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16. Abstract

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In this research, a base year reflecting the current use of turbo-prop aircraft was developed. Fleet mixes for the forecasted years were developed using the appropriate operations and enplanement forecasts. The analysis included two fleet mixes, one representing the existing turbo-prop aircraft and one representing the regional jet aircraft. Noise and air quality impacts were then measured using FAA approved and recommended software analysis tools.

For the noise analysis, the all regional jet fleet mix when compared to the existing fleet mix further reduced noise exposure impacts at the 55 dB level for eight of the 10 airports. In the air quality analysis, the regional jet fleet mix resulted in lower pollutant levels than the existing fleet mix for 2007 at many of the airports studied. Specifically, the regional jets resulted in lower CO levels at all ten airports, lower HC levels at eight of the ten airports, Lower NOX levels at six airports, lower SOX levels at five of the airports, and lower PM10 levels at all ten airports. In many of the instances where regional jet fleets did not decrease noise and emissions levels, they were not substantially higher than the existing fleet mixes that were used.

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Evaluation of the Air Quality and Noise Impacts of Regional Jet Service at Commercial Airports Serving Small Cities in Texas

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ABSTRACT

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EXECUTIVE SUMMARY

Commercial airline passenger service in small markets is entering a phase that has the potential to change the industry in ways not seen since airline deregulation. The initiation of regional jet service to and from communities that previously had limited commercial service opens up a wide range of opportunities that support economic growth and trade for many communities as service levels increase and new city pairs are introduced. At the time this research began, there were approximately 400 regional jets already in service with orders and options on nearly 1,300 more. These numbers have continued to increase and have nearly doubled at present time. Along with the opportunities, however, have come a new set of high profile environmental issues that, until now, small cities have not had to deal with. These are primarily aircraft noise and exhaust emissions from arriving and departing aircraft but also include emissions from ground support equipment (GSE) and vehicles accessing the airport. While noise issues have long been a concern at larger airports in major urban areas, smaller communities have generally not had to deal with them. Additionally, airports of all types and sizes have become aware of air quality issues in recent years as the Environmental Protection Agency (EPA) has pursued all options to reduce emissions wherever possible.

Airlines and their commuter link counterparts have recently begun operating the newer and smaller jet aircraft at many airports throughout the country. With these changes in the aviation industry on the horizon, we have yet to determine what their impacts might be on the quality of life in small cities. A community's sensitivity to aircraft noise is a genuine impediment to growth. Knowing the impacts ahead of time could prevent the economic losses associated with encroached and community-constrained airports yet contribute to the possible solutions that will enhance the prosperity and quality of life in these small cities.

This research evaluates the economic, noise, and air quality impacts of replacing and updating turbo-prop aircraft fleets with new generation regional jets at non-hub commercial service airports in Texas. These do not have regularly scheduled jet service yet serve populations up to 250,000. This includes Easterwood Airport in College Station as well as airports in Abilene, Laredo, Longview, San Angelo, Texarkana, Tyler, Victoria, Waco, and Wichita Falls.

The past five years have seen significant growth in the regional airlines and, consequently, so have the many markets they serve. The development and implementation of

new regional jets have fueled this growth and promises to transform scheduled passenger service in many smaller communities that, until now, had limited choices for air travel. According to the leading industry trade group, this growth includes route transfers from major airlines, supplemental service, new city pairs (destinations), and increases in the level of service of current routes, thus requiring larger aircraft and/or more flights.

In this research, a base year reflecting the current use of turbo-prop aircraft was developed. Fleet mixes for the forecasted years were developed using the appropriate operations and enplanement forecasts. The analysis included two fleet mixes, one representing the existing turbo-prop aircraft and one representing the regional jet aircraft. Noise and air quality impacts were then measured using the appropriate FAA approved software analysis tools.

In summary, the implementation of regional jets into the air transportation system of these ten small communities had very positive results in terms of reducing noise and emissions impacts. The results show the increases or decreases in noise levels (area affected) and emissions using 1996 as a base year. It should be noted that four of the airports had no increases or only very slight increases in passenger enplanements from 2000 to 2007. These airports were simply not expected to grow during the time period or are constrained from growing in the future.

In the final analysis, what is important is better understanding the impacts associated with new regional jet aircraft serving our communities. Perhaps the best summary measure is to examine the 2007 results and see how the two fleet mixes compare. For the noise analysis, the all regional jet fleet mix when compared to the existing fleet mix further reduced noise exposure impacts at the 55 dB level for eight of the 10 airports. In the air quality analysis, the all regional jet fleet mix resulted in lower pollutant levels than the existing fleet mix for 2007 at many of the airports studied. Specifically, the regional jets resulted in lower CO levels at all ten airports, lower HC levels at eight of the ten airports, lower NOX levels at six airports, lower SOX levels at five of the airports, and lower PM10 levels at all ten airports.

The economic impacts of implementing the regional jet service have been more problematic in determining. As airline industry and national economic problems worsened, it has resulted in some cities losing regional jet service that had recently received it. In addition, the short time period of their implementation and use in these cities makes it difficult to measure in these cities. The report will rely more on anecdotal and professional opinions of airport and economic development officials in these cities to make this determination.

Implementation of the regional jets appears to be environmentally beneficial for the small communities examined when compared to the widespread use of turboprop aircraft that have typically served these smaller markets. Anecdotal evidence also supports the notion that they are beneficial economically for the regions that they serve.

The results of this study will benefit governmental agencies ranging from the local municipalities that typically own airports up to the state and federal levels where they are responsible for environmental affairs that include noise and air quality. This includes the potential impacts of a fast growing segment of aviation on small cities where quality of life concerns and land-use planning will collide with the interests of economic growth.

It is expected that the methods developed through this research will generate interest from both state and local government officials. State environmental agencies and more recently the Aviation Division of the Texas Department of Transportation have become involved in airport air quality issues. Likewise, airport noise issues remain high among citizens. Understanding how regional jets might affect our quality of life will prove beneficial to communities where urban growth is inevitably aimed at our airports. This work assists in providing better information to communities and their airports and allows them to make better planning and policy decisions regarding a variety of issues including land-use issues while not compromising the economic impact that airports typically provide to the communities they serve.

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CHAPTER 1. INTRODUCTION

Commercial airline passenger service in small markets is entering a phase that has the potential to change the industry in ways not seen since airline deregulation. The initiation of regional jet service to and from communities that previously had limited commercial service opens up a wide range of opportunities that support economic growth and trade for many communities as service levels increase and new city pairs are introduced. Currently, there are approximately 1,300 regional jets in service with orders and options for nearly 4,100[1]. Along with the opportunities, however, have come a new set of high profile environmental issues that, until now, small cities have not had to deal with. These are primarily aircraft noise and exhaust emissions from arriving and departing aircraft but also include emissions from ground support equipment (GSE) and vehicles accessing the airport. While noise issues have long been a concern at larger airports in major urban areas, smaller communities have generally not had to deal with them. Additionally, airports of all types and sizes have become aware of air quality issues in recent years as the Environmental Protection Agency (EPA) has pursued all options to reduce emissions wherever possible.

Airlines and their commuter link counterparts have recently begun operating the newer and smaller jet aircraft at many airports throughout the country. With these changes in the aviation industry on the horizon, we have yet to determine what their impacts might be on the quality of life in small cities. A community's sensitivity to aircraft noise is a genuine impediment to growth. Knowing the impacts ahead of time could prevent the economic losses associated with encroached and community-constrained airports yet contribute to the possible solutions that will enhance the prosperity and quality of life in these small cities.

The focus of this study is on the impacts of regional jet service on small communities who may see them begin serving their communities in the future or those that currently have some regional jet service that may increase. These are primarily markets where regional jets would be replacing turboprop aircraft. Some may see them enter to serve new markets. What follows is some background information on regional jets and air service in small communities. It is intended to provide enough understanding for the analysis that follows and is not meant to be

[1] Regional Airline Association.

comprehensive in tracing the evolution of regional jet service or its implementation in larger markets.

This research will evaluate the noise and air quality impacts of replacing and updating turbo-prop aircraft fleets with new generation regional jets at non-hub commercial service airports in Texas. These do not have regularly scheduled jet service yet serve populations up to 250,000. This includes Easterwood Airport in College Station as well as airports in Abilene, Laredo, Longview, San Angelo, Texarkana, Tyler, Victoria, Waco, and Wichita Falls. A base year reflecting the current use of turbo-prop aircraft was developed. Fleet mixes for the forecasted years were developed using the appropriate operations and enplanement forecasts.

Background and Literature Review

The past five years has seen significant growth in the regional airlines and, consequently, so have the many markets they serve. The development and implementation of new regional jets have fueled this growth and promises to transform scheduled passenger service in many smaller communities that, until now, had limited choices for air travel. According to the leading industry trade group, this growth includes route transfers from major airlines, supplemental service, new city pairs (destinations), and increases in the level of service of current routes, thus requiring larger aircraft and/or more flights.

The average load factors among the regional airlines have increased steadily over the past five years. This is due in large part to the increased level of service the Regional airlines have provided beginning with the addition of the regional jet aircraft. According to the Regional Airline Association, regional airlines serve more than 700 airports in the United States. Approximately 288 of these airports in the lower 48 states are served exclusively by regional airlines. In January of 2000, these airlines had more than 400 regional jets in service, 524 on order, and 755 on option[2]. This exceptional growth is expected to continue as new technology and demand drive the market. Regional aircraft account for approximately 30percent of the commercial aircraft fleet and the jet portion of that fleet is increasing. Enplanements on these regional airlines are also increasing and the number of departures of regional aircraft is now almost equal to that of the major carriers.

[2] Regional Airline Association.

Regional airlines are a vital part of our air transportation industry providing access to many communities. With lower costs per enplanement and lower break-even load factors, they are in a unique position to bring increased levels of service to many smaller communities across the country. The implementation of regional jet service into the regional airline fleets is an important issue as it will undoubtedly enhance the mobility, accessibility, and efficiency of the airport and community. This is the case for those that live in the community and those that need to access it from remote parts of the state, country, and world. What is less clear, however, are the impacts of this shift towards jet aircraft in these communities. Specifically, the noise and air quality impacts are not widely known as we are still on the cusp of this transition in how our air travel is being and will be provided.

The airline industry in the United States has been transformed in the last decade with the evolution of the regional jet operated by regional airlines and now, many mainline carriers. This occurred in the middle to late 1990s after initial introduction by one air carrier in 1993[3]. Today, these jets are used by regional airlines and major carriers including their partially-owned subsidiaries that feed into their mainline system. Although not the focus of this study, the integration of these aircraft into the major carriers has caused considerable concern regarding pilot unions and the scope clauses in their contracts. These clauses provide for the specific use of regional jets. This is expected to be the case as more and more regional jets make their way into service. Some of scope clauses for major U.S airlines are shown in Figure 1.

[3] *Profile:Regional Jets and Their Emerging Roles in the U.S. Aviation Market*, 1998. Office of the Assistant Secretary for Aviation and International Affairs. U.S. DOT, Washington, D.C.

