Operational Impact Study of Advance Transit Fixed-Route Bus Network

Final Report

Prepared for:
City of Lebanon, New Hampshire

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i. Executive Summary

This study of the impacts of the fixed-route public bus system operated by Advance Transit, Inc. (AT) on the City of Lebanon has been prepared in response to the Lebanon City Council's December 9, 2004 Motion that ordered this work. The document examines Advance Transit's boardings history, impact on personal vehicle use, fuel consumption and exhaust emissions as well as an assessment of the costs, feasibility and policy issues of instituting fares. It also addresses employment opportunities made possible by the access the bus service provides to people who do not drive. The UVTMA has studied and analyzed AT's past and current operations and surveyed AT's riders to determine who is using the system and for what purposes. In the course of this study we have determined that the impacts of Advance Transit's fixed-route bus system on the City of Lebanon and Lebanon residents are both positive and significant.

Advance Transit's fixed-route system currently provides regular scheduled service to the core Lebanon, Hanover, White River Junction area as well as service to Enfield, Canaan, Norwich, Wilder and Hartford. It is primarily structured to serve employees and shoppers with destinations in the core area. Since the fixed-route service was upgraded in October 2000, ridership has more than doubled as shown in Figure 1. Total fixed route passenger boardings in calendar 2004 were 281,202. Currently, approximately 40% of AT's riders are residents of Lebanon as confirmed by passenger surveys in October 2004 and April 2005. The April 2005 survey also found that 60% of passengers on the four AT routes that directly serve Lebanon are going to destinations within Lebanon.

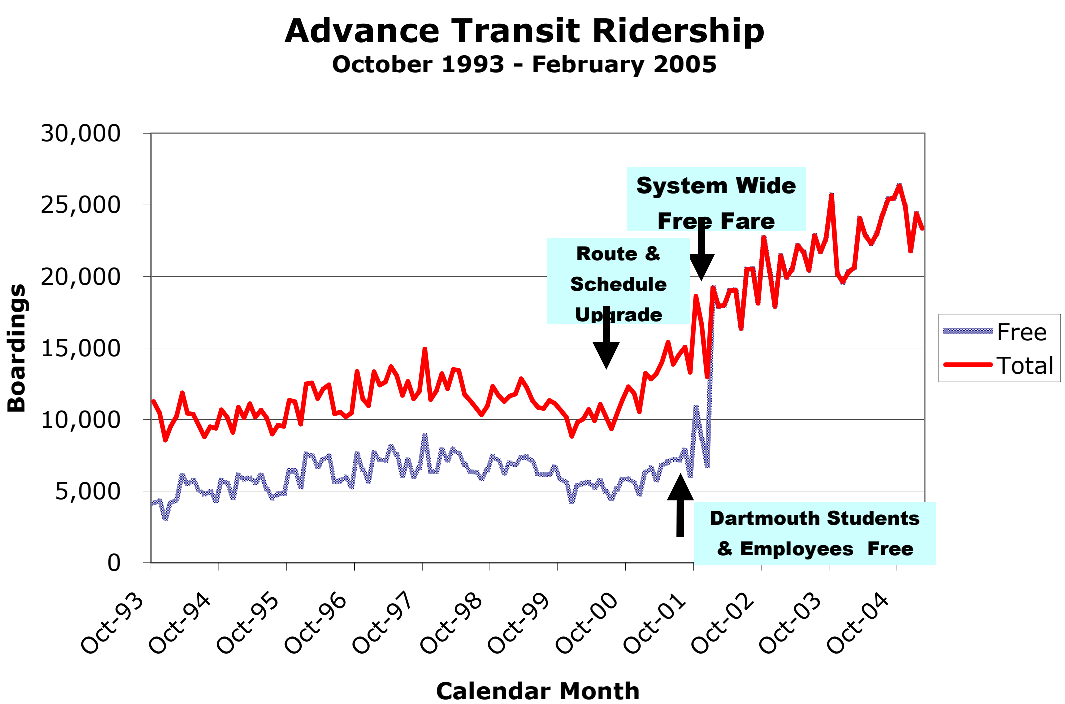

Figure 1. Monthly Advance Transit Fixed Route Fare-Paid and Fare-Free Boardings.

A summary of calendar year boardings for the past decade appears below as **Table 1**:

Table 1 -- AT Fixed-Route Boardings and Year-over-Year % Change Calendar 1994 thru 2004			
Year	Boardings[1]	Pct. Change Over Prior Year	Cumulative Pct. Chg. (1994 = Baseline)
1994	119,499	---	
1995	123,438	3.3%	3.3%
1996	138,440	12.2%	15.9%
1997	151,214	9.2%	26.5%
1998	142,720	-5.6%	19.4%
1999	133,620	-6.4%	11.8%
2000	127,582	-4.5%	6.8%
2001	173,656[2]	36.1%	45.3%
2002	229,696	32.3%	92.2%
2003	258,677	12.6%	116.5%
2004	281,202	8.7%	135.3%
2005 (proj.)	298,602[3]	6.2%	149.9%

Key findings include:

Lebanon has 28% of the population of the six municipal-ities served by the bus but supplies 40% of boardings.

Bus service replaced over 156,000 local auto trips in 2004.

- Sixty percent of all of AT's fixed-route riders, and 58% of AT riders who are Lebanon residents, are traveling to destinations in Lebanon or West Lebanon.
- More than half (57%) of the riders going to Lebanon or West Lebanon are making a work-related trip.
- Lebanon residents use Advance Transit in numbers that are proportionally larger than Lebanon's population relative to the other five municipalities that are served by AT. Based on the 2000 census, the City of Lebanon has 28% of the combined population of the six municipalities served by AT. By contrast, Lebanon residents generate 40% of AT's fixed-route boardings, even when passengers who said they reside in unserved towns are taken into account. This finding has been confirmed by two consecutive surveys of AT passengers.[4]
- Advance Transit fixed-route service allows over 100 individuals to be gainfully employed who, without access to public transit, might be unemployed or under-employed. These are not Advance Transit employees, but AT passengers who are traveling to or from work on the bus and said they would not be able to make the trip without the bus.
- It is conservatively estimated that the people who depend on AT to reach their workplace collectively earn at least $1.2-million annually in gross wages.

[1] Source: Advance Transit, except CY 2005 projection developed by UVTMA.
[2] Includes Dartmouth "Show ID-Ride Free" paid ridership of 4,195 boardings. (Source: Advance Transit)
[3] A simple projection for CY 2005 computed by multiplying actual boardings for January through April 2005 by 3. This projection is conservative because AT boardings for May-Aug and Sept-Dec have been somewhat stronger than the first four months of the year for the last two calendar years in a row.
[4] Crikelair survey of October, 2004 and UVTMA survey of April, 2005.

- The fixed-route service was responsible for more than 156,400 avoided local automobile trips[5] in calendar 2004, averaging an estimated 5.4 miles each way. This is more than 844,500 miles. These avoided automobile trips represent real savings for the individual riders, reduced air pollution, and reduced demand for parking. Valued at the 2005 Internal Revenue Service allowance of 40.5 cents per mile, this avoided automobile mileage is worth over $341,000.
- Survey results suggest that at least 50% of these avoided auto trips would've been made during peak periods. This means that the bus service is helping to reduce auto trips at the times of day when the roads are most crowded.

Table 2 compares AT's diesel fuel consumption per boarding passenger in 2004 with gasoline that would've been consumed by 842,400 miles of additional automobile use assuming 1.1 occupants per vehicle and 20 miles-per-gallon:

Table 2 -- Avoided Gasoline vs. AT Diesel Fuel Consumption, 2004		
Diesel Fuel Used by AT's Fixed-Route Buses	61,606 gallons[6]	1.52-million passenger-miles
Avoided Private Auto Gasoline Use *Per Passenger* (at 20 mpg; 1.1 passengers per auto; 842,400 miles)	38,290 gallons	926,640 passenger-miles
Diesel Fuel Used Per Boarding Passenger (AT bus):	0.22 gallons[7]	

Although AT used almost 61% more diesel fuel (in gallons) than the private auto trips it replaced in 2004, it generated 64% more passenger miles using that fuel, and will generate even more passenger-miles with about the same fuel in the future assuming the boardings trend of recent years remains positive. A straight-line allocation of diesel fuel per boarding bus passenger yields less than ¼ gallon required per boarding passenger. But, since most AT fixed-route buses have seats available on most routes and at most hours, the incremental diesel fuel required for each additional boarding passenger is very small.

Air pollutant gases and particles were reduced by about 3-1/2 tons in 2004.

- The latest EPA Mobile 6 emissions analysis model and rider survey data concerning origin, frequency and purpose of trips were used to estimate air quality impacts. Three emissions groups were estimated: Volatile hydrocarbons (VOCs or VCs), carbon monoxide (CO) and oxides of nitrogen (NOx). AT contributed a material reduction in CO emissions and a total reduction of about 3-1/2 tons of airborne pollutant particles and gases in 2004. This is equivalent to operating a late model automobile approximately 219,200 miles.
- Each additional avoided automobile trip has a direct air quality benefit, especially for avoided volatile hydrocarbons (VOCs) and carbon monoxide (CO). On the other hand, emissions of oxides of nitrogen (NOx) – associated with diesel

[5] Persons making auto trips.
[6] Source: Advance Transit. Based on 67.5% of 91,268 total gallons consumed by AT to operate all services in CY 2004. 67.5% represents mileage operated in fixed-route service after subtracting parking shuttles and other non-fixed-route operations.
[7] 61,606 gallons divided by 281,202 boardings in CY 2004.

engines – are confined to a fairly narrow range if the bus service stays the same and the composition of the fuel is the same.[8]

- About 14% of survey respondents[9] said they would otherwise take a taxi for their trip, suggesting that they do not own and/or cannot afford an automobile.
- 47% of passengers surveyed said they would participate in a voluntary contribution program to help AT defray operating costs.
- Had AT not converted to fare-free on the entire system in January 2002, current ridership might be reduced by 50,000 (or more) boardings (19% to 20%). Given that almost 75% of the riders surveyed indicated that they had alternatives to riding the bus, the system would be at risk of losing significant ridership and the associated community benefits were AT to reinstate a fare on its existing routes.
- Potentially attractive opportunities exist for future expansion, better service frequencies or both as funds permit. However, there is an opportunity cost to expanding service because expansion must be supported by sources of long-term funding, which are severely limited. This demands that careful choices be made. These choices must be prioritized based on relative number of people served, costs, and on AT's and the City's goals and objectives.

In summary, boardings for the first 4 months of calendar 2005 indicate that AT's fixed-route bus system is handling at least 2-1/2 times as many boardings as it did a decade ago and will have had five consecutive years of ridership growth. Forty percent of these boardings are Lebanon residents. About 56% of people surveyed said they would otherwise make their trip by automobile.

Table 3 below summarizes many of the key findings of this study:

Table 3 – Summary Table of Key Findings

Finding	Value (or values)	Comments
AT Boardings Growth, 1994-2004	135.3%	
Population Growth, 1990-2000	10.6%	six municipalities served by AT
Employment Growth, 1991-2000	21%	35 municipalities that make up the Hartford/Lebanon Labor Market Area (LMA)
Percentage of AT passengers who said they live in Lebanon	40%	UVTMA survey, April 2005
Percentage of AT passengers who said their destination was Lebanon or West Lebanon	60%	UVTMA survey, April 2005

[8] Diesel buses exhibit variability in performance due to passenger load, outside temperature, fuel quality and operating condition of the vehicle, plus variations in driver performance, traffic conditions, etc.. All of the foregoing is also true for automobiles and trucks. This study ignores variability in operating performance due to these factors. The EPA Mobile-6 air pollution model aggregates performance variability into a standard for buses and for cars and light trucks. See Section 6 and Appendix F.

[9] Based on 366 survey respondents who said they'd make their trip by some other mode if the bus service didn't exist.

Lebanon population as percentage of six served municipalities	28%	City of Lebanon population 12,568 per 2000 census
Percentage of AT passengers who are transit-dependent	24%	UVTMA survey
Percentage of AT passengers who said they would otherwise travel by private auto	56%	UVTMA survey
Percentage of AT passengers who ride the bus because of work	57%	UVTMA survey
Percentage of AT passengers who ride the bus because of medical or other appointments	9%	UVTMA survey
Percentage of AT passengers who ride the bus to go shopping	13%	27.4% of Red Route passengers said they were shopping; UVTMA survey
Estimated number of people whose job may depend on the bus	111	Projected from UVTMA survey
Projected number automobile trips avoided, 2005	166,059	Based on UVTMA survey
Estimated auto miles avoided, 2004 vs. 2005 (projected)	844,500 (2004) vs. 896,700 (2005 proj.)	Avg. 5.4 miles per trip
Estimated net air pollution benefit	3-1/2 tons of pollutants	Net effect autos vs. buses
Estimated number of annual boardings attracted by fare-free policy	33,000 to 56,000+	Based on two estimating methods: boardings growth rates and fare elasticity.

Although the combined population of the six municipalities through which AT's bus service operates is small (45,266 according to the 2000 census), a surprisingly large number of employed persons work and live within the immediate area. For example, a recent employer survey[10] indicates that 4,473 full-time employed people[11] who work in Lebanon or the immediate surrounding area live in one of the six towns served by AT. Of these, 1,073 – or roughly one-quarter – live in Lebanon. The fixed-route bus system is configured to be responsive to these work-related trips and is succeeding at diverting would-be auto trips onto the bus in addition to serving people who don't drive for their local work, shopping and other personal business needs.

AT's ridership growth history indicates that its customers respond strongly to improvements in the service. Principally, this means service frequencies (scheduled operating headways), hours of operation and faster schedules for commuters. However, any adjustments or expansion must be carefully planned and managed because the small population of the area coupled with limited funds means there is little margin for error.

[10] Upper Valley Housing Coalition Employer Survey conducted late 2004-early 2005.

[11] We suspect that this headcount omits a large number of workers who are classified as "hourly" and therefore may not have been reported as "full time", even if they essentially work full-time or almost full-time. For example, many employees of Dartmouth-Hitchcock Medical Center, the area's largest employer, are hourly and therefore would not have been included in the 4,473 figure cited. For example, nurses working three 12-hour shifts each week are "hourly"; also, of 667 current DHMC employees who have a Lebanon or West Lebanon zip code, 386 of them were classified as "40 hour" employees. The remaining 281 were classified as hourly or had some other status.

Finally, AT passengers often make unsolicited comments praising the courtesy of drivers, the cleanliness of the buses, express gratitude that the bus service exists and express interest in more service in the future.[12]

[12] Advance Transit Schedule Improvements, Final Report, December 2004, Tom Crikelair Associates, p. 2-10.

1. Purpose and Scope

This study identifies the direct and indirect impacts of the fixed-route, public transit bus services operated by Advance Transit, Inc. (AT) on the City of Lebanon, New Hampshire. The nature and magnitude of these impacts are documented; where practical, they are quantified. The profile of the existing ridership was surveyed and is described in detail. The effects of fares on rural transit systems generally and the likely effect of fares on AT is presented. Potential supplemental funding sources are discussed. An air quality impact assessment is included.

This study was ordered by a Motion of the Lebanon City Council on December 9, 2004 and was prepared by the Upper Valley Transportation Management Association (UVTMA). The UVTMA is affiliated with Vital Communities, Inc., a non-profit, non-partisan organization devoted to quality-of-life issues.

1.1 Acknowledgments

Assistance, expertise and technical support was furnished by the five members of a Working Group appointed by the UVTMA Board of Directors to assist, support, review and critique the work:

William A. Barr, Director of Fiscal & Auxiliary Services, Facilities Operations and Management, Dartmouth College
Bill Baschnagel, Project Manager, Creare, Inc.
Daniel Brand, Vice President, CRA International
Van Chesnut, Executive Director, Advance Transit, Inc.
Erica Wygonik, Associate, Resource Systems Group, Inc.

Peter Dzewaltowski of the Upper Valley Lake Sunapee Regional Planning Commission (UVLSRPC) prepared estimates of air quality impacts of the Advance Transit fixed-route bus system.

Len Cadwallader, Director of Vital Communities, Inc., a non-profit organization that is the fiscal agent of the UVTMA, supplied public outreach efforts and sought out volunteers to assist with the on-board survey.

The authors thank the management of several other regional transit operators for supplying operating metrics and information concerning special programs, such as voluntary fare donations.

Finally, the Study was greatly assisted by graduating Dartmouth College senior Daniel Cross-Call, whose knowledge of and interest in public transportation and public policy contributed to this work as an intern with the UVTMA during the spring of 2005.

Any errors or omissions are the responsibility of the UVTMA.

2. Introduction and Background

2.1 Advance Transit

Advance Transit, Inc. (AT) is a 501(c)(3) non-profit New Hampshire corporation, with physical headquarters in Wilder, Vermont. AT operates a fleet of 27 diesel buses and one 9-passenger van.[13] At least six of these buses are nearing the end of their useful operating life. AT has 30 full-time employees and 6 part-time employees. Its one fixed facility in Wilder, Vermont serves as its administrative offices, bus garage, maintenance and refueling facility. AT is planning to expand this facility to meet the needs of its growing fleet of buses and allow it to purchase fuel in truckload quantities and/or have the flexibility to consider adopting an alternative fuel such as biodiesel.

Three unique services are run out of the AT offices: Fixed-route transit services, Rideshare and shuttle services:

The budgeted FY 2005 operating cost of fixed-route services is $1.4-million. FY 2004 fixed-route boardings[14] were 273,609. Using these FY 2004 ridership figures and the FY 2005 budget, the operating cost per boarding is about $5.12.

The shuttle projected Fiscal Year[15] (FY) 2005 budget for shuttle operations is $674,134. This cost is borne by the Town of Hanover, Dartmouth-Hitchcock Medical Center and Dartmouth College. The shuttles are the Campus Shuttle -- entirely within Hanover -- and the DHMC Lot 9 Shuttle and Lot 20 Shuttle, both of which serve Dartmouth-Hitchcock Medical Center (DHMC), located within Lebanon. These services are beyond the scope of this study.

