge Limitations											
Maximum Daily			Report	Report	6.0 to 8.5	Report	Report	Report	Report	Report	Report
Average Monthly			Report	Report	6.0 to 8.5	—	Report	Report	Report	Report	Report

Source: Massport.

Notes: Flow rates were estimated for outfalls 001, 002, 003 and 004 by using the SWMM model developed for Logan Airport.
For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit. For geometric mean calculations (fecal coliform and Enterococcus) a value of 1 was employed for those results measured below the laboratory detection limit.

TSS Total Suspended Solids.

NA Not Analyzed.

NS Not Sampled. In January 2015, a wet weather sample could not be collected from the Porter Street Outfall 3 due to snow cover. In February 2015, sampling did not occur due to snow cover.

Table J-5 Logan Airport 2015 Monthly Monitoring Results for Second Quarter — North, West, and Maverick Street Stormwater Outfalls

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactant (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)	*Klebsiella*[1] (cfu/100mL)
001A – North Outfall	-	Wet Weather	2.28	0.43	NS	NS	NS	NS	NS	NS	NS	NS
002A – West Outfall	-	Wet Weather	8.58	1.84	NS	NS	NS	NS	NS	NS	NS	NS
004A – Maverick Street Outfall	-	Wet Weather	0.58	0.13	NS	NS	NS	NS	NS	NS	NS	NS
001C – North Outfall	4/13/2015	Dry Weather				<4.0	29	<1.0	0.100	20	110	NA
002C – West Outfall	4/13/2015	Dry Weather				<4.0	22	<1.0	0.080	2,800	10	NA
004C – Maverick Street Outfall	4/13/2015	Dry Weather				<4.0	31	<1.0	<0.050	80	20	NA
001A – North Outfall	5/19/2015	Wet Weather	2.34	0.25	6.69	<4.0	27	<1.0	0.130	250	2,600	NA
002A – West Outfall	5/19/2015	Wet Weather	5.40	0.99	6.40	<4.0	11	<1.0	0.130	260	10	NA
004A – Maverick Street Outfall	5/19/2015	Wet Weather	0.58	0.05	6.80	<4.0	36	<1.0	0.070	80	<10	NA
001C – North Outfall	5/8/2015	Dry Weather				<4.0	13	<1.0	0.260	30	2,500	NA
002C – West Outfall	5/8/2015	Dry Weather				<4.0	9.2	<1.0	0.090	780	<10	NA
004C – Maverick Street Outfall	5/8/2015	Dry Weather				<4.0	7.0	<1.0	<0.050	30	<10	NA
001A – North Outfall	-	Wet Weather	5.86	0.58	NS	NS	NS	NS	NS	NS	NS	NS
002A – West Outfall	-	Wet Weather	20.26	2.19	NS	NS	NS	NS	NS	NS	NS	NS
004A – Maverick Street Outfall	-	Wet Weather	1.55	0.15	NS	NS	NS	NS	NS	NS	NS	NS
001C – North Outfall	6/8/2015	Dry Weather				<4.0	6.0	<1.0	0.110	30	900	NA
002C – West Outfall	6/8/2015	Dry Weather				<4.0	14	<1.0	0.090	1,500	10	NA
004C – Maverick Street Outfall	6/8/2015	Dry Weather				<4.0	<5.0	<1.0	<0.050	3,100	10	NA
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.												
Discharge Limitations												
Maximum Daily			Report	Report	6.0 to 8.5	15 mg/L	100 mg/L	Report	Report	Report	Report	
Average Monthly			Report	Report	6.0 to 8.5	—	Report	Report	Report	Report	Report	

Source: Massport.

Notes: Flow rates were estimated for outfalls 001, 002, 003 and 004 by using the SWMM model developed for Logan Airport.
For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit. For geometric mean calculations (fecal coliform and Enterococcus) a value of 1 was employed for those results measured below the laboratory detection limit.

1 *Klebsiella* is an indication of non-fecal coliform bacteria and is tested for at the North Outfall when fecal coliform concentration exceeds 5,000 cfu/100ml.

TSS Total Suspended Solids.

NA Not Analyzed.

NS Not Sampled. A wet weather event was not conducted in April or in June 2015, due to timing of the rain event (weekend, early morning, or late with respect to low tide).

Table J-6 Logan Airport 2015 Monthly Monitoring Results for Second Quarter — Porter Street Stormwater Outfall

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactant (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)
003 - Porter Street Outfall 1	-	Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 2	-	Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 3	-	Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall Average		Wet Weather	1.63	0.27	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 1	4/13/2015	Dry Weather				<4.0	38	<1.0	0.100	<10	<10
003 - Porter Street Outfall 2	4/13/2015	Dry Weather				6.7	91	<1.0	0.180	<10	10
003 - Porter Street Outfall 3	4/13/2015	Dry Weather				<4.4	8.6	<1.0	0.100	<10	<10
003 - Porter Street Outfall Average		Dry Weather				2.2	46	0.0	0.127	1.0	2.2
003 - Porter Street Outfall 1	5/19/2015	Wet Weather	-	-	7.10	<4.0	30	<1.0	1.54	30	NA
003 - Porter Street Outfall 2	5/19/2015	Wet Weather	-	-	7.57	7.4	25	<1.0	2.69	130	NA
003 - Porter Street Outfall 3	5/19/2015	Wet Weather	-	-	7.41	5.4	280	<1.0	0.620	400	NA
003 - Porter Street Outfall Average		Wet Weather	0.77	0.10	7.36	4.3	112	0.0	1.62	116	NA
003 - Porter Street Outfall 1	5/8/2015	Dry Weather				<4.0	5.3	<1.0	0.140	<10	40
003 - Porter Street Outfall 2	5/8/2015	Dry Weather				<4.0	13	<1.0	0.850	<10	80
003 - Porter Street Outfall 3	5/8/2015	Dry Weather				<4.0	17	<1.0	0.090	<10	<10
003 - Porter Street Outfall Average		Dry Weather				0.0	11.8	0.0	0.360	1.0	14.7
003 - Porter Street Outfall 1	-	Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 2	-	Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 3	-	Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall Average		Wet Weather	4.06	0.38	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 1	6/8/2015	Dry Weather				<4.0	150	<1.0	0.100	5,400	260
003 - Porter Street Outfall 2	6/8/2015	Dry Weather				<4.0	29	<1.0	0.240	<10	10
003 - Porter Street Outfall 3	6/8/2015	Dry Weather				<4.0	<5.0	<1.0	0.130	10	<10
003 - Porter Street Outfall Average		Dry Weather				0.0	60	0.0	0.157	38	13.8
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.											
Discharge Limitations											
Maximum Daily			Report	Report	6.0 to 8.5	Report	Report	Report	Report	Report	Report
Average Monthly			Report	Report	6.0 to 8.5	—	Report	Report	Report	Report	Report

Source: Massport.

Notes: Flow rates were estimated for outfalls 001, 002, 003, and 0034 by using the SWMM model developed for Logan Airport.
For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit. For geometric mean calculations (fecal coliform and Enterococcus) a value of 1 was employed for those results measured below the laboratory detection limit.

TSS Total Suspended Solids.

NS Not Sampled. A wet weather event was not conducted in April or in June 2015, due to timing of the rain event (weekend, early morning, or late with respect to low tide).

Table J-7 Logan Airport 2015 Monthly Monitoring Results for Third Quarter — North, West, and Maverick Street Stormwater Outfalls

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactant (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)	*Klebsiella*[1] (cfu/100mL)
001A – North Outfall	-	Wet Weather	4.38	0.23	NS	NS	NS	NS	NS	NS	NS	NS
002A – West Outfall	-	Wet Weather	15.20	0.84	NS	NS	NS	NS	NS	NS	NS	NS
004A – Maverick Street Outfall	-	Wet Weather	1.06	0.04	NS	NS	NS	NS	NS	NS	NS	NS
001C – North Outfall	7/7/2015	Dry Weather				<4.0	5.8	<1.0	0.120	1,600	510	NA
002C – West Outfall	7/7/2015	Dry Weather				<4.0	23	<1.0	0.080	17,000	90	NA
004C – Maverick Street Outfall	7/7/2015	Dry Weather				<4.0	14	<1.0	0.070	80	20	NA
001A – North Outfall	8/11/2015	Wet Weather	2.13	0.21	6.54	<4.0	<5.0	<1.0	0.230	1,100	18,000	NA
002A – West Outfall	8/11/2015	Wet Weather	6.46	0.79	7.76	<4.0	17	<1.0	0.220	3,400	5,900	NA
004A – Maverick Street Outfall	8/11/2015	Wet Weather	0.51	0.03	6.79	<4.0	13	<1.0	0.410	>80,000	27,000	NA
001C – North Outfall	8/28/2015	Dry Weather				<4.0	19	<1.0	0.170	620	4,200	NA
002C – West Outfall	8/28/2015	Dry Weather				<4.0	22	<1.0	0.130	2,300	10	NA
004C – Maverick Street Outfall	8/28/2015	Dry Weather				<4.0	35	<1.0	0.110	24,000	2,300	NA
001A – North Outfall	9/30/2015	Wet Weather	8.79	0.44	6.25	<4.0	44	<1.0	0.090	2,000	33,000	NA
002A – West Outfall	9/30/2015	Wet Weather	31.0	1.60	7.42	8.4	**120**	<1.0	0.320	2,500	19,000	NA
004A – Maverick Street Outfall	9/30/2015	Wet Weather	2.18	0.10	7.10	<4.0	85	<1.0	0.100	26,000	15,000	NA
001C – North Outfall	9/9/2015	Dry Weather				<4.0	10	<1.0	0.690	4,000	8,700	NA
002C – West Outfall	9/9/2015	Dry Weather				<4.0	12	<1.0	0.370	13,000	>80,000	NA
004C – Maverick Street Outfall	9/9/2015	Dry Weather				<4.0	8.6	<1.0	0.140	56,000	7,600	NA
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.												
Discharge Limitations												
Maximum Daily			Report	Report	6.0 to 8.5	15 mg/L	100 mg/L	Report	Report	Report	Report	Report
Average Monthly			Report	Report	6.0 to 8.5	----	Report	Report	Report	Report	Report	Report

Source: Massport

Notes: Bold values exceed maximum daily discharge limitation.
Flow rates were estimated for outfalls 001, 002, and 004 by using the SWMM model developed for Logan Airport.
For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit. For geometric mean calculations (fecal coliform and *Enterococcus*) a value of 1 was employed for those results measured below the laboratory detection limit.

1 *Klebsiella* is an indication of non-fecal coliform bacteria and is tested for at the North Outfall when fecal coliform concentration exceeds 5,000 cfu/100ml.

TSS Total Suspended Solids.

NA Not Analyzed.

NS Not Sampled. A wet weather sampling event was not conducted in July 2015, due to timing of the rain event (weekend, early morning, or late with respect to low tide).

Table J-8 Logan Airport 2015 Monthly Monitoring Results for Third Quarter — Porter Street Stormwater Outfall

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactant (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)
003 - Porter Street Outfall 1	-	Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 2	-	Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 3	-	Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall Average		Wet Weather	2.72	0.15	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 1	7/7/2015	Dry Weather				<4.0	59	<1.0	0.110	21,000	4,500
003 - Porter Street Outfall 2	7/7/2015	Dry Weather				<4.0	73	<1.0	0.090	10	<10
003 - Porter Street Outfall 3	7/7/2015	Dry Weather				<4.0	44	<1.0	0.180	<10	<10
003 - Porter Street Outfall Average		Dry Weather				0.0	59	0.0	0.127	59	17
003 - Porter Street Outfall 1	8/11/2015	Wet Weather	-	-	6.80	<4.0	30	<1.0	0.220	3,000	14,000
003 - Porter Street Outfall 2	8/11/2015	Wet Weather	-	-	7.21	<4.0	5.6	<1.0	0.160	60	620
003 - Porter Street Outfall 3	8/11/2015	Wet Weather	-	-	6.81	<4.0	17	<1.0	0.130	30	640
003 - Porter Street Outfall Average		Wet Weather	1.19	0.15	6.94	0.0	18	0.0	0.170	175	1,771
003 - Porter Street Outfall 1	8/28/2015	Dry Weather				<4.0	33	<1.0	0.110	<10	50
003 - Porter Street Outfall 2	8/28/2014	Dry Weather				<4.0	7.3	<1.0	0.420	<10	10
003 - Porter Street Outfall 3	8/28/2014	Dry Weather				<4.0	7.8	<1.0	0.050	<10	<10
003 - Porter Street Outfall Average		Dry Weather				0.0	16	0.0	0.193	1.0	7.9
003 - Porter Street Outfall 1	9/30/2015	Wet Weather	-	-	6.82	<4.0	100	<1.0	0.070	3,900	13,000
003 - Porter Street Outfall 2	9/30/2015	Wet Weather	-	-	6.02	<4.0	10	<1.0	0.050	360	810
003 - Porter Street Outfall 3	9/30/2015	Wet Weather	-	-	**5.63**	<4.0	12	<1.0	0.050	<10	100
003 - Porter Street Outfall Average		Wet Weather	6.24	0.31	6.16	0.0	41	0.0	0.057	112	1,017
003 - Porter Street Outfall 1	9/9/2015	Dry Weather				<4.0	20	<1.0	0.200	10	30
003 - Porter Street Outfall 2	9/9/2015	Dry Weather				<4.0	5.0	<1.0	1.05	40	<10
003 - Porter Street Outfall 3	9/9/2015	Dry Weather				<4.0	7.7	<1.0	<0.250	<10	<10
003 - Porter Street Outfall Average		Dry Weather				0.0	11	0.0	0.417	7.4	3.1
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.											
Discharge Limitations											
Maximum Daily			Report	Report	6.0 to 8.5	Report	Report	Report	Report	Report	Report
Average Monthly			Report	Report	6.0 to 8.5	–	Report	Report	Report	Report	Report

Source: Massport.

Notes: Bold values exceed maximum daily discharge limitation.
Flow rates were estimated for outfall 003 by using the SWMM model developed for Logan Airport.
For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit. For geometric mean calculations (fecal coliform and Enterococcus) a value of 1 was employed for those results measured below the laboratory detection limit.

TSS Total Suspended Solids.

NS Not Sampled. A wet weather sampling event was not conducted in July 2015, due to timing of the rain event (weekend, early morning, or late with respect to low tide).

Table J-9 Logan Airport 2015 Monthly Monitoring Results for Fourth Quarter — North, West, and Maverick Street Stormwater Outfalls

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactant (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)	*Klebsiella*[1] (cfu/100mL)
001A – North Outfall	10/29/2015	Wet Weather	2.97	0.23	8.22	<4.0	5.1	<1.0	0.090	3,100	9,000	NA
002A – West Outfall	10/29/2015	Wet Weather	12.5	0.76	8.48	<4.4	20	<1.0	0.090	450	5,000	NA
004A – Maverick Street Outfall	10/29/2015	Wet Weather	0.67	0.06	7.54	<4.4	53	<1.0	0.060	26,000	4,400	NA
001C – North Outfall	10/20/2014	Dry Weather				<4.0	9.8	<1.0	0.150	110	4,400	NA
002C – West Outfall	10/20/2014	Dry Weather				<4.0	5.9	<1.0	0.160	5,100	330	NA
004C – Maverick Street Outfall	10/20/2014	Dry Weather				<4.0	16	<1.0	0.110	120	10	NA
001A – North Outfall	11/11/2015	Wet Weather	3.01	0.27	8.14	4.5	<5.0	<1.0	0.140	2,200	1,000	NA
002A – West Outfall	11/11/2015	Wet Weather	10.73	0.90	8.48	<4.0	7.4	<1.0	0.240	350	900	NA
004A – Maverick Street Outfall	11/11/2015	Wet Weather	0.71	-0.04	8.32	<4.0	5.8	<1.0	0.190	11,000	1,700	NA
001C – North Outfall	11/5/2015	Dry Weather				<4.0	10	<1.0	0.150	29,000	420	7,000
002C – West Outfall	11/5/2015	Dry Weather				<4.0	9.4	<1.0	0.180	22,000	520	NA
004C – Maverick Street Outfall	11/5/2015	Dry Weather				<4.0	14	<1.0	0.130	770	60	NA
001A – North Outfall	12/15/2015	Wet Weather	2.47	0.51	8.33	<4.0	6.0	<1.0	0.100	3,500	3,500	NA
002A – West Outfall	12/15/2015	Wet Weather	12.57	1.75	6.25	<4.0	30	<1.0	0.180	3,500	4,300	NA
004A – Maverick Street Outfall	12/15/2015	Wet Weather	1.30	0.08	7.77	<4.0	<5.0	<1.0	0.100	1,200	1,500	NA
001C – North Outfall	12/8/2015	Dry Weather				<4.0	9.0	<1.0	0.150	4,500	2,800	NA
002C – West Outfall	12/8/2015	Dry Weather				<4.0	7.0	<1.0	0.200	>80,000	2,400	NA
004C – Maverick Street Outfall	12/8/2015	Dry Weather				<4.0	30	<1.0	0.250	160	40	NA
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.												
Discharge Limitations												
Maximum Daily			Report	Report	6.0 to 8.5	15 mg/L	100 mg/L	Report	Report	Report	Report	Report
Average Monthly			Report	Report	6.0 to 8.5	–	Report	Report	Report	Report	Report	Report

Source: Massport.
Notes: Flow rates were estimated for outfalls 001, 002, and 004 by using the SWMM model developed for Logan Airport.
For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit. For geometric mean calculations (fecal coliform and Enterococcus) a value of 1 was employed for those results measured below the laboratory detection limit.
1 *Klebsiella* is an indication of non-fecal coliform bacteria and is tested for at the North Outfall when fecal coliform concentration exceeds 5,000 cfu/100ml.
In November 2015, the modeled average Maverick Street Outfall flow was negative due to tidal effects.
TSS Total Suspended Solids.
NA Not Analyzed.