U.S. Major Airline Regional Jet (RJ) Scope Clause Limitations - Autumn 2003

Carrier	Maximum Seats	Maximum Weight	Allowed Number	Other Limitations
Alaska Airlines	No limit	No limit	No limit	None
America West Airlines 1/	50		45 + 3 per each mainline aircraft over baseline	None
	70		15 + 2 per each mainline aircraft over baseline	
	90		25	
American Airlines	50	65,000 lbs.	Unlimited	(1) Total regional aircraft <110% of mainline narrowbody aircraft; (2) <1% of flying between key airports (DFW, ORD, MIA, JFK, SFO, LAX, LGA, STL and SJU); (3) 85% of all RJ flying must be from/to key airports
	70		CRJ700 aircraft to be flown by mainline subject to achieving American Eagle economics	
ATA	70	85,000 lbs.	53 plus 3 ATA aircraft above 58 to a maximum of 120	Regional must be owned by ATA
Continental Airlines	59	No limit	Unlimited	
Delta Air Lines	50	65,000 lbs.	Unlimited	(1) Maximum 15% of stage lengths 900> miles; (2) Maximum of 10% of non-hub flying; (3) Maximum of 6% inter-hub flying (except TPA/FLL/ORL); (4) Regional block hours <36% and 37% of Delta block hours in 2003 and 2004+ respectively
	70	85,000 lbs.	57 + 1 per each 10K block hours above specifed Delta mailine block hour plan, up to a maximum of 75	
Northwest Airlines	44	No limit	Unlimited	No Northwest regional may operate aircraft 60> seats or 70,000> lbs.
	55	70,000 lbs.	Depends on number of Northwest narrowbody fleet. If 332>, then base number of RJ's = 30; Add one RJ for each Northwest narrowbody 347>; If <360 at 12/2002, then reduce base number of RJ's by the difference; May add one RJ for each Avro RJ retired	(1) All flights must be flown to/from a Northwest hub or international gateway; (2) No flights between hubs or gateway and hub unless gateway is BOS/PHL/IAD/TPA and such flying is <5% of RJ block hours; (3) RJ's at Mesaba, Pinnacle, and other regionals owned by Northwest must use Northwest flight numbers
Southwest Airlines	No limit	No limit	No limit	None
United Airlines	70	80,000 lbs.	Unlimited	(1) Regional block hurs < mainline block hours; (2) 90% of flying to/from key cities; (3) TBD portion of 50> seat RJ's to be flown by furloughed United Pilots
USAirways	(1) Small RJ: 44 seats (includes CRJ240/400 with 40 seats)	47,000 lbs.	150	(1) 70 medium RJ's may fly for any regional; (2) All other small RJ's must fly for "participating" regionals, with half the jobs reserved for furloughed USAirways Pilots under Jets for Jobs; (3) Mesa may fly 20 medium RJ's plus 30 CRJ700's with ALPA labor and Jets for Jobs; (4) 25 CRJ700's may fly for another affiliate under Jets for Jobs; (5) 25 CRJ700's fly for a USAirways subsidiary carrier under Jets for Jobs; (6) Chautauqua and Midway may fly medium RJ's briefly outside of Jets for Jobs so long as they ultimately conform; (7) All other large RJ's must fly for USAirways division MidAtlantic; (8) 60% of all medium RJ's 140> must fly for MidAtlantic
	(2) Medium RJ: 50 seats	65,000 lbs.		
	(3) Large RJ: 70 seats (includes EMB-170 and EMB-175 with maximum of 76 seats)	75,000 lbs.	Medium RJ's and large RJ's <315. Add two large or medium RJ's per USAirways mainline aircraft 315>	

Source: Regional Air Service Initiative

Figure 1 U.S. Major Airline Regional Jet Scope Clause Limitations – Autumn 2003

Regional Airlines and Aircraft

Regional airlines typically serve short and medium-haul routes that connect smaller communities with larger cities. This is done with turboprop aircraft that range from nine to 68 seats and regional jet aircraft that have 30 to 100 seats[4]. According to the Regional Airline Association, in 2002, the 91 regional airlines had passenger enplanements of nearly 100 million, an increase of more than 100 percent since 1993. The total fleet size was approximately 2,400 aircraft with 44 percent being regional jets. These airlines served 643 airports with 466 airports served exclusively by regional airlines.

The most popular regional jets include those made by Embraer, Canadair, and Fairchild Dornier. The most popular regional jets appear to be those by Embraer. They currently have seven different models that range from 37 seats to approximately 118 depending on configuration. Canadair maintains three models that seat 50, 70, or 90 passengers. At the time the modeling work for this analysis was completed, the Embraer ERJ-135 and ERJ-145 models were the most widely used. Nearly all of the small cities included in this study that had seen any regional jet service saw one or both of these models. Aircraft characteristics for some of these regional jets is shown in Figure 2.

[4] Regional Airline Association.

Regional Jet (RJ) Aircraft Dimmensions and Performance Characterisitics

Manufacturer Model/Type Factories	30 to 40 Seats			50 to 70 Seats						80 to 100 Seats		
	Fairchild Dornier 328-300Jet Germany/USA	Embraer ERJ135 ER Brazil	Embraer ERJ135 LR Brazil	Bombardier CRJ200 ER Canada	Bombardier CRJ200 LR Canada	Embraer ERJ145 ER Brazil	Embraer ERJ145 LR Brazil	Bombardier CRJ700 Canada	Bombardier CRJ700 ER Canada	BAE Systems RJX-70 Great Britain	BAE Systems RJX-85 Great Britain	Bombardier CRJ900 Canada
General												
Year introduced	1999	1999	1999	1996	1996	1996	1998	2001	2001	2003	2002	2003
Passenger capacity	32	37	37	50	50	50	50	70	70	82	100	86
Flight attendant	yes	yes	yes	yes	yes	yes	yes	yes	yes	Yes	Yes	Yes
External Dimmensions												
Length (feet)	69.8	86.6	86.6	87.8	87.8	98.0	98.0	106.7	106.7	85.9	93.7	118.8
Height (feet)	23.7	22.2	22.2	20.4	20.4	22.1	22.1	24.8	24.8	28.3	28.3	24.6
Wingspan (feet)	68.8	65.7	65.7	69.6	69.6	65.7	65.7	76.3	76.3	86.4	86.4	76.3
Internal Dimemsions												
Length (feet)	33.9	42.0	42.0	48.4	48.4	54.1	54.1	68.2	68.2	50.6	58.4	80.3
Height (feet)	6.2	6.0	6.0	6.1	6.1	6.0	6.0	6.2	6.2	6.8	6.8	6.2
Width (feet)	7.2	6.9	6.9	8.2	8.2	6.9	6.9	8.4	8.4	11.2	11.2	8.5
Powerplant												
Manufactuer	Pratt & Whitney	Rolls-Royce	Rolls-Royce	General Electric	General Electric	Rolls Royce	Rolls Royce	General Electric	General Electric	Honeywell	Honeywell	General Electric
Number of engines	2	2	2	2	2	2	2	2	2	4	4	2
Factory	Quebec	Indiana	Indiana	Ohio	Ohio	Indiana	Indiana	Ohio	Ohio	Arizona	Arizona	Ohio
Output (lbs. of thrust-each)	6,050	7,424	7,424	9,220	9,220	7,424	7,424	13,790	13,790	7,000	7,000	14,255
Weights												
Max. ramp (pounds)	34,789	42,108	44,312	51,250	53,250	45,635	48,722	73,000	75,250	95,500	97,500	81,000
Max. takeoff (pounds)	34,524	41,887	44,092	51,000	53,000	45,414	48,501	72,750	75,000	95,000	97,000	80,500
Max. landing (pounds)	31,724	40,785	40,785	47,000	47,000	41,226	42,549	67,000	67,000	83,500	85,000	73,500
Zero fuel (pounds)	28,814	34,392	35,274	44,000	44,000	37,698	39,462	62,300	62,300	74,500	79,000	70,000
Max. payload (pounds)	8,047	9,050	9,716	13,500	13,500	11,215	12,610	18,800	18,800	22,469	25,213	22,500
Max. fuel (pounds)	8,039	9,200	11,435	14,305	14,305	9,200	11,435	19,450	19,450	22,706	22,706	19,450
Performance												
Take-off field length (feet)	4,535	5,200	5,600	5,800	6,290	6,519	7,441	5,130	5,500	4,985	4,925	6,160
Climb rate (feet per minute)	3,690	2,400	2,900	3,555	3,395	2,300	2,500	2,900	2,800	2,500	2,500	3,000
Ceiling (feet)	35,000	37,000	37,000	41,000	41,000	37,000	37,000	41,000	41,000	35,000	35,000	41,000
Cruise speed (knots)	397	442	448	464	464	448	450	464	464	401	401	464

Sources: Manufacturer data and Business and Commercial Aviation.

Source: Regional Air Service Initiative (secondary)

Figure 2 Regional Jet Aircraft Dimensions and Performance Characteristics

The growth of the regional jet is expected to continue although not at such a torrid pace. Prior to September 11, 2001, some were forecasting the regional jet fleet to hit 4,870 jets by 2019[5]. While it is not known whether these numbers will hold true, the regional segment of the industry remains the most profitable. In 2002, the regional/national airlines were the only profitable entities[6]. The regionals especially, are low cost carriers. They have lower labor costs, higher yields, lower break-even load factors, high utilization, and fast turn-arounds[7]. This is likely due to large and increasing utilization of regional jet aircraft.

The use or implementation of regional jets has occurred for a variety of reasons. According to the Regional Air Service Initiative, the majority of new regional jets has historically been to provide service on new routes (35percent). Other deployments are as follows: major carrier route replacement (26percent), major carrier route supplement (20percent), and turboprop replacement (19percent)[8]. As can be seen, the major U.S. air carriers are making big use of the regional jets taking advantage of their positive economic operating characteristics.

Since the tragic events of September 11th, 2001, these numbers have changed some. First-ever nonstop service accounted for 50 percent of regional jet deployments with 17 percent for turboprop upgrades and nine percent each for mainline replacement and supplement. New growth accounted for 15 percent illustrating their growing popularity and use[9]. Current fleet data for North American regional jet operators is shown in Figure 3 and is current as of December 2003. This table also shows what aircraft regional airlines are flying and the number of orders and options that currently exist.

[5] Darby, Kit, 2001. 26th Annual FAA Commercial Aviation Forecast Conference. Washington, D.C.
[6] Barnette, Skip. *Regional Airlines: Are There Limits to Growth?*, 2003. 28th Annual FAA Commercial Aviation Forecast Conference, Washington, D.C.
[7] IBID.
[8] Regional Air Service Initiative (www.regionalairservice.org).
[9] IBID.

North American Regional Jet (RJ) Operators and Fleets - December 2003

Regional Air Service Initiative

Regional Carrier	Code-Sharing Partners	Aircraft Type	In-Service Units	Units On Firm order	Units On Conditional Order	Units On Option	Total
Aerolitoral	Aeromexico	ERJ 145LR	0	5	0	25	30
Air Canada Jazz	Air Canada	CRJ-100ER	26	0	0	0	26
Air Caraibes	Air France	Embraer 170	0	2	0	2	4
		ERJ 145MP	2	0	0	0	2
Air Wisconsin	AirTran and United	BAe 146-200	12	0	0	0	12
		BAe 146-300	5	0	0	0	5
		CRJ-200LR	55	9	20	75	159
American Eagle Airlines	American	CRJ-700	18	7	0	22	47
		ERJ 135LR	40	0	0	0	40
		ERJ 140LR	59	0	0	25	84
		ERJ 145LR	56	80	0	17	153
Astral Aviation/Skyway Airlines	Midwest Express	ERJ 140	0	20	0	20	40
		F/D 328-300Jet	10	2	0	10	22
Atlantic Coast Airlines	Delta and United	CRJ-200ER	87	34	0	80	201
		F/D 328-300Jet	33	0	0	80	113
Atlantic Southeast Airlines	Delta	CRJ-200ER	92	0	0	87	179
		CRJ-700	16	15	0	78	109
Comair	Delta	CRJ-100ER	147	0	0	87	234
		CRJ-700	18	9	0	77	104
Continental Express Airlines	Continental	ERJ 135ER	30	0	0	0	30
		ERJ 145LR and/or ERJ 145XR	*189*	*56*	*0*	*100*	*345*
Great Plains Airlines		F/D 328-300Jet	2	4	0	0	6
Horizon Airlines	Alaska and Northwest	CRJ-700	16	12	0	25	53
		F28-4000	3	0	0	0	3
JetBlue		Embraer 190	0	100	0	100	200
Mesa Airlines	America West, Frontier, and USAirways	CRJ-200ER	32	0	20	0	52
		CRJ-700	15	0	0	20	35
		CRJ-900	8	17	0	20	45
		ERJ 145LR	32	4	0	45	81
Mesaba Airlines	Northwest	Avro RJ85	36	0	0	0	36
Northwest Airlines 1/		CRJ-440	36	39	0	0	75
		CRJ-200	35	19	0	175	229
Republic Airlines	America West, American, Delta, and USAirways	ERJ 135LR	15	0	0	0	15
		ERJ 145LR	45	2	0	57	104
		ERJ 140LR	15	0	0	0	15
SkyWest Airlines	Delta, United	CRJ-100/200LR	98	2	29	39	168
		CRJ-700	0	30	0	0	30
		CRJ-700 or 900			0	80	80
Trans States Airlines	USAirways	ERJ 145ER	12	3	0	0	15
USAirways 1/		CRJ-200 and/or	3	57	0	151	15
		CRJ-715	0	25	0	30	55
		Embraer 170	0	85	0	50	135
Totals			**1,298**	**638**	**69**	**1,577**	**3,386**

Notes:
1/ Orders placed by Delta, Northwest, and US Airways. Specific operator(s) to be determined.
Italics indicate specific model selection to be determined.

Sources: Published reports and manufacturers.