AT operates rideshare services, or carpool matching, under the business name Upper Valley Rideshare with a projected FY 2005 budget of $94,337. Rideshare currently has 891 registered clients, 401 of which are commuting to Lebanon and 47 of which reside in Lebanon.[16] The operation of Upper Valley Rideshare is beyond the scope of this study.

AT reports fuel and liability insurance expenses have increased faster than its other costs.[17] Unlike large trucking, rail or airline operators, AT is not in a position to effectively hedge its fuel costs by purchasing large quantities, but does "lock" a contract rate annually.[18]

AT operates five fixed-routes Monday through Friday according to a published timetable. The Blue Route has the longest period of operation beginning its first bus at 5:20 AM and operating until 7:19 PM. In general, service on all five fixed-routes (Blue, Green, Red,

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[13] See Fleet Roster supplied by Advance Transit in Appendix A.
[14] Ridership is technically boardings or "unlinked trips" in industry terminology. Ridership is the global sum of the number of boarding passengers reported by bus drivers and is not adjusted for round trips or for passengers who ride more than one bus to complete their trip. Our analysis has estimated that the ratio of weekly "boardings" to individual persons, taking into account round trips and frequency of use, is approximately 1.56. See Appendix C.
[15] AT's fiscal year currently runs from July to June.
[16] Source: Advance Transit (e-mail of May 10, 2005)
[17] See Appendix I.
[18] Source: Advance Transit.

Orange and Brown) commences between 6 AM and 7 AM and ceases between 6 PM and 7 PM. Thus, the nominal service interval is 12 hours.
A limited Saturday service was discontinued in September 2000 due to low ridership. The resources that were supporting that service were re-allocated to support improvements to weekday service. There has never been any scheduled service on Sunday.

Three key timed transfer points provide the structure for the fixed-route system: Downtown Lebanon (Court Street), West Lebanon (Main Street) and Hanover (Dartmouth Medical School). A Route Map graphic appears below. (Note: The original image is in color.)

Figure 2. Advance Transit Route Map

A fare-free zone already existed between Hanover and DHMC as from March 1994. Beginning in September 2000, AT eliminated fares on all its routes in three distinct phases. The first phase eliminated fares in Vermont. In September 2001, Dartmouth College began sponsoring the "Show ID – Ride Free" program, whereby all College students and employees could ride free anywhere on the system upon displaying their Dartmouth ID. The final phase eliminated fares throughout the system for all remaining passengers effective January 2002.

2.2 Trends in Transit

Well before the price of gasoline began rising from of its lows of the late 1990s, a reawakening of interest in both urban and rural public transportation was already emerging. Rising employment in established eastern and Midwestern cities and significant population growth in western cities led this trend, propelled by increasingly crowded highways, longer commuting distances as residents sought affordable housing in outlying areas, and rising employment due to a relatively robust economy.

Demand for rural public transportation has been motivated by somewhat different trends and objectives. They include national needs as well as needs common to Upper Valley residents:

- The needs of an aging rural population that has limited mobility. The Census Bureau predicts that growth in the nation's 65-and-over population over the next 25 years will be about 3-1/2 times the growth rate of the population as a whole.[19] In rural communities, citizens are less likely to be able to walk to their critical needs. For seniors who no longer drive, this can mean choosing between isolation and dependency or leaving their homes, even if they could otherwise care for themselves.

- Migration of working age people to suburban and rural areas. According to materials published by the American Public Transportation Association (APTA), "small urban and rural America is now home to 56 million residents in non-metropolitan counties, as well as 35-million more residents living in rural settings on the fringes of metropolitan areas". Quality-of-life and other issues contributed to a "ten percent population increase in small urban and rural communities [during the 1990s], nearly three-quarters of which are still growing."[20] This is the largest migration of population to rural and suburban areas since the 1930s.[21]

- Congestion mitigation and air quality concerns. In 2003 Vermont and New Hampshire had the 2nd and 14th, respectively, most Vehicle Miles Traveled (VMT) per capita according to the Federal Highway Administration. Although this statistic does not measure automobile dependency per se, VMTs per capita is a relevant index of automobile use. Vermont's VMT per capita was 13,423 and New Hampshire's was 11,572 for 2003. These values lump all road transportation together, including commercial traffic and tourism. By comparison, New York State with its much greater population but also much more extensive public transportation infrastructure, was 50th (lowest) in VMT per capita at 7,049 or 52.5% of the Vermont figure. The number of light car and truck registrations in Vermont – 531,561 vehicles as of 2004 – has been growing much faster than the driving-age population.[22]

  Within Lebanon, Route 120 – a north-south arterial linking Lebanon with Hanover and also the primary access to DHMC and the Centerra office and retail park -- is one of the

[19] USA Today, April 21, 2005, page 3A.
[20] "Mobility for America's Small Urban and Rural Communities," APTA, (no date), researched by Cambridge Systematics, Inc.
[21] Ibid.
[22] Burlington Free Press, April 24, 2005, p. 7D; Ibid.

City's two busiest roads after Interstate 89. According to the Hanover Master Plan, average daily traffic volume on NH 120 at the Lebanon city line grew a total of 61.3% between 1991 and 2001, the latest year for which figures are furnished.[23] Lebanon's other major traffic congestion issue is NH 12A in West Lebanon, the center of a significant retail district. Major highway construction is anticipated for NH 12A during 2007.

- The cost of parking facilities vis-à-vis higher and better uses. Communities that have one or more colleges or universities are often leaders in rural public transportation.[24] Developing strong transit systems is in the direct interest of these institutions, which are often hemmed-in by development unrelated to the operation of the school. The highest and best use of scarce land is not parking lots and garages but laboratories and classrooms, dormitories and athletic facilities. Colleges and universities often find they are unable to charge market rates for parking because subsidized parking is used as a perk to attract and retain faculty. For example, Harvard University subsidizes parking and simultaneously has a program to sell MBTA transit passes to students and faculty on a tax-advantaged basis. As a rule of thumb, Dartmouth College advises that a 200-car parking garage costs about $5-million to construct, exclusive of land acquisition -- or $25,000 per space. This figure does not include any ongoing operating and maintenance (O&M) expenses.[25] The 540-space above-grade parking garage completed in Lebanon (at DHMC) in 2004 cost $10-million or about $18,500 per space. This does not include ongoing O&M costs.

- Personal financial motivations. During a survey of Advance Transit riders conducted on April 5, 6 and 7, 2005, a few respondents volunteered that they are able to be one-car households or are striving to be one-car households by utilizing the available bus service. Avoiding owning an automobile results in significant financial savings. Regardless of the personal financial motivations, eliminated vehicle trips have significant public benefits, including reduced air pollution and road congestion.

As additional background information, almost 1,200 public transportation systems now exist in rural communities in the United States. According to a detailed study of the economic benefits of rural public transportation, the benefit-to-cost ratio of 22 rural transit systems undertaken in 1998 (eight in-depth analyses and fourteen desk audits), benefits outstripped direct costs by at least 1.67-to-1 and by as much as 4.22-to-1.[26] The average ratio of benefits to costs among the eight systems studied in depth was 3.12-to-1.[27] Nationally, in 1998 the estimated economic benefits of rural transportation were $1.25 billion per year against estimated expenditures (Federal, state and local) of approximately $375 million. This indicates a multiplier effect of 3.35-to-1.[28] As a rule of thumb, the multiplier effect of

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[23] Hanover Master Plan, Chapter 12: Transportation, adopted July 29, 2003, page 12. Traffic data from Hanover Traffic Survey, Upper Valley Lake Sunapee Regional Planning Commission, October 2003.
[24] Assessment of the Economic Impacts of Rural Public Transportation; Transit Cooperative Research Program, Report 34, Jon E. Burkhardt, James L. Hedrick and Adam T. McGavock, Transportation Research Board (TRB), 1998.
[25] Source: Dartmouth College Fiscal & Auxiliary Services Dept.
[26] Assessment of the Economic Impacts of Rural Public Transportation; pp. S-2 and S-3, et al.
[27] Assessment of the Economic Impacts of Rural Public Transportation; loc. Cit.
[28] Ibid.

expenditures on rural public transportation are said to be roughly 3-to-1, with the most economically productive systems tending to be in areas that have one or more college campuses, a hospital and/or medical center, and/or a large industrial physical plant.[29]

Public transportation in the United States saves more than 855 million gallons of gasoline a year, or 45 million barrels of oil.[30] By converting auto trips into bus trips within a relatively compact area, and in a small city like Lebanon in which about 25% of people employed full-time in the City also live there, an effective transit bus system can make a contribution to saving gasoline.

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[29] Ibid.

[30] Conserving Energy and Preserving the Environment: The Role of Public Transportation, Robert J. Shapiro, Kevin A. Hassett and Frank Arnold, July 2002, pp. 1- 3.

3. Methodology and Data Collection

A challenge of this study was to arrive at a balance between data collection, data analysis and report preparation while staying within the resources available to accomplish the effort. In this case, we were fortunate to have access to a solid body of both historical and current information on Advance Transit's operations and service population. In addition we had access to a considerably body of published information on public transit system operations from academic, industry and governmental sources. The availability of these information sources strongly shaped the details of the study methodology.

The overall process was straightforward:

- Identify key questions and information required to answer them,
- Review available data sources and identify any shortfalls,
- Develop plans and implement programs to address shortfalls,
- Validate data and formulate question responses.

3.1 Data Sources

The UVTMA identified relevant data sources and surveys as detailed below. In addition, the UVTMA undertook its own supplemental survey of AT passengers in April, 2005, which is also described below.

1. Advance Transit historical operations and ridership data over the past ten plus years. This included fleet operations data (mileage, fuel usage, cost of operations, etc.) as well as monthly fixed route passenger boardings by route. All such statistical information is provided on a calendar month/year basis unless otherwise indicated.

2. Comprehensive reviews and analyses of AT's fixed route operations conducted by Crikelair Associates in November 1999 (Crikelair 1999) and October 2004 (Crikelair 2004). Both of these studies included systemwide rider surveys that addressed ridership demographics and satisfaction, solicited public input regarding AT operations, and developed recommended service adjustments.

3. April 2005 Rider Survey (UVTMA 2005). Focusing on the fixed route service to and from Lebanon, face-to-face surveys were conducted on the Blue, Red, Orange and Green Routes. With the assistance of paid and volunteer help the UVTMA surveyed 504 riders on April 5th through April 7th, 2005, representing a large percentage of the probable number of individuals who rode one of the surveyed routes that week.

   This survey consisted of five questions designed to supplement the Crikelair 2004 survey questions by providing data on trip purpose including whether persons surveyed were employed by Dartmouth College or DHMC, their destination town, the role of bus service in making the trip, and willingness to participate in a contribution program to support AT operations. A copy of the survey form is included as **Appendix B**. Emphasis was on the morning peak period and on the mid-day off-peak period. **Figure 3** below details the time distribution of the survey responses:

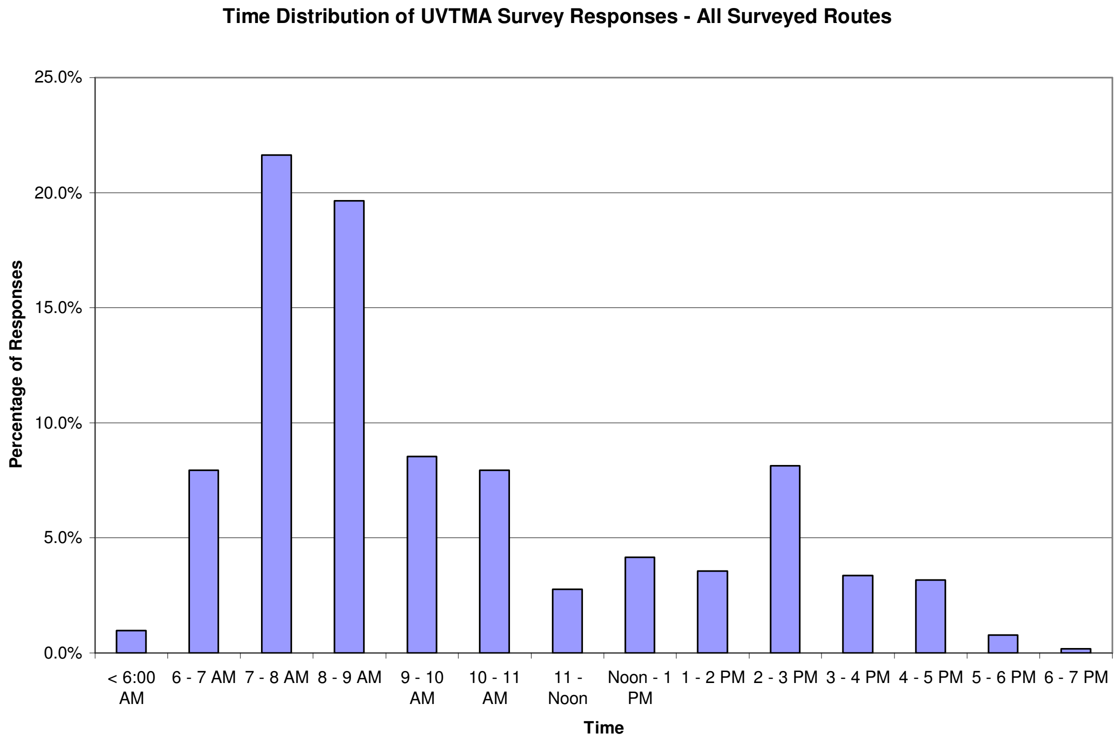

Figure 3. Time Distribution of UVTMA Surveys

Fifty percent (50%) of survey responses were collected before 9:00 AM. This is because the UVTMA survey began with the start of service each morning and continued during the morning peak period when use is high.[31] By 3:30 PM found that some people who had already completed the survey were returning home from their workplace. The responses from this and the Crikelair surveys and studies were useful in understanding and characterizing ridership to and from the City of Lebanon.

The UVTMA asked Resource Systems Group, Inc. of White River Jct., VT for an informal opinion of Confidence Interval (CI) and Margin-of-Error for the 2004 Crikelair survey results and the UVTMA's own April, 2005 survey results. In the case of the Crikelair 2004 survey, RSG confirmed a prior analysis that indicated the survey results were valid and that an adequately large sample had been collected using appropriate methods. Based on this confirmatory finding, the UVTMA did not ask RSG to comment further on the Crikelair survey. Regarding the 2005 UVTMA study, RSG wrote, "Based on the total number of returns (504), you are guaranteed 95% confidence plus or minus 5% error on any binary proportion (e.g., percent of riders who are satisfied vs. those who are not. However, on a per-route basis, the sample is smaller and thus the confidence level worsens for each of these segments."[32] (See also, **Appendix C**.)

[31] Morning peak period and evening peak period vary by system. A good rule of thumb is that the morning peak period is 7 to 9 AM and the evening peak period is 4 to 7 PM.
[32] E-mails RSG to UVTMA February 17, April 19 and May 25, 2005.

4. Employee and student data from Dartmouth College and Dartmouth-Hitchcock Medical Center (DHMC) as well as ridership studies sponsored by Dartmouth or conducted by Dartmouth Students. These include:

   - Energy and Transportation at Dartmouth: Issues and Recommendations, Environmental Studies 50, Spring Term 2000, Professor Richard Howarth

   - Description of Dartmouth College Transportation Demand Management initiatives and experiences.

5. Published and unpublished studies and reports that either focused specifically on Advance Transit or on some relevant facet of rural (non-urban) public bus transportation and/or support facilities. Review emphasis was on more recent and relevant body of literature dating from the mid-1990s forward that addresses the direct and indirect benefits of fixed route rural transit systems in a useful and relevant way (see attached bibliography.) [33]

6. State and Federal data on air pollution and emissions from automobiles, trucks and buses. This information was combined with established and accepted methodologies for estimating air quality impacts caused by avoided automobile trips as offset by public transit operations.

7. The following public transit operators provided valuable information via telephone and e-mail:

   - City Express – Keene, NH
   - Green Mountain Transit Service – Montpelier, VT
   - Marble Valley Transit Service – Rutland, VT
   - Addison County Transit Resources (ACTR) – Middlebury, VT
   - Chittenden Country Transportation Authority (CCTA) – Burlington, VT
   - Concord Area Transit (CAT), Concord, NH

   See **Section 9** for more information.

3.2 Methodological Considerations

Analyzing public transit system operations is a challenging endeavor, not unlike that of predicting the market success or profitability of a new product. Small changes in service can have large and unexpected impacts, both positive and negative. Whether to charge fares and,

[33] There is a considerable body of published literature on urban transit system operations and fare practices that was deemed not applicable to AT's rural operations. There are two primary reasons for this: (1) The population density of areas served by rural transit is much lower than for urban areas; accordingly, both the capital investment and the volume of passengers served (by mile, by hour, per vehicle) differ markedly from rural systems. (2) Urban transit riders tend to be more transit-dependent that rural riders, resulting in markedly different reactions to service changes and fare policies. In addition, much of the published literature relates to demonstration projects of short duration or limited focus conducted fifteen or more years ago and therefore deemed of less relevance to the questions addressed in this study.

if so, setting fare amounts is a challenge for every public transit system. Most significantly, successfully getting automobile owners to give up the flexibility and freedom of a car to use public transit is the product of a diverse set of individual preferences or decisions. For this an other reasons, measuring trends over time and understanding who is using the service (and not using the service), how often and why is important.

While considerable attention has been given by both industry and the academic community to developing analytical techniques appropriate to making assessments of what the effects of various actions on ridership might be, it is important to recognize that these analyses at best represents estimates and indicators. The sections below discuss briefly some of the more significant methodological considerations relative to analyzing AT's operations and identifying the communities it serves.

3.2.1 Estimating Riders vs. Ridership

Gathering operations data while minimizing the adverse impact of such efforts on day to day operations is a reality of transit operations. It is relatively easy to gather and maintain accurate data on boardings: the number of people that boarded a specific vehicle during a specific period. However, it is much more difficult, intrusive, and expensive to gather data on the individuals who make up system ridership during a given period.[34] Clearly, understanding and predicting system performance hinges on understanding rider behavior and preferences. But pragmatically, only boardings are recorded on a regular basis and are the source of virtually all ridership statistics.