Table J-10 Logan Airport 2015 Monthly Monitoring Results for Fourth Quarter — Porter Street Stormwater Outfall

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactant (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)
003 - Porter Street Outfall 1	10/29/2015	Wet Weather	-	-	**8.51**	<4.0	22	<1.0	0.090	9,000	10,000
003 - Porter Street Outfall 2	10/29/2015	Wet Weather	-	-	7.99	<4.0	5.6	<1.0	0.060	60	340
003 - Porter Street Outfall 3	10/29/2015	Wet Weather	-	-	**8.81**	<4.4	<5.0	<1.0	0.050	2,600	1,700
003 - Porter Street Outfall Average		Wet Weather	2.86	0.15	8.44	0.0	9.2	0.0	0.067	1,120	1,795
003 - Porter Street Outfall 1	10/20/2015	Dry Weather				<4.0	92	<1.0	0.240	40	30
003 - Porter Street Outfall 2	10/20/2015	Dry Weather				<4.0	21	<1.0	0.160	55	520
003 - Porter Street Outfall 3	10/20/2015	Dry Weather				<4.4	9.2	<1.0	0.230	20	250
003 - Porter Street Outfall Average		Dry Weather				0.0	41	0.0	0.210	35.3	157
003 - Porter Street Outfall 1	11/11/2015	Wet Weather	-	-	6.59	<4.0	30	<1.0	0.140	7,900	5,100
003 - Porter Street Outfall 2	11/11/2015	Wet Weather	-	-	6.22	<4.0	7.1	<1.0	0.080	<10	55
003 - Porter Street Outfall 3	11/11/2015	Wet Weather	-	-	6.40	<4.0	6.4	<1.0	0.090	1,600	1,600
003 - Porter Street Outfall Average		Wet Weather	2.19	0.18	6.40	0.0	15	0.0	0.103	233	766
003 - Porter Street Outfall 1	11/5/2015	Dry Weather				<4.0	72	<1.0	0.170	55	170
003 - Porter Street Outfall 2	11/5/2015	Dry Weather				<4.0	20	<1.0	0.170	80	60
003 - Porter Street Outfall 3	11/5/2015	Dry Weather				<4.0	6.5	<1.0	0.130	<10	10
003 - Porter Street Outfall Average		Dry Weather				0.0	33	0.0	0.157	8.9	47
003 - Porter Street Outfall 1	12/15/2015	Wet Weather	-	-	7.52	<4.0	5.0	<1.0	0.100	63,000	6,100
003 - Porter Street Outfall 2	12/15/2015	Wet Weather	-	-	**8.58**	9.0	24	<1.0	0.050	<10	<10
003 - Porter Street Outfall 3	12/15/2015	Wet Weather	-	-	7.20	<4.0	22.0	<1.0	0.110	70	90
003 - Porter Street Outfall Average		Wet Weather	2.74	0.28	7.77	3.0	17	0.0	0.087	164	82
003 - Porter Street Outfall 1	12/8/2014	Dry Weather				9.8	190	<1.0	0.760	>80,000	22,000
003 - Porter Street Outfall 2	12/8/2014	Dry Weather				18	11	<1.0	0.130	<10	110
003 - Porter Street Outfall 3	12/8/2014	Dry Weather				<4.0	<5.0	<1.0	0.140	<10	10
003 - Porter Street Outfall Average		Dry Weather				9.3	67	0.0	0.343	43.1	289
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.											
Discharge Limitations											
Maximum Daily			Report	Report	6.0 to 8.5	Report	Report	Report	Report	Report	Report
Average Monthly			Report	Report	6.0 to 8.5	—	Report	Report	Report	Report	Report

Source: Massport.

Notes: Bold values exceed maximum daily discharge limitation.
Flow rates were estimated for outfall 003 using the SWMM model developed for Logan Airport.
For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit. For geometric mean calculations (fecal coliform and Enterococcus) a value of 1 was employed for those results measured below the laboratory detection limit.
The modeled Maverick Street Outfall on average ended up being negative because of tidal effects.

TSS Total Suspended Solids.

Table J-11 Logan Airport 2015 Quarterly Wet Weather Monitoring Results – North, West, Maverick Street, and Porter Street Stormwater Outfalls

	Date	Wet Weather pH (S.U.)	Benzo(a)-anthracene (µg/L)	Benzo(a)-pyrene (µg/L)	Benzo(b)-fluoranthene (µg/L)	Benzo(k)-fluoranthene (µg/L)	Chrysene (µg/L)	Dibenzo(a,h,)-anthracene (µg/L)	Indeno(1,2,3-cd)-pyrene (µg/L)	Naphthalene (µg/L)	Total PAHs (µg/L)
001 - North Outfall	8/11/2015	6.54	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
002 - West Outfall	8/11/2015	7.76	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
004 - Maverick Street Outfall	8/11/2015	6.79	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003 - Porter Street Outfall 1	8/11/2015	6.80	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003 - Porter Street Outfall 2	8/11/2015	7.21	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003 - Porter Street Outfall 3	8/11/2015	6.81	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003 - Porter Street Outfall Average		6.94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	ND
001 - North Outfall	12/15/2015	8.33	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
002 - West Outfall	12/15/2015	6.26	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
004 - Maverick Street Outfall	12/15/2015	7.77	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003 - Porter Street Outfall 1	12/15/2015	7.52	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003 - Porter Street Outfall 2	12/15/2015	**8.58**	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	3.8	3.8
003 - Porter Street Outfall 3	12/15/2015	7.20	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003 - Porter Street Outfall Average		7.77	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.27	1.3
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.											
Discharge Limitations											
Maximum Daily		6.0 to 8.5	Report	Report	Report	Report	Report	Report	Report	Report	Total

Source: Massport

Notes: Quarterly Samples were unable to be collected during the first and second quarters. During the first quarter, the perimeter road was mostly inaccessible because of the historic snowfall events, as were many of the sampling locations. There were few rain opportunities late in the season which were not timed well with the tides. During the second quarter, sampling could not be conducted due to thunderstorms and timing of precipitation versus the low tide.
Bold values exceed maximum daily discharge limitation.
For averaging calculations, a value of zero was employed for those results measures below the laboratory detection limit.

PAHs Polynuclear Aromatic Hydrocarbons

ND Not Detected

Table J-12 Logan Airport 2015 Quarterly Wet Weather Monitoring Results – Northwest and Runway/Perimeter Stormwater Outfalls

	Date	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (SU)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)
005 - Northwest Outfall	8/11/2015	0.29	0.02	6.75	<4.4	7.8	<1.0
006- Runway/ Perimeter Outfall (A9)	8/11/2015	0.12	0.01	7.74	<4.0	<5.0	<1.0
006- Runway/ Perimeter Outfall (A18)	8/11/2015	0.02	0.002	7.03	<4.0	65	<1.0
006- Runway/ Perimeter Outfall (A19)	8/11/2015	0.02	0.002	6.87	<4.0	<50	<1.0
006- Runway/ Perimeter Outfall (A21)	8/11/2015	1.06	0.11	6.94	<4.0	5.7	<1.0
006- Runway/ Perimeter Outfall (A23)	8/11/2015	0.10	0.01	7.15	<4.0	54	<1.0
006- Runway/ Perimeter Outfall (A33)	8/11/2015	0.07	0.01	7.04	<4.4	24	<1.0
006- Runway/ Perimeter Outfall (A38)	8/11/2015	0.12	0.01	6.71	<4.4	7.4	<1.0
006- Runway/Perimeter Outfall Average		0.2	0.02	7.07	0.0	22	0.0
005 - Northwest Outfall	12/15/2015	0.30	0.06	7.47	<4.0	11	<1.0
006- Runway/ Perimeter Outfall (A9)	12/15/2015	0.19	0.03	7.49	<4.0	<5.0	<1.0
006- Runway/ Perimeter Outfall (A18)	12/15/2015	0.03	0.01	7.82	<4.0	<5.0	<1.0
006- Runway/ Perimeter Outfall (A19)	12/15/2015	0.03	0.00	7.48	<4.0	<5.0	<1.0
006- Runway/ Perimeter Outfall (A21)	12/15/2015	1.47	0.27	6.94	<4.0	<5.0	<1.0
006- Runway/ Perimeter Outfall (A23)	12/15/2015	0.16	0.03	7.39	<4.0	<5.0	<1.0
006- Runway/ Perimeter Outfall (A33)	12/15/2015	0.11	0.03	7.42	<4.0	<5.0	<1.0
006- Runway/ Perimeter Outfall (A38)	12/15/2015	0.18	0.03	6.58	<4.0	<5.0	<1.0
006- Runway/Perimeter Outfall Average		0.31	0.06	7.30	0.0	0.0	0.0
Discharge Limitations		Report	Report	Report	Report	Report	Report

Source: Massport
Notes: Bold values exceed maximum daily discharge limitation.
For averaging calculations, a value of zero was employed for those results measures below the laboratory detection limit.
Requirements are from NPDES Permit MA 0000787, issued July 31, 2007.
TSS Total Suspended Solids
ND Not Detected

Table J-13 Logan Airport January 2015 Wet Weather Deicing Monitoring Results – North, West, Porter Street, and Runway/Perimeter Stormwater Outfalls

	Date	Ethylene Glycol, Total (mg/L)	Propylene Glycol, Total (mg/L)	BOD5 (mg/L)	COD (mg/L)	Ammonia Nitrogen (mg/L)	Nonylphenol (µg/L)	4-Methyl-1-H-benzotriazole (µg/L)	5-Methyl-1-H-benzotriazole (µg/L)	Tolytriazole (µg/L)
001B - North Outfall	1/30/2015	1,200	8,800	12,000	23,000	0.574	<0.02	5,002.51	5,961.51	10,964.02
002B - West Outfall	1/30/2015	440	4,400	3,000	8,500	0.426	<0.02	69.80	84.74	154.54
003B - Porter Street Outfall 1	1/30/2015	22	17	<200	2,400	2.60	<0.02	15.64	11.82	27.46
003B - Porter Street Outfall 2	1/30/2015	38	180	780	1,800	0.098	<0.02	43.23	28.39	71.62
003B - Porter Street Outfall 3	1/30/2015	NS	NS	NS	NS	NS	NS	NS	NS	NS
003B - Porter Street Outfall Average		30	99	390	2,100	1.3	0.0	29.44	20.11	49.54
006B- Runway/ Perimeter (A7)	1/30/2015	<7.0	<7.0	11	160	4.71	<0.02	14.21	6.04	20.25
006B- Runway/ Perimeter (A9)	1/30/2015	<7.0	<7.0	<2.0	120	0.734	<0.02	7.21	2.76 J	9.97 J
006B- Runway/ Perimeter (A21)	1/30/2015	<7.0	<7.0	23	620	2.14	<0.02	11.33	4.44	15.77
006B- Runway/ Perimeter (A22)	1/30/2015	<7.0	<7.0	20	220	2.95	<0.02	18.09	5.31	23.40
006B- Runway/ Perimeter (A23)	1/30/2015	<7.0	<7.0	9.4	77	2.56	<0.02	18.99	5.40	24.39
006B- Runway/ Perimeter (A35)	1/30/2015	<7.0	<7.0	41	170	4.29	<0.02	27.72	7.53	35.25
006B- Runway/ Perimeter (A38)	1/30/2015	<7.0	<7.0	<5.0	180	0.451	<0.02	<5.0	2.76 J	2.76 J
006B- Runway/Perimeter Outfall Average		0.0	0.0	15	221	2.55	0.00	13.94	4.89	18.83
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.										
Discharge Limitations										
Average Monthly		Report	Report	Report	Report	Report	Report	Report	Report	Report
Maximum Daily		Report	Report	Report	Report	Report	Report	Report	Report	Report

Source: Massport.
Notes: For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit.
J = value is an estimate calculated by the lab from the response factors of the other two triazole compounds.
Tolytriazole concentrations calculated as sum of 4-Methly-1-H-benzotriazole and 5-Methyl-1-H-benzotriazole.
BOD5 Five-day Biochemical Oxygen Demand
COD Chemical Oxygen Demand
NS Not Sampled. Locations were inaccessible due to snow piles.

Table J-14 Logan Airport April 2015 Wet Weather Deicing Monitoring Results – North, West, Porter Street, and Runway/Perimeter Stormwater Outfalls

	Date	Ethylene Glycol, Total (mg/L)	Propylene Glycol, Total (mg/L)	BOD5 (mg/L)	COD (mg/L)	Ammonia Nitrogen (mg/L)	Nonylphenol (µg/L)	4-Methyl-1-H-benzotriazole (µg/L)	5-Methyl-1-H-benzotriazole (µg/L)	Tolytriazole (µg/L)
001B - North Outfall	4/9/2015	20	16	76	86	0.284	0.05 J	<0.10	<0.10	ND
002B - West Outfall	4/9/2015	18	110	150	240	0.362	0.20	5.01	<0.10	5.01
003B - Porter Street Outfall 1	4/9/2015	<7.0	<7.0	7.6	66	0.433	0.03 J	<0.10	<0.10	ND
003B - Porter Street Outfall 2	4/9/2015	<7.0	30	350	670	0.150	<0.02	7.29	<0.10	7.29
003B - Porter Street Outfall 3	4/9/2015	<7.0	1,200	970	2,200	0.224	0.11 J	<0.10	<0.10	ND
003B - Porter Street Outfall Average	4/9/2015	0.0	410	443	979	0.269	0.05	2.43	0.00	2.43
006B- Runway/ Perimeter (A9)	4/9/2015	<7.0	<7.0	30	61	0.638	<0.02	<0.10	<0.10	ND
006B- Runway/ Perimeter (A18)	4/9/2015	<7.0	<7.0	66	100	1.64	<0.02	<0.10	<0.10	ND
006B- Runway/ Perimeter (A20)	4/9/2015	<7.0	<7.0	140	220	4.11	<0.02	3.05	<0.10	3.05
006B- Runway/ Perimeter (A21)	4/9/2015	<7.0	<7.0	9.3	38	0.406	<0.02	<0.10	<0.10	ND
006B- Runway/ Perimeter (A23)	4/9/2015	<7.0	<7.0	14	70	0.404	<0.02	<0.10	<0.10	ND
006B- Runway/ Perimeter (A33)	4/9/2015	<7.0	<7.0	32	110	0.535	<0.02	<0.10	<0.10	ND
006B- Runway/ Perimeter (A38)	4/9/2015	<7.0	<7.0	<2.0	33	0.133	<0.02	<0.10	<0.10	ND
006B- Runway/Perimeter Outfall Average		0.0	0.0	42	90	1.12	0.00	0.44	0.00	0.44
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.										
Discharge Limitations										
Average Monthly		Report	Report	Report	Report	Report	Report	Report	Report	Report
Maximum Daily		Report	Report	Report	Report	Report	Report	Report	Report	Report

Source: Massport.
Notes: For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit.
J = value is an estimate calculated by the lab from the response factors of the other two triazole compounds.
Tolytriazole concentrations calculated as sum of 4-Methly-1-H-benzotriazole and 5-Methyl-1-H-benzotriazole.
BOD5 Five-day Biochemical Oxygen Demand
COD Chemical Oxygen Demand
ND Not Detected

Table J-15 Logan Airport Stormwater Outfall NPDES Water Quality Monitoring Results – 1993 to 2015

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
# / # = Number of samples at or below NPDES limits / Total number of samples taken[1]																							
Oil and Grease (mg/L)																							
North Outfall	30/31	35/36	33/35	29/35	30/35	35/36	29/30	34/36	28/28	36/36	30/32	32/34	33/35	33/33	29/29	23/23	24/24	24/24	24/24	21/21	20/20	21/21	19/20
West Outfall	29/30	36/36	34/34	36/36	34/35	36/36	30/30	35/35	27/28	36/36	31/32	33/34	35/35	32/33	28/28	22/23	24/24	24/24	22/24	21/21	21/21	21/21	19/19
Maverick Street Outfall	29/29	36/36	35/35	36/36	35/35	35/36	30/30	34/34	26/28	35/36	32/32	34/34	35/35	32/33	29/29	22/23	20/21	19/19	23/23	15/15	4/4	20/20	18/18
Settable Solids[2] (mg/L)																							
North Outfall	19/19	34/35	34/35	32/35	31/34	34/36	30/30	34/36	29/29	32/36	32/32	34/34	33/35	32/34	22/22	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
West Outfall	19/19	32/36	34/34	35/36	34/34	35/36	29/30	36/36	27/28	36/36	31/32	34/34	32/35	33/33	22/22	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TSS (mg/L)																							
North Outfall	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6/6	24/24	24/24	22/23	24/24	21/21	20/21	21/21	20/20
West Outfall	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5/6	24/24	24/24	23/23	22/24	20/22	21/21	20/21	18/19
Maverick Street Outfall	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4/6	22/24	20/21	18/19	20/23	14/15	4/4	19/20	18/18
pH																							
North Outfall	34/35	33/36	35/35	35/35	35/35	36/36	30/30	36/36	29/29	36/36	32/32	34/34	35/35	34/34	26/26	12/12	16/16	11/11	12/12	9/9	8/8	8/8	8/8
West Outfall	34/34	28/36	33/34	35/36	35/35	36/36	30/30	36/36	29/29	36/36	32/32	34/34	35/35	33/33	26/26	12/12	16/16	11/11	12/12	9/9	9/9	8/8	8/8
Porter Street Outfall[2]	35/35	30/36	34/34	36/36	35/35	36/36	30/30	36/36	28/28	36/36	32/32	34/34	35/35	33/33	22/22	21/21	48/48	24/24	23/23	26/27	24/27	24/24	19/23
Maverick Street Outfall	35/35	35/36	35/35	36/36	34/35	36/36	30/30	35/35	28/28	36/36	32/32	34/34	35/35	33/33	26/26	10/10	16/16	10/10	11/11	6/6	2/2	7/7	7/7

Source: Massport

Notes: Sampling requirements changed in 2007 with the issuance of a new NPDES permit. Results through 2007 are based on NPDES Permit MA0000787, issued March 1, 1978. Stormwater outfall water quality monitoring results collected in accordance with the requirements of former NPDES permit. A portion of the Porter Street Drainage Area was incorporated into the West Drainage Area as part of roadway construction projects at Logan Airport.

1 The total number of samples at each outfall varies year to year. In some years, fewer samples are taken due to factors such as construction, weather, and/or tidal conditions.

2 Settleable solids analyses were replaced with TSS in 2008.

Table J-16 Logan Airport Oil and Hazardous Material Spills[1] and Jet Fuel Handling – 1990 to 2015

Year	Total Number of all Spills	Total Number of all Spills >10 gallons	Total Volume of all Spills (Gallons)	Estimated Volume of Jet Fuel Handled (Gallons)	Total Volume of Jet Fuel Spilled (Gallons)
1990	173	NA	NA	438,100,000	3,745
1991	186	NA	NA	NA	2,471
1992	195	NA	NA	NA	4,355
1993	188	NA	NA	451,900,000	3,131
1994	217	NA	NA	476,700,000	4,046
1995	161	NA	NA	309,200,000	21,412[2]
1996	159	NA	NA	346,700,000	1,321
1997	147	NA	NA	377,488,161	2,029[3]
1998	191	NA	NA	387,224,004	10,047[4]
1999	196	43	7,151	425,937,051	7,012[5]
2000	136	20	1,318	441,901,932	1,227
2001	139	37	1,924	416,748,819	1,771
2002	101	16	653	358,190,362	559
2003	128	19	10,364	319,439,910	10,188[6]
2004	126	18	894	373,996,141	574
2005	97	15	2,319	368,645,932	585
2006	92	11	752	364,450,864	644
2007	108	7	604	367,585,187	361
2008	99	20	944	345,631,788	662
2009	95	6	1004	327,358,619	915
2010	87	15	476	335,693,997	360
2011	108	12	572	340,421,373	337
2012	132	5	593	343,731,127	439
2013	94	6	452	349,397,940	351
2014	129	17	2,785	370,222,342	785
2015	196	16	1,278	374,985,216	885

Source: Massport Fire-Rescue Department.
NA Not available.
Notes:
1 Materials include: jet fuel, hydraulic oil, diesel fuel, gasoline, and other materials such as glycol and paint.
2 One tenant spill, which occurred on October 15, 1995, totaled 18,000 gallons (84 percent of the annual spill total). The spill did not enter the Airport's storm drain system.
3 On October 23, 1997, a fuel line on an aircraft failed, resulting in the release of approximately 2,500 gallons, all but 60 gallons of which were recovered in drums before reaching the ground. Only the 60 gallons is included in the 1997 total.
4 Includes a 7,200-gallon spill that was discovered on September 2, 1998, and a 1,300-gallon spill that occurred on June 3, 1998. Neither spill entered the Airport's storm drain system.
5 Includes a 5,000-gallon spill, none of which entered the Airport's storm drainage system.
6 In 2003, one fuel spill comprised 9,460 gallons or 94 percent of the total volume of the MassDEP/MCP reportable spills that year. The fuel spill was contained and did not enter the drainage system.