Source: Regional Air Service Initiative (secondary)

Figure 3 North American Regional Jet Operators and Fleets – December 2003

The outlook for the regional airlines and regional jets in particular is expected to remain strong. Industry experts believe the regional airlines will increasingly provide additional point-to-point service with stage lengths increasing[10]. They also expected the phasing-out of smaller turboprop aircraft (19-seat) to lead to problems with air service in smaller communities as they are put at an economic disadvantage. Regional jets are likely to get larger but the growth will continue to be lead by the 50-seat jets replacing turboprops on many route segments. Overall load-factors are expected to increase as well as regional jets comprise an increasingly larger share of the fleet. The average number of seats available and the length of trip are also expected increase in the coming decade[11]. An historical review of the regional airline fleet clearly shows a trend away from smaller turboprop aircraft, diminishing use of 20 to 40-seat turboprop aircraft, and large increases in regional jet use since 1996[12]. Regional jets will continue to play a role in mainline operations as they serve previously unprofitable routes in an industry currently facing financial difficulties as a result of terrorist attacks and a lagging economy.

As briefly mentioned above, the wide-spread and evolving use of regional jets and the phasing out of turboprop aircraft can be problematic for some smaller communities that already faced limited air service. The aforementioned economic downturn and the terrorist events of September 11, 2001 are cited by the U.S. General Accounting Office (GAO) as two economic factors and the main contributors to the profitability decline in the airline industry[13]. As the report also notes, the level of service in the 202 small communities studied declined by 19 percent between October 2000 and October 2001. Communities of all sizes declined in service but the smaller communities were most affected as nearly the entire decline came from routes serviced by turboprop aircraft. The total number of daily departures declined and the number of cities served by one airline increased. Smaller markets that had multiple carriers were more likely to see carriers withdraw. Communities with populations over 100,000 were more likely to see such competition. Those communities that had only one carrier typically had populations of

[10] *Future Aviation Activities 12th International Workshop*, 2003. Transportation Research Circular E-C051. Transportation Research Board, Washington, D.C.
[11] IBID.
[12] Regional Air Service Initiative.
[13] *Commercial Aviation: Air Service Trends at Small Communities Since October 2000*, 2002. GAO-02-432. U.S. General Accounting Office, Washington, D.C.

less than 100,000 and were likely already served by only one carrier. With that said, populations over 100,000 were more likely to experience service declines[14].

The GAO has also reported that regional jet service has yet to reach many smaller communities[15]. As noted in the study, regional jet deployment has largely been a function of economics. Mainline carriers have used them a lot to provide service in markets to profitable by larger aircraft. The deployment has not had much to do with serving smaller communities. The rapid growth has been in serving larger cities adding to existing congestion and delay concerns[16]. In addition, some of the expected transition from turboprop aircraft to regional jet aircraft was either short lived or never happened. For example, ExpressJet, a Continental Airlines regional partner switched its fleet to an all-jet fleet in 2003. This led to actual and expected regional jet service at several small communities in Texas served by ExpressJet. However, in 2003, several of these cities saw this service eliminated as ExperessJet withdrew from these markets. The service was eventually picked up, uninterrupted, by another regional airline partner, Skywest, who initiated service using turboprop aircraft. This happened in several Texas cities including Victoria, Killeen, Waco, Tyler, Abilene, San Angelo, and College Station[17]. All of these airports with the exception of Killeen are included in this analysis.

Regional Jets and Economics

The economics of regional jets have been widely established both in the above discussion and the industry in general. The cost advantages have allowed airlines to use these jets to replace and supplement existing mainline routes as well as to initiate new service. They have also been used to replace older turboprop aircraft on short and medium-haul routes. What is lesser know are their economic benefits to the communities they serve. Originally, this study was to look at some of those benefits associated with the implementation of regional jet service in small communities. However, the economic downturn and the terrorist activities of September 11, 2001 have made this a virtual impossibility.

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[14] IBID.
[15] *Aviation Competition: Regional Jet Service Yet to Reach Many Small Communities*, 2001. GAO-01-344. U.S. General Accounting Office, Washington, D.C.
[16] IBID.
[17] Continental Airlines Press Release, 2003.

The levels of service and the passenger traffic at the airports under study have all declined[18]. Many never received the jet service that was thought to be coming and at least one saw it come and go. Passenger levels at most of the airport in this study are not rebounding nor are they expected to in the near future. It will be many years before they see pre 9/11 levels. For some, the low enplanement levels may preclude them from seeing any regional jet service for years to come. Any analysis of the economic benefits of regional jet service in the communities selected for this analysis using the existing data would not be meaningful as originally hoped when regional jets were sprouting up on new routes and regional airlines were initiating jet service in small communities across the country.

There are, however, economic factors regional jet operators view as important when considering new markets for either replacing turboprop aircraft or serving new routes as it pertains to small communities. Existing research has shown how regional jets are being used by airlines as well as how they have impacted passenger demand. Using data from Continental Airlines deployment of regional jets through their commuter affiliates, researchers examined how the airlines are using regional jets[19]. The majority of the deployments were for new routes (57 percent). This was followed by supplementing existing turboprop routes (28 percent), and replacement of turboprop aircraft (15 percent). This further bolsters the notion that regional jets are being used for their economic advantages. Eventually, regional jets are likely to more broadly replace turboprop aircraft but their cost structure allows them to be used to replace larger jets in some markets and initiate service to others that are cost-prohibitive for larger jets and too far for turboprops. Dresner also points out that regional jets offer practical ranges approaching 1,600 miles while the same for a turboprop aircraft is approximately 350 miles[20]. But in the mean time, regional jets are likely to be used in other areas. According to US Airways officials "regional jets give us more long-range capability so we can add flights from, for example, Philadelphia to points in the Midwest where there may not be enough demand to justify the cost per seat mile of larger jets."[21] This also essentially allows airlines to continue serving a market that they may have to leave for cost reasons.

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[18] Federal Aviation Administration, 2004. Terminal Area Forecast Data.
[19] Dresner, Martin, Robert Windle, and Ming Zhou, 2002. *Regional Jet Services: Supply and Demand*. Journal of Air Transportation Management 8, 267-273.
[20] IBID.
[21] Futterman, Evan, 2003. *The RJ Phenomenon*. Airport World, August/September, 51-53.

Dresner also notes that their research indicated a significant demand effect for regional jets. This, they state, suggests “strong passenger preferences for RJs over turboprop aircraft.”[22] The theory here is that there may be some expectation of increased demand simply as a result of initiating use of the regional jets. Dresner states that “the use of RJs has increased so extensively, in part, because they are popular with passengers, providing a relatively quiet, fast, safe, and comfortable ride, at least compared to many turboprop airplanes.”[23] It is generally believed that implementing regional jet service would be a positive economic benefit to small communities. However, a lot of this may depend on the existing air markets these small communities have and whether or not use of regional jets would be cost-effective.

Small Community Air Service

What this means for small communities is that they are more likely to see regional jet service in a new market that is further away from their existing air service markets. Of course this may not be likely considering that many of these small communities may have a hard time supporting their existing air markets. Having already noted the characteristics of regional jets and preferences for their use by airlines and passengers, there are some additional findings from the Dresner analysis that are noteworthy especially for small communities. ”RJ usage is positively correlated with the number of competitors on a route, population, and available seats on a route, indicating that the RJs are being used on more competitive, heavily traveled routes, in larger markets.”[24] This is not surprising considering what he have noted earlier.

Dresner showed that regional jets are also positively correlated with income levels and route distance. The research, which focused on two Continental hubs, showed that the mean distance of routes served by regional jets was 287 miles, the mean population of the service area was 1.25 million, and the mean income level was $25,400.[25] These findings with respect to regional jet deployment, population, competitor status, and route distance were also noted by Savage and Scott who studied the Cincinnati market.[26] These factors, or lack of, were also cited as contributing to the so called crisis in small community air service. Back Aviation noted a lack

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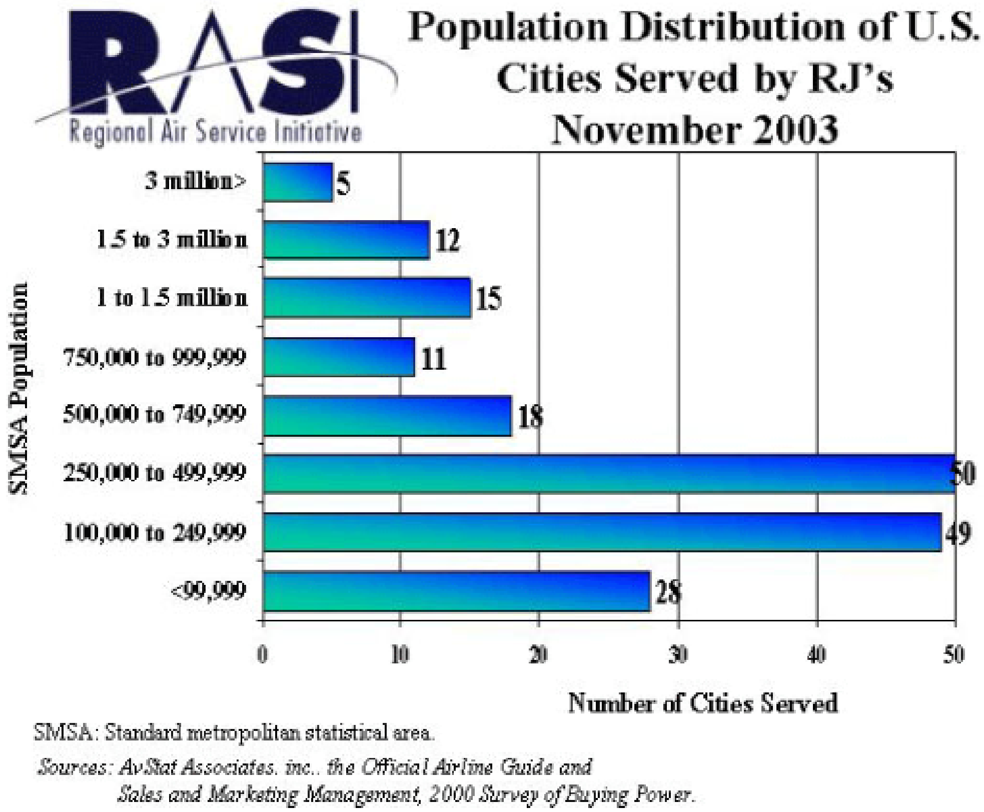
[22] Dresner, Martin, Robert Windle, and Ming Zhou, 2002. *Regional Jet Services: Supply and Demand*. Journal of Air Transportation Management 8, 267-273.
[23] IBID.
[24] IBID.
[25] IBID.
[26] Savage, Ian and Burgess Scott, 2004. *Deploying Regional Jets to Add New Spokes to a Hub*. Journal of Air Transportation Management 10, 147-150.

of demand related to insufficient population and low levels of economic activity.[27] They cited GAO analysis that showed regional jet service was related to jobs per capita and per capita income. The Regional Air Service Initiative points to regional jets being deployed at cities of all sizes with a concentration on those in the 100,000 to 500,000 range. This is shown below in Figure 4.

[27] Larsen, Tulinda, 2003. *Crisis in Small Community Air Service*. 28th Annual FAA Commercial Aviation Forecast Conference, Washington, D.C.



Source: Regional Air Service Initiative (secondary)

Figure 4 Population Distribution of Cities Served By Regional Jets, November 2003.

For small communities, this leaves little for them to affect in order to become more attractive to regional jet service. Their location, vis-à-vis airline hubs, is something they can do little about. However, growth in population and employment base in terms of number of jobs and type of jobs (higher paying) is something that they can work toward in terms of ultimately attracting higher levels of airline service. But these are not steadfast rules. Some airlines may phase out turboprop aircraft or want access to smaller communities for various reasons. Their partnerships with regional airlines may change and new partners may have all-jet fleets. So while some important factors have been outlined above, they are by no means absolutes. As an example, the Regional Air Service Initiative recently announced that several cities received first-time regional jet service in the Spring of 2003 bringing the total number of airports in North America served by regional jets to 245. As for the 12 cities, "they included: (1) Panama City, Florida; (2) Waterloo, Iowa; (3) New Orleans, Louisiana; (4) Meridian, Mississippi; (5) State College, Pennsylvania; (6) Lynchburg, Virginia (7) Lewisburg, West Virginia; (8) Jackson, Wyoming; (9) Fredericton, Canada; and (9-12) Manzanillo, Mazatlan, and Morelia, Mexico."[28] As can be seen from the list, not all of them are small communities but some are. Some also have additional elements that make them more marketable for higher levels of air service. This includes the presence of a large university as well as being a large tourism destination

Summary Comments

Since the terrorist attacks of September 11, 2001, airlines have restructured their operations in order to operate more efficiently. This included a larger and more prominent role for regional airlines and regional aircraft. The use of regional jets is expected to continue to grow replacing larger jets on inefficient routes, adding new routes, and replacing turboprop aircraft and smaller communities are likely to be apart of the equation in the future.