A simple example illustrates the problem. Consider a given individual from Enfield who rides the Blue Route to Lebanon and transfers to the Red Route to travel to her job in West Lebanon, following the reverse path to return home each day of the week. In ridership terms, this individual accounts for 20 boardings per week. In contrast, a Lebanon resident who commutes five times per week to his job at Dartmouth College or DHMC accounts for only ten boardings per week since no transfer is required between Lebanon and Hanover. However, both may be critically dependent on AT's services to get to and from work. Accounting for individuals who ride the bus to work but car pool home, or only use the AT system a few days per week introduces other distortions between riders and boardings. (See **Appendix** C.)

To estimate numbers of individuals dependent on AT, or number of automobile miles saved by AT riders, or jobs supported by AT, it is critical to understand the relationship between riders and boardings. Therefore, as part of this study an analysis was conducted to estimate the number of individuals using AT's services. Key to this analysis was the survey data on number of times a week an individual used AT, the number of transfers involved in the trip, and the purpose of the trip. On the basis of this survey data weighed averages of the number of boardings per week per individual were calculated as a function of these variables. The full analysis is contained in **Appendix C**.

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[34] For example, Concord Area Transit received a proposal for electronic stored fare card readers and associated equipment in 2003 that totaled nearly $58,000. The authors are aware of large metropolitan transit systems that were unable to accurately count exiting passengers during peak periods because the available staff and financial resources were not adequate to install and maintain the necessary systems.

Both the Crikelair 2004 and UVTMA 2005 survey results were analyzed. The 2004 Crikelair 2004 survey canvassed all five fixed routes. It determined that the weekly number of riders using the AT system when the survey was taken was approximately 750. On this basis, that survey sampled approximately 45% of these riders. For the UVTMA 2005 survey, which did not survey the Brown Route, it was estimated that approximately 35 to 45% of the actual persons using the system during the three-day survey period were interviewed. These estimates of number of riders using the system then become the basis for estimating numbers of AT related jobs and avoided automobile trips, etc. **See Appendix C**.

3.2.2 Assessing Fare Elasticity

Fare elasticity measures or predicts the change in boardings for a given change in fare. It is a topic of much study in the transit community. Moreover, it is particularly of interest for this study since the question has been raised as to the potential impact on system operation were AT to abandon its present free fare system – and whether or not the existing fare-free policy has attracted a worthwhile number of additional riders.

The study team approached this question from two perspectives. The more formal approach was to review the literature and attempt to develop a numerical estimate of the relationship between changes in fares and changes in ridership applicable to AT's operations. The challenges of developing a fare elasticity metric are discussed below. The second approach was to review AT's ridership history as the system has moved from a conventional fare based system to its current fare-free status. An overview of the second empirical analysis is provided below. A complete discussion of the conclusions reached is provided in **Section 5** and **Appendix E**.

Virtually all public transit systems exhibit an inverse relationship between the amount charged per ride and the number of people who use the system. For small changes in fare, the average fare elasticity for public transit systems has been estimated at **–0.40**. This means that ridership will decrease 4.0% for every 10% increase in fare.[35]

Key to using fare elasticity to estimate changes in ridership is recognition that it is a constant measure and the actual number varies from system to system. It is most useful in assessing the impact of small changes, moving from $1.00 to $1.20 per ride for example, based on previous experience. However, even for a system with a previous history of charging fares and making fare adjustments, its utility is less certain when estimating the effects of dropping a fare entirely or instituting a fare on a currently free system. For example, a fare-free system presents no economic, functional or psychological barrier to entry that a fare – however modest an amount it may be – represents. Thus, a fare-free system attracts passengers over time who might abandon the bus if a fare – any fare – is charged. This is relatively more likely in the case of the 60 % (+/-) of AT's fixed-route passengers who said they would make their trip by other means if the bus service didn't exist, because this group

[35] Fare Elasticity and Its Application to Forecasting Transit Demand, Larry H. Pham, Ph.D. and James Linsalata, American Public Transit Association, Research and Statistics Division, August 1991.

has implied that it has access to transportation alternatives that could be substituted for the bus.

Techniques have been developed to calculate what are referred to as "arc elasticities" using somewhat more complex formulas to account for the non-linear nature of larger fare changes. Using these techniques the study team addressed the following:

- What does the body of literature show concerning fare sensitivities on rural bus systems in general or on average?

- Can we estimate the probable fare sensitivity of AT passengers based on past behavior when a fare existed?

The Study Team independently estimated an arc-elasticity value for the AT system of minus (-)0.426 based on actual boardings data. This value is remarkably consistent with studies of other rural transit systems and strongly argues that AT's customers and the type of service AT provides is very typical of other rural transit bus systems. (See **Appendix E**.) Some of the most recent work, in fact, finds that *on average*, the fare elasticity for peak and off-peak periods combined is –0.43 – i.e., the same number.[36]

In parallel with the more formal quantitative analysis, the Study Team closely examined AT ridership trends over the past seven years from 1998 to present. As can be seen from the data presented in this document, fixed route boardings increased about 97% during that period in response to a number of changes made in the system, including both level of service, route restructuring, and elimination of fares.

Finally, an analysis was conducted to compare ridership growth patterns before and after the combined fare and service changes implemented during 1999-2000 in the context of the relatively short period when a portion of the system was free and fares were collected on the balance. The detailed methodology and results of this analysis are presented in **Section 5**.

3.2.3 Environmental Impacts

The analysis of the environmental benefits associated with use of AT services in lieu of personal vehicles or other modes of transportation was carried out using standard NHDOT and EPA models. Passenger vehicle emission factors are from the EPA Mobile 6.2 emissions model. New Hampshire conditions were modeled by the NH Department of Environmental Services, 2005. Summer driving conditions were assumed. Estimates of the vehicle miles avoided were derived from the April UVTMA survey data on rider destinations and alternative modes of transportation were AT services not available.

The calculated emission quantities for avoided vehicle miles based on current ridership were then compared with calculated emissions for the AT vehicles. The detailed analysis and conclusions are discussed in more detail in **Section 6**.

[36] Larry H. Pham, Ph.D. and James Linsalata, loc. Cit.

4. Identification and Analysis of AT's Existing Ridership and Market Demand

Advance Transit ridership is growing. Annual boardings increased in each of the last four years, amounting to a more than doubling in total ridership since 2000. This growth can be attributed to numerous factors including improved service frequencies, route restructuring, and adoption of a system-wide fare-free policy. This growth took place against a backdrop of a 10.6% growth in the combined population of the six served towns between 1990 and 2000, and a 21% growth in employment in the Hartland/Lebanon Labor Market Area[37]. **Table 4**, below, displays population data for each of the six served municipalities in 1990 and 2000.

Table 4 - Ten Year Population and Employment Growth

	Lebanon	Hanover	Hartford	Enfield	Canaan	Norwich	Total
Population per 2000 Census	12,568	10,850	10,367	4,618	3,319	3,544	45,266
Population per 1990 Census	12,183	9,212	9,404	3,979	3,045	3,093	40,916
Absolute Change	385	1,638	963	639	274	451	4,350
Percent Change	3.2%	17.8%	10.2%	16.1%	9.0%	14.6%	10.6%
Regional Employment Growth 1991-2000	**Hartford/Lebanon Labor Market: +10,837 jobs (up 21% 1991 to 2000 from 52,476 to 63,313)** vs. Claremont & Springfield LMAs combined: +4,988 jobs (up 15.7%)						

Note: The Hartford/Lebanon Labor Market Area (LMA) as defined by the **Upper Valley Housing Needs Assessment** consists of 23 Vermont communities and 12 New Hampshire communities. These 35 communities include the six municipalities served by Advance Transit.

In this section, AT ridership trends are examined on a system-wide basis and specific to the City of Lebanon. A number of components of AT ridership are analyzed including transit-dependent and non-transit-dependent passengers, and transit market demand according to trip purpose. While the analysis is based on data from a variety of sources, it primarily focuses on ridership data supplied by AT, results from the 1999 and 2004 Crikelair surveys and the 2005 UVTMA survey. Some discussion of significant changes to AT services is included, though a more detailed history and analysis of fare policy is presented in **Section 5**.

[37] Source: Upper Valley Housing Needs Analysis: Summary Report; Upper Valley Lake Sunapee Regional Planning Commission; Applied Economic Research, Laconia, NH; August 2000.

4.1 Advance Transit Ridership Trends

Following a period of low-to-no-growth in its fixed-route ridership during the late 1990s, boardings strongly advanced beginning in 2001 and have grown every year since. The reader should note that AT formally reports boardings on a Fiscal Year basis that starts in July and ends in June.[38]

Figure 4 displays Advance Transit's annual fixed route boardings over the past decade:

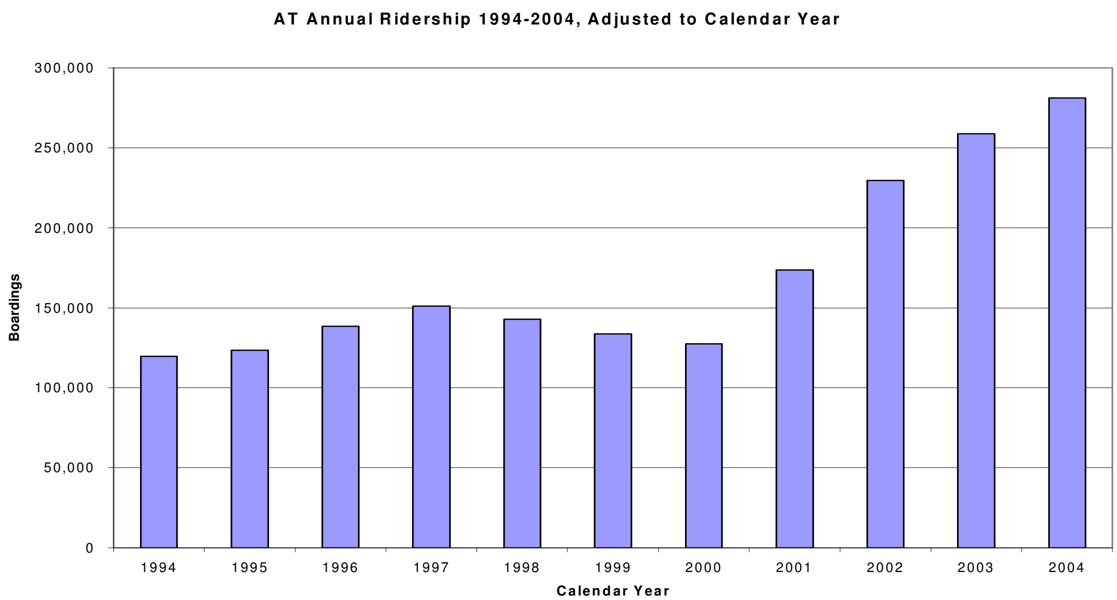

Figure 4. Advance Transit Annual Boardings 1994-2004

Fixed-route ridership showed slow growth from 1994 through 1997 followed by a mildly deteriorating trend through 1999 and never exceeded 152,000 boardings. In September 1999, AT implemented a strategic change that reintroduced a dedicated shuttle bus service in Hanover to connect the Thompson and Dewey parking lots with the Dartmouth campus and separated this shuttle operation from the fixed-route, scheduled network. This policy has continued such that all AT shuttles are operationally separate from the fixed-route network. Results for the year 2000 are therefore misleading if taken out of context because the service adjustment just described created a one-time anomaly.

Upon completion of a major planning effort, fixed-route services were further restructured in September 2000. Improved service frequencies were added and other service improvements were made. The weakly-performing Saturday service was suspended and resources were re-allocated to further strengthen weekday services. Some of these restructuring changes were:

[38] Unless otherwise noted or obviously excepted, boardings figures in this study represent calendar years.

- Reconfiguring the Blue Route and using two buses to provide 30-minute service[39];
- Improvements to commuter-oriented schedules serving Enfield and Canaan;
- Adjustments to the Red Route and the Green Route;
- Launching the Orange Route with direct links from White River Jct. to West Lebanon, downtown Hanover and the Dartmouth campus;

These and other service improvements and corresponding schedule adjustments were followed by significant growth in total ridership. The next year (2001), AT's fixed-route ridership exceeded 152,000 riders for the first time, despite the fact that fixed-route passengers and shuttle passengers were now being tracked separately. In the same year, service in Vermont went fare-free and Dartmouth students and employees could ride free upon presenting appropriate ID.

Effective January 2002, with additional sponsorship from Dartmouth College and DHMC, the entire AT system became fare-free for all riders. This change eliminated the need for passengers to display a Dartmouth ID to ride fare-free, making the system more user-friendly and eliminating costs associated with fare collection and oversight. Following this change, fixed-route ridership made its largest yearly increase in both absolute and percentage terms: 2002 boardings increased by 56,000 over the 2001 total, or 32%, to 230,000.

AT's fixed-route ridership has continued to expand each year since, up to and including 2004, when total boardings exceeded 280,000.

4.2 Advance Transit Ridership by Route

Advance Transit operates five fixed routes. Each exhibited increasing ridership in recent years. **Figure 5** compares ridership growth trends by route for the past three years. With the exception of the Blue Route, each is served by a single bus throughout the service day. What follows is a short discussion of the character of each route and specific ridership trends. (See **Appendix D** for route-by-route annual ridership numbers.)

[39] The Blue Route now has a 3rd bus during peak periods.

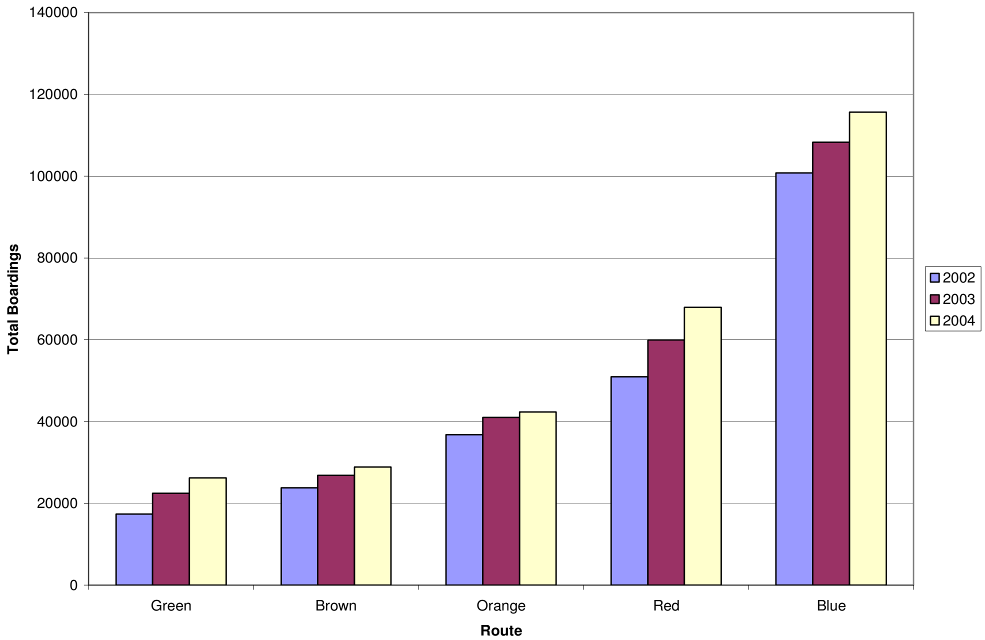

Figure 5. Boardings by Route, 2002-2004

Blue Route

The Blue Route is the most utilized of Advance Transit's five fixed-routes due to the nature of the route and the high frequency of service provided. The Route runs between Canaan and Hanover via Enfield, with stops in downtown Lebanon, DHMC and Centerra, among others, along the way. Two buses serve the route throughout the day. A third bus operates only during peak periods. Blue Route ridership increased from over 100,000 boardings in 2002 to close to 116,000 in 2004. The route has consistently shown nearly equal northbound versus southbound ridership in recent years. During peak periods, however, the dominant passenger travel is toward DHMC and Hanover in the morning and in the opposite direction during the afternoon and evening. Capacity is readily available from Hanover to DHMC and Lebanon in the morning and visa-versa in the afternoon and evening. The service is also popular with Mascoma High School students who board in the "reverse peak" direction (inbound to Lebanon) in the afternoon.

Red Route

The Red Route provides service between downtown Lebanon and the Route 12A commercial district of West Lebanon, and is the second most utilized AT route. The route is characterized by a mix of shopping and work-related trips and is the only AT route that operates entirely within Lebanon. A significant share of commuters ride during peak hours and shoppers ride throughout the day. From not quite 51,000 boardings in 2002, the Red Route grew to nearly 68,000 in 2004 – the largest boardings increase of any AT route over this period.

Orange Route

The Orange route travels NH Route 10 between Hanover and the West Lebanon transfer site, then continues to White River Junction and the VA Hospital. Annual boardings on this route increased by 5,500 over the past two years, to more than 42,000 in 2004. Of all routes, the Orange demonstrates the greatest imbalance in direction of travel, with 67% of 2004 passengers boarding at southbound stops. This directionality is part of a slightly increasing trend, up from 64% in 2002, and implies there is available northbound capacity on this route.

Green Route

The Green Route runs along US 5 in Vermont, with service between Hanover and White River Junction. The route also stops at the transfer point in West Lebanon and travels up the White River along VT 14 as far as Hartford Village. The Green Route has been the least utilized AT route in each of the last three years (26,000 boardings in 2004), though it has the highest annual growth rate of any route over this period. Hanover and Hartford have both experienced strong population growth as shown in **Table 4** (which appears in the introduction to this Section). This and the close proximity of new residential units in Wilder built in response to housing demand might be contributing to the positive ridership trend.

Brown Route

The Brown Route covers the least distance of any AT route, providing service from Norwich to Hanover and on to CRREL and the Rivercrest housing development on NH Route 10. Over the past three years, Brown Route ridership increased by more than 5,000 boardings, to nearly 29,000 in 2004.

Table 5, from the 2004 Crikelair Study, displays the share of residents from each town on each of AT's fixed-routes. On three of the five routes, the largest share of passengers are residents of Lebanon. At 78%, the Red Route has the greatest share of Lebanon residents. The Blue and Orange Routes have 42% and 47% Lebanon residents, respectively.