Table J-17 Type and Quantity of Oil and Hazardous Material Spills at Logan Airport – 1999 to 2015

	Jet Fuel			Hydraulic Oil			Diesel Fuel			Gasoline			Other		
Year	No. of Spills	Quantity (Gallons)	No. of Spills ≥ 10 Gallons	No. of Spills	Quantity (Gallons)	No. of Spills ≥ 10 Gallons	No. of Spills	Quantity (Gallons)	No. of Spills ≥ 10 Gallons	No. of Spills	Quantity (Gallons)	No. of Spills ≥ 10 Gallons	No. of Spills	Quantity (Gallons)	No. of Spills ≥ 10 Gallons
1999	151	7,012	40	24	67	1	13	49	2	5	7	0	3	16	0
2000	115	1,227	18	8	59	2	3	11	0	8	16	0	2	5	0
2001	104	1,771	32	21	92	3	5	30	1	6	26	1	3	5	0
2002	79	559	15	7	38	0	8	37	1	4	8	0	3	11	0
2003	89	10,188	15	15	91	3	15	30	0	7	24	0	2	31	1
2004	82	574	12	17	189	4	14	52	0	7	26	0	6[1]	53[2]	2[3]
2005	66	585	12	14	78	1	7	1,610	2	7	45	0	3[4]	1	0
2006	65	644	9	10	25	0	6	57	1	4	9	0	7	17	1
2007	66	361	4	16	37	0	16	57	1	3	8	0	7	141[5]	2
2008	74	662	19	15	56	2	5	14	0	1	7	0	4	205[6]	1
2009	95	915	6	21	51	0	9	20	0	3	3	0	11	15	0
2010	54	360	12	17	50	1	5	56	2	2	3	0	7	7	0
2011	69	337	10	21	149	1	7	55	1	4	16	0	7	15	0
2012	80	439	4	25	79	1	17	38	0	2	12	0	8	25	0
2013	56	351	5	15	51	0	13	32	0	2	<2	0	7	10	0
2014	81	785	13	24	98	1	17	1,810	2	4	9	0	3	83	1
2015	110	885	10	43	149	3	16	151	2	7	46	1	20	47	0

Source: Massport

Notes:

1 Includes two Unknown spills (14 gallons), plus one spill of each of the following: Ethylene Glycol, Propylene Glycol, AVGAS, and Paint.

2 Ethylene Glycol (25 gallons), Propylene Glycol (10 gallons), AVGAS (1 gallon) and Paint (3 gallons).

3 One spill of Ethylene Glycol; one spill of Propylene Glycol.

4 Includes two spills of an unknown substance and volume.

5 Includes one spill of motor oil (4 gallons); one spill of kerosene (5 gallons); one spill of cooking oil (120 gallons); one spill of fuel oil (10 gallons); one spill from a battery (1 gallon); two spills of an unknown substance (1 gallon).

6 Includes one spill of transformer oil (200 gallons).

Table J-18 MCP Activities Status of Massport Sites at Logan Airport

Location (Release Tracking Number) and MassDEP Reporting Status	Action/Status
1. Fuel Distribution System (3-1287)	
2007	Inspection and Monitoring Status Reports were submitted to the MassDEP detailing monitoring and product recovery efforts along the FDS between September 2006 and September 2007. A Periodic Evaluation Report was submitted in January 2008 which indicated that a Condition of No Substantial Hazard existed at the FDS and a permanent solution was not currently feasible. Massport coordinated with BOSFUEL who prepared construction documents for replacing a portion of the FDS. Construction was conducted under a RAM Plan.
2008	Inspection and monitoring reports were submitted to the MassDEP detailing monitoring and product recovery efforts along the FDS between September 2007 and September 2008. Massport coordinated with BOSFUEL during construction to replace a portion of the FDS. The work was conducted under a RAM Plan that was submitted to the MassDEP in May 2008. A RAM Status Report was submitted in September 2008. Construction of the pipeline replacement was approximately 90 percent complete.
2009	Inspection and monitoring reports were submitted to the MassDEP detailing monitoring and product recovery efforts along the FDS between September 2008 and December 2009. The BOSFUEL project to replace a portion of the FDS continued, with work being completed on pipeline connections, testing of the new fuel line, and abandonment of the old fuel line. RAM Status Reports for the BOSFUEL Project were submitted in February and September 2009.
2010	Inspection and monitoring reports were submitted to the MassDEP detailing monitoring and product recovery efforts along the FDS between September 2009 and September 2010. A RAM Completion Report for the BOSFUEL Project was submitted in February, and the report was revised in March 2010.
2011	A Periodic Review of the Temporary Solution for the FDS was submitted in April 2011. Additionally, three Post-Class C RAO Status Reports were submitted for the FDS in February, June, and December 2011, summarizing the routine inspection and monitoring activities.
2012	Post-Class C RAO Status Reports were submitted in May and November 2012, summarizing the routine inspection and monitoring activities.
2013	Post-Class C RAO Status Reports were submitted in May and November 2013, summarizing the routine inspection and monitoring activities.
2014	Post-Class C RAO Status Reports were submitted in May and November 2014, summarizing the routine inspection and monitoring activities. In addition, a RAM Plan was submitted in April 2014 to address construction in the area of the FDS followed by a RAM Completion Report submitted in August 2014.
2015	Post-Temporary Solution Status Reports were submitted in May and November 2015, summarizing the routine inspection and monitoring activities.
2. North Outfall (3-4837)	
Phase II and Phase III Reports filed in March 1997	Indicated petroleum contamination present at the site was likely the result of decades of airport operation; risk assessment reported no significant risk to human health, or to the aquatic and avian community.
RAO submitted in March 1998	Class C RAO using a Temporary Solution (periodic site monitoring and assessment); remediation steps included (not limited to) installation of a new fuel distribution system and decommissioning of certain fuel lines, and natural biodegradation processes; goal is to have petroleum contamination reduced to an area less than 1,000 square feet. Installation of the new fuel distribution system and decommissioning of sections of the old system were completed. Massport initiated site evaluation to document the reduction of petroleum contamination following the decommissioning of the North Fuel Farm and fuel distribution system.
Post Class C RAO evaluation report submitted in December 2002	Massport has eliminated substantial hazards at this site and submitted a Class C RAO statement. In accordance with applicable regulations, Massport will conduct a periodic evaluation at five-year intervals until a Permanent Solution has been achieved. The next periodic evaluation was scheduled for 2007.
2004	Evaluation report indicated that a “Condition of No Significant Risk” has not been achieved at this site. Massport scheduled another assessment in 2007.
2005	No change in status for 2005.
2006	Massport prepared the five-year review of the Class C RAO for this site, which was due in December 2007.
2007	Massport completed its five-year review of the Class C RAO and transmitted it to MassDEP in December 2007. It was determined that a “Condition of No Significant Risk” has not been achieved at this site at this time. The next five-year re-evaluation will be conducted in 2012.
2008	No change in status.
2009	No change in status.
2010	No change in status.

Table J-18 MCP Activities Status of Massport Sites at Logan Airport (Continued)

2. North Outfall (3-4837) (Continued)	
2011	No change in status. Massport provided updated data for the MassDEP website.
2012	Response Action Outcome submitted to DEP on December 27, 2012. No further MCP response action is required.
3. Former Robie Park (3-10027)	
2005	A Phase I was completed in 2005 with an RAO retraction. The RAO had been completed by the former property owner.
2006	No change in status for 2006.
2007	No change in status for 2007.
2008	A Phase II Scope of Work was prepared on May 9, 2008. A RAM Plan was submitted to MassDEP on September 16, 2008.
2009	A Phase V Remedy Operation Status Plan was submitted on March 31, 2010.
2010	Two Remedy Operation Status Reports were submitted on September 29, 2010 and March 28, 2011. The next status report was scheduled for September 30, 2011.
2011	Phase IV Project Status Reports 2 and 3 were submitted in March and September 2011, respectively.
2012	Phase V Status Reports 4 and 5 were submitted in March and September, 2012, respectively.
2013	Phase V Status Reports 6 and 7 were submitted in March and September, 2013, respectively.
2014	Phase V Status Reports 8 and 9 were submitted in March and September, 2014, respectively.
2015	Phase V Reports 10 and 11 were submitted in March and September, 2015, respectively. A Permanent Solution Statement is currently being prepared.
4. Former Robie Property (3-23493)	
2005	A Phase I was completed in 2005.
2006	No change in status for 2006.
2007	No change in status for 2007.
2008	A Phase II was submitted to MassDEP on October 21, 2008.
2009	An Activity and Use Limitation (AUL) was recorded with the Suffolk County Registry of Deeds for the site on December 16, 2009.
2010	A Class A-3 RAO was submitted on January 4, 2010, corresponding with the recording of an AUL. On May 21, 2010, a RAM Plan for the Economy Parking Structure was submitted. The first RAM Status Report was submitted on September 21, 2010. An AUL Amendment was recorded on December 9, 2010.
2011	A RAM Completion Statement was submitted on March 15, 2011. Regulatory closure has been achieved. No further response actions are required.
5. Tomahawk Drive (3-27068)	
2007	Release notification form submitted in August 2007.
2008	A Class B-1 RAO was submitted to MassDEP on January 9, 2009. No further response actions were required.
2009	No further response actions were required.
6. Fire Training Facility (3-28199)	
2008	Oral notification of release was provided to MassDEP/BWSC on December 10, 2008.
2009	A Phase I/Tier classification was submitted on December 17, 2009.
2010	A RAM Plan was submitted to MassDEP on August 6, 2010. A RAM Status Report was submitted to MassDEP on December 3, 2010.
2011	A RAM Completion Statement was submitted on April 25, 2011. A Phase II Scope of Work was prepared and submitted to MassDEP on January 18, 2011. Phase II and Phase III Reports were submitted on December 8, 2011. A RAM Completion Statement was submitted on April 25, 2011.
2012	Phase 4 Status Report transmitted in June 2012; the Phase IV Remedy Implementation Plan was submitted in December 2012.
2013	Phase 4 Status Report transmitted in June 2013, the Phase IV Completion Report was transmitted in December 2013.

Table J-18 MCP Activities Status of Massport Sites at Logan Airport (Continued)

6. Fire Training Facility (3-28199) (Continued)	
2014	Phase 5 Remedy Operation Status Reports submitted in June and December, 2014.
2015	Phase 5 Remedy Operation Status Reports submitted in June and December, 2015.
7. Southwest Service Area (3-28792)	
2009	Release notification form was submitted to MassDEP/BWSC on October 8, 2009.
2010	A Class B-1 RAO was submitted to MassDEP on October 18, 2010. No further response actions required.
2011	No further response actions required.
8. Airfield Duct Bank Site (3-29716)	
2010	Release notification form was submitted on December 22, 2010.
2011	A Class A-1 RAO was submitted on December 23, 2011. No further response actions required.
9. West Outfall Release (3-29792)	
2011	Release notification form was submitted on April 8, 2011. Two IRA Status Reports were submitted to MassDEP on June 9 and December 5, 2011. An RAO was submitted on February 13, 2012. No further response actions required.
10. Hertz Parking Lot Site (3-30260)	
2011	Release notification form was submitted on August 29, 2011. A RAM Plan was submitted to MassDEP on September 1, 2011.
2012	A Class A-2 RAO was submitted on September 10, 2012. No Further response actions required.
11. Former Butler Aviation Hangar (3-30654)	
2012	Verbal notification of a release was provided to MassDEP on February 14, 2012, when Rental Car Center construction encountered an unidentified underground storage, and a Release Notification Form was submitted on April 23, 2012. An IRA Plan was submitted May 21, 2012 and IRA Status Reports were submitted on June 18 and December 26, 2012.
2013	Phase I Report and Tier Classification submitted February 21, 2013 and IRA Completion Report submitted on July 11, 2013.
2014	A Permanent Solution Statement was submitted in October 2014. No further response actions required.
12. Taxi Pool Site (3-32022)	
2014	MassDEP notified of 72-hour Reportable Condition on March 10, 2014
2015	Phase I Report and Tier Classification submitted March 9, 2015.
13. Hangar 16 (3-32351)	
2014	Release Notification Form Submitted August 4, 2014.
2015	A RAM Plan was submitted on January 29, 2015; a Phase I Report and Tier Classification were submitted on August 3, 2015; a RAM Completion Report was submitted November 16, 2015; and a Permanent Solution Statement was submitted on January 21, 2016. No further response actions are required.

Source: Massport

Notes: This list includes Massport MCP sites only. Additional sites are the responsibility of Logan Airport tenants. Refer to Figure 8-2 for location of MCP sites. Complete information dating back to 1997 is included in Appendix J, Water Quality/Environmental Compliance Management.

AUL	Activity and Use Limitation	Phase I	Initial Site Investigation
MCP	Massachusetts Contingency Plan	Phase II	Comprehensive Site Assessment
RAM	Release Abatement Measure	Phase III	Identification, Evaluation, and Selection of Comprehensive Remedial Actions
RAO	Response Action Outcome	Phase IV	Implementation of Selected Remediation Action
FDS	Fuel Distribution System	Phase V	Operation, Maintenance and/or Monitoring
IRA	Immediate Response Action		

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Capital Programs and Environmental Affairs

EnviroNews

A Massport Newsletter

Volume 41, Issue 1
February 2015

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EnviroNews is a newsletter published quarterly for Massport and its tenants. Your comments and suggestions are welcome. Please contact Brenda Enos (benos@massport.com) at 617-568-5963.

SUSTAINABLE MASSPORT

Many of you have already received the 2015 Sustainable Massport calendar. The program is a year-long initiative to roll our sustainability program across the Authority.

Massport was selected to receive a FAA grant to prepare a Sustainability Management Plan (SMP) for Logan Airport as part of a nationally recognized pilot program. Massport was selected due to our exemplary track record in implementing sustainability initiatives and commitment to stewardship. When completed, the SMP will provide a baseline assessment of all Massport's activities and major accomplishments to date as well as support and promote sustainability at the Airport.

Massport has a very broad view of sustainability, which goes beyond environmental considerations to also include economic/financial benefits, social/community aspects, and the operational efficiency of facilities. This broad outlook of sustainability necessitates the involvement of all Airport employees.

The calendar has monthly programming on Hot Sustainability Topics. You will learn what Massport is doing; what you can do in the office and at home; and where to get more information.

The following is the summary of topics for the year:

January 2015 – Sustainability Awareness
February 2015 – Recycling
March 2015 – Energy/Electricity
April 2015 – Passenger Experience
May 2015 – Parks and Open Space
June 2015 – Sustainable Transportation
July 2015 – Water Conservation
August 2015 – Community Outreach and Support
September 2015 – Waste Management/Reduction
October 2015 – Climate Change Adaptation/Resiliency
November 2015 – Employee Wellness
December 2015 – Air Quality/Greenhouse Gas Reduction

For a copy of the calendar contact Jacob Glickel at jglickel@massport.com or (617) 568-3558

Jacob Glickel, Sustainability Project Manager

Jacob joined the Massport Staff in September 2014. The following is an interview with him.

What brought you to Massport?

Massport is an important economic engine in the region and a leader in incorporating sustainability throughout its organization. For example, the new Consolidated Rental Car Center has applied for a green building certification of LEED Gold and is served by buses using clean natural gas. Yet, there is always opportunity for Massport to continue to raise the bar on sustainability and be at the forefront among airports nationally. While airplane travel and port operations require high energy use and release of greenhouse gas emissions, the opportunity is enormous for Massport to make significant impact. Whether it be increasing recycling, reducing our energy use, or preparing for rising seas, Massport is primed to continue to be a leader.

What interests you most about expanding sustainability programs at Massport?

I have always been interested in bringing proven technologies and successful sustainable programs to a wider audience. There is often reporting of the next big technology or new product that will solve many of our climate and energy issues. Science and industry have already made great strides, and by just using existing technology, Massport could make drastic reductions in our energy use and greenhouse gas emissions. Of course, the key is to incorporate these sustainability programs and technology into how business is done today without a significant impact on our customers. I know it can be done and I will work with my colleagues across Massport to reach our goals. I encourage everyone to provide your ideas, give us feedback, and keep an open mind to new programs and technologies.

Can you give us an example of a project you are working on?

I know I have been talking a lot about energy use, but I am really excited to work on improving the amount of material recycled in the terminals and across Massport. I believe we can increase the recycling rate by 25% by the end of the year. Not only will this save Massport money but it will reduce our greenhouse gas emissions.

Where did you work prior to joining Massport?

For the past seven years, I worked for the City of Boston's Office of Environment, Energy and Open Space. I was able to take part in a number of firsts and big changes at the City of Boston around sustainability. I helped craft the first Climate Action Plan, which lays out a blueprint for how Boston is going to meet its sustainability goals. I engaged residents and businesses about reducing their energy use through Renew Boston. In just a two-year span, Renew Boston completed over 13,000 home energy assessments.

One of my biggest takeaways from working at the City of Boston was Mayor Thomas M. Menino's focus on relating sustainability to people's everyday lives. Mayor Menino constantly pushed our department to show the benefits to residents and businesses (our customers!) of being sustainable.

Where did you grow up?

I grew up and live in the Boston neighborhood of Jamaica Plain. When Boston first started offering monthly recycling drop offs, I remember separating the household trash and organizing my parents to drive me there. I love working and living in Boston. I take the T to work every day and know that I am adding one less car to traffic, as well saving money on my commute.

Service Station Safety Tips

An estimated 5,020 fires and explosions occurred at public service stations per year from 2004-2008. That means that, on average, one in every 13 service stations experienced a fire. These 7,400 fires caused an annual average of 2 deaths, 48 injuries and $20 million in property damage. Almost two-thirds of those fires involved vehicles. These statistics show that pumping gas is a hazardous operation. It is necessary to pay attention to what you're doing.

Check out this video clip of a fire started by static electricity as a young lady was refueling her SUV.

https://www.youtube.com/watch?v=tuZxFL9cGkI

If you search for "gas station fire videos", there are many more like this one. Some other tips are:

- Turn off your vehicle's engine when refueling.
- Keep gasoline and other fuels out of children's sight and reach. Gasoline is highly toxic in addition to being a fire hazard. Never allow a child to pump gas.
- Don't smoke, light matches or use lighters while refueling.
- Don't engage in other activities.
- If you must use any electronic device, such as cell phones, computers or portable radios while refueling, follow manufacturer's instructions. Again, play attention to what you are doing.
- Do not jam the latch with an object to hold it open.
- To avoid spills, do not top off or overfill your vehicle.
- After pumping gasoline, leave the nozzle in the tank opening for a few seconds to avoid drips when you remove it.
- If a fire starts while you're refueling, don't remove the nozzle from the vehicle or try to stop the flow of gasoline. Leave the area immediately and call for help.
- Don't get in and out of your vehicle while refueling. A static electric charge can develop on your body as you slide across the seat, and when you reach for the pump, a spark can ignite gasoline vapor.
- If you must get into the vehicle during refueling, discharge any static electricity by touching metal on the outside of the vehicle, away from the filling point, before removing the nozzle from your vehicle.
- Use only approved portable containers for transporting or storing gasoline. Make sure the container is in a stable position.
- Never fill a portable container when it is in or on the vehicle. Always place the container on the ground first. Fires caused by static charges have occurred when people filled portable containers in the back of pick-up trucks, particularly those with plastic bed liners. Removing the container will also prevent a dangerous spill of gasoline.
- When filling a portable container, keep the nozzle in direct contact with the container. Fill it only about 95 percent full to leave room for expansion.

Ground Service Equipment, Did You Know …?