Little has been done to examine the environmental impacts on small communities associated with regional jets. They are believed to be quieter and cleaner but how this translates to small communities not used to dealing with jet aircraft has not been addressed. This study will do that using ten communities in Texas that have some regional jet use or expected to have some in the coming years.

[28] Regional Air Service Initiative, www.regionalairservice.com.

CHAPTER 2. DATA AND METHODOLOGY

The noise impacts will be evaluated using the latest version of the FAA's Integrated Noise Model (INM). An FAA standard tool since 1978, the INM allows planners to accomplish a variety of noise related analysis including the development of noise contour maps for land use compatibility studies. This state-of-the-practice model will be used to evaluate the noise impacts of regional jets by reviewing them with respect to those developed using the current fleet.

The air quality impacts of these new aircraft were evaluated using the FAA recommended Emissions and Dispersion Modeling System (EDMS) software. An emissions inventory of aircraft and their related ground service equipment was developed.

Investigation of the initiation of regional jets into our non-hub airports will promote safety and a safe environment by examining noise and air quality impacts of newer, more technologically advanced aircraft. The implementation of regional jet service is an important issue as it will undoubtedly enhance the mobility, accessibility, and efficiency of the airport and community for those that live in it and those that need to access it from remote parts of the state, country, and world. What follows are the results of the noise and air quality analysis for the ten airports included in the study.

The data used in this analysis includes information on airports, aircraft fleet mixes, and passenger demand data among others. The following section highlights the data used as well as its sources.

Airports

The 27 commercial service airports in the Texas Airport System Plan provide varying levels of service to communities of different sizes. These range from large international airports in Dallas and Houston with non-stop destinations around the world to small, community airports in places such as Victoria and San Angelo that seed into airline networks in Dallas and Houston. Table 1 shows these 27 airports, the city where they are located, their population, and whether or not they have regularly scheduled jet service. The Commercial airports were taken from the Texas Airport System Plan document and the population data was taken from Texas State Data Center. Whether or not an airport had regularly scheduled jet service was derived from the T-100 data obtained through a private vendor who obtains it from the FAA. The vendor is used to pull the needed data from the voluminous amounts of electronic tapes on which the data is permanently stored. The T-100 data is quite detailed and for the each airport requested includes the scheduled and non-scheduled departures by aircraft type, number of passengers and seats available, load factors, available seat miles, revenue passenger miles, and average trip length.

In addition, 298c data was obtained. This is passenger data by airport for the commuter airlines that were not included in the T-100 data. Only passenger data is included. Any airline that operates an aircraft in excess of 60 seats has their data included in the T-100 dataset and includes data even if it was on an aircraft smaller than 60 seats. However, if the airline does not operate any aircraft larger than 60 seats, it is included in a different dataset for commuter airlines. Both Continental Express, now Express Jet, and American Eagle are included in the T-100 data.

Table 1 Commercial Service Airports in Texas, Their City, Population, and Level of Service

Airport Name	City	MSA Population	Jet Service
Abilene Regional	Abilene	127,391	No
Amarillo International	Amarillo	210,690	Yes
Austin-Bergstrom International	Austin	1,155,102	Yes
Jefferson County	Beaumont/Port Arthur	378,816	No
Brownsville/South Padre Island	Brownsville	324,127	Yes
Easterwood Field	College Station	143,533	No
Corpus Christi International	Corpus Christi	383,095	Yes
Dallas Love Field	Dallas	3,318,801	Yes
Dallas-Fort Worth International	Dallas-Fort Worth	3,318,801	Yes
El Paso International	El Paso	698,787	Yes
Rio Grande Valley International	Harlingen	324,127	Yes
Bush Intercontinental	Houston	4,051,752	Yes
Ellington Field	Houston	4,051,752	No
William P. Hobby	Houston	4,051,752	Yes
Killeen Municipal	Killeen	302,043	No
Laredo International	Laredo	198,399	No
Gregg County	Longview	211,592	No
Lubbock International	Lubbock	229,931	Yes
McAllen Miller International	McAllen	542,528	Yes
Midland International	Midland	240,703	Yes
Mathis Field	San Angelo	104,462	No
San Antonio International	San Antonio	1,571,512	Yes
Texarkana Regional-Webb Field	Texarkana	82,047	No
Tyler Pounds Field	Tyler	169,263	No
Victoria Regional	Victoria	83,395	No
Waco Regional	Waco	204,609	No
Sheppard AFB/Wichita Falls Municipal	Wichita Falls	136,200	No

As mentioned earlier, the airports of interest for this study are those that have populations under 250,000 that do not currently have regularly scheduled passenger jet service. These criteria were established because these are the airports that are likely to be candidates for regional jet service and thus, be faced with the noise and air quality issues facing growing communities. This is in large part due to the fact that these growing communities are currently being served by turbo-prop aircraft that are scheduled to be phased out in the future and replaced by more efficient and economical jet aircraft. The ten airports meeting the criteria are shown in Table 2.

Table 2 Airports Meeting Criteria for Regional Jet Analysis, Their City, and Population

City	Airport Name	Location Identifier	2000 Population*	
			City	MSA
Abilene	Abilene Regional	ABI	116,806	127,391
College Station	Easterwood Field	CLL	64,743	143,533
Laredo	Laredo International	LRD	185,815	198,399
Longview	Gregg County	GGG	76,848	211,592
San Angelo	Mathis Field	SJT	90,094	104,462
Texarkana	Regional-Webb Field	TXK	35,262	82,047
Tyler	Tyler Pounds Field	TYR	83,899	169,263
Victoria	Victoria Regional	VCT	63,361	83,395
Waco	Waco Regional	ACT	108,793	204,609
Wichita Falls	Sheppard AFB / Wichita Falls Municipal	SPS	97,672	136,200

* Populations are January 1, 2000 population estimates provided by the Texas State Data Center.

In summary, the passenger and fleet mix data for 1996 and 2000 came from the FAA data as described above. The forecasted data for 2007 also came from the FAA. Two scenarios for 2007 were developed for this analysis. One assumed the same fleet mix from 2000 and the second assumed that all of the existing turbo-prop aircraft would be phased out and replaced by regional jet aircraft.

The FAA Terminal Area Forecasts were used to obtain 2007 enplanement data for all ten airports. Average load factors were used, in conjunction with the forecasted passenger enplanements, to determine the number of operations of regional jets at each airport. One specific regional jet was selected for each airport to represent the regional jet activity. This was done based on year 200 fleet data and whether or not the airport had any existing regional jet activity. Many of the 10 airports did have some regional jet operation as airlines began to use then on occasion. In nine of the ten cases, the Embraer 145, a 50-passsenger jet, was selected. In the remaining case, at Gregg County airport, the smaller 37-passenger Embraer 135 was selected. While not all airlines operate the same model or "family" of aircraft, it was assumed for this analysis that the regional jets had similar operating characteristics. Considering that they are all new generation aircraft employing the latest technology in engine efficiency, this seems a reasonable assumption, rather than speculating on which aircraft may be selecting in the future by each airline in each market.

Tables 3 through 12 show the fleet mixes and operations for each of the ten airports. This includes historical 1996 and 2000 data as well as the two forecasted scenarios for 2007.

Table 3 Abilene Regional Airport – Historical and Forecasted Operations by Aircraft Type

Aircraft	1996 Operations	2000 Operations	2007 Operations	2007 Operations with RJ Replacement
BCH 1900	----	2	2	----
ATR-42	2	7	7	----
ATR-72	8	12	12	----
SF-340 Saab	6	2,317	2,323	----
EMB-120	4,109	819	811	----
737-200C	6	21	19	19
MD-80/DC-9	33	50	50	50
737-3/700	1	1	1	1
EMB-135	----	7	7	----
EMB-145		353	350	1,884
F-100 Fokker	8	12	12	12
MD-90	1	----	----	----
727-200	8	8	8	8
DC-9-30	----	1	1	1
Total	4,182	3,610	3,603	1,975

Table 4 Waco Regional Airport – Historical and Forecasted Operations by Aircraft Type

Aircraft	1996 Operations	2000 Operations	2007 Operations	2007 Operations with RJ Replacement
BCH 1900	886	553	652	----
ATR-42	15	6	8	----
ATR-72	7	6	8	----
SF-340 Saab	2,453	2,665	3,205	----
EMB-120	10	486	572	----
737-200C	18	20	22	22
MD-80/DC-9	17	9	11	11
757-200	1	----	----	----
EMB-135	----	2	2	----
EMB-145	----	9	11	2,408
F-100 Fokker	1	6	7	7
727-200	1	----	----	----
Total	3,409	3,762	4,498	2,448

Table 5 Easterwood Field Airport – Historical and Forecasted Operations by Aircraft Type

Aircraft	1996 Operations	2000 Operations	2007 Operations	2007 Operations with RJ Replacement
BCH 1900	411	339	488	----
ATR-42	119	110	157	----
ATR-72	8	75	109	----
SF-340 Saab	3,211	2,824	4,031	----
EMB-120	1,451	1,490	2,148	----
737-200C	3	2	3	3
737-500	----	1	1	1
MD-80/DC-9	----	1	1	1
737-3/700	----	1	1	1
EMB-135	----	3	4	----
EMB-145	----	11	17	4,272
Total	5,203	4,857	6,960	4,278

Table 6 Gregg County Airport – Historical and Forecasted Operations by Aircraft Type

Aircraft	1996 Operations	2000 Operations	2007 Operations	2007 Operations with RJ Replacement
727-200	2	2	2	2
ATR-72	----	4	4	----
SF-340 Saab	1,546	1,722	1,767	----
737-200C	2	6	6	6
MD-80/DC-9	9	6	6	6
EMB-135	----	1	1	1,552
Total	1,559	1,741	1,786	1,566

Table 7 Laredo International Airport – Historical and Forecasted Operationsby Aircraft Type

Aircraft	1996 Operations	2000 Operations	2007 Operations	2007 Operations with RJ Replacement
BCH 1900	6	1	1	----
ATR-42	9	75	82	----
ATR-72		291	315	----
SF-340 Saab	1	1,419	1,555	----
EMB-120	3,258	1,505	1,647	----
737-200C	5	7	7	7
DC-9-15/15	----	3	----	----
Dassault/Falcon	----	22	----	----
EMB-135	----	3	3	----
EMB-145	----	8	9	2,698
727-200	----	1	1	1
747-100	1	----	----	----
Total	3,280	3,335	3,620	2,706

Table 8 San Angelo Regional/Mathis Field Airport – Historical and Forecasted Operations by Aircraft Type

Aircraft	1996 Operations	2000 Operations	2007 Operations	2007 Operations with RJ Replacement
ATR-42	2	8	8	----
ATR-72	4	3	3	----
SF-340 Saab	2,303	2,302	2,334	----
EMB-120	1,368	742	742	----
Dassault/Falcon	----	1	----	----
EMB-145	----	8	9	1,600
Total	3,677	3,064	3,096	1,600

Table 9 Sheppard AFB/Wichita Falls Municipal Airport – Historical and Forecasted Operations by Aircraft Type

Aircraft	1996 Operations	2000 Operations	2007 Operations	2007 Operations with RJ Replacement
ATR-42	1	----	----	----
ATR-72	6	3	3	----
SF-340 Saab	1,685	2,200	2,208	----
EMB-120	1,395	1,302	1,315	----
737-200C	11	20	19	19
757-200	1	1	1	1
Dassault/Falcon	----	1	----	----
EMB-135	----	1	1	----
EMB-145	----	9	9	1,784
727-200	8	8	8	8
F-100 Fokker	1	6	6	6
RJ145-200E	----	2	2	----
MD-80/DC-9	15	18	18	18
MD-90 M	1	1	1	1
737-3/700	1	----	----	-----
737-1/200	2	----	----	-----
767-300	1	----	----	----
Total	3,128	3,572	3,591	1,837

Table 10 Tyler Pounds Field Airport – Historical and Forecasted Operations by Aircraft Type

Aircraft	1996 Operations	2000 Operations	2007 Operations	2007 Operations with RJ Replacement
ATR-42	18	3	4	**----**
ATR-72	4	6	10	**----**
SF-340 Saab	3,731	3,074	4,278	**----**
EMB-120	45	486	680	**----**
BCH 1900	1,216	588	833	**----**
EMB-145	**----**	7	10	3,177
Total	5,014	4,164	5,815	3,177

Table 11 Texarkana Regional - Webb Field Airport – Historical and Forecasted Operations by Aircraft Type

Aircraft	1996 Operations	2000 Operations	2007 Operations	2007 Operations with RJ Replacement
ATR-42	2	----	----	----
ATR-72	98	4	4	----
SF-340 Saab	----	1,602	1,659	----
EMB-120	2,823	1,271	1,320	----
737-200C	3	3	3	----
EMB-145	----	1	1	1,337
RJ145-200E	----	64	66	3
Total	2,926	2,945	3,053	1,340

Table 12 Victoria Regional Airport – Historical and Forecasted Operations by Aircraft Type

Aircraft	1996 Operations	2000 Operations	2007 Operations	2007 Operations with RJ Replacement
ATR-42	1	7	562	----
BCH 1900	437	432	9	----
EMB-120	1,167	974	1,273	----
EMB-145	----	----	----	1,100
Total	1,605	1,413	1,844	1,000

It should be noted that the number of aircraft operations in 2007 using the all regional jet scenario decreased. In many cases this decrease was quite large. This is reflective of the increased capacity per operation when using the regional jets compared to the available seats typically found on the turboprop aircraft that were being used. Table 13 shows the most common turbo prop aircraft and the two regional jet models used in this analysis to help illustrate how such a shift in aircraft type can reduce overall operations. Some of the turboprop aircraft do seat more passengers than the regional jets but this is offset by the large number of operations and passengers flown in the smaller turboprops.