Table 5 – Distribution of Riders by Town of Residence and Route

	Blue	Red	Green	Orange	Brown
Lebanon	42%	78%	22%	47%	0%
Hartford	5%	19%	61%	41%	6%
Hanover	22%	0%	9%	0%	25%
Norwich	2%	0%	0%	3%	39%
Canaan	12%	1%	0%	0%	0%
Enfield	10%	1%	0%	0%	0%
Other	9%	0%	9%	9%	31%

4.3 Analysis of Existing Ridership in Lebanon

Lebanon generates the most boardings on AT both in terms of where its passengers live and where they are going. **Table 6** displays the population of each municipality served by AT's existing route network, according to the 2000 Census. The population of each is then expressed as a percentage of the total population of the six municipalities. Estimates of the total number of 2004 boardings by municipality were generated based on the April 2005 UVTMA survey.

Table 6 - Populations of Municipalities Served by AT vs. Boardings by Residence								
	Lebanon	**Hanover**	**Hartford**	**Enfield**	**Canaan**	**Norwich**	**Other Origins**	**Total**
Population per 2000 Census	12,568	10,850	10,367	4,618	3,319	3,544	NA	45,266
Percent of Total Population	**27.8%**	24.0%	22.9%	10.2%	7.3%	7.8%	NA	100.0%
AT Boardings (2004), Apportioned by 2005 Survey	113,274	48,134	45,251	21,040	18,735	9,799	24,787	281,020
Percent of Boardings	**40.3%**	17.1%	16.1%	7.5%	6.7%	3.5%	8.8%	100.0%

Note: 2.5% of survey respondents did not answer Question 1 of the UVTMA survey or gave an unusable response. The calculations were normalized accordingly. "NA" = Not Applicable.

Lebanon generates proportionately more boardings than its portion of the population of the six municipalities. This is true even when the boardings data is adjusted for the 8.8% of respondents who said they live outside of the service territory.

Figure 6 on the following page diagrams the flow of passengers identified by the UVTMA's April 2005 survey of the Blue, Red, Green and Orange routes – the four fixed-routes operated by Advance Transit that serve Lebanon. The circles are sized such that their area is consistent with the number of surveyed passengers identified as fitting that category. Similarly, the size of each arrow corresponds to the number of respondents who indicated that they live in a given town and are traveling to the town linked by that arrow.

The majority of passenger trips represented by the 2005 survey originate, terminate, or originate *and* terminate in the City of Lebanon (294 out of 491 or 59.9% of valid responses to this survey question). Hanover represents the next largest source and destination of passengers. Hartford/Wilder/White River Junction is the third most reported source and destination, based on the April 2005 UVTMA survey.

Note that it is important to distinguish between boardings and survey results. A *boarding* represents a passenger entering a bus. Advance Transit maintains boardings data for its own use and to comply with reporting requirements, and furnished boardings data to the UVTMA for use in this study. The bus drivers report boardings at the end of their shift. If a passenger changes to another AT bus to complete his or her journey, the act of entering the second bus to continue his or her trip counts as another boarding, which is also recorded by Advance Transit bus drivers. UVTMA survey results are the product of (in many instances) face-to-face contact with individual persons by a paid or volunteer UVTMA surveyor. Passengers were asked not to complete the UVTMA survey (nor the 2004 Crikelair survey) more than once. The data represented in Figure 6 on the following page, for example, reflects survey results.

Figure 6 – Residence and Trip Destination

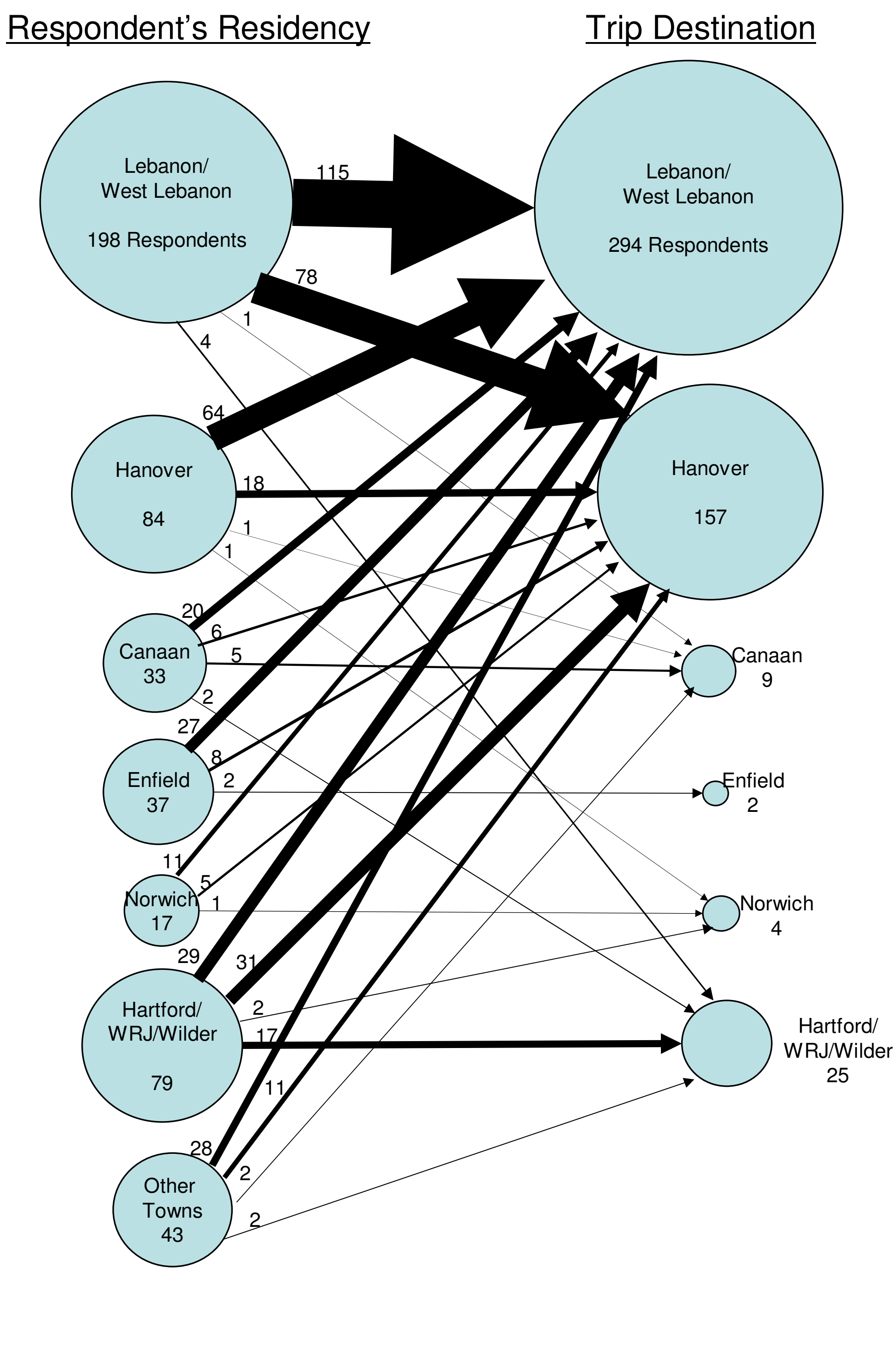

Figure 6. Residency ("origin") and Destination of Surveyed Passengers

The result of pairing responses to the first survey question: "What town do you live in?" with responses to the second question: "Where are you going on this or a connecting AT bus?" is unavoidably influenced by the time of day when the respondent completed the survey. Return trips are underrepresented by **Figure 6** because surveys were conducted from early morning to mid-afternoon and passengers were asked not to fill out more than one survey.[40]

Finally, **Table 7** displays the results for rider residency from the Crikelair surveys for 1999 and 2004[41]. These results are compared to projections based on the UVTMA survey of April 2005.

Table 7 – Town or City of Residence

	1999		2004		2005 adjusted[42]	
Lebanon	51%	68,146	41%	115,855	41%	123,024
Hartford	16%	21,379	16%	45,555	16%	48,374
Hanover	10%	13,362	13%	37,119	13%	39,415
Norwich	1%	1,336	11%	31,213	11%	33,145
Canaan	12%	16,034	5%	14,341	5%	15,229
Enfield	3%	4,009	5%	14,341	5%	15,229
Other	6%	8,017	8%	22,777	8%	24,187
# of surveys	117		346		491[43]	
Total Boardings		133,620		281,202		298,602[44]

Although the portion of total AT riders living in Lebanon evidently decreased between 1999 and 2004, total boardings more than doubled over this period. Boardings of Lebanon residents increased 80% in the same period.

Additional metrics may be found in **Section 9.4**.

4.3.1 Transit-Dependent

This section analyzes, and attempts to quantify, Advance Transit services as they serve transit-dependent passengers. Transit-dependent passengers are those riders who would not otherwise be able to make their trip if the bus service did not exist. Transit-dependence occurs for a variety of reasons, including physical incapacity to drive and unavailability of either a personal automobile or other transportation means. Assessments are based on the 2005 UVTMA survey. Transit dependence is examined, as indicated by survey respondents' 'yes' or 'no' answer to the question: "Would you still make this trip if the bus service didn't exist?"

[40] Many repeat passengers appear from the mid-afternoon onward as they return home from their workplace.
[41] Advance Transit Schedule Improvements, Final Report Submitted to Advance Transit, Tom Crikelair Associates, December 31, 2004, p. 2-3.
[42] Projected 2005 boardings by town have been corrected for under-representation of Norwich residents because the Brown Route wasn't surveyed in 2005. This was done by factoring 2004 data by the actual growth rate in boardings for 2005-to-date.
[43] 491out of 504 respondents answered the question.
[44] Projected based on 2005 year-to-date.

Table 8 summarizes the transit dependency findings of the UVTMA study.

Table 8 -- Transit Dependency by Route Surveyed				
Route	Yes, I'd Make This Trip Anyway	No, I Would Not Make Trip Without Bus		
		and Trip is *Not* Work-Related	and Trip is Work-Related	***Total Transit-Dependent***
Blue	198	36	26	***62***
Red	98	25	14	***39***
Orange	45	6	6	***12***
Green	25	6	1	***7***
All Routes Surveyed	*366*	*73*	*47*	***120***

Survey results indicate that:

- 24% of respondents said they would not make their trip if the bus service did not exist, indicating that they are transit-dependent.
- 73% said they would make their trip whether the bus existed or not, indicating they were not transit-dependent.

(The remaining 3% either did not answer or gave an ambiguous response.)

The percentage of respondents indicating that they are transit dependent varied only slightly by route, ranging between 21% on the Green Route to 27% on the Red Route. However, of the 366 respondents who said they were not dependent on the bus, 13% said they would walk, 10% bicycle, and 4% said they would use some other non-auto means.[45] Assuming a degree of weather dependency on walking or bicycling, and the fact that the survey was conducted in April and that the weather was generally fair, the survey results might understate the segment of AT's ridership that is transit-dependent.

Importantly, a total of 47 people indicated that they were transit-dependent *and* said they were going to or from work. Thus, it is inferred that the survey directly detected up to 47 jobs held by transit-dependent persons (that is, 47 individual persons actually surveyed said they were going to or from work and wouldn't make the trip without the bus).

Table 9 presents further analysis by projecting the survey sample for just Tuesday, April 5 into the total reported ridership for that day. From this analysis, it is estimated that the total number of bus-dependent employment situations enabled by AT on that day was 52. The reader is cautioned that this number may represent an upper limit, as it is likely that some of these employed persons would manage to find an alternative way to reach their workplace rather than give up their job or find different, though perhaps less desirable, employment. However, the estimate is also likely to somewhat under-represent bus-dependent employment due to the fact that Brown Route estimates are not included.

[45] Normalized to 100% because some respondents identified more than one alternate mode.

Table 9 -- Total Bus-Dependent Employment Implied by Survey Sample When Projected into Boardings for Tuesday April 5, 2005				
Route	Surveyed Bus-Dependent Work Trips	All Surveyed Work-Related Trips	Percent of Work Trips that are Bus-Dependent (1)	Estimated Number of Bus-Dependent Jobs Among All Tuesday Riders (3)
Blue	11	80	13.8%	25
Red	7	50	14.0%	14
Orange	3	24	12.5%	9
Green	1	11	9.1%	4
Total(2)	**22**	**165**	**13.3%**	**52**

(1) Surveyed persons who said their trip is work-related *and* they would not make trip without the bus divided by all survey respondents who said their trip is work-related.
(2) Estimates do not include additional bus-dependent jobs served by Brown Route
(3) Truncated to nearest integer value.

The "Estimated Number of Bus-Dependent Jobs…" identified in the above table is just for Tuesday, April 5. The survey results for Tuesday likely missed some additional bus-dependent jobs because the total number of valid survey responses collected over the three-day survey period identified 47 bus-dependent jobs. Because individual respondents were surveyed only once, 25 (i.e., 47 minus 22) people having bus-dependent jobs were "missed" on Tuesday. (Either they were not contacted by a UVTMA surveyor or declined to complete the survey or did not pick up a survey on the bus when not staffed by a UVTMA surveyor).

The ratio of surveyed bus-dependent jobs to all bus-dependent jobs in **Table 9**, above, is 2.36-to-1 (i.e., 52/22). When this ratio is multiplied by the 47 bus dependent jobs actually identified by face-to-face survey over the three days the survey was conducted, the probable number of employment situations supported by the bus service is 47 times 2.36 or one hundred and eleven (111).

Therefore, the AT bus service enables an estimated 111 Upper Valley residents to access employment opportunities that might otherwise be unavailable to them. If the best alternative for these people is a lower-paying job (or no job at all), such persons may be more vulnerable to credit risk, poverty and/or reliance on public assistance. Quantifying the impact of this important benefit of the bus service is beyond the scope of this study, but a conservative estimate of this group's aggregate annual earnings appears in **Section 7**.

4.3.2 Park & Ride and Shuttle

Park & Ride patrons are an integral component of the total population of AT passengers riding the system's fixed-routes. The 2004 Crikelair study found that 8% of survey respondents had a car parked "near an AT stop." Another 2% said their car was in a "Dartmouth or Hanover lot." Taken together, this represents half of the 20% of all respondents who implied that they drove a car for part of their trip. Presumably, this means that Park & Ride use accounts for half of all AT patrons who start and/or end their trip by auto but use the bus for the rest of their trip.

Anecdotally, most of the Park & Ride patrons ride the Blue Route, during morning and evening peak periods. The Crikelair survey found that of those respondents employed at

DHMC – by far the area's largest single employer – 47% who rode AT to work came from Enfield and another 11% came from Canaan, where Park & Ride lots exist and are served by AT.

Quantifying the number of AT passengers utilizing Park & Ride facilities beyond this rough assessment is inherently difficult. Most of the Park & Ride lots within AT's service territory are unofficial and therefore would be difficult to evaluate. Additionally, many municipal parking lots throughout the region likely support Park & Ride activities. For example, municipal lots in Lebanon and Hanover probably support some AT patrons who leave their cars in one of these lots and then take the bus.

4.3.3 Other Non-Transit Dependent

A total of 366 people, or 75.3% of all respondents surveyed by the UVTMA who answered the question, said they would still make their trip absent the bus service. Of those:

- 32.3% said they would otherwise be operating a single-occupant vehicle (SOV).
- 27.1% said they would have carpooled or gotten a ride with someone
- 14.4% said they would have taken a taxi.

These figures total 73.8%.[46] The remaining fraction of non-transit-dependent riders presumably would use non-auto means to make their trip.

Figure 7 presents a comparison of how AT riders said they would otherwise travel in the absence of the bus service.

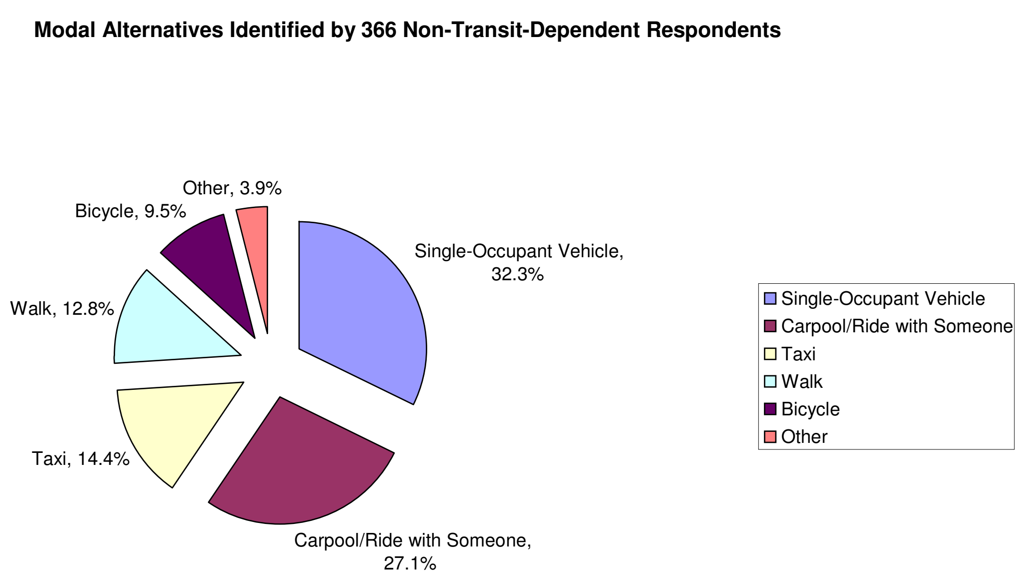

Figure 7. Modal Alternatives Among Surveyed Non-Transit-Dependent Passengers

[46] This number multiplied by the fraction of passengers who said they aren't transit-dependent (75.3%) yields 56%. This number is an important input to the air quality analysis presented in Section 6.

Table 10 develops total avoided auto trips on a daily (weekday) and annual (working weekdays) basis. It focuses only on the survey results for Tuesday, April 5 -- when approximately 47% of the surveys were collected. This controls for the phenomenon of different work schedules that might vary by day of the week, including part-time employment.