Did you know that there are over 1200 pieces of Ground Service Equipment (also known as GSE) on the ramp at Logan? That is a lot of equipment in a small footprint of the terminal and cargo areas where GSE operate! This is in addition to the more than 200 on-road vehicles, such as trucks and vans, and 80 pieces of snow removal equipment that also operate on the ramp. Why bring up GSE equipment? Because GSE typically accounts for 25% of the fire alarm calls for fuel spills each year. In 2014, there were 32 notifications to fire alarm for GSE equipment leaking fuel on the ramp. In June and July of 2014 when ambient temperatures on the ramp began to rise, GSE spills increased to 30% with most spills attributed to thermal expansion. Equipment should not be topped off when refueling which is specifically prohibited under Logan's stormwater permit. In addition, given the age of many of the GSEs at Logan, implementation of routine inspections and maintenance to ensure equipment is in good operating condition is strongly encouraged. As you know, all fuel spills regardless of quantity require notification to Fire Alarm.

Provided below is a summary of fuel spills that occurred in 2014

Total number of spills: 129

Total fuel spilled: 2,785 gallons

Total reportable spills: 17

MA DEP and National Response Center
(10 gallons or more or impact to storm drainage system)

<u>Spill sources</u>:

49	Aircraft
32	GSE
8	Aircraft fueling system
29	Aircraft fueling system/GSE
2	Operator Error
1	Snowmelter
8	Other (gas station pump dispenser; transformer; jet bridge; construction truck; private auto)

<u>Fuel types</u>:

Jet Fuel:

Diesel Fuel:

Hydraulic oil:

Transmission oil:

Other: (gasoline; transmission fluid; unknown)

Brain Teaser

If you topped off a 20 gallon tank with diesel fuel with a beginning temperature of 75^{o} F and the tank warmed up to 95^{o} as it sat on the ramp in July, how much would the diesel fuel expand to overflow the tank?

<u>Formula:</u>

amount fueled **x** thermal expansion coefficient of diesel fuel (0.00046/^{o}F) **x** the increase in temperature = number of gallons spilled

Answer to Brain Teaser:

Answer: 0.2 gallons

Solution:

20 gallons (amount fueled) x 0.00046 (thermal expansion coefficient) x 20 (increase in temperature) = 0.2 gallons

Questions about Environmental/Safety Issues

Who should you contact?

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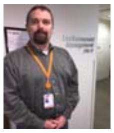 **Air Quality/Hazardous Waste**		
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Capital Programs and Environmental Affairs

EnviroNews

A Massport Newsletter

Volume 41, Issue 2
June 2015

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Sustainability Management Plan Release

Two years ago, Massport embarked on a comprehensive effort to prepare a Sustainability Management Plan (SMP) for Logan International Airport. This plan serves as a roadmap for prioritizing initiatives and moving goals forward along our path towards a more "Sustainable Massport". This plan will guide our sustainability practices over the next decade and will support the Authority's continued commitment to sustainability.

The report represents the combined efforts of over 125 employees and tenants who came together to establish our baseline sustainability performance, shape our goals, and identify new initiatives. Massport is focused on a holistic approach with an emphasis on economic viability, operational efficiency, natural resource conservation, and social responsibility.

Massport's commitment to sustainability has a long history, with recent accomplishments including the consolidation of the rental car shuttle bus fleet into a unified, alternative fuel busing system; the implementation of innovative applications of solar and wind energy technology; and the opening of the East Boston Greenway Connector. Additionally, the SMP has included several ground-breaking elements including the launch of an Authority-wide sustainability engagement calendar, distributed in January 2015, and the development of Sustainability Planning Optimization Tools (SPOT™) for use to manage Massport's sustainability efforts.

Logan Airport experienced record-breaking passenger levels in 2013, with 30.2 million passengers. The Airport achieved another milestone in 2014 with 31.6 million annual passengers. With passenger levels projected to reach 35 million by the end of 2022, the sustainable operation of Logan Airport is more important than ever before. As an increasing number of people pass through our gates, we will aim to engage our passengers, employees, and the community in a sustainable manner.

The SMP outlines the following:

- A summary of Logan Airport's current sustainability performance, with specific focus areas of energy and greenhouse gas emissions; resiliency; waste management, and recycling; water conservation; and community well-being.
- Sets sustainability goals to improve performance at Logan Airport, and established metrics for ongoing tracking of progress toward achieving those goals.
- Develops a well laid out and organized framework as a key to the successful implementation.

To view the Sustainability Management Plan Highlights Report go to:

www.Massport.com/Environment

WIPERS ON; LIGHTS ON!

Massachusetts joins a number of other states that specifically require headlights to be on when windshield wipers are on. A new state law went into effect on April 7, 2015, requiring motorists to turn on their headlights and tail-lights whenever their vehicle's windshield wipers are needed.

The new law also states that headlights and tail-lights should be turned on a half-hour after sunset and a half-hour before sunrise or when visibility is less than 500 feet. Relying on daytime running lights for these conditions is not sufficient under the law.

The fine for violating the new headlight law is only $5. However, a driver who gets ticketed for a headlights offense will face increased vehicle insurance premiums as it is a surchargeable offense (there are talks to have this portion removed from the law).

Here's the text of the new law, as it appears in Section 15, Chapter 85, of Massachusetts General Laws:

> A vehicle, whether stationary or in motion, on a public way, shall have attached to it headlights and tail-lights which shall be turned on by the vehicle operator and so displayed as to be visible from the front and rear during the period of 1/2 hour after sunset to 1/2 hour before sunrise; provided, however, that such headlights and tail-lights shall be turned on by the vehicle operator at all other times when, due to insufficient light or unfavorable atmospheric conditions, visibility is reduced such that persons or vehicles on the roadway are not clearly discernible at a distance of 500 feet or when the vehicle's windshield wipers are needed; provided further, that this section shall not apply to a vehicle which is designed to be propelled by hand; and provided further, that a vehicle carrying hay or straw for the purpose of transporting persons on a hayride shall display only electrically operated lights which shall be 2 flashing amber lights to the front and 2 flashing red lights to the rear, each of which shall be at least 6 inches in diameter and mounted 6 feet from the ground.

Baggage Conveyor Safety

Every day at the airport, numerous people work with automatic baggage conveyors. These can be stationary such as a stripping belt, mobile ramp trucks with conveyors, or back-of-house units transporting luggage across the terminal or across the airport. Baggage conveyors can start and stop without warning, even though most are equipped with audible warning signals. The Bureau of Labor and Standards – Occupational Safety and Health Administration, from 1998-2014, identifies many unfortunate incidents across a variety of occupations. Injuries related to conveyors identified 524 investigated injuries. Airport related injuries or fatalities were 50. Finally, "baggage conveyor" exhibits 21 documented injuries with 5 being fatal. Victims range from children being placed on baggage claim belts, to technicians absentmindedly forgoing Lock-Out/Tag-Out procedures. When servicing conveyor equipment or working around them, Please do not forget, the controls and operators of conveyors may be 100's of feet away, in remote offices.

The acute and prolonged risks of baggage handling are unique to airport workers. In an effort to communicate these inherent challenges, OSHA offers education specific to baggage handlers.

https://www.osha.gov/SLTC/etools/baggagehandling/baggage_makeup.html

2015 Regulatory Changes for Massachusetts Underground Storage Tanks

The Massachusetts Department of Environmental Protection (MADEP) recently enacted some changes to the underground storage tank (UST) regulations. These Regulations (310 CMR 80.00) address the registration, installation, operation, maintenance, closure and inspection of UST systems used to store petroleum fuels and hazardous substances. MADEP has also incorporated recent federal requirements and added new provisions to ensure that UST systems are properly installed, operated and maintained; that leaks and spills are prevented and contained; that UST systems and components found to be leaking or not working properly are repaired or replaced; and any resulting environmental damage is limited, assessed and cleaned up.

Below are some of the more significant changes in these regulations. This list however is not meant to be all inclusive. Tank owners and operators should read these regulations to make sure they are in compliance.

- Monthly inventory reconciliation is no longer required for double wall USTs/piping with continuous interstitial monitoring;
- Signs must be posted (and updated as necessary) at each UST indicating what steps should be followed in the event of a UST system or UST component emergency;
- Owners/operators must develop (and update when necessary) written procedures for how UST facility employees and contractors should respond in the event of an UST sys tem or UST component emergency;
- UST Leak Detection Systems must be tested on an annual basis;
- Piping sumps, intermediate sumps and dispenser sumps must be inspected annually, and must pass an integrity test by January 2, 2017;
- Inspections of USTs and associated systems must be conducted monthly under the direction of Class A or B Operator (interval not previously defined);
- The regulation identifies and clarifies specific timelines for responding to alarms/leaks/etc. to more closely match requirements in the Massachusetts Contingency Plan. Alarms must be investigated and resolved within 72 hours;
- Compliance Certifications must be submitted to MADEP by owner/operator 18 months after each third-party inspection (which are still due every 3 years);
- Spill buckets must be inspected monthly;
- New or replacement spill buckets must be double walled and have a minimum 5-gallon capacity and must pass a tightness test at installation;
- Existing spills buckets must pass an integrity testing by January 2, 2017, and at 5 year intervals thereafter;
- Double-walled tanks can be temporarily taken out of service for up to 5 years provided certain conditions are met (previous limit was 2 years); and
- Financial responsibility language in the regulations has been expanded/clarified to address exemptions. Specifically, the regulation indicates that financial responsibility is not required for "State and Federal government entities whose debts and liabilities are the debts and liabilities of a state or the United States government"

Please refer to http://www.mass.gov/eea/agencies/massdep/toxics/ust for detailed information.

Questions about Environmental/Safety Issues

Who should you contact?

Contact	Phone Number	Email Address
 **Auditing/General**		
Brenda Enos	(617) 568-5963	benos@massport.com
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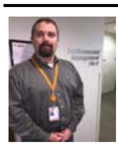 **Air Quality/Hazardous Waste**		
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Capital Programs and Environmental Affairs

EnviroNews

A Massport Newsletter

Volume 41, Issue 3
October 2015

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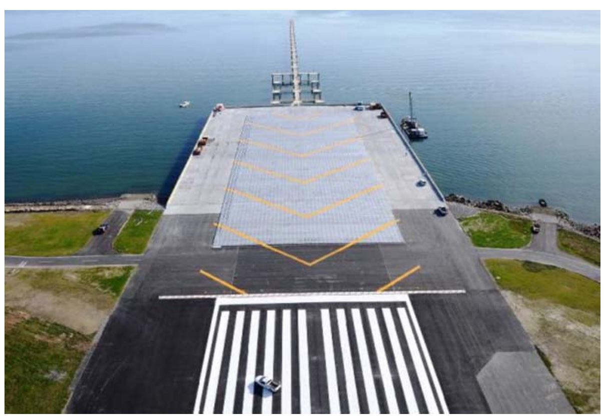
Massport's Conservation Mooring Program - An Eelgrass Alternative Mitigation Strategy

Why are eelgrass habitats important?

Eelgrass habitats are among the most productive and biologically diverse ecosystems on the planet. Living and dead plant material, including leaves, roots and rhizomes, has many valuable ecological functions such as stabilizing seafloor sediments and shorelines, cleaning coastal waters, providing habitat for a diversity of flora and fauna, and supporting the foundation of the detrital food web. The economic value of eelgrass habitat is demonstrated by the abundance and diversity of commercially and recreationally important species such as flounder, weakfish, blue crabs, bay scallops, lobsters, striped bass, and blue mussels (http://seagrant.mit.edu/eelgrass/eelgrassscience).

What is Massport's Conservation Mooring Program?

Massport's Conservation Mooring Program was developed as an alternative innovative strategy to mitigate for the unavoidable loss of 1.5 acres of eelgrass habitat when Runway 33L Safety Area (RSA) Improvements project was constructed.



Logan International Airport Runway 33L Safety Area

The initial eelgrass mitigation effort consisted of harvesting and transplanting more than 100,000 eelgrass shoots from the Runway 33L RSA project footprint prior to construction in June, 2011. The eelgrass shoots were relocated to two areas in Boston Harbor to re-establish eelgrass in those areas and encompassed a 4.6 acre footprint to meet the 3:1 regulatory mitigation ratio.

As early as October 2011, field surveys indicated that the Old Harbor Boston site had no surviving transplanted eelgrass and the White Head Flat sites showed only limited survival. At the Interagency Working Group (IWG), which comprised of the MA

Continued on next page

Compliance Corner

Hazardous Waste Compliance

Do you know your hazardous waste generator status?

Many Massport tenants generate regulated hazardous waste during the course of their operation. In Massachusetts, all businesses generating hazardous waste need to submit notification to MassDEP. Generator status is based on the amount of hazardous waste generated per month. Massachusetts regulates waste oil as a hazardous waste. This designation triggers requirements for proper storage, labeling, handling, transportation, disposal and record keeping. Very Small Quantity Generators (VSQG), those generating less than 220 lbs. / 27 gallons of federally regulated hazardous waste and up to 2200 lbs. / 270 gallons per month of Massachusetts regulated hazardous waste must fill out and submit a MassDEP Hazardous waste Generator Registration form. VSQG status allows on-site storage of up to 2200 gallons (5 – 55 gallon drums) at one time and has no time limit for duration of storage as long as it is below the storage limit. Generation of waste(s) above VSQG thresholds triggers other reporting and compliance requirements. More information is available at the MassDEP web site at **http://www.mass.gov/eea/agencies/massdep/recycle/hazardous/**

If you have any questions or concerns about hazardous waste compliance, contact the Massport Environmental Department.

Massport's Conservation Mooring Program - An Eelgrass Alternative Mitigation Strategy

DEP, US EPA, NOAA, MA Coastal Zone Management, Army Corps of Engineers, and Boston Conservation Commission, it was agreed that, given the limited transplanting success and the potential for long-term temporal loss of replacing eelgrass functions, Massport needed to pursue an alternative mitigation strategy to fulfill its eelgrass mitigations goals for the construction project. Massport elected to pursue conservation moorings, which would provide for the funding of traditional boat moorings in eelgrass with conservation moorings.

What are conservation moorings?

Conservation boat moorings utilized for Massport's Conservation Mooring Program consist of helical anchors and flexible mooring rodes. The helical anchor is an embedment anchor fabricated with high grade steel and designed to penetrate cohesive soils. Helix anchor installation has minimal environmental impact as it is hydraulically driven to a specified depth (~15 – 20 feet) using a specialized hydraulic anchor driver. Unlike traditional boat moorings which may have a concrete block and large footprint (i.e., 4 feet by 4 feet), the helix anchor footprint is typically no more than six inches in diameter at the substrate/water interface. Upon installation, the elastic mooring rode has several immediate benefits to the aquatic environment including the elimination of scour within the eelgrass meadow; reduction and/or elimination of suspended sediments in the water column; and reduction in water column turbidity which concomitantly improves water column clarity and enhances sunlight availability for the eelgrass shoots.

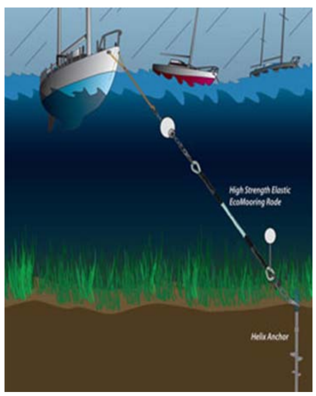
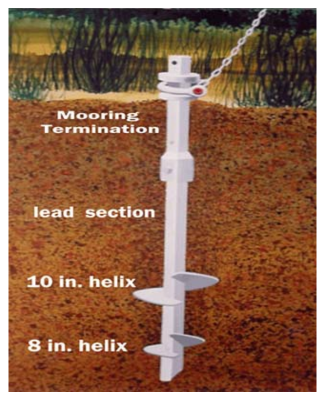


Figure 3. Ecomooring system
www.boatmoorings.com.



The Helix Anchor
www.helixanchors.com

Conservation Mooring Site Selection

The expansiveness of the eelgrass meadows in the selected harbors selected was one of Massport's important criteria for selection: the meadow had to be expansive with at least 25 boat moorings within the meadow footprint. The basis for the criteria was to maximize environmental benefit; the greater number of mooring replacements with conservation moorings within a defined eelgrass bed, the greater realization of the environmental benefits.

Under this program, Massport funded individual towns and entities for the purchase and installation of conservation boat mooring equipment to replace a total of 225 conventional chain moorings in harbors where extensive eelgrass meadows were co-located. Funding recipients included Manchester-by-the-Sea, Gloucester, West Falmouth, Wareham, and Camp Harbor View Foundation.

Expected benefits: With the replacement of conventional, substrate disturbing boat moorings, a multitude of environmental benefits are expected to be realized over time. With the rise and fall of the tides in the harbor environments and movement of the boats driven by the wind, it is expected that suspended solids will be measurably reduced and result in the overall improvement of water quality. Reduction in suspended solids in the water column is not only beneficial to the eelgrass habitat but is a more favorable environment for the aquatic organisms, such as fish and shellfish that seek shelter in the eelgrass meadow. Though the damaged eelgrass meadow may take some time to recover, the scars formed from the conventional moorings may fill in with eelgrass which will enhance the stability of the harbor bottom to further reduce sediment suspension in the water column.

Massport's Conservation Mooring Program was multifaceted that involved a diverse group of stakeholders who worked together to realize the collective goal of implementing the Conservation Mooring Program; the program strengthened Massport's commitment and those of the participants in the implementation of this significant environmental initiative; and ultimately, the citizens of the Commonwealth of Massachusetts benefit from the Conservation Mooring Program because eelgrass restoration and preservation is not just a local issue, it is regionally beneficial to enhancing the aquatic habitat.

2015 Airports Going Green Award

Massport has been chosen as a recipient of the 2015 Airports Going Green award for the Eelgrass Habitat/ Conservation Mooring Program which complements Massport's long-standing industry leadership and overall demonstrated commitment to sustainability. This prestigious award recognizes the value of this program as as well as Massport's outstanding leadership in pursuit of sustainability within the aviation industry. The award will be presented at the 8th Annual Airports Going Green Conference in Chicago on October 27th.

The Massport Safety Alliance Fair 2015

The Logan Airport Safety Alliance is a working group that promotes Ramp and Apron Safety. The group is chaired by Aviation Operations and Massport Safety and works closely with Massport Fire Rescue, Massport State Police, Massport Facilities, FAA, airline and ground service company partners to keep the ramp operation working safety and efficiently. The group meets monthly to discuss operational concerns and learn from each other. Typically, the meeting is held at the Massport Briefing Room the third Tuesday of each month. All are invited.

Each year, the Alliance sponsors a Safety Fair to support the effort. 2015 marked the 11th Massport Safety Fair. It was held on September 16th in the JetBlue Hangar with great success. There were 35 vendor tables showing the latest safety gear to over 1000 attendees. Jet Blue staff cooked up a delicious lunch of sausages, hamburgers and hotdogs for the hungry bunch. The Red Cross was also on-site collecting Blood Donations with 18 attendee's volunteering.

The Safety Alliance also manages the Logan Airport Safety Hotline. This is a voluntary, confidential reporting system which was created to provide a means for people to report unsafe practices or conditions on the Logan Apron without fear of retaliation. It can be reached by calling 617-568-3600. Each item will be logged and discussed at the next monthly Alliance meeting. As always, emergency conditions should be immediately reported to:

Massport Fire-Rescue at 617-567-2020,
Massport State Police at 617-568-7300 or
Massport Operations Department at 617-561-1919.

Thank you for putting *SAFETY FIRST* at Logan International Airport!