Table 13 Most Common Commuter Aircraft from Analysis and Number of Available Seats

Aircraft Type	Available Seats
Beech 1900 (turboprop)	19
Saab 340 (turboprop)	30
ATR-42 (turboprop)	48
ATR-72 (turboprop)	66
Embraer EMB 120 (turboprop)	30
Embraer EMB 135 (regional jet)	37
Embraer EMB 145 (regional jet)	50

Source: Aviation Week and Space Technology, Sourcebook, 2003.

Measurement/Methodology

As mentioned earlier, the FAA's Integrated Noise Model and the Emissions and Dispersion Modeling System software were used to evaluate the noise and air quality impacts of the regional jet service. Many of the default settings for the ten airports were used in the analysis. Additional airport specific information, when needed, was used and came from the AirNav website (www.airnav.com). The mixing height temperatures used in the EDMS model came from the Environmental Protection Agency and their guidance on preparing emissions inventories. These mixing heights are shown in Table 14.

Table 14 Mixing Heights for the Ten Texas Airports

Airport Name	Mixing Height (feet)
Abilene Regional	1,640
Easterwood Field	2,296
Gregg County	1,804
Laredo International	3,116
Mathis Field	2,132
Pounds Field	1,804
Webb Field	1,640
Sheppard AFB/Wichita Falls Municipal	1,410
Victoria Regional	2,624
Waco Regional	2,132

Source: EPA

Aircraft and Ground Service Equipment Emissions

The annual emissions for the ten Texas airports were found using the EDMS program. Only the emissions generated by the commercial service aircraft at these airports are being considered. A separate run of the EDMS program displaying the annual CO, HC, NOx, SOx, and PM10 was performed for each of the 1996, 2000, 2007, and 2007 RJ scenarios. The two model runs for the year 2007 include the airline's plans to have predominately a regional jet fleet mix in the future. Thus, a decrease in the number of turboprops in their fleet mix is recognized.

The unique characteristics of each airport were needed to obtain the emissions from the EDMS program. The mixing heights, shown in Table 14 and the temperatures shown in Table 15 are two of the characteristics needed. Averages for the year 2000 for each airport or city were used for all of the EDMS runs. A constant temperature value was used for all four scenarios to eliminate any change in emissions from year to year due to the change in temperature and to simplify the analysis. This allows only the change in fleet mix and Landing/Take-Off (LTO) cycles to affect the emissions. Also, the type of commercial aircraft and the number of LTO cycles for each aircraft were needed for each of the ten airports.

The fleet mix data, mixing height, temperature, and LTO cycles were all inputs to the model. The aircraft engines were selected according to those used in the INM program. When a match could not be found or determined, the default engine was chosen. In the event an aircraft was not contained within the program, a substitute aircraft was selected. The default characteristics of each aircraft were used, including the takeoff weight, the times in mode, and the ground service equipment used by the specific aircraft.

Aircraft Noise Analysis

The noise levels for the ten Texas airports were calculated using the Integrated Noise Model program. The commercial service aircraft were the only aircraft taken into consideration in this study. A separate run of the INM program was made for 1996, 2000, 2007, 2007 RJ scenarios resulting in noise levels, the area within each noise level, and a noise contour map.

As with the emissions model, specific airport information was needed to operate the INM program. The diagrams of the airports were included within the program, except for the Victoria Regional Airport. The latitude and longitude of the airport, the elevation of the airport, and all of the runway information was obtained for the AirNav website and the 2001-2002 Texas Airport Directory. This information was then used to create the airport within the INM Program.

The climate data for each airport was also used in the program. The average temperature, pressure, and dew point temperature for each city was obtained from the State Climatologist Office. The temperature, pressure, and humidity (calculated from the temperature, pressure and dew point) averages for the year 2000 were then inserted in the program for each run of the INM program. The default value for the head wind was also used. In the cases where any of this data was not attainable, the default values were used. The climate data used in the INM program is listed in Table 15.

Table 15 Climate Data for the Ten Texas Airports

Airport Name	Average Temperature	Average Dew Point Temperature	Average Pressure	Average Humidity
Abilene Regional	66.18	46.80	28.11	50.99
Easterwood Field	69.33	----	----	----
Gregg County	65.73	----	----	----
Laredo International	75.56	----	----	----
Mathis Field	67.70	48.10	27.98	49.44
Pounds Field	66.20	54.30	29.43	65.61
Webb Field	64.31	----	----	----
Sheppard AFB/Wichita Falls Municipal	65.00	48.11	28.90	55.89
Victoria Regional	71.69	61.58	29.88	70.82
Waco Regional	68.12	55.35	29.46	64.88

Source: Office of the Texas State Climatologist

For each airport, a primary runway was chosen from the runways listed on the airport diagram. The runway was selected based on the runway length, runway condition, and proximity to the terminals. Selecting the designated air carrier runway was the objective and was not difficult considering the airport size and available facilities at these ten non-hub airports. Also, a designated flight path was chosen to be 10 nautical miles straight out from the runway end.

Once the number of aircraft operations were obtained and determined, the annual operations were designated into one of three time periods for use in the program : day, evening, and night. The annual operations were distributed among these times of day based on the following :

1. The annual flights were equally distributed over a 365 day period to obtain the number of daily flights.

2. The number of daily flights was equally distributed over the three time periods to reach the number of daily flights per time period.

3. The number of daily flights per time period was equally distributed over the two runway ends of the primary runway.

Based on the fleet mix data for each run, the aircraft were selected within the program. In the event an aircraft was not listed, a suitable substitution was selected. For some aircraft, multiple combinations between aircraft type and engine type do exist. In this case, a logical combination with regard to commercial airline service was chosen. The default characteristics of each aircraft were used, including the maximum gross takeoff weight, the number of engines and many others.

CHAPTER 3. RESULTS AND ANALYSIS

The results of the air quality and noise analyses are shown in the tables below. Each airport is discussed separately with emissions and noise results detailed for each. The operations discussed for each airport pertain to their scheduled passenger service and not any general aviation operations that occurred. The air quality results show annual emissions for each year or scenario for five pollutants including CO, HC, NOX, SOX, and PM10. All of the units shown are in tons per year.

The noise results are shown in millions of square feet and are shown by year, or scenario. They are also further stratified by noise level in decibels. The impacts were examined vis-à-vis these noise and air quality measures.

Abilene Regional Airport - Abilene, Texas

The Abilene Regional Airport is located three miles southeast of the city of Abilene. Due to the proximity of the airport, the noise and emissions generated by the airport may be a concern of the city of Abilene.

The Abilene Regional Airport saw a decrease in total flights from 1996 to 2000 of 13.7 percent (572 flights). The forecast year of 2007 showed only a slight decrease of 0.2 percent (7 flights) from that of the year 2000. Due to the commercial air service industry's lean toward a total regional jet fleet, the number of flights forecasted for 2007 with the regional jet replacements shows a large decrease in the number of flights of 46.2 percent when compared to the 2007 predictions.

Noise

Despite the decrease in the number of flights from 1996 to 2000, the noise effects of the airport increased. The effects from the year 2000 to the forecast year of 2007 remained consistent with that of the decrease in flights showing a small decrease in the area affected. With the regional jet factor included in the 2007 forecast, the noise effects decreased. This is evident in the 60 dB noise level where the area affected by this noise level decreased by 88 percent. The noise levels generated by the commercial air service at the Abilene Regional Airport and the area influenced by these noise levels are listed in Table 16.

Table 16 Noise Levels and the Area Within Each Noise Level (millions of square feet) for Abilene Regional Airport

Noise Level (dB)	1996 (m.sq.ft.)	2000 (m.sq.ft.)	2007 Forecast (m.sq.ft.)	2007 Regional Jet Forecast (m.sq.ft.)
55	14.44	30.38	29.75	19.74
60	0.23	7.07	6.23	0.75

Emissions

The changes in annual aircraft emissions depend greatly on the type of pollutant studied. The changes were fairly small from the year 2000 to the 2007 forecast for all of the pollutants considered. However, the CO emissions decreased with the implementation of the regional jets for the year 2007. The HC and NOX emissions showed an increase with the regional jet implementation and the SOX showed a much smaller increase. The emissions for the aircraft are shown in Table 17.

Table 17 Annual Aircraft Emissions – Abilene Regional Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)
1996	10.919	0.109	5.148	0.789
2000	8.49	0.902	3.251	0.505
2007 Forecast	8.458	0.902	3.227	0.502
2007 Regional Jet Forecast	6.524	1.031	4.251	0.551

Although little change occurred between 1996, 2000 and the 2007 forecast, the annual emissions generated by the ground service equipment decreased greatly with the implementation of the regional jet. The emissions generated by the ground service equipment (GSE/AGE/APU**)** for each year and both forecast scenarios are shown in Table 18.

Table 18 Annual Emissions from Ground Service Equipment – Abilene Regional Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	89.57	2.104	6.473	0.334	0.258
2000	77.036	1.784	6.49	0.331	0.223
2007 Forecast	76.885	1.781	6.481	0.331	0.224
2007 Regional Jet Forecast	42.133	0.972	3.694	0.188	0.122

Due to the large changes in the ground service equipment emissions, the total yearly emissions for the Abilene Regional Airport showed an overall decrease in the emissions of each pollutant. The total aircraft related emissions for each pollutant are shown in Table 19.

Table 19 Total Annual Aircraft Related Emissions – Abilene Regional Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	100.489	2.213	11.621	1.123	0.258
2000	85.526	2.686	9.741	0.836	0.223
2007 Forecast	85.343	2.683	9.708	0.833	0.224
2007 Regional Jet Forecast	48.657	2.003	7.945	0.739	0.122

Easterwood Field - College Station, Texas

Easterwood Field experienced a slight decrease in the number of annual airline operations of 6.65 percent from the year 1996 to the year 2000. Despite this decrease, the number of operations for 2007 is forecasted to increase by 43.30 percent to 6,960 operations per year. The number of operations is expected to decrease to 4,278 in the year 2007 once the regional jets are phased in.

Noise

As would be expected, the noise impacts decrease slightly with the decrease in operations from 1996 to 2000. Despite the large increase in operations from 2000 to the 2007 forecast, the noise level impacts increased slightly. However, the phase-in of the regional jet in the 2007 forecast decreased the noise impacts greatly. The noise levels on and around Easterwood Field and the area influenced by these noise levels are listed in Table 20.

Table 20 Noise Levels and the Area Within Each Noise Level (millions of square feet) for Easterwood Field

Noise Level (dB)	1996 (m.sq.ft.)	2000 (m.sq.ft.)	2007 Forecast (m.sq.ft.)	2007 Regional Jet Forecast (m.sq.ft.)
55	21.57	20.52	24.77	9.95
60	6.68	6.17	8.68	3.42
65	2.34	2.21	2.96	1.05
70	0.77	0.7	1.02	0.13
75	0.05	0.03	0.12	----

Emissions

The large increase in the number of operations from 2000 to the 2007 forecast resulted in an increase in the major pollutants generated by the aircraft themselves. The increased role of the regional jet did decrease the CO and HC emissions compared to that of the 2007 forecast but these emissions were still higher than that of the levels in 2000. The pollutants NOX and SOX responded very differently to the increase in the regional jet operations. These pollutants increased when compared to the 2000 levels and the 2007 forecasted levels. The emissions for the aircraft are shown in Table 21.