Table 10 -- Total Avoided Auto Trips Implied by Survey Sample When Projected into Boardings for Tuesday April 5, 2005

Route	Avoided SOV Trips in Survey Sample	Avoided Carpool/Ride and Taxi Trips in Survey Sample	Percent of Surveyed Riders Who Indicated They Would Otherwise Use an Auto	Reported Total Boardings for Tuesday April 5	Total Projected Auto Trips Avoided (Tuesday April 5)	Implied Avoided Auto Trips per Year (254 days)(2)
Blue	41	42	69%	473	327	83,098
Red	17	28	64%	244	157	39,842
Orange	9	10	54%	184	100	25,371
Green	4	5	56%	109	61	15,573
Total(1)	**71**	**85**	65%	**1,010**	**654**	**166,059**

"SOV" = Single-Occupant Vehicle

(1) Totals do not include additional auto trips avoided by Brown Route passengers; the Brown Route was not surveyed.

(2) Scale-up for full year at 254 working weekdays per year is an approximation. There is no explicit evidence that Tuesday is typical of all weekdays.

The number of people surveyed on Tuesday was 241.

The year-over-year growth in boardings from 2004 to 2005-to-date is at least 6.2%. (This is probably conservative because boardings for the first third of the year have been weaker than the latter two-thirds of the year for the last two years in a row; so an *annualized* projection of 2005 boardings would be even higher.) It is interesting that when the annualized figure for avoided auto trips presented above (166,059) is divided through by 1.062 to account for growth in projected ridership from 2004 to 2005, the result is 156,364 – almost exactly the estimated avoided auto trips for 2004. This provides a measure of assurance that the results of surveys collected just on Tuesday, April 5 fairly represent the behavior and alternative modal choices of AT's patrons.

4.4 Transit Market Demand in Lebanon Area

Transit market demand in Lebanon and the surrounding region is inexorably dominated by work trips. This has been amply confirmed by three ridership surveys from 1999 to date. However, recent survey results suggest that trip purpose is diversifying -- with growth in absolute numbers occurring in shopping trips, medical and personal business trips and "Other", which presumably are discretionary trips. Broadly speaking, passenger and freight carriers alike welcome diversification of traffic sources because this lessens reliance on any one sector, all other things (such as rates, tariffs or fares) being the same.

The distribution of trips by trip purpose is presented in **Table 11**. Employment related trips are 57% of all trips undertaken on Advance Transit. Shopping is the second most common purpose for AT trips (13%).

Table 11 - Trip Purpose

	1999	2004	2005
Work	72%	62%	57%
Shopping	13%	14%	13%
School	10%	11%	7%
Medical	2%	6%	9%
Recreation/Social	3%	4%	13%
Other	no data	4%	
# of surveys	117	346	504 (1)
Boardings	133,620	281,202	298,602(2)

(1) 2005 UVTMA results were normalized to 100% because some respondents indicated more than one trip purpose.
(2) Projected.

Figure 8, below, displays the breakdown of trip purpose aboard the Blue Route – the most utilized of AT's fixed routes and a key element of the overall system. Data is based on the 2005 UVTMA survey.

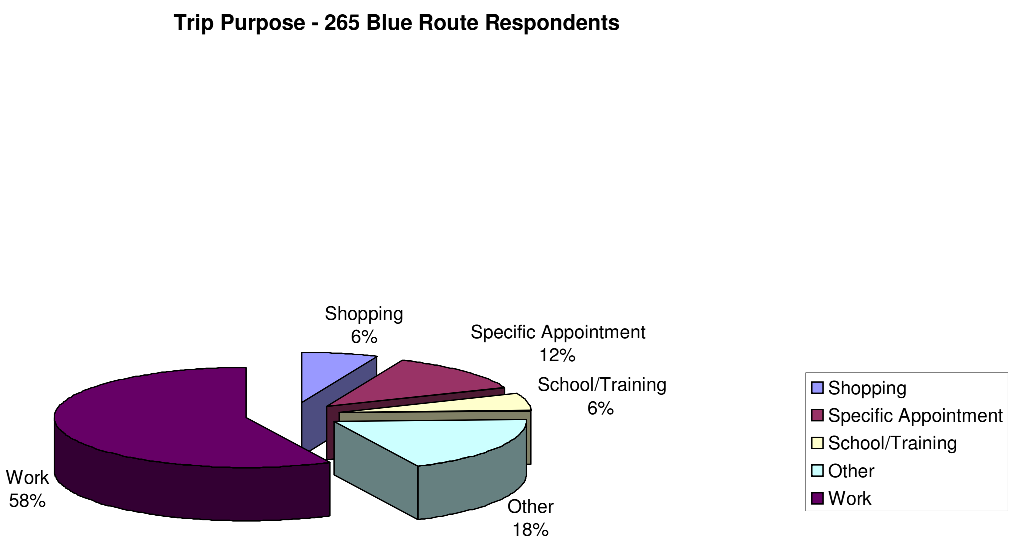

Figure 8. Blue Route Trip Purpose From UVTMA 2005 Survey

As will be further discussed in **Section 4.4.2**, "Shopping and Personal Business", the Blue Route is somewhat unique, being AT's prime "commuter" service lane serving downtown Lebanon, downtown Hanover (including Dartmouth College and Dartmouth Medical School) and DHMC. As discussed later, there is some potential to serve more DHMC employees if resources become available in the future to extend service hours later into the evening.

Unlike AT's other four fixed routes, shopping is proportionately not a major reason why people ride the Blue Route; in fact it is overcome 3-to-1 by "Other", unspecified trip purposes. School-generated trips are probably under-reported on the Blue Line because students leaving school in the afternoon don't consider the trip school-related, and may be a large portion of "Other".

The key observation regarding the Blue Route is that it may be a model for other, future commuter-oriented services – perhaps serving Park & Ride facilities such as the anticipated P&R facility at Exit 13 on I-89 in Grantham, or future routes to the south of downtown Lebanon via Route 120 and/or 12A. These possibilities are discussed in **Section 8**.

4.4.1 Employment

Work-related travel has already been shown to represent AT's largest existing and potential market. Passenger surveys indicate that commuter trips account for nearly two-thirds of passengers' primary trip purpose. According to the 2004 Crikelair Study, Advance Transit carries a higher share of commuters than most other rural public transit systems.

Work-related trips are likely to be repetitive. According to the 2004 Crikelair survey, "more than half of Advance Transit bus riders said they use the bus service five days a week" and 31% said they ride three or four days a week. Therefore, to the extent that work-related trips remove Single-Occupant Vehicles (SOVs) from the road, work-related trips by bus result in a disproportionately large share of avoided SOV trips and probably carpool and taxi trips. The direct and indirect benefits to the City of Lebanon and the surrounding region that accrue because of this phenomenon are analyzed elsewhere in this report.

4.4.1.1 Overview of Commuter Shed

The following paragraphs present an overview of recent data on employee and student numbers for DHMC, Dartmouth College including Dartmouth Medical School, and finally some key figures from a recent survey of all of the employers in the greater Lebanon area.

The results of the 2005 UVTMA survey of AT passengers found 81 people who work for DHMC and 73 people who work for Dartmouth College. In percentage terms, this represents 53% of all respondents who were making a work-related trip, and nearly 31% of all respondents. This also means that about half of all work-related trips on AT are generated by other employers, and that these other employers are responsible for another 30% of all AT bus trips.

DHMC is the largest employer in the Lebanon area – the 2004 employee headcount at DHMC was 5,530.[47] However, many of DHMC's employees commute during times when the AT bus service is not operating. For example, DHMC informs us that nurses frequently work three twelve-hour shifts each week. They are thus unable to consider the bus for their commute because the service either is not operating early enough for them to arrive when

[47] "Dartmouth-Hitchcock Medical Center, DHMC/DHC Lebanon Employees", single page handout furnished to Vital Communities, Inc., no date.

required or is not operating late enough for them to return home. Similarly, evening, night and weekend employees, housestaff and physicians on-call are unable to consider using the bus.

Dartmouth College is the second largest employer in the region, with a faculty and employee headcount in excess of 2,500. A detailed analysis of energy and transportation issues at Dartmouth by a 2000 Dartmouth Environmental Studies class found that roughly 60% of the College's employees and faculty lived within the Advance Transit service territory. Thirty-two percent of the payroll headcount lived in Hanover[48]. In addition, Dartmouth College was attended locally by 3,843 undergraduate and 1,692 graduate students in 2004, many of whom do not have own a car.

These employee and student populations are increasing. For example, the comparable headcount at DHMC in 1999 was 4,315.[49] The student body at Dartmouth College in 1999 numbered 3,759 undergraduate and 1,305 graduate students, respectively. Thus, the employee population at DHMC (physicians, staff and housestaff) increased by 1,215 or 28% over five years. The student population at Dartmouth College and its affiliated schools increased by 9% over the same period.

Examples of other large employers include: Timken (formerly Split Ball Bearing), Novell (formerly Tally Systems), Hypertherm, TeleAtlas (formerly GDT), King Arthur Flour, Alice Peck Day and the VA Hospital.

The *Upper Valley Housing Coalition Commuter Survey*, which queried many central Upper Valley employers in late 2004 and early 2005, identified 4,473 reported full-time employed persons who reside within one of the six municipalities directly served by Advance Transit.[50] Of these, 1,073 (24%) are Lebanon residents. A four percent penetration of the work-related market for all AT towns yields 179 people. If these riders average 3 round-trip bus rides per week for 48 weeks of the year, this represents 51,552 boardings annually. Every 1% increase in market penetration of this group of prime potential bus customers – that is, Lebanon residents who have full-time jobs within the City -- translates to 12,882 more boardings annually following the same assumptions.

4.4.2 Shopping and Personal Business

Shopping is an important trip purpose and is second only to work-related trips as the reason people are riding AT buses. **Table 12** displays the relative share of shopping related trips for each route, as determined by the 2005 UVTMA survey.

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[48] Energy and Transportation at Dartmouth: Issues and Recommendations, Environmental Studies 50, Spring Term 2000, Professor Richard Howarth, p. 24
[49] Ibid.
[50] Source: Upper Valley Housing Coalition.

Table 12 -- Shopping Trips on AT			
Route	**Shopping Trips Surveyed**	**All Respondents**	**Percentage**
Blue	17	266	6.4%
Red	40	146	27.4%
Orange	7	58	12.1%
Green	3	34	8.8%
All Routes Surveyed	67	504	13.3%

At 27% of surveyed riders over the three-day survey period, the Red Route is used much more intensively by shoppers than the other three surveyed routes. The Red Route operates completely within Lebanon, and the 2004 Crikelair Study determined that 78% of its riders are residents of Lebanon. Anecdotally, some residents of downtown Lebanon have said they rely on the Red Route for grocery shopping, citing the closure of Butson's grocery store (opposite Colburn Park in downtown Lebanon).

As retail businesses continue to proliferate along NH 12A in West Lebanon and also in West Lebanon proper, use of the Red Route for shopping and work-related trips is likely to continue to be very significant. The addition of a second Red Route bus will help to meet this market demand. (See also, **Section 8.1**.)

4.4.3 Education-Related

School-related trips constituted between 10% and 15% of surveyed passengers on the Orange and Green routes, thus by fraction this trip purpose is relatively significant among passengers on these two routes. However, the Blue Route is believed to support the greatest number of school-generated trips overall. The Blue Route serves the Lebanon High School and the Mascoma High School, both of which generate significant afternoon boardings.

Although only 15 Blue Route respondents (5.6%) marked "School" as their trip purpose, anecdotal observations suggest that some school students probably marked "Other" or "Work" as their trip purpose because many of them are traveling on AT in the afternoon and are therefore *leaving* school. This might account for "Other" non-specified trips overwhelming even appointment-related trips – the former representing 18.0% of Blue Route passengers surveyed and accounting for 48 responses out of 266 Blue Route surveys.

Survey results suggest that education-related trips are not growing as rapidly as AT's boardings overall.

4.4.4 Medical and Other Appointments

Nine percent of AT riders, an increasing share, identified "medical or other specific appointment" as the primary purpose of their trip. AT satisfies an important community need by accommodating these riders. At 12%, a relatively large share of Blue Route riders are using the system to reach an appointment – logical given that the route serves DHMC.

Apart from DHMC medical appointments, this is not a major market segment for AT. This may be partly due to the fact that the system is aimed primarily at AT's largest market – work trips – and does not yet have enough boardings to support mid-day service headways that are practical for short-duration round-trips. For example, it is presently difficult to take an "off-peak" round-trip on AT and return to one's point of origin within an hour unless the trip is a very short one.

4.4.5 Recreation/Other

Thirteen percent of passengers are riding for recreational or other purposes. This category encompasses a diverse array of reasons for using the bus that are not captured by the above purposes. In carrying out the survey, we noted that about 20 of Mascoma High School students rode the Blue Route in the afternoon in order to reach the Carter Community Center Building (CCBA). Another reason frequently written in for this category – by youth and elderly residents alike – was to visit friends. It is nearly impossible to project trends or estimate numbers for this segment except to assume that, unless service frequencies are upgraded, these trips will continue to increase about in step with local population growth. If service becomes more frequent[51] in the future, discretionary trips by bus may become more feasible – especially for people within walking distance of a bus stop.

[51] That is, service headway or average waiting time for the next bus.

5. Fare Collection and Effects of Fare-Paid and Fare-Free Policies

5.1. Overview

Earlier sections of this study have chronicled how the AT bus system has evolved to its current fare-free policy, which was possible primarily because of financial support from municipalities and institutions served by the bus network. Analysis described in this section and further documented in **Appendix E** shows that the fare-free policy has probably attracted and retained a relatively large number of additional boardings. At the same time, lack of a fare policy presents a greater financial hurdle to potential proposed expansion of the service (more frequencies, additional hours of operation, Saturday service or new routes). A legitimate argument for not expanding service is not having a source of funding to commence and sustain that service, whether the demand is potentially there or not. This section will also show that a subscription fare on the former Yellow Route – a possible source of supplemental revenue for specialty services or longer-distance commuting – was not sufficient to sustain that service.

Fares cost money to administer and collect, and fare elasticity formulas and modeling enable reasonable estimates of the contraction in boardings that will accompany a given fare increase (or decrease).

Figure 9, below, depicts the history of fare-free implementation on Advance Transit and overall ridership (boardings) trends since late 1993.

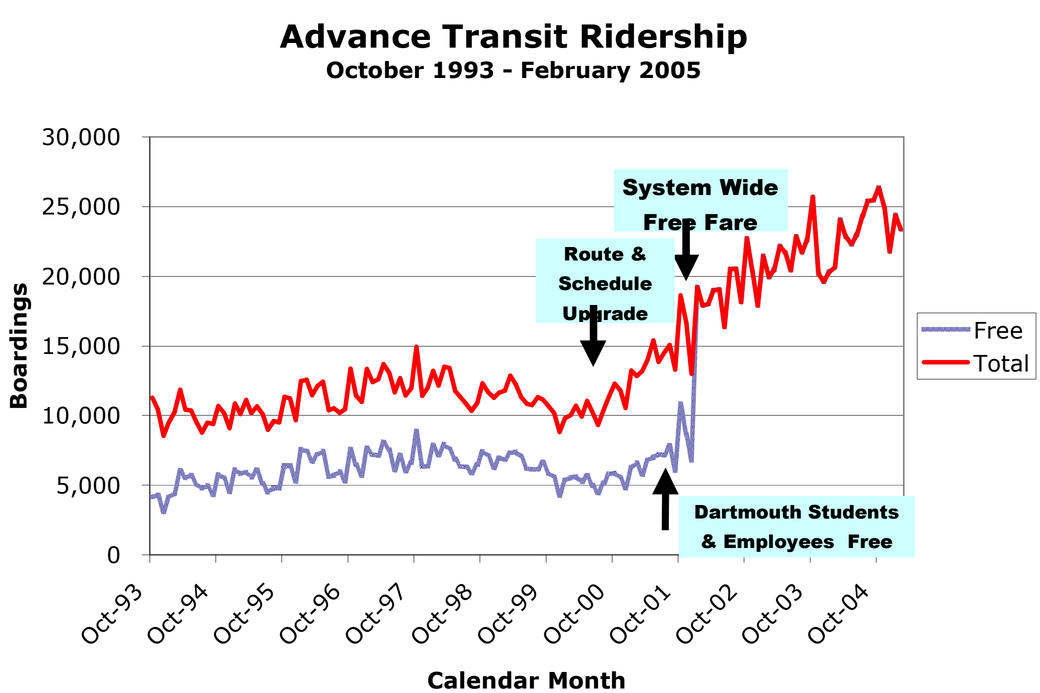

Figure 9. Monthly Advance Transit Fixed Route Fare-Paid and Fare-Free Boardings

Note that the upswing in boardings that occurred in 2001 started before the AT system became entirely fare-free. This illustrates the impact of service improvements that were implemented while a fare policy was still in place. While on the one hand it is a credit to AT management that service improvements were met with a strong and positive response, it is also more challenging to separate for analysis the effects of those improvements from the effects of a phased migration to an entirely fare-free system that got underway shortly thereafter.

5.2. Fare Policy and Collection

An important policy question is the desirability and appropriateness of charging a fare. An extensive body of research from the 1960s forward[52] has clearly established the following:

- Farebox revenues are important to large urban transit systems, and farebox recovery is a key operating metric of such systems;
- Farebox revenues are typically *not* an important component of cost recovery for small transit systems[53];
- There is an inverse relationship between boarding counts and fare increases (or decreases), assuming no other changes in service quality. This is called *fare elasticity*. Typical fare elasticities for public transit systems range from lows of about -0.12 (very inelastic) to -0.40 or more (relatively elastic).
- A fare elasticity of -0.40 means that 4.0% (four percent) of boardings will be lost if the fare is increased by 10%.
- The relationship between lost (gained) boardings and an increase (decrease) in the average fare can be measured by elasticity modeling;
- Rural transit bus passengers have been shown to be more sensitive to fares and fare changes than their counterparts using urban transit systems.

And finally:

- Fares cost money to collect.