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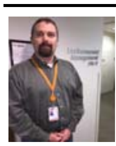 **Air Quality/Hazardous Waste**		
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2015 and 2016 Peak Period Pricing Monitoring Report

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BOSTON-LOGAN INTERNATIONAL AIRPORT MONITORING REPORT ON SCHEDULED AND NON-SCHEDULED FLIGHT ACTIVITY

Peak Period Surcharge Regulation
740 CMR 27:00: Massachusetts Port Authority

Report Number:	**012**
Monitoring Period:	**Through Sept. 2015**
Report Issue Date:	**May 2015**

Note: This report reflects the Boston-Logan Airport flight activity monitoring under 740 CMR 27.03 Peak Period Surcharge Regulation on Aircraft Operations at Boston-Logan International Airport.

Findings: This report includes actual and projected activity data **through September 2015**. Current and projected near-term flight levels at Boston Logan are well below Logan's good weather (VFR) throughput of approximately 120 flights per hour. **As a result, average VFR delays are projected to be minimal and well below the 15 minutes threshold through the analysis period.**

In the event demand conditions at the airport change significantly from the current projection, Massport will issue updates to this report.

Attachments

Table 1: Summary Overview of Peak Period Surcharge Program

Table 2: Summary Overview of Forecast Methodology

Table 3: Projected Aircraft Operations at Logan Airport Projected

Table 4: Projected Hourly Operations, Average Weekday

Table 5: Forecast Logan Average Weekday Operations

Massport Contact:

Mr. Flavio Leo
Deputy Director, Aviation Planning and Strategy
617-568-3528
fleo@massport.com

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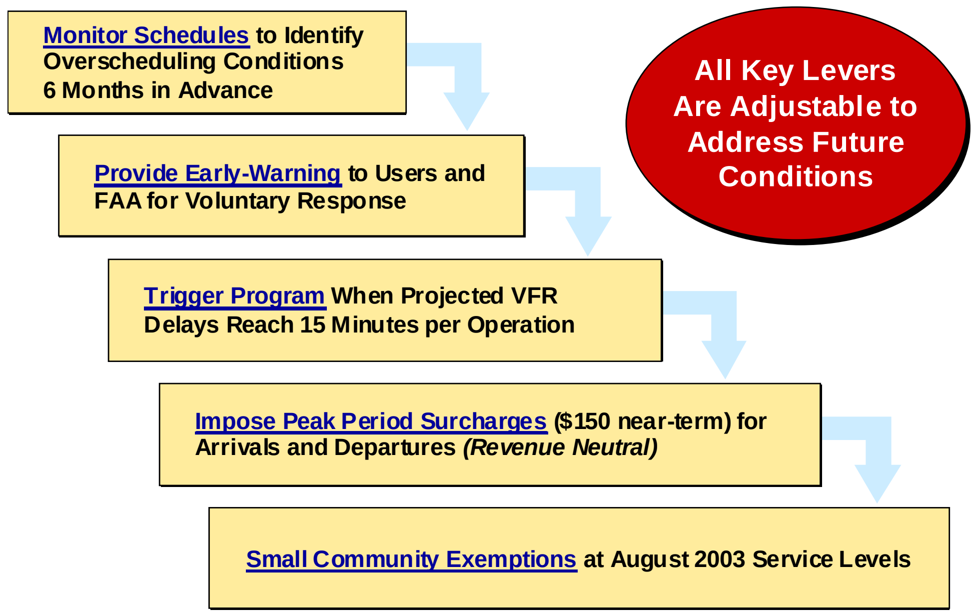

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- Scheduled passenger airline flights represent more than 93 percent of total aircraft operations. Passenger airline activity for the Spring and Summer periods were projected based on published advance airline schedules
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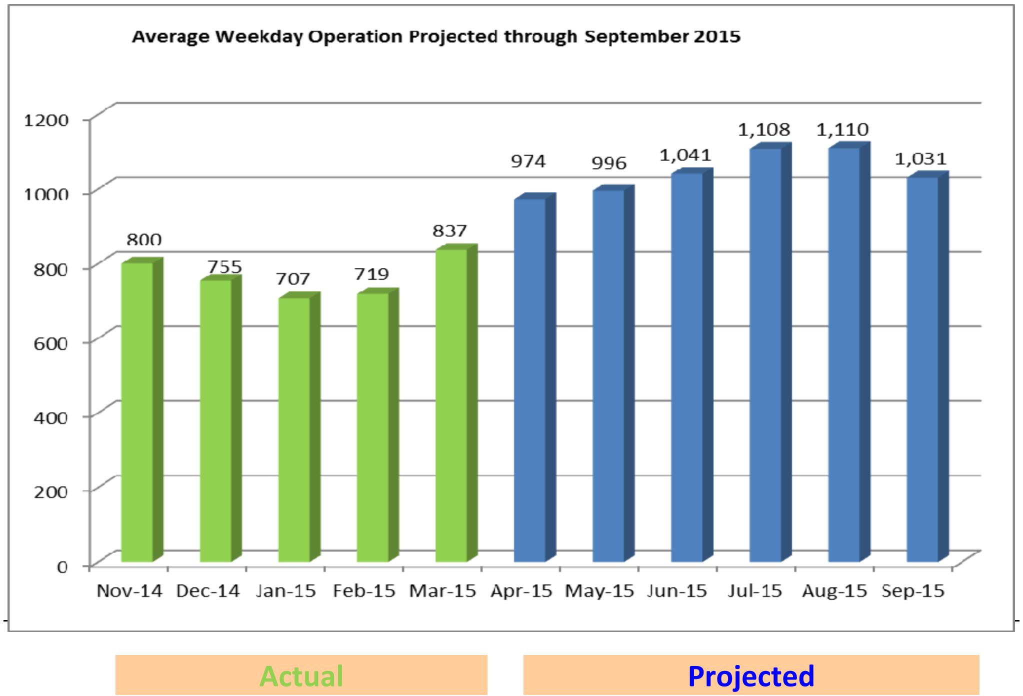

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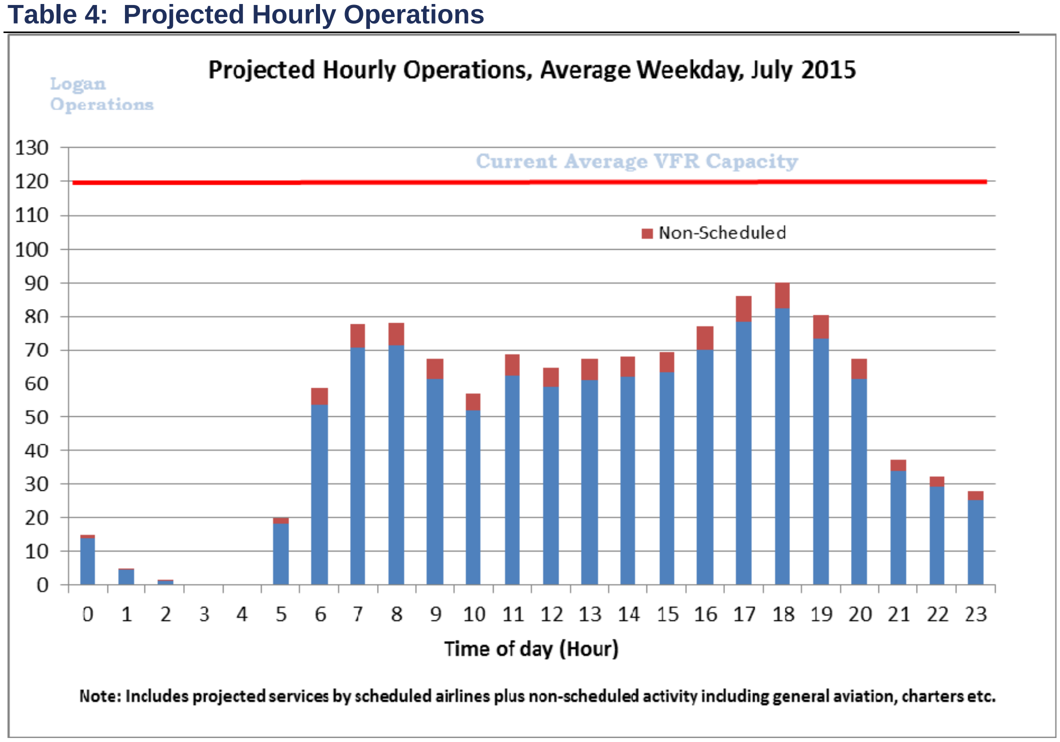

Table 5: Forecast Logan Average Weekday Operations, *Feb. – Sep.*

	Average Daily Operations							
Hour Range	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15
0	12	14	11	12	13	14	14	13
1	3	4	3	3	4	4	3	3
2	1	1	0	0	1	1	1	0
3	0	0	0	0	0	0	0	0
4	1	1	0	0	0	0	0	0
5	6	11	17	17	20	18	18	16
6	32	45	49	46	47	54	53	49
7	37	47	55	65	67	71	68	60
8	39	50	73	66	67	71	71	65
9	44	52	60	57	57	61	63	56
10	38	41	43	48	49	52	54	52
11	35	42	48	51	58	62	62	58
12	34	40	50	56	56	59	59	59
13	36	41	51	53	56	61	62	53
14	37	42	52	51	55	62	64	62
15	41	48	56	51	57	63	66	56
16	45	55	63	64	67	70	71	70
17	46	56	75	72	75	78	76	75
18	50	55	71	74	75	82	84	81
19	48	53	61	67	71	73	70	61
20	44	47	50	56	57	61	61	56
21	33	37	33	32	34	34	34	33
22	29	28	24	27	28	29	30	28
23	26	25	28	28	26	25	27	24
Total	**719**	**837**	**974**	**996**	**1,041**	**1,108**	**1,110**	**1,031**

February – March, actual data

April – September, forecast data

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BOSTON-LOGAN INTERNATIONAL AIRPORT MONITORING REPORT ON SCHEDULED AND NON-SCHEDULED FLIGHT ACTIVITY

Peak Period Surcharge Regulation
740 CMR 27:00: Massachusetts Port Authority

Report Number:	**013**
Monitoring Period:	**Through Sept. 2016**
Report Issue Date:	**May 2016**

<u>Note</u>: This report reflects the Boston-Logan Airport flight activity monitoring under 740 CMR 27.03 Peak Period Surcharge Regulation on Aircraft Operations at Boston-Logan International Airport.

<u>Findings</u>: This report includes actual and projected activity data **<u>through September 2016</u>**. Current and projected near-term flight levels at Boston Logan are well below Logan's good weather (VFR) throughput of approximately 120 flights per hour. **As a result, average VFR delays are projected to be minimal and well below the 15 minutes threshold through the analysis period.**

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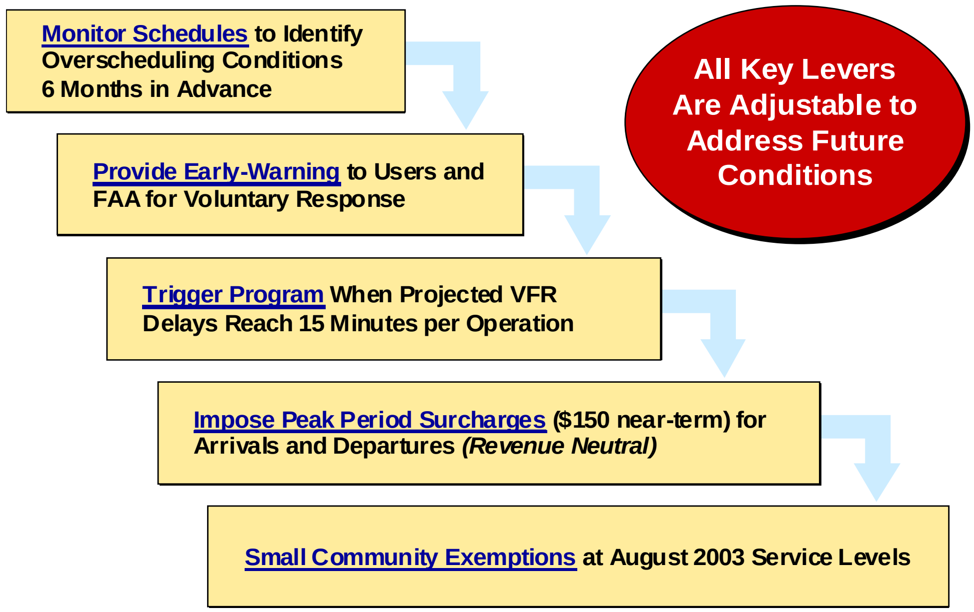

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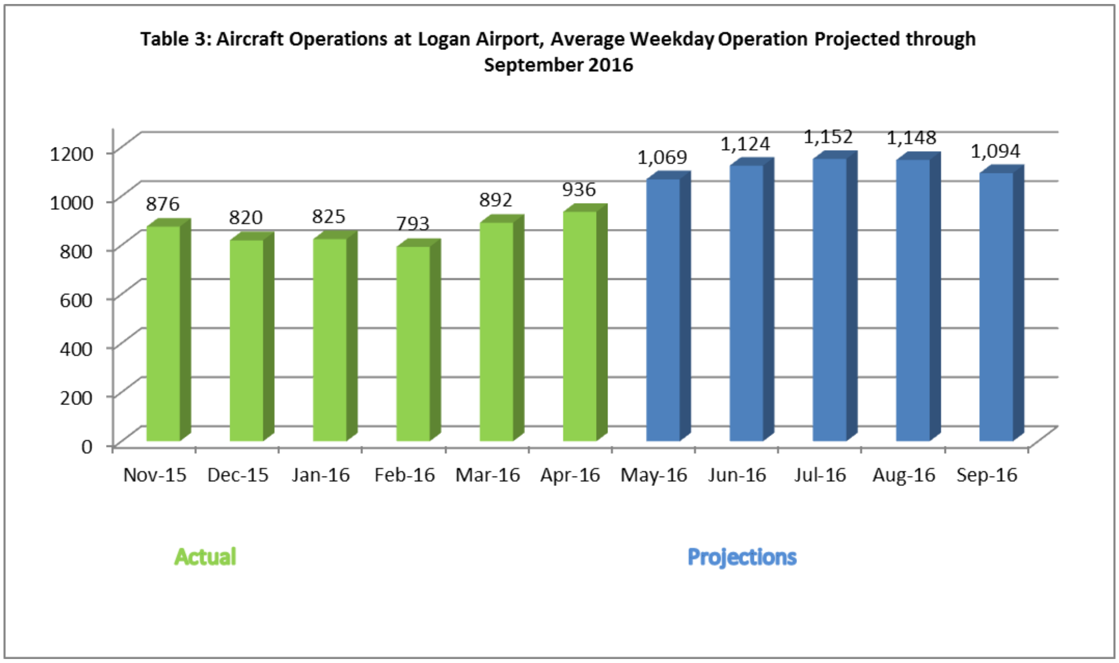

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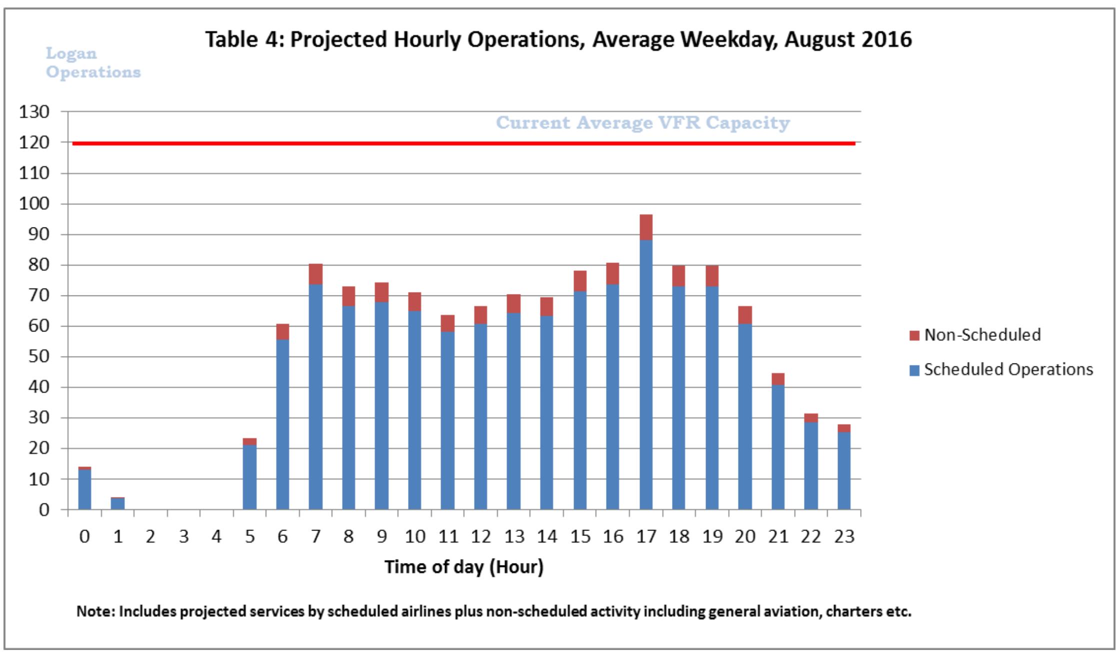

Table 5: Forecast Logan Average Weekday Operations, *Feb. – Sep.*

Forecast Daily Operations								
Hour Range	**Feb-16**	**Mar-16**	**Apr-16**	**May-16**	**Jun-16**	**Jul-16**	**Aug-16**	**Sep-16**
0	14	14	12	16	16	16	13	11
1	3	4	3	2	3	4	4	3
2	2	1	0	1	0	0	0	0
3	1	0	0	0	0	0	0	0
4	1	1	0	0	0	0	0	0
5	14	19	17	18	23	26	21	16
6	38	45	51	54	54	58	56	53
7	45	50	58	68	71	66	73	69
8	49	54	76	65	63	66	67	65
9	48	56	63	68	68	71	68	67
10	43	45	45	58	63	66	65	57
11	42	49	50	48	55	57	58	57
12	39	45	52	50	57	61	61	57
13	41	47	53	60	63	61	64	62
14	37	42	55	58	63	66	63	65
15	42	51	59	61	68	70	71	66
16	50	55	66	73	80	81	74	70
17	54	61	79	82	84	87	88	85
18	50	57	75	70	70	71	73	73
19	47	54	64	74	73	75	73	70
20	46	49	52	49	55	58	61	58
21	36	38	35	39	40	38	41	36
22	27	31	25	28	28	31	29	30
23	25	24	30	25	27	24	25	23
Total	**793**	**892**	**1,020**	**1,069**	**1,124**	**1,152**	**1,148**	**1,094**

February – April, actual data

May – September, forecast data

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Reduced/Single Engine Taxiing at Logan Airport Memoranda

This Appendix provides detailed information in support of Chapter 7, *Air Quality/ Emissions Reduction:*

- Memorandum from Edward C. Freni, Massport Director of Aviation, to the Boston Logan Airline Committee, Regarding Single/Reduced-Engine Taxiing and the Use of Idle Reverse Thrust as Strategies to Reduce Aircraft-Generated Emissions and Noise at Boston Logan, Dated May 4, 2015
- Memorandum from Edward C. Freni, Massport Director of Aviation, to the Boston Logan Airline Committee, Regarding Single/Reduced-Engine Taxiing and Other Strategies to Reduce Aircraft-Generated Emissions and Noise at Boston Logan, Dated May 18, 2016
- Simaiakis, I, Khadilkar, H., Balakrishnan, H., Reynolds, T.G., Hansman, R.J., Reilly, B., and Urlass, S. "Demonstration of Reduced Airport Congestion Through Pushback Rate Control." *Ninth USA/Europe Air Traffic Management Research and Development Seminar (ATM2011)*.