Table 21 Annual Aircraft Emissions – Easterwood Field

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)
1996	13.366	1.712	3.918	0.661
2000	12.474	1.479	3.98	0.648
2007 Forecast	17.724	2.101	5.631	0.922
2007 Regional Jet Forecast	13.507	2.023	9.421	1.182

The ground service equipment emissions, however, experienced a different trend than that of the aircraft emissions. All of the pollutants increased or decreased according to the change in operations from year to year. The emission levels for the year 2007 with the regional jet fleet are considerably lower than that of the 2007 forecast and the 1996 base year. The ground service emissions are listed in Table 22.

Table 22 Annual Emissions from Ground Service Equipment – Easterwood Field

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	108.436	2.494	8.794	0.446	0.306
2000	101.752	2.342	8.232	0.419	0.291
2007 Forecast	145.462	3.348	11.761	0.596	0.414
2007 Regional Jet Forecast	91.126	2.097	8.047	0.41	0.266

Due to the significance of the aircraft NOX and SOX emissions, the total emissions indicated a varying response with the increased role of the regional jet. The pollutants CO, HC, and PM10 experienced a large increase with the 2007 forecast over the 1996 and 2000 levels, but experienced an even larger decrease with the 2007 regional jet forecast. This resulted in CO HC, and PM10 levels lower than that of 1996. The pollutants NOX and SOX did not respond in the same manner as the other pollutants with the 2007 regional jet forecast. The NOX and SOX pollutant levels did experience an increase between the 2000 and the 2007 forecast. However, the 2007 regional jet forecast had an increased NOX and SOX levels when compared to the 2007 forecast and considerably larger levels than that of 1996. The total annual aircraft related emissions are listed in Table 23.

Table 23 Total Annual Aircraft Related Emissions – Easterwood Field

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	121.802	4.206	12.712	1.107	0.306
2000	114.226	3.821	12.212	1.067	0.291
2007 Forecast	163.186	5.449	17.392	1.518	0.414
2007 Regional Jet Forecast	104.633	4.12	17.468	1.592	0.266

Gregg County Airport - Longview, Texas

The Gregg County Airport experienced a small gain in yearly operations of 11.7 percent from 1996 to 2000. This small gain, coupled with other factors, resulted in a very slight gain of 2.6 percent between 2000 and the 2007 forecast to only 1,741 yearly operations. Due to the small number of operations, the regional jet forecast for 2007 showed a decrease of only 12.3 percent, which is much smaller than other airports. This decrease caused the 2007 regional jet forecasted operations to drop close to the1996 level of operations.

Noise

Despite the smaller increase in operations from 1996 to 2000, the noise levels greatly increased. After not experiencing any major changes in operations or the noise effects from 2000 to the 2007 forecast, the greatest increase can be seen with the 2007 regional jet forecast, largely due to the small decrease in operations and the increase in the number of operations by the regional jet. The noise levels on and around Gregg County Airport and the area influenced by these noise levels are listed in Table 24.

Table 24 Noise Levels and the Area Within Each Noise Level (millions of square feet) for Gregg County Airport

Noise Level (dB)	1996 (m.sq.ft.)	2000 (m.sq.ft.)	2007 Forecast (m.sq.ft.)	2007 Regional Jet Forecast (m.sq.ft.)
55	10.34	14.69	14.57	17.48
60	0.16	1.08	1.04	5.62
65	0.00	0.00	0.00	0.13

Emissions

The pollutants experienced an increase in levels for each case in the study. The largest increase occurred with the 2007 regional jet forecast. The emissions for the aircraft are shown in Table 25.

Table 25 Annual Aircraft Emissions – Gregg County Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)
1996	3.148	0.41	0.779	0.14
2000	3.508	0.448	0.87	0.157
2007 Forecast	3.597	0.461	0.891	0.162
2007 Regional Jet Forecast	4.932	0.741	3.206	0.415

The pollutants generated by the ground service equipment all increased from 1996 to 2000 but only slightly increased from 2000 to 2007. However, the 2007 regional jet forecast resulted in levels lower than 2000 and the 2007. The pollutant levels for the 2007 regional jet forecast are almost identical to the 1996 levels. The emissions levels for the ground service equipment are listed in Table 26.

Table 26 Annual Emissions from Ground Service Equipment – Gregg County Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	33.217	0.764	2.931	0.148	0.097
2000	37.095	0.853	3.271	0.165	0.107
2007 Forecast	38.053	0.876	3.356	0.170	0.11
2007 Regional Jet Forecast	33.367	0.768	2.942	0.148	0.097

Overall, the pollutants experienced increased levels in 2000 when compared to 1996 and only slightly higher levels with the 2007 forecast. The pollutants CO and PM10 slightly decreased with the 2007 regional jet forecast, the only pollutants to do so. The pollutants HC, NOX, and SOX increased with the 2007 regional jet forecast, with the NOX and SOX levels increasing more than HC. The total annual aircraft related emissions for the Gregg County Airport are listed in Table 27.

Table 27 Total Annual Aircraft Related Emissions – Gregg County Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	36.365	1.174	3.71	0.288	0.097
2000	40.603	1.301	4.141	0.322	0.107
2007 Forecast	41.65	1.337	4.247	0.332	0.11
2007 Regional Jet Forecast	38.299	1.509	6.148	0.563	0.097

Laredo International Airport - Laredo, Texas

The Laredo International Airport experienced a very minimal increase in operations from 1996 to 2000 of 1.7 percent (55 operations). The 2007 forecast increased the number of operations by 8.5 percent (285 operations). The 2007 regional jet forecast decreased the number of operations in 2000 by 629 operations (18.9 percent) and the number of operations in the 2007 forecast by 914 (25.2 percent).

Noise

Despite the relatively small increase in operations, the noise levels increased greatly between 1996 and 2000. The noise affects did increase slightly with the increase in operations with the 2007 forecast. However, the noise affects decreased with the 2007 regional jet forecast. The top noise level of 60 dB affected 0.51 m.sq.ft. in the 2007 regional jet forecast compared to 1.55 m.sq.ft. in 2000 and 0.97 m.sq.ft with the 2007 forecast. The noise levels on and around the Laredo International Airport and the area influenced by these noise levels are listed in Table 28.

Table 28 Noise Levels and the Area Within Each Noise Level (millions of square feet) for Laredo International Airport

Noise Level (dB)	1996 (m.sq.ft.)	2000 (m.sq.ft.)	2007 Forecast (m.sq.ft.)	2007 Regional Jet Forecast (m.sq.ft.)
55	6.87	17.81	19.45	10.11
60	0.58	1.55	0.97	0.51

Emissions

The CO emissions generated by the aircraft decreased from 1996 (8.887 tons) to 2000 (8.574 tons) and to the 2007 forecast (8.458 tons). The 2007 regional jet forecast did not continue this trend, however, increasing the emissions to 8.718 tons. The HC emissions jumped dramatically from 1996 to 2000 but decreased with the 2007 forecast. The 2007 regional jet forecast, however, increased those emissions, almost tripling the 2007 forecast. The NOX and SOX emissions experienced a similar trend by decreasing in 2000 but increasing with the 2007 forecast and increasing even more with the 2007 regional jet forecast. The emissions for the aircraft are shown in Table 29.

Table 29 Annual Aircraft Emissions – Laredo International Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)
1996	8.887	0.07	4.525	0.676
2000	8.574	0.49	4.034	0.574
2007 Forecast	8.485	0.442	4.371	0.623
2007 Regional Jet Forecast	8.718	1.318	6.865	0.826

The major pollutants all experienced the same basic trend for the ground service equipment. After a slight increase in 2000, the 2007 forecast showed an increase in the emissions levels, mainly due to the increase in operations. The 2007 regional jet forecast had the opposite affect. The emissions levels for every pollutant decreased either almost to or below their respective levels in 1996. The annual emissions for the ground service equipment are shown in Table 30.

Table 30 Annual Emissions from Ground Service Equipment – Laredo International Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	70.192	1.648	5.068	0.261	0.204
2000	71.075	1.649	5.716	0.294	0.206
2007 Forecast	77.297	1.796	6.229	0.320	0.226
2007 Regional Jet Forecast	57.644	1.326	5.090	0.258	0.168

The increased effects of the regional jet on the annual total emissions lie mainly with the aircraft emissions. The CO emissions increased with the 2007 forecast when compared to the 2000 levels but decreased with the 2007 regional jet forecast to a level even lower than 1996. The levels showed very little change from 1996 to 2000. The HC and NOX emissions, however, increased with the 2007 forecast and increased even more with the 2007 regional jet forecast. Despite a decrease in emissions from 1996 to 2000, the SOX emissions also increased with the 2007 forecast and increased even more with the 2007 regional jet forecast. All three of these pollutants (HO, NOX, and SOX) increased with the 2007 regional jet forecast despite the decrease in operations. The total annual aircraft related emissions are listed in Table 31.

Table 31 Total Annual Aircraft Related Emissions – Laredo International Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	79.079	1.718	9.593	0.937	0.204
2000	79.649	2.139	9.75	0.868	0.206
2007 Forecast	85.782	2.238	10.6	0.943	0.226
2007 Regional Jet Forecast	66.362	2.644	11.955	1.084	0.168

Mathis Field - San Angelo, Texas

Mathis Field experienced a decrease in the number of yearly operations from 1996 (3,667 operations) to 2000 (3,064 operations) of 16.7 percent. The 2007 forecast increases the number of operations slightly to 3,096 operations. The 2007 regional jet forecast substantially decreases this number to 1,600 annual operations.

Noise

Along with the considerable decrease in operations between 1996 and 2000, the noise effects also decreased. As the number of operations increased slightly with the 2007 forecast, so did the affected noise area. The noise impacts remained consistent with the number operations into the 2007 regional jet forecast. The noise levels decreased dramatically with the 2007 regional jet forecast along with the number of yearly operations. The noise levels on and around the Mathis Field area are listed in Table 32.

Table 32 Noise Levels and the Area Within Each Noise Level (millions of square feet) for Mathis Field

Noise Level (dB)	1996 (m.sq.ft.)	2000 (m.sq.ft.)	2007 Forecast (m.sq.ft.)	2007 Regional Jet Forecast (m.sq.ft.)
55	20.71	18.23	18.37	2.11
60	2.62	2.34	2.36	0.02
65	0.08	0.00	0.00	0.00

Emissions

The changes in CO emissions generated by the aircraft between each year in the study followed the same trends as the changes in operations. The CO emissions decreased from 1996 to 2000 but did increase with the 2007 forecast. The 2007 regional jet forecast had the opposite affect, decreasing the emissions even lower than that of the 2000 levels. The HC emissions, however, did increase from 1996 to 2000 despite the decrease in operations and increased to a higher level with the 2007 forecast. The 2007 regional jet forecast also resulted in increased HC emissions. The 2007 forecast did result in higher NOX levels than the 2000 levels but lower than that of 1996. However, the 2007 regional jet forecast increased the NOX levels over the 2000 levels. The 2007 forecast also had increased SOX emissions over the year 2000 but the emissions were decreased from 1996. The emissions for the aircraft are shown in Table 33.

Table 33 Annual Aircraft Emissions – Mathis Field

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)
1996	8.134	0.588	2.807	0.464
2000	6.590	0.594	2.068	0.348
2007 Forecast	6.622	0.600	2.087	0.353
2007 Regional Jet Forecast	5.022	0.752	3.417	0.434

The major pollutants for the ground service equipment all experienced increases or decreases along with increases or decreases in the total yearly operations. Despite the small increase in emissions for the 2007 forecast over that of 2000, the regional jet forecast resulted in a large decrease in emission levels over the 2000 levels. The emission levels for the ground service equipment are shown in Table 34.

Table 34 Annual Emissions from Ground Service Equipment – Mathis Field

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	78.470	1.821	6.461	0.330	0.229
2000	65.342	1.513	5.512	0.280	0.189
2007 Forecast	66.029	1.528	5.573	0.284	0.192
2007 Regional Jet Forecast	34.080	0.784	3.011	0.154	0.100

Despite the various changes in the aircraft emissions, the total yearly emissions for the major pollutants all increased with the 2007 forecast. However, the total yearly emissions decreased for all major pollutants with the 2007 regional jet forecast, mainly due to the decrease in the emissions generated by the ground service equipment. The total annual aircraft related emissions are listed in Table 35.