Fares are charged on bus transit systems by several mechanisms. Common are:

- Cash fare – by coin, coin and bill, by token, or by deducting the fare from a debit card the patron purchases prior to boarding the bus;

[52] The following scholarly works discuss fares, fare-free policy, fare elasticity, fare collection, relative importance of fares to rural transit systems or some combination. Some have already been cited. A pioneering work is: The Effects of Fares on Transit Riding, John F. Curtin, Highway Research Record, No. 213, 1968. More recent: Fare, Free, or Something In Between?, Jennfier S. Perone and Joel M. Volinski, National Center for Transportation Research, 2002.; Elasticity-Based Method for Forecasting Travel on Current Urban Transportation Alternatives; Daniel Brand and Joy L. Benham, Transportation Research Record 895, 1982; Fare Elasticity and Its Application to Forecasting Transit Demand, American Public Transit Association, Research and Statistics Division, August 1991; Transit Pricing and Fares, TCRP Report 95, Brian E. McCollum and Richard H. Pratt, Transportation Research Board, Washington, DC, 2004.

[53] Multiple sources, including: Perone and Volinski (see Footnote above), p. 5.

- Multi-ride ticket – by punching, marking or swiping a multi-ride ticket or voucher the patron purchases in advance. A multi-ride ticket typically offers a discount over the single-ride fare. An employer might establish a program to offer multi-ride tickets to its employees at a discount, on either a before-tax or after-tax basis.
- Pass – A card the passenger purchases in advance, which is often sold at the greatest discount. Employers may establish programs to sell passes (such as monthly passes) at a discount on a pre-tax or after-tax basis by payroll deduction, or by direct cash sale with or without subsidizing the cost to their employees.

It is advantageous to the transit operator to sell multi-ride tickets and passes instead of taking cash fares on the bus. This method is also more convenient for frequent users of the system. Multi-ride tickets and passes yield revenue up-front to the transit operator whether the trips they represent are made or not, support flexibility to offer discounts, and are a potential vehicle for cooperation between the transit operator and employers. Cash fares involve handling, counting and depositing bills and coins which entails an ongoing daily labor cost even under the most ideal circumstances. It is, however, a convenience for the walk-up customer who has not purchased a multi-ride coupon or a pass. Some low-income passengers might not have the resources to purchase multi-ride tickets or passes.

The decision to eliminate fares on Advance Transit was motivated by the desire to encourage people to take the bus. A secondary but important benefit was elimination of the costs of handling cash money on Advance Transit buses. In a recent research paper, Perone and Volinski[54] write, "Traditionally, one measure of system effectiveness is the farebox recovery rate. In support of fare-free service, researchers[55] state that an overemphasis on farebox recovery is counterproductive with respect to the goal of increasing ridership. Instead, system effectiveness could be measured by cost per rider, rather than farebox recovery. In the case of Austin, Texas, in the 12 months prior to [a] fare-free experiment, the average cost per rider was $2.51. During the 15 months of the fare-free experiment, the average cost per rider was $1.51 and rose back up to an average cost per rider of $2.18 in the year following the experiment. [The same] researchers purport that the system also gained some efficiencies because there were no labor and capital expenses associated with collecting fares."

Advance Transit estimates the cost of fare collection as follows. The costs displayed below assume that cash money will be collected on the bus to accommodate walk-ups, but do *not* include a non-recurring cost to install fareboxes on AT buses:[56]

Monthly ongoing costs:	$ 660 / year
Weekly ongoing costs:	$ 2,080 / year
Daily ongoing costs (including bus driver tasks):	$ 44,700 / year
--	
Total recurring fare collection costs (estimated):	***$ 47,440 / year***
Non-recurring costs (administrative setup; printing):	$ 3,500 one time

[54] Loc. Cit. (see footnotes on previous page)
[55] Hodge, D.C., Orrell III, J.D., & Strauss, T.R. (1994). Fare-Free Policy: Costs, Impacts on Transit Service and Attainment of Transit System Goals. Report Number WA-RD 277.1, Washington State Dept. of Transportation.
[56] Formerly, AT bus drivers collected cash fares by selling tickets themselves. This slows down boardings.

Note that the above estimated costs do not escalate with boardings within modest limits. They are flat costs that are fixed in the short run unless buses and bus drivers are added or removed. For example, adding capacity (more buses) would increase fare collection costs because there would be more drivers. AT believes that even if drivers spend just 15 minutes a day on fare collection tasks, which it regards as an absolute minimum, the annual cost of collection will be at least $35,000.[57] See **Appendix H** for additional collections cost detail.

For Fiscal 2002, the last Fiscal Year during which AT charged a fare to some of its passengers for at least part of the year, the fare-paid boardings would have been about 87,648.[58] Charging "a quarter" (25 cents), for example, without otherwise changing the fare policy would have collected gross revenue of $21,912 assuming no shrinkage and a fare elasticity of zero (meaning that no boardings whatsoever would have been deterred by this fare). An attempt to collect such a small sum would have been non-accretive, even if fare collection costs were only one-half of AT's higher cost estimate. Later in this Section, the implications of re-applying a fare at its former level are examined.

5.3 Estimated Effects of Fare-Paid vs. Fare-Free Policies on AT

Table 13 displays actual Fiscal Year "free" and "paid" boardings from FY 1995 through FY 2002. In January 2002 (mid-way through FY 2002 that ran from July 2001 through June 2002), the entire system became fare-free. Thereafter, all boardings were free. The FY 2002 "free" boardings were adjusted downward by the same amount by which the "paid" boardings were doubled.

Note that fare-paid boardings increased in FY 2001 even though AT services in Vermont had been made fare-free. Moreover, the projection for FY 2002 fare-paid boardings for the full fiscal year based on the actual results for the first six months of FY 2002 suggest that fare-paid boardings would have increased again in FY 2002 were it not for the decision to make the rest of the system fare-free effective January, 2002. This is because of service improvements that had been implemented by AT.

[57] E-mail Advance Transit to UVTMA dated June 22, 2005.
[58] This number was developed by multiplying the fare-paid boardings for the first six months of FY 2002 (i.e., the last six months of calendar 2001) by two.

Table 13 -- Fiscal Year Fare-Paid and Fare-Free Boardings, FY 95 through FY 02		
Fiscal Year	Boardings	% Change from Prior Year
FY 95 Fare-Free	64,448	---
FY 95 Fare-Paid	**56,164**	---
Total	120,612	
FY 96 Fare-Free	74,215	15.2%
FY 96 Fare-Paid	**57,667**	**2.7%**
Total	131,882	
FY 97 Fare-Free	80,405	8.3%
FY 97 Fare-Paid	**63,393**	**9.9%**
Total	143,798	
FY 98 Fare-Free	85,149	5.9%
FY 98 Fare-Paid	**64,615**	**1.9%**
Total	149,764	
FY 99 Fare-Free	81,272	-4.6%
FY 99 Fare-Paid	**56,802**	**-12.1%**
Total	138,074	
FY 00 Fare-Free	67,132	-17.4%
FY 00 Fare-Paid	**57,549**	**1.3%**
Total	124,681	
FY 01 Fare-Free	71,246	6.1%
FY 01 Fare-Paid	**77,059**	**33.9%**
Total	148,305	
FY 02 Fare-Free	112,991	35.6%
FY 02 Fare-Paid	**87,648 (1)**	**13.7%**
Total	200,639	

Note (1): Fare-paid boardings for the first 6 months of FY 2002 were 43,824, including 4,195 Dartmouth "Show ID-Ride Free" boardings Oct '01 thru Dec. '01 recorded as paid boardings. Thereafter, the system was entirely fare-free. To project annualized paid boardings for all of FY 2002 as if the system fare structure had remained in place, paid boardings for the first 6 months of FY 2002 were doubled to yield 87,648. Fare-free boardings were correspondingly adjusted downward by the same amount (by -43,824)

Three questions emerge from the above finding:

1. Did the policy decision to remove all fares entice additional boardings?
2. Can an implied fare elasticity be estimated for Advance Transit?[59], and
3. What is likely to happen if a similar fare is put back on, applicable to the same routes, services and regions as until January 2002?

As will be shown on the following pages:

- The policy decision to remove all fares attracted 33,419 to 50,574 additional boardings in 2004. Moreover, results for the first four months of calendar 2005 indicate that boardings are still increasing despite no recent changes in the service.

- If a fare were reinstated at the former level and with the former fare-free Lebanon-Hanover zone, boardings will almost certainly decrease -- but not back to pre-2002 or pre-2001 levels. This is because service improvements were implemented in addition to phased removal of the fare structure.

For the following analysis, it is important to note:

1. The current fare on AT is zero. Therefore, re-application of a fare would represent a percentage increase of infinity over the existing "fare" of zero. To circumvent this dilemma, which is not usually considered by traditional fare elasticity analysis, one must look to past behavior when a fare was in place, compare it with current behavior and assume that there is a correlation between past passenger behavior under a fare regime and future passenger behavior if a fare were re-introduced.

2. Important policy decisions other than gradually eliminating fares were made between 1999 and 2002 as previously discussed. The boardings data clearly show that AT's fare-free and fare-paid ridership broke out of its low-growth mode during calendar 2001 – *even before the system went entirely fare-free*. This strongly suggests that strategies implemented at that time to improve the weekday fixed-route bus service were highly effective. It also means that it would be inappropriate and misleading to assume that reinstatement of a similar fare policy would drive ridership back down to pre-2001 levels.

The results of the UVTMA April 2005 survey allow an estimate of additional auto trips that would've been on Lebanon's roads if the AT system *had not* gone fare-free. Typically, passengers who have good transportation alternatives are more likely than their transit-dependent counterparts to abandon the bus or to reduce their use of the bus if faced with a fare or a fare increase. But studies[60] also indicate that commuters may be more tolerant of fares and fare increases than off-peak (mid-day and evening/nighttime) riders. (For calculation details and Methodology, see **Appendix E.**)

[59] Typically, fare elasticity is computed for systems that already charge a fare, and predict decreases in ridership due to increasing the fare. Our analysis attempts to reverse-engineer an approximate fare elasticity.
[60] For example, Pham and Linsalata, loc. Cit.

Table 14, below, displays estimated numbers of auto trips that result from discouraged bus boardings if a fare policy based on the former structure had existed during FY 2004. It also displays the additional estimated number of auto trips put back on the roads if the former average fare of $1.04 is increased by 10%. Auto trips that are converted to bus passengers through the convenience and enticement of a fare-free policy directly contribute to reduced exhaust emissions because the buses are operating with or without these passengers.

Table 14 --Predicted Change in FY 04 Boardings and Auto Use If Fare Structure Prior to Jan. 2002 Remained In Effect, and Increased Auto Use Predicted Due to a 10% Fare Increase

Growth Scenario	Predicted Decrease in FY04 Boardings Due to Fare	Increase in Total Auto Trips per Year (55.6% of boardings)[61]	Increase in Daily Auto Trips (based on 254 service days/year)	Daily Auto Trips To, From or Within Lebanon[62]
Low Growth Projection				
at 2001 average fare	-50,574	28,119	110	**67**
with 10% fare increase	-54,264[63]	30,170	118	**71**
Higher Growth Projection				
at 2001 average fare	-33,419	18,580	73	**44**
with 10% fare increase	-37,699[64]	20,960	85	**51**

Given an estimated average trip length of 5.4 miles and the *2005* IRS cost allowance of 40-1/2 cents per mile in 2004 as an all-inclusive average rate, the daily cost of the additional auto trips to, from or within Lebanon ranges from $96.23 to $155.27.

Figures 10 and 11 revisit the "Low-Growth" and "Higher-Growth" scenarios and the resulting implied "lower" and "higher" gross potential fare revenue. In addition, they display a fare increase scenario in which the fare is raised 10% from its former level.

Research of rural transit systems indicates that the expected ridership shrinkage would be 4.3% in response to such a fare increase (i.e., the average fare elasticity, peak and off-peak, is -0.43).[65] Under this regime, gross potential fare revenue is higher than without the fare increase but a further 4,280 to 5,032 boardings under the Low-Growth and Higher-Growth scenarios, respectively, would be diverted back to alternative transportation modes – notably the private automobile. Additional analysis of the probable fare elasticity on Advance Transit can be found in **Appendix E** .

[61] 55.6% of all AT fixed-route passengers surveyed in April 2005 said they'd use some form of automobile transportation to make their trip if the bus didn't exist.
[62] 60.9% of all AT fixed-route passengers surveyed in April 2005 said they were either Lebanon residents and/or were traveling to AT destinations within Lebanon or West Lebanon.
[63] Estimated **fare-paid** boardings multiplied by the estimated fare elasticity (4.3%), plus the lost boardings due to charging the original fare. In the case of the Higher Growth scenario, the calculation is 99,533 fare-paid boardings (from Table 11) times 0.043, plus 33,419.
[64] Ibid.
[65] Fare Elasticity and Its Application to Forecasting Transit Demand, loc. Cit.

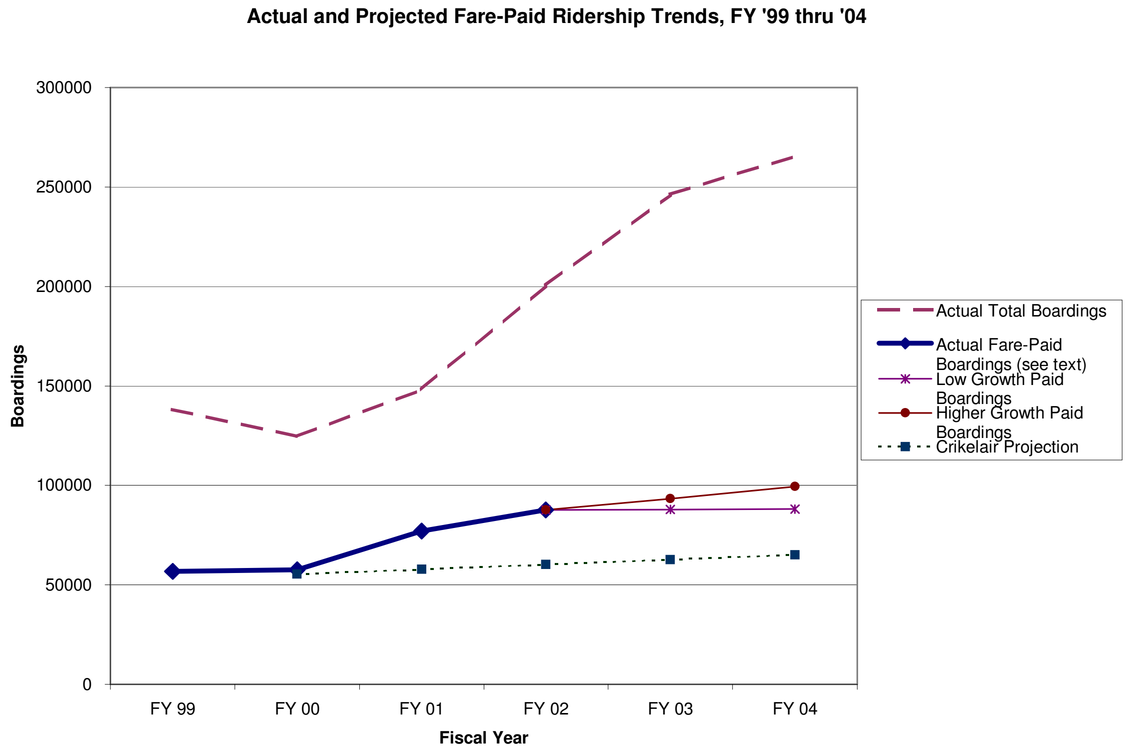

Figure 10. Actual and Projected Fare-Paid Ridership Trends vs. All Boardings

Two of the trendlines shown in the above graph deserve further mention. The "Actual Fare-Paid Boardings" trend line stops at FY '02 because AT became completely fare-free in January of that year. Moreover, the "fare paid" component of FY '04 boardings was projected on the basis of fare-paid ridership for the first six months of that fiscal year. The "Crikelair Projection" displays a forecast prepared by Tom Crikelair Associates in calendar 2000 that assumed a 15% aggregate growth in boardings through FY 2004 from FY 2000. At that time, the service improvements made shortly thereafter had not yet been implemented. It is included for comparison.

Figure 11 displays maximum gross potential fare revenue under ideal conditions assuming a return to the fare policy that existed prior to 2001 and then a 10% increase on top of that. Under that fare policy regime, AT reported that the average fare was $1.04. This accounted for cash fares, multi-ride tickets and monthly passes.

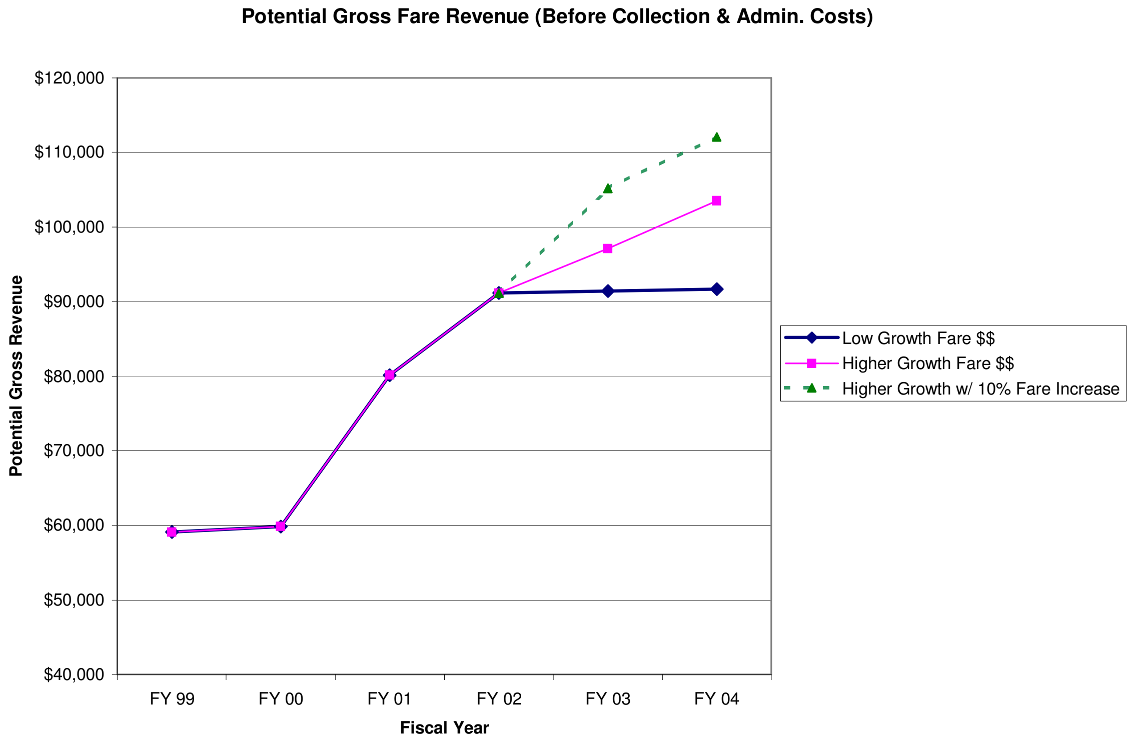

Figure 11. Gross Fare $$ Collection Potential Under Three Scenarios

Before deducting the cost of collecting, counting and depositing cash fares or any printing or other administrative or setup costs, the gross farebox recovery under the most optimistic scenario above would be about 8% of AT's FY 2005 operating budget for the fixed-route system[66]. Note that a 10% fare increase recovers more money for the transit operator even though it modestly reduces ridership and converts some existing bus passengers into automobile operators or passengers.