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massport
Massachusetts Port Authority
One Harborside Drive
East Boston, MA 02128-2909
Telephone (617) 568-5000
www.massport.com

TO: Boston Logan Air Carriers, Chief Pilots

FROM: Edward C. Freni
Director of Aviation

DATE: May 4, 2015

RE: Single/Reduced-Engine Taxiing and the Use of Idle Reverse Thrust as Strategies to Reduce Aircraft-Generated Emissions and Noise at Boston Logan

As an important user of Boston-Logan International Airport ("Boston Logan"), you are an essential partner in our efforts to ensure that Boston Logan operates in the safest, most dependable and environmentally responsible manner possible. Working together, we have successfully implemented many safety technologies and airfield improvements at Boston Logan and we look forward to continuing these collaborative relationships.

Our success in implementing physical and technological improvements and conducting cutting-edge safety research at Boston Logan is based, in part, on continuing to evaluate and promote operational measures with the potential to reduce environmental impacts from various landside and airside operations. Two important operational measures that have been identified are single/reduced-engine taxiing and the use of idle-reverse thrust.

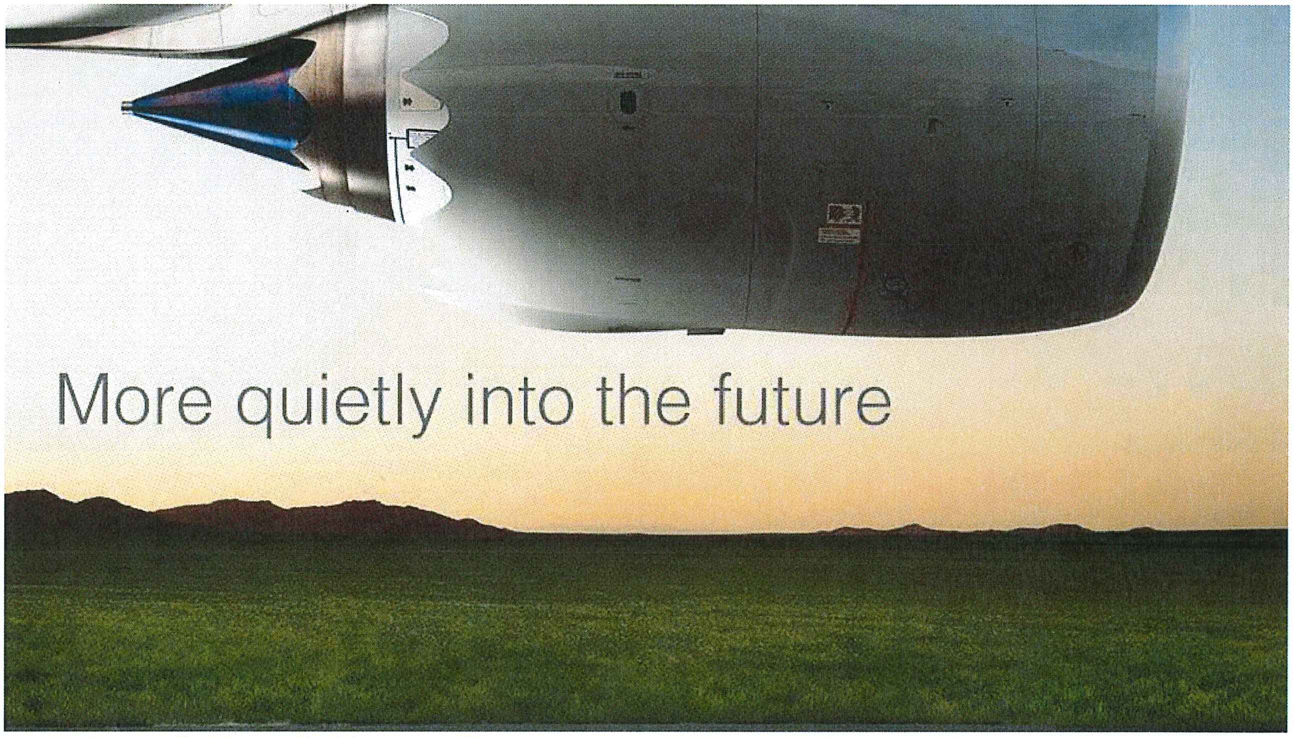
Based on our outreach to the air carrier community serving Boston Logan and survey information, it is clear that single- or reduced-engine taxiing is being voluntarily utilized by the vast majority of air carriers at Boston Logan. I write to you again to encourage your continued use of this fuel saving and emissions reduction strategy subject to pilot discretion and consistent with air carrier operating safety procedures.

I also encourage your use of idle reverse thrust (or minimize the use of reverse thrust) on landing, as a second operational measure, again, only at the discretion of the pilot and when consistent with air carrier operational safety procedures. This measure provides noise relief to our closest neighbors and, at the same time, provides companion benefits to you, such as reducing fuel burn and engine wear. Clearly, the use of this procedure must be consistent with operational conditions at Boston Logan, including runway surface conditions and whether LAHSO is in use.

On a related note, I want to share with you information regarding recent industry efforts to retrofit A320 aircraft with "vortex generators" to reduce aircraft noise. Although the A320 is a fully compliant/modern aircraft, this is an excellent example of additional, incremental actions we can take as an industry to reduce operational impacts on the environment. Attached please find more information related to this technology.

I encourage you to share this letter with your flight crews and thank you for your continued work to enhance Boston Logan's operational safety and efficiency, while improving its environmental footprint. If you have any questions or would like to discuss any aspect of this letter, please feel free to contact me or Mr. Flavio Leo, Deputy Director of Planning and Strategy, at 617-568-3528.

Edward C. Freni
Director of Aviation



Retrofitting the existing fleet

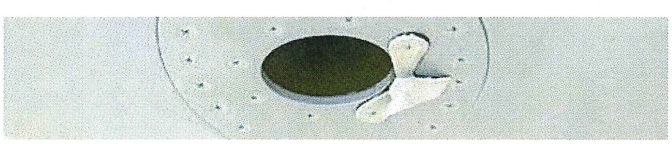
The Lufthansa Group is also retrofitting older aircraft in its fleet with noise-reducing technologies. In this connection the Group is working closely with the German Aerospace Center (DLR) and the various aircraft manufacturers.

Lufthansa is retrofitting more than 200 aircraft with vortex generators so that they will fly more quietly in the future.

In February 2014 Lufthansa became the first airline in the world to take delivery of an Airbus A320 equipped with vortex generators. A total of 157 aircraft in the existing fleet will be equipped with the new noise-reducing component, so that, when the expected new deliveries are added in, more than 200 A320 aircraft in total will be flying more quietly. As result, every second Lufthansa landing in Frankfurt and one in three in Munich will become audibly quieter. Overfly measurements revealed that the vortex generators are able to eliminate two unpleasant tones and thereby lower the aircraft's total noise level on approach by up to four decibels at distances between 17 and 10 kilometers from the runway. Thus the Lufthansa Group has realized a key objective of the "Alliance for More Noise Protection", a joint initiative of the Lufthansa Group, Fraport, the airline association BARIG, DFS, the Airport and Region Forum (FFR), and the government of the State of Hesse.

A320 audio tests

A320 audio tests with and without vortex generators on the **final approach at Frankfurt Airport** from the Offenbach-Lauterborn monitoring point



Further information

Refitting existing aircraft

→ Active noise protection – More than 200 Lufthansa Airbus A320 aircraft will become quieter from February 2014

Video: Active noise protection at Frankfurt Airport

→ Retrofitting of the Boeing 737 fleet

Press Releases

29.10.13

→ Lufthansa to make majority of short-haul aircraft quieter

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→ Overview

Without vortex generators **With vortex generators**

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Without vortex generators **With vortex generators**

massport

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Important measures that have been identified are:

1.) Single/reduced-engine taxiing,
2.) Use of idle-reverse thrust, and
3.) Retrofitting older A320 aircraft with "vortex generators" to reduce aircraft noise.

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Director of Aviation

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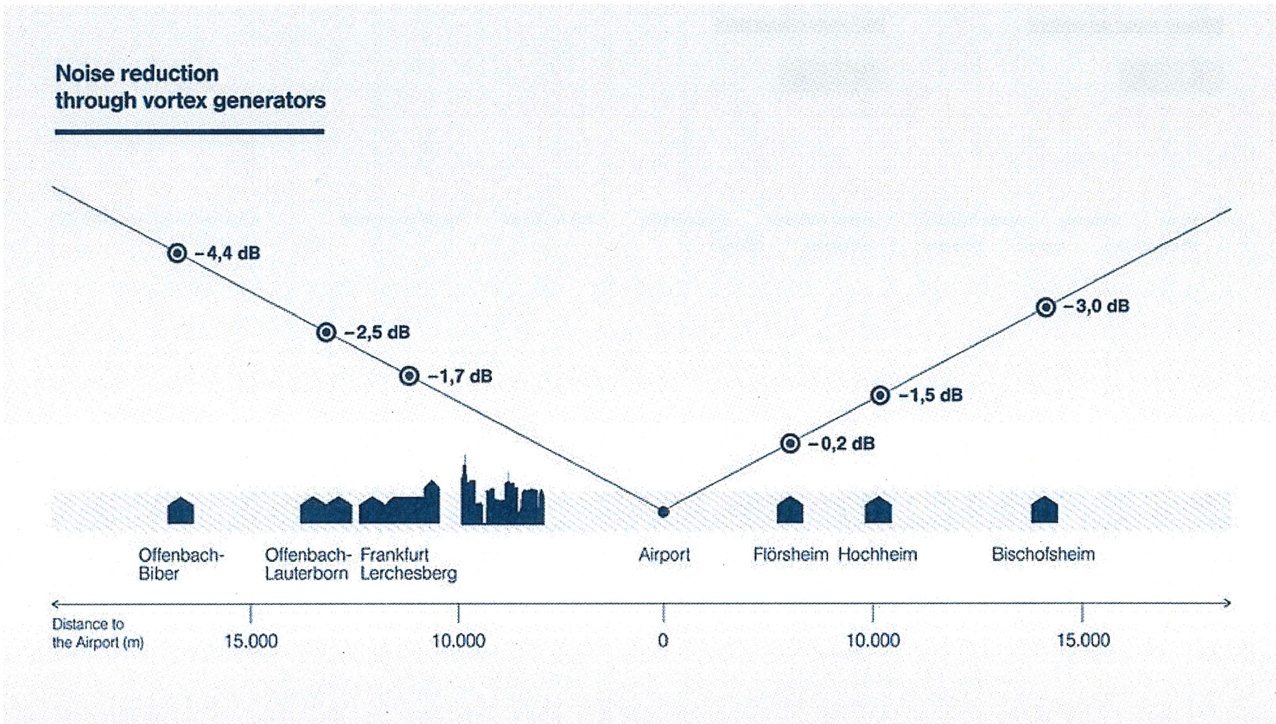

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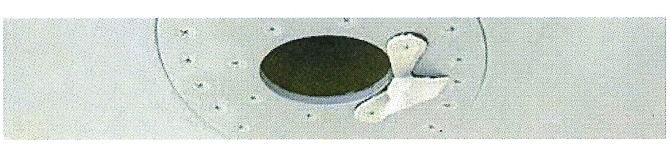

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Overview

Without vortex generators **With vortex generators**

A320 audio tests with and without vortex generators on the **final approach at Munich Airport** from the Massenhausen monitoring point

Without vortex generators **With vortex generators**

Demonstration of Reduced Airport Congestion Through Pushback Rate Control

I. Simaiakis, H. Khadilkar, H. Balakrishnan, T. G. Reynolds and R. J. Hansman
Department of Aeronautics and Astronautics
Massachusetts Institute of Technology
Cambridge, MA, USA

B. Reilly
Boston Airport Traffic Control Tower
Federal Aviation Administration
Boston, MA, USA

S. Urlass
Office of Environment and Energy
Federal Aviation Administration
Washington, DC, USA

***Abstract*—Airport surface congestion results in significant increases in taxi times, fuel burn and emissions at major airports. This paper describes the field tests of a congestion control strategy at Boston Logan International Airport. The approach determines a suggested rate to meter pushbacks from the gate, in order to prevent the airport surface from entering congested states and to reduce the time that flights spend with engines on while taxiing to the runway. The field trials demonstrated that significant benefits were achievable through such a strategy: during eight four-hour tests conducted during August and September 2010, fuel use was reduced by an estimated 12,000-15,000 kg (3,900-4,900 US gallons), while aircraft gate pushback times were increased by an average of only 4.3 minutes for the 247 flights that were held at the gate.**

Keywords- departure management, pushback rate control, airport congestion control, field tests

I. Introduction

Aircraft taxiing on the surface contribute significantly to the fuel burn and emissions at airports. The quantities of fuel burned, as well as different pollutants such as Carbon Dioxide, Hydrocarbons, Nitrogen Oxides, Sulfur Oxides and Particulate Matter, are proportional to the taxi times of aircraft, as well as other factors such as the throttle settings, number of engines that are powered, and pilot and airline decisions regarding engine shutdowns during delays.

Airport surface congestion at major airports in the United States is responsible for increased taxi-out times, fuel burn and emissions [1]. Similar trends have been noted in Europe, where it is estimated that aircraft spend 10-30% of their flight time taxiing, and that a short/medium range A320 expends as much as 5-10% of its fuel on the ground [2]. Domestic flights in the United States emit about 6 million metric tonnes of CO_2, 45,000 tonnes of CO, 8,000 tonnes of NOx, and 4,000 tonnes of HC taxiing out for takeoff; almost half of these emissions are at the 20 most congested airports in the country. The purpose of the Pushback Rate Control Demonstration at Boston Logan International Airport (BOS) was to show that a significant portion of these impacts could be reduced through measures to limit surface congestion.

This work was supported by the Federal Aviation Administration's Office of Environment and Energy through MIT Lincoln Laboratory and the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER).

A simple airport congestion control strategy would be a state-dependent pushback policy aimed at reducing congestion on the ground. The *N-control* strategy is one such approach, and was first considered in the Departure Planner project [3]. Several variants of this policy have been studied in prior literature [4, 5, 6, 7]. The policy, as studied in these papers, is effectively a simple threshold heuristic: if the total number of departing aircraft on the ground exceeds a certain threshold, further pushbacks are stopped until the number of aircraft on the ground drops below the threshold. By contrast, the *pushback rate control* strategy presented in this paper does not stop pushbacks once the surface is in a congested state; instead it regulates the rate at which aircraft pushback from their gates during high departure demand periods so that the airport does not reach undesirable highly congested states.

A. Motivation: Departure throughput analysis

The main motivation for our proposed approach to reduce taxi times is an observation of the performance of the departure throughput of airports. As more aircraft pushback from their gates onto the taxiway system, the throughput of the departure runway initially increases because more aircraft are available in the departure queue. However, as this number, denoted N, exceeds a threshold, the departure runway capacity becomes the limiting factor, and there is no additional increase in throughput. We denote this threshold as N^*. This behavior can be further parameterized by the number of arrivals. The dependence of the departure throughput on the number of aircraft taxiing out and the arrival rate is illustrated for one runway configuration in Figure 1 using 2007 data from FAA's Aviation System Performance Metrics (ASPM) database. Beyond the threshold N^*, any additional aircraft that pushback simply increase their taxi-out times [8]. The value of N^* depends on the airport, arrival demand, runway configuration, and meteorological conditions. During periods of high demand, the pushback rate control protocol regulates pushbacks from the gates so that the number of aircraft taxiing out stays close to a specified value, N_{ctrl}, where $N_{\text{ctrl}} > N^*$, thereby ensuring that the airport does not reach highly-congested states. While the choice of N_{ctrl} must be large enough to maintain runway utilization, too large a value will be overly conservative, and result in a loss of benefit from the control strategy.

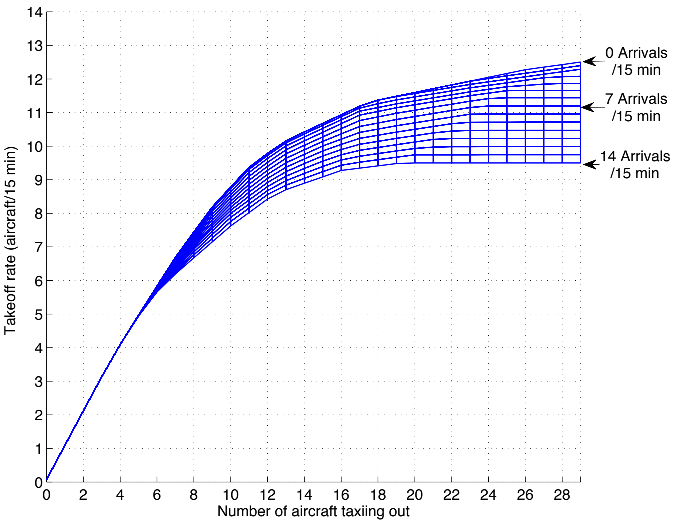

Fig. 1: Regression of the departure throughput as a function of the number of aircraft taxiing out, parameterized by the arrival rate for 22L, 27 | 22L, 22R configuration, under VMC [9].

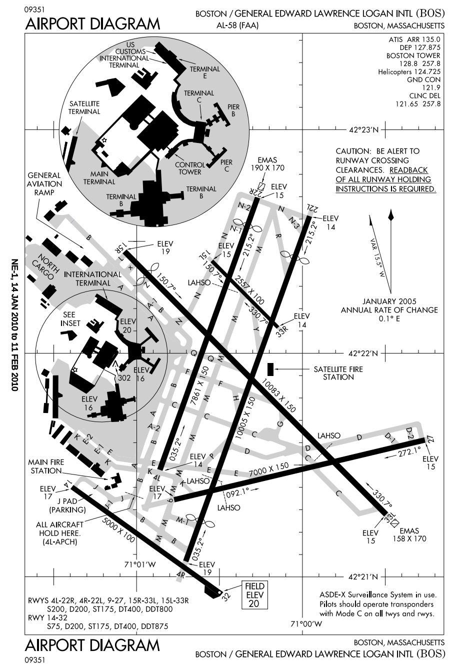

Fig. 2: BOS airport diagram, showing alignment of runways.

II. Design of the pushback rate control protocol

The main design consideration in developing the pushback rate control protocol was to incorporate effective control techniques into current operational procedures with minimal additional controller workload and procedural modifications. After discussions with the BOS facility, it was decided that suggesting a rate of pushbacks (to the BOS Gate controller) for each 15-min period was an effective strategy that was amenable to current procedures.

The two important parameters that need to be estimated in order to determine a robust control strategy are the N^* threshold and the departure throughput of the airport for different values of N. These parameters can potentially vary depending on meteorological conditions, runway configuration and arrival demand (as seen in Figure 1), but also on the fleet mix and the data sources we use.

A. Runway configurations

BOS experiences Visual Meteorological Conditions (VMC) most of the time (over 83% of the time in 2007). It has a complicated runway layout consisting of six runways, five of which intersect with at least one other runway, as shown in Figure 2. As a result, there are numerous possible runway configurations: in 2007, 61 different configurations were reported. The most frequently-used configurations under VMC are 22L, 27 | 22L, 22R; 4L, 4R | 4L, 4R, 9; and 27, 32 | 33L, where the notation 'R1, R2 | R3, R4' denotes arrivals on runways R1 and R2, and departures on R3 and R4. The above configurations accounted for about 70% of times under VMC.