Table 35 Total Annual Aircraft Related Emissions – Mathis Field

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	86.604	2.409	9.268	0.794	0.229
2000	71.932	2.107	7.580	0.628	0.189
2007 Forecast	72.651	2.128	7.660	0.637	0.192
2007 Regional Jet Forecast	39.102	1.536	6.428	0.588	0.100

Pounds Field - Tyler, Texas

The number of total operations decreased for Tyler Pounds Field from 1996 to 2000 by 850 operations or 17 percent. Despite this decrease, the 2007 forecast resulted in an increase in total operations to 5,815, a 39.6 percent (1,615 operations) increase over 2000. Due to the restrictions for the 2007 regional jet forecast, the number of annual operations decreased to 3,177, a decrease of 23.7 percent (987 operations) over the year 2000.

Noise

As would be expected the area affected by each noise level decreased with the decrease in the number of operations from 1996 to 200. The area affected by each noise level also increased from 2000 to the 2007 forecast, as did the number of operations. The affected area also decreased dramatically with the 2007 regional jet forecast along with the number of operations, despite the fact the only aircraft used in this forecast was the regional jet EMB-145. The noise levels in and around the Pounds Field and the area influenced by these noise levels are listed in Table 36.

Table 36 Noise Levels and the Area Within Each Noise Level (millions of square feet) for Tyler Pounds Field

Noise Level (dB)	1996 (m.sq.ft.)	2000 (m.sq.ft.)	2007 Forecast (m.sq.ft.)	2007 Regional Jet Forecast (m.sq.ft.)
55	20.45	17.77	22.79	9.72
60	6.03	3.87	7.78	0.22

Emissions

The aircraft emission levels decreased from 1996 to 2000. The pollutants increased considerably from 2000 to the 2007 forecast along with the number of operations. The CO, NOX, and SOX emissions for the 2007 forecast were actually higher than that of 1996. The 2007 regional jet forecast, however, had varying affects on the pollutants. The CO and HC emissions decreased as a result of the 2007 regional jet forecast. The NOX and SOX emissions, however, had the opposite results. These emissions levels for the 2007 regional jet forecast were higher than any other year in the study. The emissions for the aircraft are shown in Table 37.

Table 37 Annual Aircraft Emissions – Tyler Pounds Field

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)
1996	15.726	3.498	2.304	0.488
2000	11.311	2.010	2.232	0.427
2007 Forecast	15.853	2.829	3.118	0.598
2007 Regional Jet Forecast	9.892	1.474	6.353	0.827

As the number of operations decreased from 1996 to 2000, so did the levels of the major pollutants. Despite this decrease, the 2007 forecast resulted in an increase of these levels over the 1996 and 2000 levels. The 2007 regional jet forecast, however, had a very positive affect on the levels of each pollutant, decreasing them well below the levels for the years 1996 and 2000. The ground service equipment yearly emissions are shown in Table 38.

Table 38 Annual Emissions from Ground Service Equipment – Tyler Pounds Field

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	99.216	2.23	8.022	0.396	0.264
2000	85.079	1.937	6.998	0.349	0.235
2007 Forecast	118.737	2.704	9.76	0.487	0.33
2007 Regional Jet Forecast	67.671	1.558	5.978	0.304	0.198

Due to the considerable increase in the NOX and SOX aircraft emissions for the 2007 forecast and the 2007 regional jet forecast, the total yearly emissions for these pollutants also increased for these cases over the 1996 and 2000 levels. The NOX yearly emissions for the regional jet forecast were lower than that of the 2007 forecast. However, the SOX levels were higher for the regional jet forecast than that of the 2007 forecast. In contrast, the CO, HC, and PM10 pollutants were affected greater by the decrease in the ground service equipment. The total yearly emissions for these pollutants increased greatly for the 2007 forecast, as did the emissions for the ground service equipment. The regional jet forecast had a very positive affect on these pollutants, decreasing the total yearly emissions to the lowest of all the cases in the study. The total annual aircraft related emissions are listed in Table 39.

Table 39 Total Annual Aircraft Related Emissions – Tyler Pounds Field

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	114.942	5.728	10.326	0.884	0.264
2000	96.39	3.947	9.23	0.776	0.235
2007 Forecast	134.59	5.533	12.878	1.085	0.33
2007 Regional Jet Forecast	77.563	3.032	12.331	1.131	0.198

Texarkana Regional - Webb Field - Texarkana, Texas

The Texarkana Regional Airport experienced a slight increase (19 operations) in the number of operations from 1996 to 2000. This trend continued into the 2007 forecast, resulting in another slight increase of 108 operations. Due to the constraints of the regional jet forecast, the number of operations decreased considerably by 1,713 operations for the 2007 regional jet forecast.

Noise

Despite only a slight increase in operations from 1996 to 2000, the area affected by each noise level increased considerably. This is most likely due to the change in the fleet mix for the airport, not the number of operations. The 2007 forecast resulted in a slight increase in the affected area. The affected area decreased considerably with 2007 regional jet forecast and the decrease in the number of operations. The noise levels on and around the Webb Field and the area influenced by these noise levels are listed in Table 40.

Table 40 Noise Levels and the Area Within Each Noise Level (millions of square feet) for Webb Field

Noise Level (dB)	1996 (m.sq.ft.)	2000 (m.sq.ft.)	2007 Forecast (m.sq.ft.)	2007 Regional Jet Forecast (m.sq.ft.)
55	10.74	13.54	13.80	6.54
60	2.64	3.43	3.67	0.06

Emissions

Due to the change in the fleet mix between 1996 and 2000, the CO, NOX, and SOX yearly emission levels for the aircraft decreased despite the increase in the number of operations. The HC emissions, however, increased dramatically. For all of the major pollutants with regard to the aircraft, the 2007 forecast showed a slight increase in levels over the year 2000. The 2007 regional jet forecast resulted in an increase in HC and NOX emissions but a decrease in the CO and SOX emissions. These CO and SOX emission levels were lower than that of 1996 or 2000. The emissions for the aircraft are shown in Table 41.

Table 41 Annual Aircraft Emissions – Webb Field

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)
1996	7.369	0.002	3.482	0.537
2000	6.601	0.425	2.283	0.381
2007 Forecast	6.843	0.44	2.365	0.395
2007 Regional Jet Forecast	4.164	0.619	2.61	0.343

The small increase in operations from 1996 to 2000 resulted in small changes in the ground service equipment emissions. While the CO, NOX, SOX, and PM10 emissions increased slightly, the HC emissions decreased. The increase in operations with the 2007 forecast caused an increase in all of the major pollutants. The 2007 regional jet forecast had the opposite affect, with all of the pollutants decreasing to levels below that of 1996 or 2000. The annual emissions from the ground service equipment are shown in Table 42.

Table 42 Annual Emissions from Ground Service Equipment – Webb Field

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	62.638	1.470	4.557	0.236	0.182
2000	62.872	1.459	5.115	0.262	0.183
2007 Forecast	65.179	1.513	5.302	0.271	0.189
2007 Regional Jet Forecast	28.545	0.657	2.521	0.128	0.083

The emissions for all of the pollutants increased from 1996 to 2000 with the exception of HC where there was a slight decrease. The 2007 emissions using the same fleet mix showed an increase for all of the pollutants as well. When the regional jet fleet mix was used, there were noticeable decreases in the emissions for all pollutants. This trend was more mixed for the total emissions analyzed. Emissions from 1996 to 2007 increased for some pollutants and deceased for others. When the regional jet fleet mix was used, all of the pollutants were notably less. These results are shown below in Table 43.

Table 43 Total Annual Aircraft Related Emissions – Webb Field

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	70.007	1.472	8.039	0.773	0.182
2000	69.473	1.884	7.398	0.643	0.183
2007 Forecast	72.022	1.953	7.667	0.666	0.189
2007 Regional Jet Forecast	32.709	1.276	5.131	0.471	0.083

Sheppard AFB/Wichita Falls Municipal Airport - Wichita Falls, Texas

The number of total operations at Wichita Falls Municipal Airport increased from 1996 to 2000 by 14 percent from 3,128 to 3,572. The 2007 forecast shows a slight increase to 3,591 as there is not much growth expected at the airport. The number of 2007 operations using an all regional jet fleet mix drops to 1,837 or a decrease of nearly 50 percent as the larger aircraft are introduced. The Saab 340 and Embraer 120, both 30 passenger aircraft, have been replaced in the regional fleet mix by the 50 passenger Embraer 145.

Noise

The noise levels in and around the Wichita Falls Municipal Airport are shown in Table 44. Noise levels for all three noise categories increased from 1996 to 2000 and then dropped slightly for 2007. When using the 2007 all regional jet fleet mix, the noise levels all decreased to pre-1996 levels.

Table 44 Noise Levels and the Area Within Each Noise Level (millions of square feet) for Wichita Falls Municipal

Noise Level (dB)	1996 (m.sq.ft.)	2000 (m.sq.ft.)	2007 Forecast (m.sq.ft.)	2007 Regional Jet Forecast (m.sq.ft.)
55	33.06	36.92	36.30	27.41
60	8.08	11.16	10.10	5.62
65	0.81	1.28	1.19	0.18

Emissions

The emissions for the aircraft are shown below in Table 45. The emissions for all pollutants remained fairly level from 1996 to 2000 and 2007. When the regional jet fleet mix was used, the emissions levels for CO decreased but increased for HC, NOX, and SOX.

Table 45 Annual Aircraft Emissions - Wichita Falls Municipal

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)
1996	8.381	0.627	2.747	0.461
2000	8.047	0.622	2.664	0.448
2007 Forecast	8.054	0.619	2.675	0.451
2007 Regional Jet Forecast	5.895	0.899	3.626	0.481

The emissions from the ground service equipment are shown in Table 46. From 1996 to 2000 emissions were fairly level but did all decrease for 2007. Using the regional jet fleet mix, all pollutants showed decreases to levels less than that of 1996.

Table 46 Annual Emissions from Ground Service Equipment - Wichita Falls Municipal

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	80.505	1.866	6.618	0.339	0.234
2000	76.259	1.769	6.269	0.321	0.221
2007 Forecast	76.672	1.779	6.303	0.323	0.223
2007 Regional Jet Forecast	39.166	0.902	3.443	0.175	0.113

The total emissions related to aircraft operations are shown in Table 47. Decreases were noted for all pollutants from 1996 to 2000. The 2007 emissions were similar to that of 2000 which makes sense considering the limited growth expected in passenger enplanements. Emissions dropped off for all pollutants using the regional jet fleet mix to pre-1996 levels.

Table 47 Total Annual Aircraft Related Emissions - Wichita Falls Municipal

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	88.886	2.493	9.365	0.800	0.234
2000	84.306	2.391	8.933	0.769	0.221
2007 Forecast	84.726	2.398	8.978	0.774	0.223
2007 Regional Jet Forecast	45.061	1.801	7.069	0.656	0.113

Victoria Regional Airport - Victoria, Texas

Total airline operations at Victoria Regional Airport decreased from 1996 to 2000 by 12 percent but were expected to increase in 2007 above the 1996 levels. Using an all regional jet fleet, operations were expected to drop to approximately 1,000 from the 1,605 and 1,413 in 1996 and 2000 respectively. Since this research began, Continental Express (ExpressJet) which was the only airline operating at the airport announced it would no longer serve Victoria. However, the analysis for this airport will be included.

Noise

The noise levels in and around the Victoria Regional Airport and the area influenced by these noise levels are listed in Table 48. The area affected increased from 1996 to 2000 but is expected to fall off in 2007. When the all regional jet fleet was used, noise levels increased in the 55 dB category and remained slight in the 60 dB category.

Table 48 Noise Levels and the Area Within Each Noise Level (millions of square feet) for Victoria Regional Airport

Noise Level (dB)	1996 (m.sq.ft.)	2000 (m.sq.ft.)	2007 Forecast (m.sq.ft.)	2007 Regional Jet Forecast (m.sq.ft.)
55	1.61	3.54	1.94	6.85
60	0.03	0.26	0.07	0.43

Emissions

The emissions for the aircraft are shown in Table 49. Emissions for all pollutants decreased from 1996 to 2000 reflecting the drop in operations. They all increased above the 1996 levels in 2007. Using the regional jet fleet mix, all pollutants but NOX dropped. A large drop was registered in CO and HC which both dropped by more than half.