According to Advance Transit, fare collections costs and one-time administrative setup and printing costs detailed earlier will reduce gross receipts by up to $50,000 in the first year, and by a somewhat smaller amount in subsequent years assuming no change in the number of assigned buses and drivers. It is important to note that implementation of a fare would affect every bus driver operating a fixed-route bus, unless capital dollars are spent on equipment that will relieve the bus drivers of having to sell tickets. (See **Section 9.4** for more about automated equipment and costs.)

Also, we can't know at this time if institutions served by AT would attempt to reinstate a type of fare exemption system upon presentation of an ID or a pass, and what costs this might entail.

Finally, this subject has received some treatment in academia. In summary, the research

[66] $112,000 divided by AT's FY 2004 fixed-route operating budget of $1.4-million.

finds:

- [A] "fare-free policy will yield substantial gains in ridership", and

- "The experience with fare-free service in large urban areas has not been successful in terms of overall service quality."[67] This is because of "problem riders" who are not using the transit system for gainful transportation but instead as a pastime or even as temporary shelter.

According to Advance Transit, "problem riders" have not been a major issue so far.[68] Researchers[69] shed some light on this by noting that "the severity of problem riders may vary as a function of whether the system started fare-free or if the system converted". Where problem riders are or could be an issue, the same researchers write: "Even a minimum fare offers a barrier to problem riders that cause a deterioration in the service, image and comfort of a given transit system."[70]

5.4 Fares As A Demand Management Tool

Fares can also be a demand management tool. Amtrak and airlines, cruise operators and cargo carriers all employ fare or rate policy as a demand management tool. When excess capacity exists during off-peak times of day, seasons of the year or direction of movement, rates may be reduced. On the other hand, when a capacity shortage exists, rates rise until demand and supply balance.

Use of fares as a demand management tool has not been necessary on AT so far, because demand has been met with existing and some newer buses. The newer buses replaced older buses and AT still operates its fixed-route service with about 15 buses each weekday. If public policy is aimed at maximizing use of public transportation, presumably additional vehicles will be acquired and additional drivers will be hired to operate them. If, on the other hand, demand is either so great that chronic "standing room only" conditions exist at certain times on certain routes and there is no near-term prospect of capacity enhancement, then short-term management of the situation with a fare or fee might be appropriate. In general, this has not been the case on AT so far; however, this *was* a factor in considering a fee for the former Yellow Route service.

5.5 AT's Yellow Route: A Case Study

The history of Advance Transit's Yellow Route provides an interesting case study of the effects of fare free bus service. Upon receipt of a CMAQ grant via the State of Vermont, AT began operation of the Yellow Route in August 1996. Section 5311 (FTA) and matching funds from the Hartland School District supported the service upon expiration of CMAQ

[67] Conserving Energy and Preserving the Environment: The Role of Public Transportation, Robert J. Shapiro, Kevin A. Hassett and Frank Arnold, July 2002, p 10.
[68] Various conversations between AT management and UVTMA pursuant to this study.
[69] Perone and Volinski, loc. Cit.
[70] Ibid, p. 12.

grant funds after three years. According to AT, this funding structure remained in place for approximately five years.

The fixed-route service provided transportation from the town of Hartland, VT, north through Hartford to Norwich, then across the Connecticut River to Hanover and on to the DHMC medical center. The route had mixed ridership, with a large share of Hartland students traveling to Hartford High School. The route saw relatively stable ridership from year to year into 2003, with the exception of significantly reduced ridership in the summer months due to the large segment of the ridership that was made up of school students.

In 2002, Hartland School District discontinued its matching grants, yet an equivalent revenue source was maintained until mid-2004 because funding was supplied by an anonymous donor. In October *2003*, because of increasing costs and capacity constraints, AT instituted a subscription fee for riders traveling into and out of Hartland in the amounts of $25 for a 10-ride ticket or $50 for a monthly pass.

Figure 12 tracks Yellow Route ridership after the subscription fee program was implemented for passengers boarding the bus in both Hartland and outside of Hartland. Monthly boardings are calculated according to the absolute change from the average boardings in the two years prior to the fee program. **Table 15** shows ridership numbers and absolute and percent changes from the pre-fee baseline.

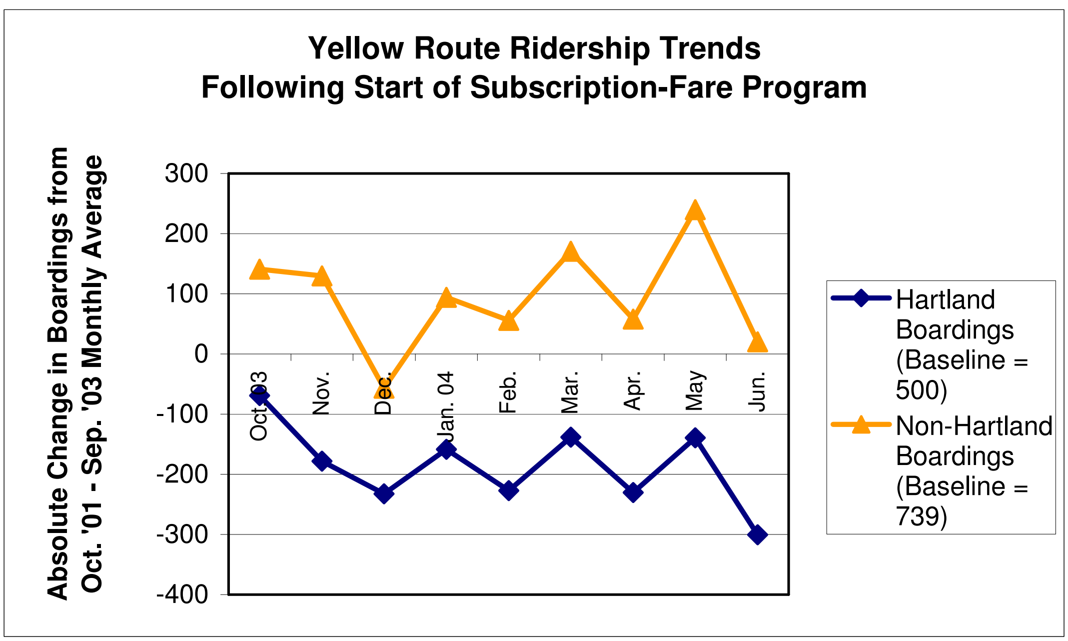

Figure 12. Yellow Route Ridership Trend After Subscription Fee Applied

Table 15 – Yellow Route Month-by-Month Ridership **Change Compared to Previous Monthly Average (Oct. 01 - Sept. 03)**						
	Hartland Boardings			Non-Hartland Boardings		
	Total Boardings	Absolute Change from Baseline	% Decline from Baseline	Total Boardings	Absolute Change from Baseline	% Change from Baseline
Average Monthly Boardings Oct '01 thru Sept. '03 = Baseline[71]	500	-----	-----	739	-----	-----
Oct. 03	431	-69	-14%	880	141	19%
Nov. 03	322	-178	-36%	869	130	18%
Dec. 03	268	-232	-46%	682	-57	-8%
Jan. 04	342	-158	-32%	833	94	13%
Feb. 04	273	-227	-45%	795	56	8%
Mar. 04	362	-138	-28%	910	171	23%
Apr. 04	270	-230	-46%	797	58	8%
May 04	361	-139	-28%	979	240	32%
Jun. 04	200	-300	-60%	759	20	3%

After the subscription fee program was implemented, ridership on the Yellow Route outside of Hartland remained at or above its previous average of 739. Boardings taking place within Hartland, however, dropped far below their previous monthly average of 500, never to regain their previous levels.

The Yellow Route was cancelled completely in July 2004 due to increasing bus operating costs and no municipal funding.

While there are important distinctions between this case of the Yellow Route and the larger AT system, including the limited geographic scope of the fare program and the unique demographics of the Yellow Route passenger population, this history does provide some insight into ridership changes following the imposition of a service-charge on a previously free bus system. In the case of the Yellow Route, previously steady ridership declined rapidly following the implementation of fares on a part of the route.

[71] See Appendix J for month-by-month boardings from 1998 to 2003.

6. Environmental Impacts

The following analysis pursues the use of accepted air quality modeling methods and assumptions including the EPA Mobile 6 model[72] to quantify the net air quality impact of the Advance Transit fixed-route system based on avoided automobile use offset by emissions from the buses themselves. The modeling results indicate a net air quality benefit attributed to the operation of the AT fixed route transit bus system.

For a detailed list of Assumptions, see **Appendix F**.

6.1. Modeling Results and Discussion

There is a trade-off between automobile emissions that are avoided because would-be automobile operators and passengers are riding the bus versus the emissions of the buses themselves. **Table 16** below presents EPA emissions data for one vehicle mile of travel for a passenger automobile (cars and light trucks combined) and diesel buses:

Table 16 – EPA Mobile-6 Emissions Assumptions for Autos and Buses
(all values are grams per vehicle mile)

	Hydrocarbons (HC)[73]	Carbon Monoxide (CO)	Oxides of Nitrogen (Nox)
Cars & Light Trucks	1.063	12.600	1.014
Diesel Bus	0.594	3.882	14.925

Diesel buses produce significantly more pollution per mile than passenger cars, but because a bus can carry many more passengers, a reduction in pollution frequently results with transit use. Current daily fixed route ridership on Advance Transit (AT) removes approximately 3,200 Vehicle Miles Traveled (VMT) from Upper Valley roads each day. This results in decreased traffic congestion, and removes an estimated net of 1,254 pounds of hydrocarbons and 17,742 pounds of carbon monoxide from our air each year. However, AT's diesel buses contribute more oxides of nitrogen (NOx) than they save: about 11,800 lbs more per year. Still, with new technologies and the advancement of particulate traps and ultra low sulfur diesel fuel, there is a potential to significantly lower AT's contribution of NOx in the near future.

Advance Transit's air quality benefits grow as ridership increases. The American Public Transit Association has researched the impacts of driving a car and has found that one person converting from driving to riding the bus for a period of one year reduces 130 lbs of emissions each year on average.

Table 17 on the following page displays the inputs and results of the analysis:

[72] For more information about the EPA Mobile 6 model, see http://www.epa.gov/ebtpages/airmobilesources.html.

[73] Sometimes described as Volatile Hydrocarbons.

Table 17 -- Air Quality Analysis Model Inputs and Results		
	STEP 1: VEHICLE MILES TRAVELED	
1	Total Ridership July '03 to June '04	278,704
2	Total Operating Days per fiscal year	254
3	Average Daily Ridership	1,097
4	Estimated Number of Passengers per Vehicle	1.1
5	Percentage of Passengers *not* using an Automobile	44%
6	Adjusted Average Daily Ridership	614
7	Average Trip Length (miles)	5.4
8	Vehicle Miles Traveled (VMT)per day	3,016
	STEP 2: PASSENGER VEHICLE EMISSIONS (LDGV)	
9	Average Speed on Routes (MPH)	35
10	Vehicle Emissions Factors HC	1.063
11	Vehicle Emissions Factors CO	12.600
12	Vehicle Emissions Factors Nox	1.014
	STEP 3: BUS EMISSIONS (HDDBT)	
13	Total Fixed Route Bus Miles Traveled	413,733
14	Bus Miles Traveled per day	1,629
15	Bus Emissions Factors HC	0.594
16	Bus Emissions Factors CO	3.882
17	Bus Emissions Factors Nox	14.925
	STEP 4: RECONCILE-GROSS/NET EMISSIONS (grams/day)	
18	Vehicle Emissions HC (grams/day)	3,207
19	Vehicle Emissions CO (grams/day)	38,007
20	Vehicle Emissions Nox (grams/day)	3,059
21	Bus Emissions HC (grams/day)	968
22	Bus Emissions CO (grams/day)	6,323
23	Bus Emissions Nox (grams/day)	24,311
24	Emissions Saved HC (gram/day)	2,239
25	Emissions Saved CO (gram/day)	31,684
26	Emissions Saved NOx (gram/day)	(21,252)
27	Emissions Saved HC (pounds/year)	**1,254**
28	Emissions Saved CO (pounds/year)	**17,742**
29	Emissions Saved NOx (pounds/year)	**(11,900)**
	Net pounds/year	**7,095**

	Net "U.S." tons/year	**3.5**

The results of the air quality analysis indicate that despite its small size, the AT bus system actually delivers air quality benefits. Moreover, each additional person who foregoes an automobile trip for the bus directly adds to this benefit. The downside is that emissions of oxides of nitrogen (NOx) increase because the diesel buses are in use. To put 3-1/2 tons of air pollutants into perspective, it is equivalent to the EPA standard car/light truck operated 219,278 miles.[74] Particulate matter, where relevant, is accounted-for in the Mobile-6 model as hydrocarbons.

Additional assumptions pursuant to the foregoing analysis using the EPA Mobile-6 model appear in **Appendix F**.

[74] UVLSRPC calculation from EPA data. See referenced EPA website.

7. Economic Value of Certain Impacts of AT Bus Service

The economic impacts of the Advance Transit bus service fall into three broad categories:

1. Directly quantifiable impacts, such as avoided automobile use;
2. Indirectly quantifiable impacts, such as reduced need for parking facilities;
3. Difficult-to-quantify impacts, such as time saved by having fewer and briefer traffic delays, or the economic impact of bus-dependent employment.

A key differentiator of each of these categories is the facility by which a dollar value can be attached to the associated impact. For example, the economic impact of a transit-dependent employment opportunity may be the avoided cost of public assistance payments (including unemployment benefits) that might otherwise be paid to the individual. However, we do not know if employed persons who depend on the bus to reach their workplace would otherwise be unemployed – or if they would be under-employed or would be fully employed elsewhere but at less attractive compensation. We can only assume that the bus affords a transit-dependent person access to an attractive employment opportunity that would otherwise be unavailable to him or her, and we can make a conservative estimate of the value of the annual gross earnings of this group.

Some impacts, such as air quality, can -- and have -- been quantified for the nation as a whole, but may be less meaningful at the local level. For example, in 1999, the use of public transportation nationally reduced NOx and VOC emissions (nitrogen oxides and volatile hydrocarbons, respectively) by nearly 100,000 metric tons, implicitly saving between $130-million and $200-million a year in mitigation costs.[75]

Table 18 displays the number of avoided automobile trips estimated for calendar 2004 based on AT's actual boardings and the April 2005 UVTMA survey results.

Table 18 -- Estimate of Avoided Auto Trips and Auto Mileage Based on AT Fixed-Route Boardings Per Year and Results of April 2005 UVTMA Survey
Calendar Year 2004

AT Boardings	Pct. Non-Transit-Dependent Riders	Non-Transit-Dependent Boardings	Avoided SOV Trips (32.3%)	Avoided Other Auto (27.1%)	Avoided Taxi (14.4%)	Total Avoided Auto Trips/Year
281,202	75.4%	212,026	68,484	57,459	30,532	**156,475**

Table 19, below, attaches a dollar value to the avoided private automobile mileage shown above by using the mileage rate the Internal Revenue Service allowed for business travel during calendar 2004: 37.5 cents per mile. This is considered to be an all-inclusive rate that accounts for out-of-pocket expenses such as fuel and supplies, plus insurance and depreciation:

[75] Conserving Energy and Preserving the Environment: The Role of Public Transportation, Shapiro, Hassett and Arnold, American Public Transportation Association, July, 2002, page 9.

Table 19 --"Cash" Value of Avoided Private Automobile Trips at 2004 Costs Calendar Year 2004					
Total Avoided Auto Trips/Year (from Table 15)	Avoided Private Auto Trips	Avg. Trip Distance	Avoided Miles	IRS Cost/Mile	After-Tax $ Saved per Year
156,475	125,944	5.4	680,096	$0.375	**$255,036**

The dollar value of avoided private automobile mileage that accrued to Advance Transit passengers last year was approximately one quarter of a million dollars. This equates to approximately **$347,220** in before-tax dollars for people in the 28% income tax bracket. The IRS mileage allowance for 2005 has been increased to 40.5 cents. Using the new rate, the figure just cited becomes **$375,000**.

Avoided taxi trips in 2004 numbered an estimated 28,838 to 30,532. Assuming a fare per trip of six dollars (noting that the average trip distance on AT is about 5.4 miles), this equates to an estimated **$173,028** to **$183,192**. The value of this benefit to people who have an income tax liability is, of course, even greater as shown for the private automobile savings. Moreover, it is reasonable to assume that local residents take taxis because they do not have a car.

We have made the assumption that the estimated 111 people who depend on Advance Transit to reach their workplace have taken the most desirable job available to them and that absent the bus, the employment opportunities available to this group would diminish. To put a value on this group's aggregate gross annual earnings, let us assume 100 people are paid $10 per hour and work an average of 25 hours per week, 48 weeks per year. These modest assumptions yield **$1.2-million** annually. Because it is unclear what employment opportunities would still be available absent the bus service, it is unclear how much the income of this group would diminish absent the bus but we assume that this group is taking the most attractive jobs available to them. A study of this question could be an interesting stand-alone scope-of-work. For the purposes of the present analysis we note based on the foregoing assumptions that the earnings of this transit-dependent group are important to the local economy and important to these individual persons and their dependents.