We note that, of these frequently used configurations, 27, 32 | 33L involves taxiing out aircraft across active runways. Due to construction on taxiway "November" between runways 15L and 22R throughout the duration of the demo, departures headed to 22R used 15L to cross runway 22R onto taxiway "Mike". This resulted in departing aircraft crossing active runways in the 27, 22L | 22L, 22R configuration as well.

During our observations prior to the field tests as well as during the demo periods, we found that under Instrument Meteorological Conditions (IMC), arrivals into BOS are typically metered at the rate of 8 aircraft per 15 minutes by the TRACON. This results in a rather small departure demand, and there was rarely congestion under IMC at Boston during the evening departure push. For this reason, we focus on configurations most frequently used during VMC operations for the control policy design.

B. Fleet mix

Qualitative observations at BOS suggest that the departure throughput is significantly affected by the number of propeller-powered aircraft (props) in the departure fleet mix. In order to determine the effect of props, we analyze the tradeoff between takeoff and landing rates at BOS, parameterized by the number of props during periods of high departure demand.

Figure 3 shows that under Visual Meteorological Conditions (VMC), the number of props has a significant impact on the departure throughput, resulting in an increase at a rate of nearly one per 15 minutes for each additional prop departure. This observation is consistent with procedures at BOS, since air traffic controllers fan out props in between jet departures, and therefore the departure of a prop does not significantly interfere with jet departures. The main implication of this observation for the control strategy design at BOS was that props could be exempt from both the pushback control as well as the counts of aircraft taxiing out (N). Similar analysis also shows that heavy departures at BOS do not have a significant

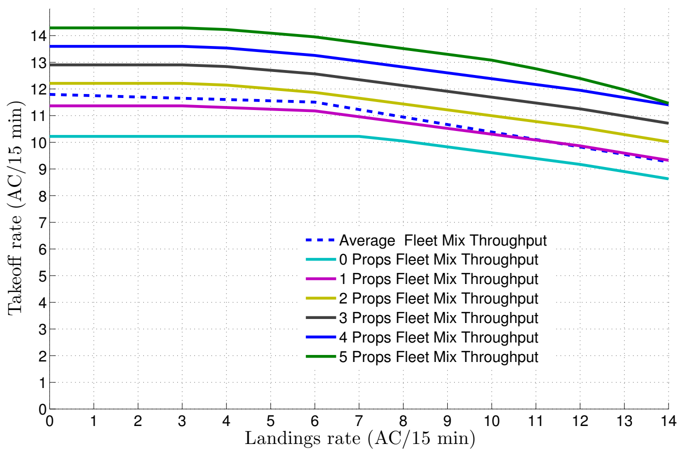

Fig. 3: Regression of the takeoff rate as a function of the landing rate, parameterized by the number of props in a 15-minute interval for 22L, 27 | 22L, 22R configuration, under VMC [9].

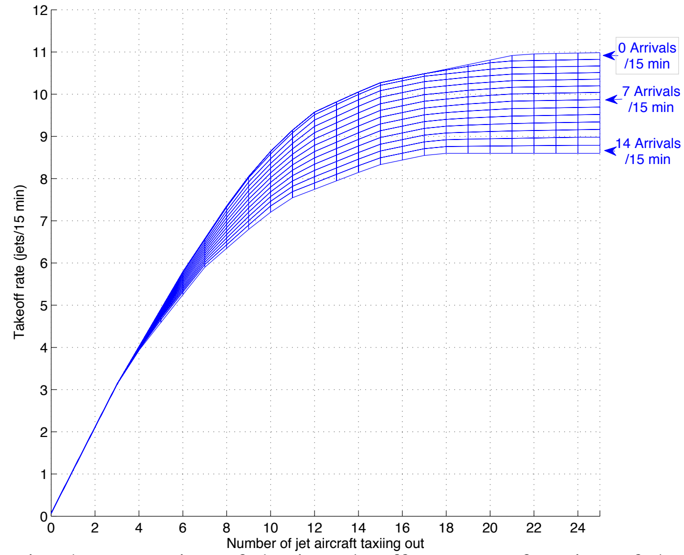

Fig. 4: Regression of the jet takeoff rate as a function of the number of departing jets on the ground, parameterized by the number of arrivals for 22L, 27 | 22L, 22R configuration, under VMC [9].

impact on departure throughput, in spite of the increased wake-vortex separation that is required behind heavy weight category aircraft. This can be explained by the observation that air traffic controllers at BOS use the high wake vortex separation requirement between a heavy and a subsequent departure to conduct runway crossings, thereby mitigating the adverse impact of heavy weight category departures [9].

Motivated by this finding, we can determine the dependence of the jet (i.e., non-prop) departure throughput as a function of the number of jet aircraft taxiing out, parameterized by the number of arrivals, as illustrated in Figure 4. This figure illustrates that during periods in which arrival demand is high, the jet departure throughput saturates when the number of jets taxiing out exceeds 17 (based on ASPM data).

C. Data sources

It is important to note that Figure 1, Figure 3 and Figure 4 are determined using ASPM data. Pushback times in ASPM are determined from the brake release times reported through the ACARS system, and are prone to error because about 40% of the flights departing from BOS do not automatically report these times [10]. Another potential source of pushback and takeoff times is the Airport Surface Detection Equipment Model X (or ASDE-X) system, which combines data from airport surface radars, multilateration sensors, ADS-B, and aircraft transponders [11]. While the ASDE-X data is likely to be more accurate than the ASPM data, it is still noisy, due to factors such as late transponder capture (the ASDE-X tracks only begin after the pilot has turned on the transponder, which may be before or after the actual pushback time), aborted takeoffs (which have multiple departure times detected), flights cancelled after pushback, etc. A comparison of both ASDE-X and ASPM records with live observations made in the tower on August 26, 2010 revealed that the average difference between the number of pushbacks per 15-minutes as recorded by ASDE-X and by visual means is 0.42, while it is -3.25 for ASPM and visual observations, showing that the ASPM records differ considerably from ASDE-X and live observations. The above comparison motivates the recalibration of airport performance curves and parameters using ASDE-X data in addition to ASPM data. This is because ASPM data is not available in real-time and will therefore not be available for use in real-time deployments, and the ASDE-X data is in much closer agreement to the visual observations than ASPM.

We therefore conduct similar analysis to that shown in Figure 4, using ASDE-X data. The results are shown in Figure 5. We note that the qualitative behavior of the system is similar to what was seen with ASPM data, namely, the jet throughput of the departure runway initially increases because more jet aircraft are available in the departure queue, but as this number exceeds a threshold, the departure runway capacity becomes the limiting factor, and there is no additional increase in throughput. By statistically analyzing three months of ASDE-X data from Boston Logan airport using the methodology outlined in [9], we determine that the average number of active jet departures on the ground at which the surface saturates is 12 jet aircraft for the 22L, 27 | 22L, 22R configuration, during periods of moderate arrival demand. This value is close to that deduced from Figure 5, using visual means.

D. Estimates of N^*

Table I shows the values of N^* for the three main runway configurations under VMC, that were used during the field tests based on the ASDE-X data analysis. For each runway configuration, we use plots similar to Figure 5 to determine the expected throughput. For example, if the runway configuration is 22L, 27 | 22L, 22R, 11 jets are taxiing out, and the expected arrival rate is 9 aircraft in the next 15 minutes, the expected departure throughput is 10 aircraft in the next 15 minutes.

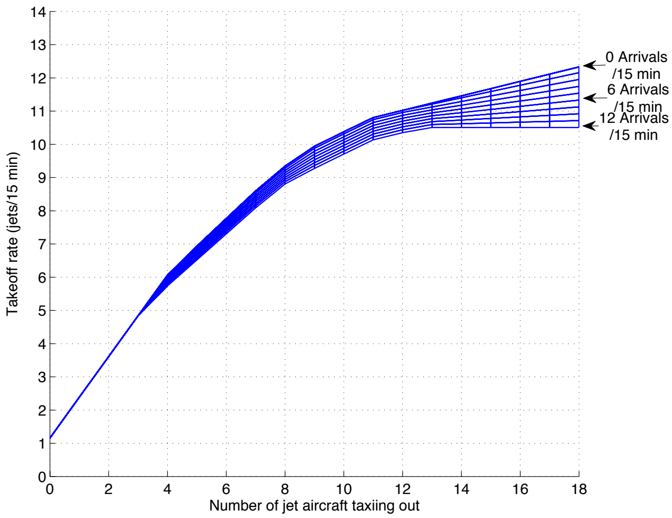

Fig. 5: Regression of the takeoff rate as a function of the number of jets taxiing out, parameterized by the number of arrivals, using ASDE-X data, for the 22L, 27 | 22L, 22R configuration.

III. Implementation of Pushback Rate Control

The pushback rate was determined so as to keep the number of jets taxiing out near a suitable value (N_{ctrl}), where N_{ctrl} is greater than N^*, in order to mitigate risks such as under-utilizing the runway, facing many gate conflicts, or being unable to meet target departure times. Off-nominal events such as gate-use conflicts and target departure times were carefully monitored and addressed. Figure 6 shows a schematic of the decision process to determine the suggested pushback rate.

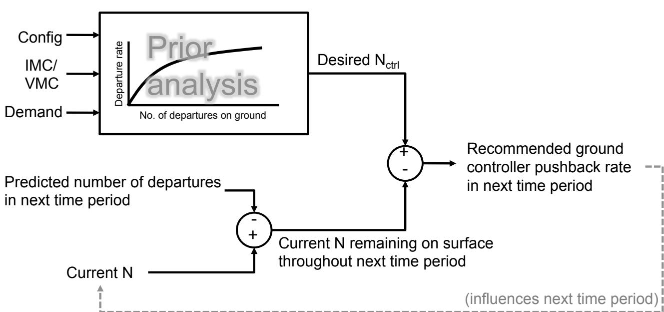

Fig. 6: A schematic of the pushback rate calculation.

The determination of the pushback rate is conducted as follows. Prior to the start of each 15-minute period, we:

1) Observe the operating configuration, VMC/IMC, and the predicted number of arrivals in the next 15 minutes (from ETMS) and using these as inputs into the appropriate departure throughput saturation curves (such as Figure 5), determine the expected jet departure throughput.
2) Using visual observations, count the number of departing jets currently active on the surface. We counted a departure as active once the pushback tug was attached to the aircraft and it was in the process of pushing back.
3) Calculate the difference between the current number of active jet departures and the expected jet departure throughput. This difference is the number of currently active jets that are expected to remain on the ground through the next 15 min.
4) The difference between N_{ctrl} and the result of the previous step provides us with the additional number of pushbacks to recommend in next 15 minutes.
5) Translate the suggested number of pushbacks in the next 15 minutes to an approximate pushback rate in a shorter time interval more appropriate for operational implementation (for example, 10 aircraft in the next 15 minutes would translate to a rate of “2 per 3 minutes.”).

TABLE I
Values of N^* estimated from the analysis of ASDE-X data.

Configuration	N^*
22L, 27 | 22L, 22R	12
27, 32 | 33L	12
4L, 4R | 4L, 4R, 9	15

A. Communication of recommended pushback rates and gate-hold times

During the demo, we used color-coded cards to communicate suggested pushback rates to the air traffic controllers, thereby eliminating the need for verbal communications. We used one of eight 5 in × 7.5 in cards, with pushback rate suggestions that ranged from “1 per 3 minutes” (5 in 15 minutes) to “1 aircraft per minute” (15 in 15 minutes), in addition to “Stop” (zero rate) and “No restriction” cards, as shown in Figure 7 (left). The setup of the suggested rate card in the Boston Gate controllers position is shown in Figure 7 (right).

Fig. 7: (Left) Color-coded cards that were used to communicate the suggested pushback rates. (Right) Display of the color-coded card in the Boston Gate controller’s position.

The standard format of the gate-hold instruction communicated by the Boston Gate controller to the pilots included both the current time, the length of the gate-hold, and the time at which the pilot could expect to be cleared. For example:
Boston Gate: “AAL123, please hold push for 3 min. Time is now 2332, expect clearance at 2335. Remain on my frequency, I will contact you.”

In this manner, pilots were made aware of the expected gate-holds, and could inform the controller of constraints such as gate conflicts due to incoming aircraft. In addition, ground crews could be informed of the expected gate-hold time, so that they could be ready when push clearance was given. The post-analysis of the tapes of controller-pilot communications showed that the controllers cleared aircraft for push at the times they had initially stated (i.e., an aircraft told to expect to push at 2335 would indeed be cleared to push at 2335), and that they also accurately implemented the push rates suggested by the cards.

B. Handling of off-nominal events

The implementation plan also called for careful monitoring of off-nominal events and system constraints. Of particular concern were gate conflicts (for example, an arriving aircraft is assigned a gate at which a departure is being held), and the ability to meet controlled departure times (Expected Departure Clearance Times or EDCTs) and other constraints from Traffic Management Initiatives. After discussions with the Tower and airlines prior to the field tests, the following decisions were made:

1) Flights with EDCTs would be handled as usual and released First-Come-First-Served. Long delays would continue to be absorbed in the standard holding areas. Flights with EDCTs did not count toward the count of active jets when they pushed back; they counted toward the 15-minute interval in which their departure time fell. An analysis of EDCTs from flight strips showed that the ability to meet the EDCTs was not impacted during the field tests.
2) Pushbacks would be expedited to allow arrivals to use the gate if needed. Simulations conducted prior to the field tests predicted that gate-conflicts would be relatively infrequent at BOS; there were only two reported cases of potential gate-conflicts during the field tests, and in both cases, the departures were immediately released from the gate-hold and allowed to pushback.

C. Determination of the time period for the field trials

The pushback rate control protocol was tested in select evening departure push periods (4-8PM) at BOS between August 23 and September 24, 2010. Figure 8 shows the average number of departures on the ground in each 15-minute interval using ASPM data. There are two main departure pushes each day. The evening departure push differs from the morning one because of the larger arrival demand in the evenings. The morning departure push presents different challenges, such as a large number of flights with controlled departure times, and a large number of tow-ins for the first flights of the day.

IV. Results of field tests

Although the pushback rate control strategy was tested at BOS during 16 demo periods, there was very little need to control pushbacks when the airport operated in its most

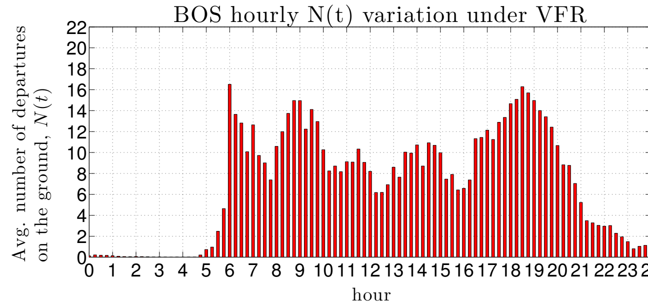

Fig. 8: Variation of departure demand (average number of active departures on the ground) as a function of the time of day.

efficient configuration (4L, 4R | 4L, 4R, 9), and in only eight of the demo periods was there enough congestion for gate-holds to be experienced. There was insufficient congestion for recommending restricted pushback rates on August 23, September 16, 19, 23, and 24. In addition, on September 3 and 12, there were no gate-holds (although departure demand was high, traffic did not build up, and no aircraft needed to be held at the gate). For the same reason, only one aircraft received a gate-hold of 2 min on September 17. The airport operated in the 4L, 4R | 4L, 4R, 9 configuration on all three of these days. In total, pushback rate control was in effect during the field tests for over 37 hours, with about 24 hours of test periods with significant gate-holds.

A. Data analysis examples

In this section, we examine three days with significant gate-holds (August 26, September 2 and 10) in order to describe the basic features of the pushback rate control strategy.

Figure 9 shows taxi-out times from one of the test periods, September 2. Each green bar in Figure 9 represents the actual taxi-out time of a flight (measured using ASDE-X as the duration between the time when the transponder was turned on and the wheels-off time). The red bar represents the gate-hold time of the flight (shown as a negative number). In practice, there is a delay between the time the tug pushes them from the gate and the time their transponder is turned on, but statistical analysis showed that this delay was random, similarly distributed for flights with and without gate-holds, and typically about 4 minutes. We note in Figure 9 that as flights start incurring gate-holds (corresponding to flights departing at around 1900 hours), there is a corresponding decrease in the active taxi-out times, i.e., the green lines. Visually, we notice that as the length of the gate-hold (red bar) increases, the length of the taxi-out time (green bar) proportionately decreases. There are still a few flights with large taxi-out times, but these typically correspond to flights with EDCTs. These delays were handled as in normal operations (i.e., their gate-hold times were not increased), as was agreed with the tower and airlines. Finally, there are also a few flights with no gate-holds and very short taxi-out times, typically corresponding to props.

The impact of the pushback rate control strategy can be further visualized by using ASDE-X data, as can be seen in

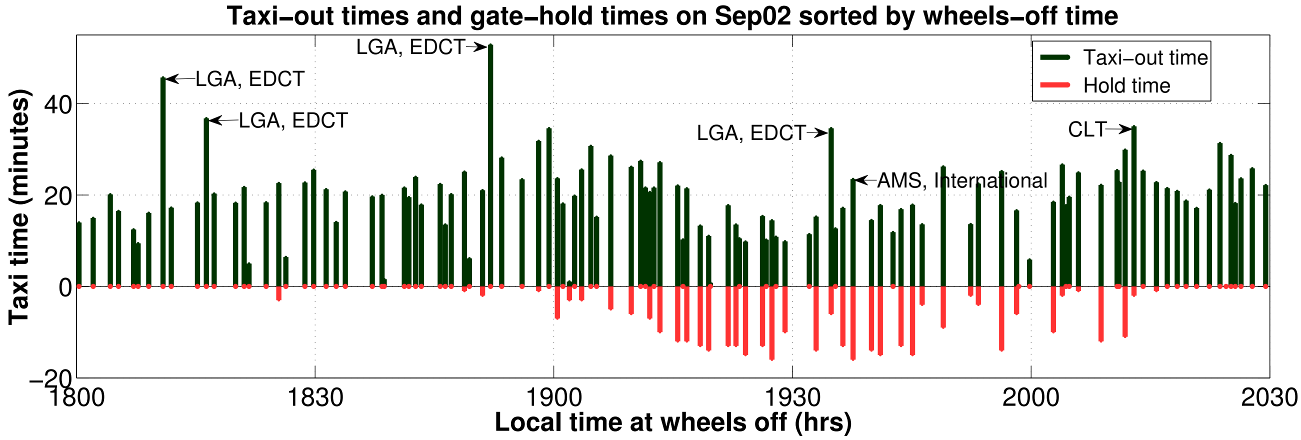

Fig. 9: Taxi-out and gate-hold times from the field test on September 2, 2010.

Fig. 10: Snapshots of the airport surface, (left) before gate-holds started, and (right) during gate-holding. Departing aircraft are shown in green, and arrivals in red. We note that the line of 15 departures between the ramp area and the departure runway prior to commencement of pushback rate control reduces to 8 departures with gate-holds. The white area on the taxiway near the top of the images indicates the closed portion of taxiway "November".

the Figure 10, which shows snapshots of the airport surface at two instants of time, the first before the gate-holds started, and the second during the gate-holds. We notice the significant decrease in taxiway congestion, in particular the long line of aircraft between the ramp area and the departure runway, due to the activation of the pushback rate control strategy.