Table 49 Annual Aircraft Emissions - Victoria Regional Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)
1996	6.129	0.941	1.743	0.294
2000	5.605	0.93	1.506	0.255
2007 Forecast	7.307	1.21	1.967	0.335
2007 Regional Jet Forecast	3.491	0.525	2.555	0.316

The ground service equipment emissions related to aircraft operations are shown in Table 50. The trends fro 1996 to 2000 were the same as noted above with small decreases in 2000 followed by increases in 2007. The 2007 regional jet fleet mix saw decreases to levels at or below 1996 for all pollutants.

Table 50 Annual Emissions from Ground Service Equipment - Victoria Regional Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	31.588	0.719	2.128	0.106	0.083
2000	27.508	0.623	1.835	0.09	0.071
2007 Forecast	35.911	0.813	2.396	0.117	0.093
2007 Regional Jet Forecast	23.430	0.540	2.070	0.106	0.069

Table 51 shows the total aircraft related emissions. The trends are similar to the previous emissions results with decreases from 1996 to 2000 followed by increases in 2007. The 2007 regional jet fleet mix scenario shows decreases in CO, HC, and PM10 to pre-1996 levels and only marginal increases in NOX and SOX. The regional jet scenario for 2007 shows emissions levels less than the normal 2007 scenario. This was using passenger enplanement levels for 2007 that were above 2000 by approximately 15 percent.

Table 51 Total Annual Aircraft Related Emissions - Victoria Regional Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	37.717	1.66	3.871	0.400	0.083
2000	33.113	1.553	3.341	0.345	0.071
2007 Forecast	43.218	2.023	4.363	0.452	0.093
2007 Regional Jet Forecast	26.921	1.065	4.625	0.422	0.069

Waco Regional Airport - Waco, Texas

The airline operations at Waco Regional Airport increased from 3,409 in 1996 to 3,762 in 2000. The 2007 forecasts using existing fleet mix data show operations are expected to be approximately 4,498. The all regional jet fleet mix for 2007 drops that number to 2,448. This is primarily due to the change in aircraft selection from the Saab 340 (30 seats/2,665 operations in 2000) to the larger, 50-passenger Embraer 145.

Noise

The noise levels in and around the Waco Regional Airport and the area influenced by these noise levels are listed in Table 52. All of the noise categories experienced increases from 1996 to 2000 with similar increases projected for 2007. Under the regional jet fleet mix, noise levels are expected to drop 1996 levels or below.

Table 52 Noise Levels and the Area Within Each Noise Level (millions of square feet) for Waco Regional Airport

Noise Level (dB)	1996 (m.sq.ft.)	2000 (m.sq.ft.)	2007 Forecast (m.sq.ft.)	2007 Regional Jet Forecast (m.sq.ft.)
55	20.05	24.03	27.19	17.94
60	6.22	8.43	10.57	5.99
65	1.39	2.03	2.38	1.49
70	0.05	0.25	0.4	0.09

Emissions

The emissions for the aircraft are shown in Table 53. Emissions were quite similar from 1996 to 2000 with some pollutants increasing and others decreasing. A larger percentage of Embraer 1320 turboprops were used in 2000 and this may explain the little differences despite an increase of ten percent in operations. The 2007 regional jet scenario dropped the emissions for CO and HC while increasing those for NOX and SOX.

Table 53 Annual Aircraft Emissions - Waco Regional Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)
1996	11.898	2.521	2.2	0.417
2000	10.661	1.905	2.45	0.437
2007 Forecast	12.702	2.265	2.916	0.523
2007 Regional Jet Forecast	7.837	1.181	5.409	0.686

The ground service equipment emissions are shown below in Table 54. The emissions increased from 1996 to 2000 for all pollutants and increased again under the 2007 forecast.

Using the regional jet fleet mix for 2007, the emissions saw decreases for all of the pollutants, especially CO.

Table 54 Annual Emissions from Ground Service Equipment - Waco Regional Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	71.24	1.603	5.607	0.276	0.188
2000	76.757	1.748	6.271	0.314	0.211
2007 Forecast	91.831	2.09	7.512	0.376	0.254
2007 Regional Jet Forecast	52.169	1.202	4.597	0.235	0.152

The total aircraft related emissions are shown in Table 55. The trends are similar as the two previous tables. The 2007 forecasts expect increases over 1996 for all pollutants but many emissions drop substantially using the all regional jet fleet mix. This is especially the case for CO.

Table 55 Total Annual Aircraft Related Emissions - Waco Regional Airport

Year	CO (tons)	HC (tons)	NOX (tons)	SOX (tons)	PM10 (tons)
1996	83.138	4.124	7.807	0.693	0.188
2000	87.418	3.653	8.721	0.751	0.211
2007 Forecast	104.533	4.355	10.428	0.899	0.254
2007 Regional Jet Forecast	60.006	2.383	10.006	0.921	0.152

CHAPTER 4. CONCLUSION

The implementation of regional jets into the air transportation systems of these ten small communities had very positive results in terms of reducing noise exposure and emissions levels.

While the overall approach was fairly simplistic in nature, it served to compare the use of two different aircraft types serving the same level of passenger demand. The differences were attributable to the change in fleet mix of which one was an existing fleet mix and the other was an all-regional jet fleet. The approach and departure paths were defined by the researchers without consideration to specific patterns at the individual airports. The same approach was used for each airport, fleet mix, and year to ascertain any differences in noise level exposure and aircraft emissions in the aircraft used.

Overall, the results using all regional jet fleets were quite positive. Only two airports realized increases in noise levels but the impacts above the 60db level were negligible at Gregg County and Victoria Regional. The all regional jet fleet saw decreases in CO and PM10 levels for all 10 airports when compared to the existing fleet mix. For the other three pollutants, the results were positive but not unanimous among the 10 airports. For HC, all but two airports saw reductions. Those that did not, Laredo and Gregg County, had HC levels that were very close and still had annual emissions of less than three and two tons respectively.

NOX levels increased at the following four airports: Easterwood Field, Laredo International, Gregg County and Victoria Regional. The general pattern indicated that the regional jet fleet had increases in aircraft emissions but decreases in GSE emissions. The overall emissions levels for NOX at these airports were not all that different for the two fleet mixes but were higher for the regional jet fleet.

SOX levels increased at five airports including Easterwood Field, Laredo International, Gregg County, Tyler Pounds Field, and Waco Regional. As with NOX, the general pattern indicated that the regional jet fleet yielded lower emissions from the GSE than from the aircraft itself. While the levels for these five airports were higher using the regional jet fleet, the actual pollutant levels were quite similar with the actual levels being around one ton per year.

The regional jets did reduce pollutant and noise levels and had an overall beneficial impact on the environmental quality of the communities they serve. While their numbers may not have been large in magnitude, especially when compared to on-road vehicle emissions, this analysis did give us some idea of the noise and air quality impacts of moving towards an all regional jet fleet.

These results are summarized in Tables 56 through 61 which show the changes in noise levels (area affected) and emissions using 1996 as a base year. A "+" in the column indicates the levels increased while a "-" indicates it decreased. The last column compares the two projected 2007 scenarios and indicates the affects of the regional jet fleet. These tables give us an idea of the general trends at the airports as well. It should be noted here as before that four of the airports had no increases or only very slight increases in passenger enplanements from 2000 to 2007. These airports were simply not expected to grow during the time period or are constrained from growing in the future.

Table 56 Summary of Noise Impacts at 55 Decibel Level

Airport Name	1996-2000	2000-2007	2000-2007RJ	2007 vs. 2007RJ
Abilene Regional	+	-	-	-
Easterwood Field	-	+	-	-
Laredo Int'l	+	+	-	-
Gregg County	+	-	+	+
San Angelo Mathis Field	-	+	-	-
Texarkana Webb Field	+	+	-	-
Tyler Pounds Field	+	+	-	-
Victoria Regional	+	-	+	+
Waco Regional	+	+	-	-
Wichita Falls Municipal	+	-	-	-

Table 57 Summary of Air Quality Impacts - CO

Airport Name	1996-2000	2000-2007	2000-2007RJ	2007 vs. 2007RJ
Abilene Regional	-	-	-	-
Easterwood Field	-	+	-	-
Laredo Int'l	+	+	-	-
Gregg County	+	+	-	-
San Angelo Mathis Field	-	+	-	-
Texarkana Webb Field	-	+	-	-
Tyler Pounds Field	-	+	-	-
Victoria Regional	-	+	-	-
Waco Regional	+	+	-	-
Wichita Falls Municipal	-	+	-	-

Table 58 Summary of Air Quality Impacts - HC

Airport Name	1996-2000	2000-2007	2000-2007RJ	2007 vs. 2007RJ
Abilene Regional	-	-	-	-
Easterwood Field	-	+	+	-
Laredo Int'l	+	+	+	+
Gregg County	+	+	+	+
San Angelo Mathis Field	-	+	-	-
Texarkana Webb Field	+	+	-	-
Tyler Pounds Field	-	+	-	-
Victoria Regional	-	+	-	-
Waco Regional	-	+	-	-
Wichita Falls Municipal	-	=	-	-

Table 59 Summary of Air Quality Impacts - NOX

Airport Name	1996-2000	2000-2007	2000-2007RJ	2007 vs. 2007RJ
Abilene Regional	-	-	-	-
Easterwood Field	-	+	+	+
Laredo Int'l	+	+	+	+
Gregg County	+	+	+	+
San Angelo Mathis Field	-	+	-	-
Texarkana Webb Field	-	+	-	-
Tyler Pounds Field	-	+	+	-
Victoria Regional	-	+	+	+
Waco Regional	+	+	+	-
Wichita Falls Municipal	-	+	-	-

Table 60 Summary of Air Quality Impacts - SOX

Airport Name	1996-2000	2000-2007	2000-2007RJ	2007 vs. 2007RJ
Abilene Regional	-	-	-	-
Easterwood Field	-	+	+	+
Laredo Int'l	-	+	+	+
Gregg County	+	+	+	+
San Angelo Mathis Field	-	+	-	-
Texarkana Webb Field	-	+	-	-
Tyler Pounds Field	-	+	+	+
Victoria Regional	+	+	+	-
Waco Regional	+	+	+	+
Wichita Falls Municipal	-	+	-	-

Table 61 Summary of Air Quality Impacts – PM10

Airport Name	1996-2000	2000-2007	2000-2007RJ	2007 vs. 2007RJ
Abilene Regional	-	=	-	-
Easterwood Field	-	+	-	-
Laredo Int'l	+	+	-	-
Gregg County	+	+	-	-
San Angelo Mathis Field	-	+	-	-
Texarkana Webb Field	=	+	-	-
Tyler Pounds Field	-	+	-	-
Victoria Regional	-	+	-	-
Waco Regional	+	+	-	-
Wichita Falls Municipal	-	=	-	-

In the final analysis, what is important is better understanding the impacts associated with new regional jet aircraft serving our small communities. Perhaps the best summary measure is to examine the 2007 results and see how the two fleet mixes compare. For the noise analysis, the all regional jet fleet mix when compared to the existing fleet mix further reduced noise exposure impacts at the 55 dB level for eight of the 10 airports. In the air quality analysis, the regional jet fleet mix resulted in lower pollutant levels than the existing fleet mix for 2007 at many of the airports studied. Specifically, the regional jets resulted in lower CO levels at all ten airports, lower HC levels at eight of the ten airports, Lower NOX levels at six airports, lower SOX levels at five of the airports, and lower PM10 levels at all ten airports. In many of the instances where regional jet fleets did not decrease noise and emissions levels, they were not substantially higher than the existing fleet mixes that were used. It was also not unusual to see either of the noise or emissions levels in the regional jet fleet in 2007 less than that of prior years. This appears to be largely attributable the cleaner, quieter aircraft flying more passengers with fewer operations.

The type of aircraft used impacts noise exposure and air quality emissions differently. A single aircraft type can have negative impacts on a community whereas emissions impacts tend to be cumulative. The types of associated ground support equipment are also a factor. Those associated with newer fleets such as regional jet fleets, are emit lower levels of pollutants than their older aircraft counterparts. For the airports included in this study, lower emissions from the regional jet ground support equipment accounted for a large part of the overall lower pollutant levels when they were lower and helped mitigate any increases that were realized.

Implementation of the regional jets appears to be environmentally beneficial for the small communities examined when compared to the widespread use of turboprop aircraft that have typically served these smaller markets. While the level of benefit may ultimately turn on the number of operations, and types of regional jets used, and their actual approach and departure paths to the airports, benefits from their use can be realized. This is in addition to the perceived benefits to a community of having jet service that typically center on safety and reliability. The economic growth benefits, although not directly tested in this study, appear to be positive as well.

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