Looking at another day of trials with a different runway configuration, Figure 11 shows taxi-out times from the test period of September 10. In this plot, the flights are sorted by pushback time. We note that as flights start incurring gate-holds, their taxi time stabilizes at around 20 minutes. This is especially evident during the primary departure push between 1830 and 1930 hours. The gate-hold times fluctuate from 1-2 minutes up to 9 minutes, but the taxi-times stabilize as the number of aircraft on the ground stabilizes to the specified N_{ctrl} value. Finally, the flights that pushback between 1930 and 2000 hours are at the end of the departure push and derive the most benefit from the pushback rate control strategy: they have longer gate holds, waiting for the queue to drain and then taxi to the runway facing a gradually diminishing queue.

Figure 12 further illustrates the benefits of the pushback rate control protocol, by comparing operations from a day with pushback rate control (shown in blue) and a day without it (shown in red), under similar demand and configuration. The upper plot shows the average number of jets taxiing-out, and the lower plot the corresponding average taxi-out time, per 15-minute interval. We note that after 1815 hours on September 10, the number of jets taxiing out stabilized at around 15. As a result, the taxi-out times stabilized at about 16 minutes. Pushback rate control smooths the rate of the pushbacks so as to bring the airport state to the specified state, N_{ctrl}, in a controlled manner. Both features of pushback rate control, namely, smoothing of demand and prevention of congestion can be observed by comparing the evenings of September 10 and September 15. We see that on September 15, in the absence of pushback rate control, as traffic started accumulating at 1745 hours, the average taxi-out time grew to over 20 minutes. During the main departure push (1830 to

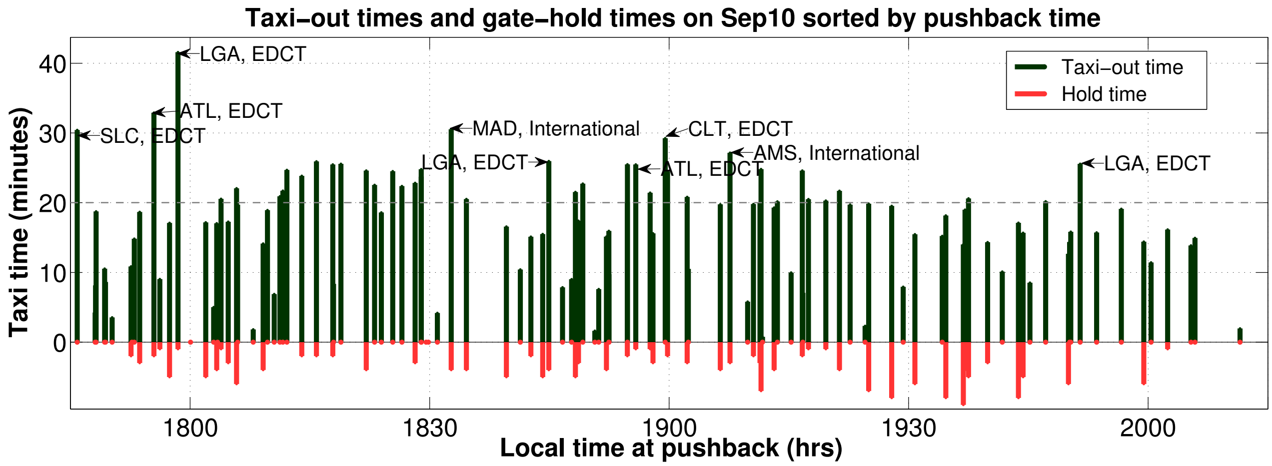

Fig. 11: Taxi-out and gate-hold times from the field test on September 10, 2010.

1930), the average number of jets taxiing out stayed close to 20 and the average taxi-out time was about 25 minutes.

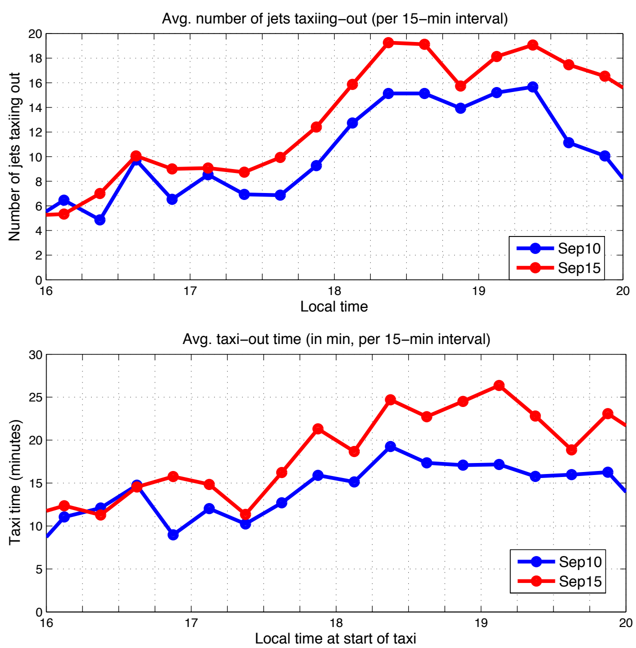

Fig. 12: Surface congestion (top) and average taxi-out times (bottom) per 15-minutes, for (blue) a day with pushback rate control, and (red) a day with similar demand, same runway configuration and visual weather conditions, but without pushback rate control. Delay attributed to EDCTs has been removed from the taxi-out time averages.

Similarly, Figure 13 compares the results of a characteristic pushback rate control day in runway configuration 27, 22L | 22L, 22R, August 26, to a similar day without pushback rate control. We observe that for on August 26, the number of jets taxiing out during the departure push between 1830 and 1930 hours stabilized at 15 with an average taxi-out time of about 20 minutes. On August 17, when pushback rate control was not in effect, the number of aircraft reached 20 at the peak of the push and the average taxi-out times were higher than those of August 26.

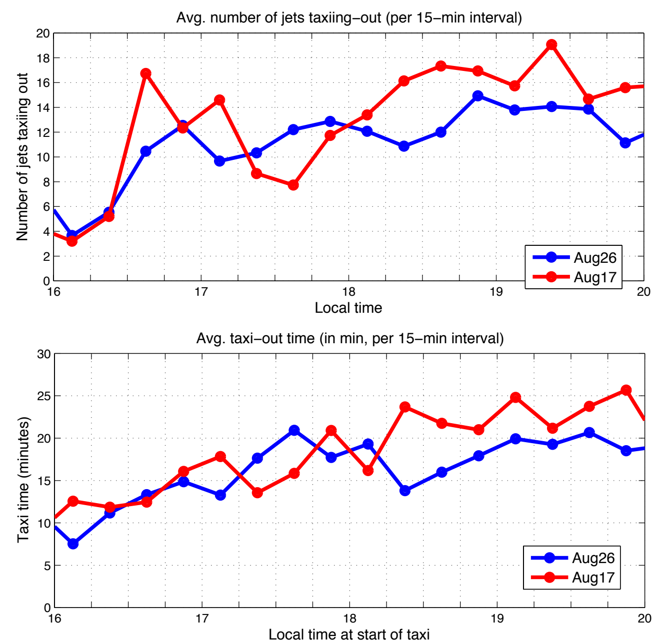

Fig. 13: Ground congestion (top) and average taxi-out times (bottom) per 15-minutes, for (blue) a day with pushback rate control, and (red) a day with similar demand, same runway configuration and weather conditions, but without pushback rate control. Delay attributed to EDCTs has been removed from the taxi-out time averages.

B. Runway utilization

The overall objective of the field test was to maintain pressure on the departure runways, while limiting surface congestion. By maintaining runway utilization, it is reasonable to expect that gate-hold times translate to taxi-out time reduction, as suggested by Figure 9. We therefore also carefully analyze runway utilization (top) and departure queue sizes (bottom) during periods of pushback rate control, as illustrated in Figure 14.

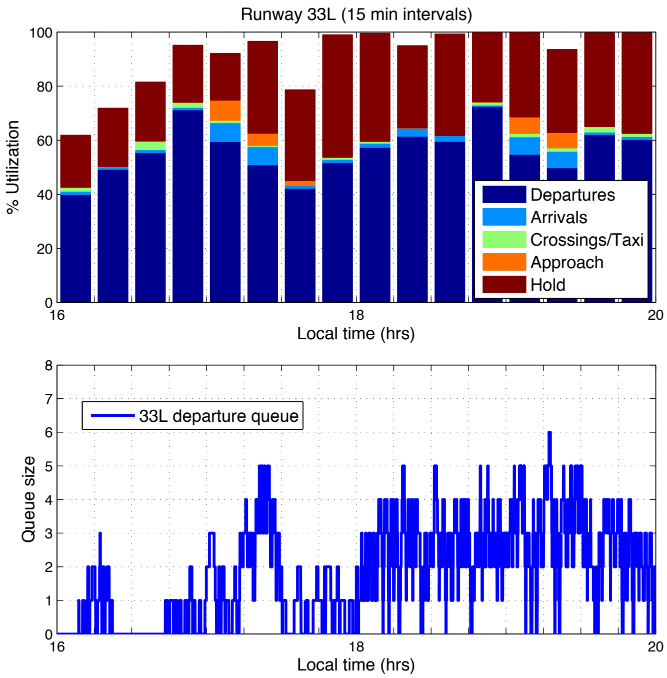

Fig. 14: Runway utilization plots (top) and queue sizes (bottom) for the primary departure runway (33L) during the field test on September 10, 2010. These metrics are evaluated through the analysis of ASDE-X data.

In estimating the runway utilization, we determine (using ASDE-X data) what percentage of each 15-min interval corresponded to a departure on takeoff roll, to aircraft crossing the runway, arrivals (that requested landing on the departure runway) on final approach, departures holding for takeoff clearance, etc. We note that between 1745 and 2000 hours, when gate-holds were experienced, the runway utilization was kept at or close to 100%, with a persistent departure queue as well.

Runway utilization was maintained consistently during the demo periods, with the exception of a three-minute interval on the third day of pushback rate control. On this instance, three flights were expected to be at the departure runway, ready for takeoff. Two of these flights received EDCTs as they taxied (and so were not able to takeoff at the originally predicted time), and the third flight was an international departure that had longer than expected pre-taxi procedures. Learning from this experience, we were diligent in ensuring that EDCTs were gathered as soon as they were available, preferably while the aircraft were still at the gate. In addition, we incorporated the longer taxi-out times of international departures into our predictions. As a result of these measures, we ensured that runway utilization was maintained over the remaining duration of the trial. It is worth noting that the runway was "starved" in this manner for only 3 minutes in over 37 hours of pushback rate control, demonstrating the ability of the approach to adapt to the uncertainties in the system.

V. Benefits analysis

Table II presents a summary of the gate-holds on the eight demo periods with sufficient congestion for controlling pushback rates. As mentioned earlier, we had no significant congestion when the airport was operating in its most efficient configuration (4L, 4R | 4L, 4R, 9).

TABLE II
Summary of gate-hold times for the eight demo periods with significant gate-holds.

	Date	Period	Configuration	No. of gate-holds	Average gate-hold (min)	Total gate-hold (min)
1	8/26	4.45-8PM	27,22L | 22L,22R	63	4.06	256
2	8/29	4.45-8PM	27,32 | 33L	34	3.24	110
3	8/30	5-8PM	27,32 | 33L	8	4.75	38
4	9/02	4.45-8PM	27,22L | 22L,22R	45	8.33	375
5	9/06	5-8PM	27,22L | 22L,22R	19	2.21	42
6	9/07	5-7.45PM	27,22L | 22L,22R	11	2.09	23
7	9/09	5-8PM	27,32 | 33L	11	2.18	24
8	9/10	5-8PM	27,32 | 33L	56	3.7	207
Total				247	4.35	1075

A total of 247 flights were held, with an average gate-hold of 4.3 min. During the most congested periods, up to 44% of flights experienced gate-holds. By maintaining runway utilization, we traded taxi-out time for time spent at the gate with engines off, as illustrated in Figures 9 and 11.

A. Translating gate-hold times to taxi-out time reduction

Intuitively, it is reasonable to use the gate-hold times as a surrogate for the taxi-out time reduction, since runway utilization was maintained during the demonstration of the control strategy. We confirm this hypothesis through a simple "what-if" simulation of operations with and without pushback rate control. The simulation shows that the total taxi-out time savings equaled the total gate-hold time, and that the taxi time saving of each flight was equal, in expectation, to its gate holding time. The total taxi-out time reduction can therefore be approximated by the total gate-hold time, or 1077 minutes (18 hours).

In reality, there are also second-order benefits due to the faster travel times to the runway due to reduced congestion, but these effects are neglected in the preliminary analysis.

B. Fuel burn savings

Supported by the analysis presented in Section V-A, we conduct a preliminary benefits analysis of the field tests by using the gate-hold times as a first-order estimate of taxi-out time savings. This assumption is also supported by the taxi-out time data from the tests, such as the plot shown in Figure 9. Using the tail number of the gate-held flights, we determine the aircraft and engine type and hence its ICAO taxi fuel burn index [12]. The product of the fuel burn rate index, the number of engines, and the gate-hold time gives us an estimate of the fuel burn savings from the pushback rate control strategy. We can also account for the use of Auxiliary Power Units (APUs) at the gate by using the appropriate fuel burn rates

[13]. This analysis (not accounting for benefits from reduced congestion) indicates that the total taxi-time savings were about 17.9 hours, which resulted in fuel savings of 12,000-15,000 kg, or 3,900-4,900 US gallons (depending on whether APUs were on or off at the gate). This translates to average fuel savings per gate-held flight of between 50-60 kg or 16-20 US gallons, which suggests that there are significant benefits to be gained from implementing control strategies during periods of congestion. It is worth noting that the per-flight benefits of the pushback rate control strategy are of the same order-of-magnitude as those of Continuous Descent Approaches in the presence of congestion [14], but do not require the same degree of automation, or modifications to arrival procedures.

C. *Fairness of the pushback rate control strategy*

Equity is an important factor in evaluating potential congestion management or metering strategies. The pushback rate control approach, as implemented in these field tests, invoked a First-Come-First-Serve policy in clearing flights for pushback. As such, we would expect that there would be no bias toward any airline with regard to gate-holds incurred, and that the number of flights of a particular airline that were held would be commensurate with the contribution of that airline to the total departure traffic during demo periods. We confirm this hypothesis through a comparison of gate-hold share and total departure traffic share for different airlines, as shown in Figure 15. Each data-point in the figure corresponds to one airline, and we note that all the points lie close to the 45-degree line, thereby showing no bias toward any particular airline.

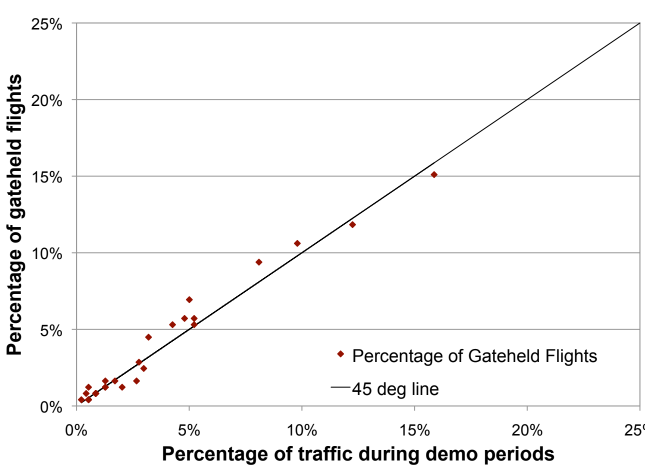

Fig. 15: Comparison of gate-hold share and total departure traffic share for different airlines.

We note, however, that while the number of gate-holds that an airline receives is proportional to the number of its flights, the actual fuel burn benefit also depends on its fleet mix. Figure 16 shows that while the taxi-out time reductions are similar to the gate-holds, some airlines (for example, Airlines 3, 4, 5, 19 and 20) benefit from a greater proportion of fuel savings. These airlines are typically ones with several heavy jet departures during the evening push.

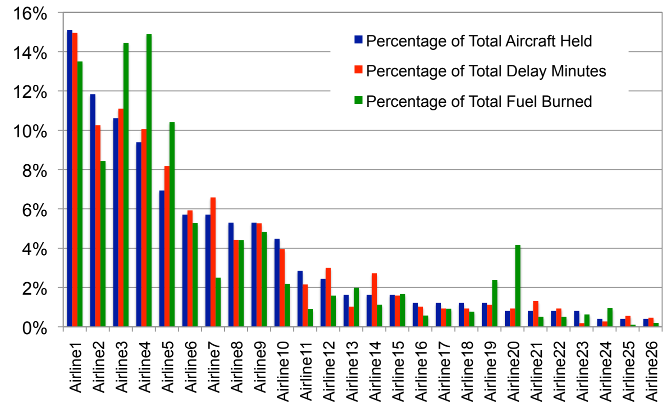

Fig. 16: Percentage of gate-held flights, taxi-out time reduction and fuel burn savings incurred by each airline.

VI. Observations and Lessons Learned

We learned many important lessons from the field tests of the pushback rate control strategy at BOS, and also confirmed several hypotheses through the analysis of surveillance data and qualitative observations. Firstly, as one would expect, the proposed control approach is an aggregate one, and requires a minimum level of traffic to be effective. This hypothesis is further borne by the observation that there was very little control of pushback rates in the most efficient configuration (4L, 4R | 4L, 4R, 9). The field tests also showed that the proposed technique is capable of handling target departure times (e.g., EDCTs), but that it is preferable to get EDCTs while still at gate. While many factors drive airport throughput, the field tests showed that the pushback rate control approach could adapt to variability. In particular, the approach was robust to several perturbations to runway throughput, caused by heavy weight category landings on departure runway, controllers' choice of runway crossing strategies, birds on runway, etc. We also observed that when presented with a suggested pushback rate, controllers had different strategies to implement the suggested rate. For example, for a suggested rate of 2 aircraft per 3 minutes, some controllers would release a flight every 1.5 minutes, while others would release two flights in quick succession every three minutes. We also noted the need to consider factors such as ground crew constraints, gate-use conflicts, and different taxi procedures for international flights. By accounting for these factors, the pushback rate control approach was shown to have significant benefits in terms of taxi-out times and fuel burn.

VII. Summary

This paper presented the results of the demonstration of a pushback rate control strategy at Boston Logan International Airport. Sixteen demonstration periods between August 23 and September 24, 2010 were conducted in the initial field trial phase, resulting in over 37 hours of research time in the BOS tower. Results show that during eight demonstration periods (about 24 hours) of controlling pushback rates, over 1077 minutes (nearly 18 hours) of gate holds were experienced during the demonstration period across 247 flights, at an average of 4.3 minutes of gate hold per flight (which correlated well to the observed decreases in taxi-out time). Preliminary fuel burn savings from gate-holds with engines off were estimated to be between 12,000-15,000 kg (depending on whether APUs were on or off at the gate).

ACKNOWLEDGMENTS

We would like to acknowledge the cooperation and support of the following individuals who made the demo at BOS possible: Deborah James, Pat Hennessy, John Ingaharro, John Melecio, Michael Nelson and Chris Quigley at the BOS Facility; Vincent Cardillo, Flavio Leo and Robert Lynch at Massport; and George Ingram and other airline representatives at the ATA. Alex Nakahara provided assistance in computing the preliminary fuel burn savings from the gate-hold data, and Regina Clewlow, Alex Donaldson and Diana Michalek Pfeil helped with tower observations before and during the trials. We are also grateful to Lourdes Maurice (FAA) and Ian Waitz (MIT) for insightful feedback on the research, and James Kuchar, Jim Eggert and Daniel Herring of MIT Lincoln Laboratory for their support and help with the ASDE-X data.

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