Avoided or deferred construction of parking facilities is a direct public benefit of Advance Transit. Two recent parking garage projects within AT's service territory cost $5-million (five years ago) and $10-million (in 2004), respectively. These two projects created 289 spaces and 540 spaces, respectively. Upcounting (escalating) the cost of the older project at 5% per year yields $6.358-million. Taking the total -- $16.348-million -- and converting it to an annuity at 6% (a 4% "real" interest rate plus 2% inflation) yields a levelized cost of **$96,255** or **$116** per space per year, assuming the structure has a useful life of 30 years. This does not include ongoing operation and maintenance costs.

If 125,944 private auto trips are avoided annually or 495 per day[76], this implies 495/2 = 247 to 248 automobiles. Since approximately 58% of trips on AT's fixed-route system are work-related, it can be assumed that a like percentage of these vehicles would be parked all day

[76] Divide 125,944 by 254 working days per year.

requiring 143 parking spaces at $116 per space per year or **$16,588** per year to pay for the levelized lifetime construction cost of these parking spaces before any O&M costs. This is just for work trips, where an auto is typically parked all day.

Unless parking facilities are constructed and operated as private ventures that return business tax revenues to the City, there is an opportunity cost to constructing parking facilities because the land would otherwise be put to a more productive (and tax generating) use. This is also why colleges and universities prefer to construct dormitories, laboratories, classrooms and athletic facilities instead of parking. (For more on parking issues and Transportation Demand Management (TDM) initiatives at Dartmouth College, see **Appendix G**.)

According to the EPA, it cost $1,300 to $2,000 per metric ton to reduce VOCs and NOx (volatile hydrocarbons and oxides of nitrogen) as of 1999[77]. The net impact of AT's diesel buses is to increase NOx emissions, because NOx emissions are more characteristic of diesel engines than gasoline engines found in most automobiles. This is especially true during the summertime, which the Mobile 6 air quality model assumes – i.e., a worst-case assumption. The AT bus service directly and materially reduces CO emissions because auto trips are converted to bus trips. However, we conclude there is presently no significant net dollar benefit associated with the air quality impacts of AT, even though CO is a poisonous gas and is measurably reduced as a direct impact of the bus service. Unfortunately, we were unable to confirm a precedent for aggregating the net impacts among all motor vehicle pollutant categories and then attaching a dollar value to the aggregated result. However, as shown in **Section 6**, the AT bus service does reduce the net mass (physical weight) of pollutant gases by a measurable amount.

In summary:

- The immediately quantifiable economic impacts of Advance Transit are equivalent to putting over **$530,400** back into the local economy by allowing local residents to either spend it or save it. This equates to $1.88 per boarding based on 281,202 boardings during calendar 2004. Thus, the net cost per boarding is actually reduced from $5.12 to $3.24. Intangible or difficult-to-quantify benefits reduce the net cost even further.

- In addition to the above-cited figure, employed persons who said they are dependent upon the bus to reach their workplace are probably earning at least **$1.2-million** in aggregate gross income. How much of this would have been earned by this group absent the bus is difficult or impossible to determine accurately, because we lack good information about the employment alternatives that might be available to them and how the this group would address their transportation needs absent the bus.

We have not estimated anything for the value and quality-of-life the bus system brings to people who can't or shouldn't drive. For example, senior citizens who can enjoy living in the least restrictive setting their health permits are generally better able to care for themselves, deplete

[77] Conserving Energy and Preserving the Environment: The Role of Public Transportation, Robert J. Shapiro, Kevin A. Hassett and Frank Arnold, July 2002, loc. sit.

their assets more slowly and are happier. All of these factors tend to reduce or defer their need for public and/or other third-party assistance.

8. Issues and Trade-Offs of Potential Service Expansions and Adjustments

Any potential future service adjustments need to be considered with the objective of improving service for the broadest possible sector of the local population and to increasing total ridership numbers while containing operating costs. This section presents information about AT's existing plans and about AT's former (discontinued) Saturday service. It is the considered view of the authors and the Working Group that supported this effort that a detailed analysis of potential future expansion opportunities is beyond the scope of this study. It may be appropriate to develop a Scope of Work for such an analysis as a separate project. AT, for its part, conducts internal studies of its existing operation as well as strategic opportunities on an ongoing basis.

- The over-arching theme of this section is that every choice concerning service expansion (more hours, improved frequencies, new or expanded routes, Saturday service, etc.) costs money on an ongoing basis, and each decision has an opportunity cost vis-à-vis another potentially deserving service improvement that must then be deferred.

- Advance Transit plans to add a second bus on the Red Route in 2006, and notes that identification of this need goes back to 2000. This provides a context for understanding the lead times that may ensue from long-range planning to actual implementation.

According to AT, there is nothing preventing it from adding evening and weekend services except money -- but this in itself is a valid argument for not otherwise proceeding. The exact costs of service expansions depend on the configuration and hours of operation of the service, the quantity and type of equipment needed, etc.. On average, costs per service hour for FY 2006 are anticipated to be around $60. For the sake of this discussion, we will use this number.[78]

Right now, Advance Transit is focused on improving service on its existing fixed routes and within existing service delivery hours. With the rising cost of all transportation services, and an existing commitment to improve Red Route service frequency (more on this on following pages), it is unlikely that AT will be in a position to further extend its other services in the immediate future. The company believes that it needs to remain focused on supporting established services for long term success.

Public transit services are heavily dependent upon Federal transit funding. Therefore, the future of Federal transportation policy will have direct bearing on AT's ability to further expand. If Federal funding becomes available for expanded services, it will be important for AT to extend its planning efforts to objectively determine its service expansion priorities. Even if Federal funding does increase, it does not necessarily follow that additional state and municipal matching funds will be forthcoming. Some limited public transit service expansion might occur anyway if local sponsors see it as a cost-effective way to meet their growing transportation and parking needs, but this cannot be determined with certainty.

[78] Memo from Advance Transit to UVTMA, May 11, 2005.

8.1 AT's Existing Proposed Operating Plan Enhancements

In the Short Range Transit Plan completed in 2000 by Tom Crikelair Associates, a number of significant service improvements were identified and many were subsequently implemented in September 2000. The fixed routes and schedules currently operated by Advance Transit are virtually the same as identified in that plan.

Among the long-term service improvement strategies recommended in that study is the addition of a second bus on the Red Route. The Red Route connects the downtowns of Lebanon and West Lebanon with the plazas, Mechanic Street and the Miracle Mile. One bus provides hourly service throughout the day. With a second bus on the Red Route, connections will be greatly improved with other routes and additional capacity will be added. This is important since the Red is AT's fastest growing route, averaging 24 passenger boardings per hour.

In 2003, AT applied for federal Congestion Mitigation and Air Quality (CMAQ) funds through the New Hampshire Department of Transportation (NHDOT) to help fund this service improvement strategy. As the name of the program implies, CMAQ funds are intended for transportation projects that provide congestion mitigation and/or air quality impacts. The vast majority of these funds are used in areas that are determined to be not in attainment[79] under standards established by the Clean Air Act. In 2003, NHDOT announced that it would accept applications from other areas of the state and that it intended to award a small portion of the funds to areas considered to be in attainment. Advance Transit's application was chosen for funding by the State's selection committee.

An additional justification for the project is that improved transit service will help to relieve traffic in the Route 12A area during the two construction seasons that the Exit 20 project will span. Furthermore, it will mitigate the detrimental impacts on the existing schedule that traffic delays could cause.

- Implementation of the second bus on the Red Route is anticipated for summer or fall of 2006.

The planned service frequency improvement for the Red Route illustrates how CMAQ funding works and its implications: CMAQ funds will cover 80% of the cost of the service expansion for up to three years. If service is to continue after that time period, other sources of revenue will need to be secured. Advance Transit will need to work diligently to secure a significant amount of money to continue this service. The annual cost of the second Red Route bus is expected to reach $200,000 when the 3-year CMAQ funding runs out. In the meantime, even while the CMAQ grant continues, Advance Transit will be required to provide $120,000 in additional matching funds for the three year operating grant while it continues to operate the existing system.

[79] Areas deemed not in attainment with EPA air quality standards are eligible for mitigation resources from the Federal Government for qualifying projects and programs.

8.2 Other Adjustments, Enhancements or Expansions to Weekday Fixed Route Services

AT frequently receives requests and inquiries for a variety of changes to its service. Many requests are for the addition of specific stops in order to better meet individual needs. Others are for adjustments to service timings to better meet individuals' schedules. Additionally, there are requests for additional routes, expansion of the service zone and extension of service hours.

Although it is true that many existing AT riders have suggested service hours and days be extended, it is not clear how many additional riders would be attracted. Certainly the incremental cost per passenger for off-peak service will be much higher.

8.2.1 Extending AT Service Hours

Given numerous comments from existing AT riders, extending AT service hours later into the weekday evening would be an attractive service expansion from the point of view of the public. Pragmatically, however, it would need to be designed strategically in order to capture enough additional riders to make it viable. Some routes are better candidates than others for potential service hours expansion. For example, 12-hour shift workers at DHMC can't presently use the bus for a round trip to work because the bus service isn't operating early or late enough.

Using existing route configurations and service frequencies, extending service on all routes by one hour would add seven hours per day. Given 254 service days per year the estimated additional annual cost would be $106,680.[80] One can multiply hours and routes and see how the costs multiply for expanded service hours and how they compare to the cost of other service opportunities.

In the 2004 Crikelair Study, riders were asked "What do you like about Advance Transit bus service? What can we do to improve the service?" 35 of 347 survey respondents requested longer evening operating hours. This was the second most popular service request, eclipsed only by requests for renewed service on Saturday.

One specific example of an identifiable pool of potential transit bus users who presently can't use the service is 12-hour shift workers at DHMC. According to DHMC, this group is dominated by nurses.[81] DHMC reports that its 12-hour shift employees generally work three times a week. **Table 20** provides a breakdown of daytime 12-hour shift employees at DHMC:

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[80] Ibid.

[81] Source: "Zip Code Counts for DHMC Lebanon and Immediate Area" dated April 4, 2005, furnished by DHMC.

Table 20 -- Potential DHMC Market for Extended AT Weekday Service Hours (number of employees)	
Employees Working 12-hour Daytime Shifts, by Town or City of Residence	
All Advance Transit-served Towns	**167**
<u>Blue Route Towns</u>	
Canaan	22
Enfield and Enfield Center	31
Hanover	19
Lebanon	47
Sub-Total	**119**
Incremental Regional Market	**150**
Total Potential Market (sum of 167+150)	317

The above table shows that 167 people who live within the six municipalities served by AT's fixed-route buses work a daytime 12-hour shift at DHMC. Of them, 119 live in towns served by the Blue Route. Assuming they work three times each week, these 119 people represent a potential of 714 weekly boardings, or 34,272 annual boardings, assuming 48 workweeks per year.

- The real question is how many of these 119 people would actually take the bus. If one assumes a 4% market penetration, which seems reasonable for the mobile population at large, that's only 5 more individual persons. But if one proposes that people who work at DHMC – an 'anchor' destination on the Blue Route -- and live in Canaan, Enfield, Hanover or Lebanon are more likely to take the bus than the mobile population at large, the market penetration might be higher.

So far, these data support no conclusions or recommendations. However, these types of potential opportunities that appear to be a "fit" with existing AT routes and services may merit more study as a separate project.

8.2.2 Extending the Geographic Service Area

AT has received numerous requests to expand its route coverage beyond the existing service area. Claremont, Plainfield, Grantham, and Lyme are some of the areas most often suggested for new commuter routes.[82]

[82] Sources: Advance Transit Memo to UVTMA dated May 11, 2005;unsolcited comments received by UVTMA verbally and via e-mail; Upper Valley Housing Coalition, loc. Cit.

An important territory not presently served by AT or any other fixed-route carrier operating into Lebanon is the Plainfield-Windsor-Cornish-Claremont corridor arrayed along US 5, Route 120 and 12A. This four-town area houses an additional 727 full-time employed persons who work for central Upper Valley employers[83], according to the *Upper Valley Housing Coalition Commuter Survey*. Again assuming a market penetration of 4% (hence 29 customers) and 3 round-trips per week, this represents 8,375 annual boardings – or about 3% of all fixed-route boardings on AT in 2004.

According to the above-cited survey, the Town of Grantham -- including the Eastman community -- houses 301 surveyed full-time employees who work in the Lebanon area. A Park and Ride facility at Exit 13 on I-89 is scheduled for construction during the summer of 2005. This potential emerging market is not presently served by AT or any other regional transit bus carrier.

- The foregoing illustrates an important observation: The same survey, cited earlier in this document, indicates that one-in-four people who work in Lebanon lives in Lebanon. The "core" of the region is highly concentrated and this is a reason for AT's success so far. Therefore, it is axiomatic that if transit services expand to outlying areas, there will be diminishing demand for the service – at least in the near term. If extending AT bus service a significant distance to the south captures only 3% more boardings, this is not by itself a compelling argument for near-term action.

Figure 13 displays existing Advance Transit bus stops as well as a representation of Upper Valley population concentrations.[84] The map provides a sense of which towns and specific areas in the region are well-served by the AT bus system, as well as areas that might emerge as worthwhile service expansion opportunities as part of Advance Transit's long-term growth objectives.

[83] According to the Upper Valley Housing Coalition, which conducted the survey, the "central Upper Valley" employers were not confined to Lebanon, Hanover and Hartford but are located throughout the Upper Valley area.
[84] Population data was obtained from ESRI Census 2000 Tiger data, and is represented by 1 dot equal to 1 person. Dots do not represent the precise location of individuals' homes, but rather are displayed as a scattered distribution within individual census blocks, so that population data should be considered an approximate representation of concentrated residential areas.

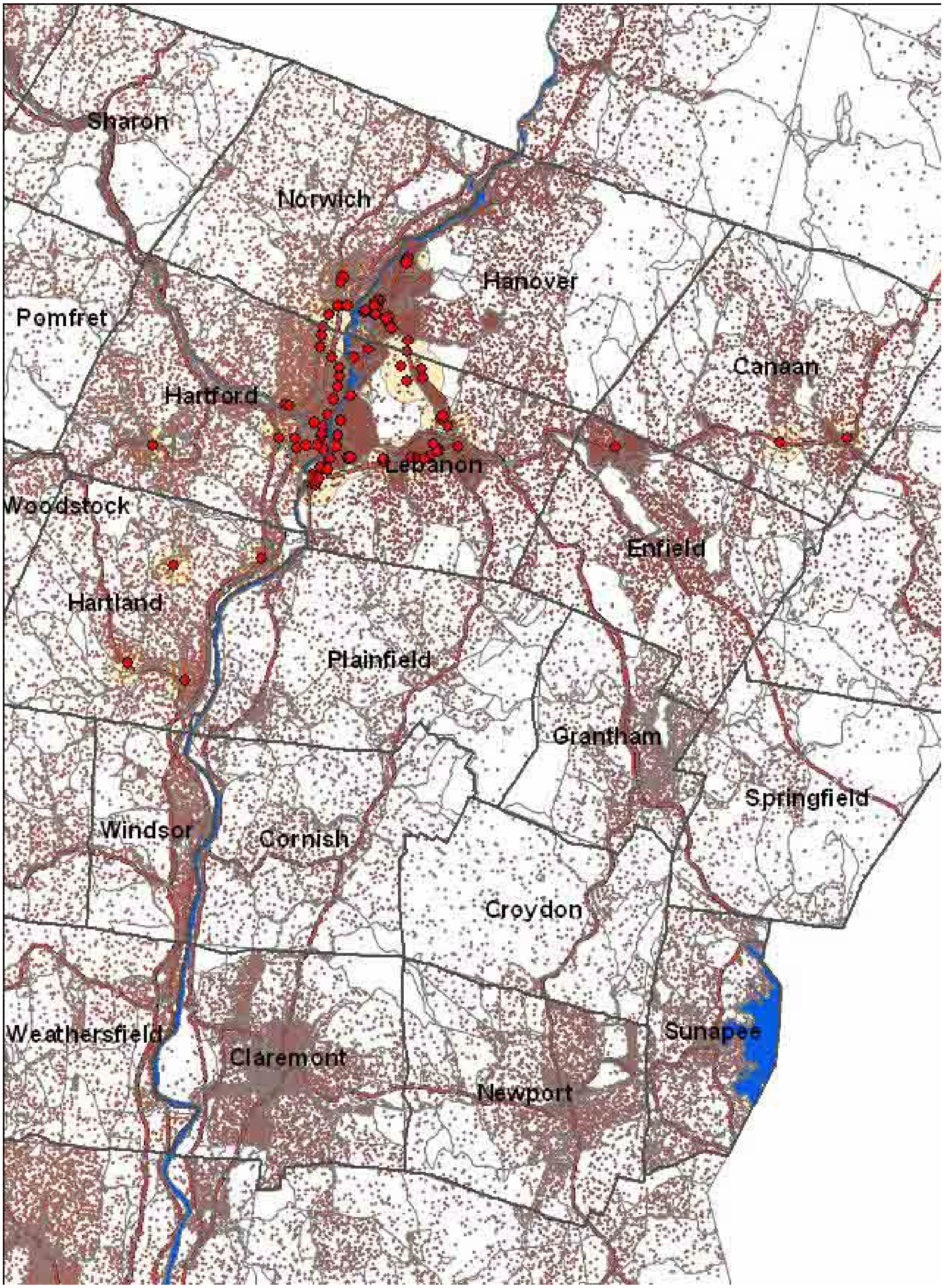

Figure 13. Map of Existing AT Bus Stops vs. Regional Population Density

Bus stops are approximated and are encircled by 1 kilometer buffers in order to roughly capture the area from which a person could be reasonably expected to walk to the stop[85]. As the availability of on-demand "flag" stops along Route 4 of the Blue Route is not represented on this map, Canaan and Enfield are better served than the map suggests. The map displays stops in Hartland previously served by the Yellow Route, but those stops no longer exist.

Currently, other public transit bus systems provide transportation services to some of the area's outlying towns and there are important linkages between these systems and Advance Transit. We know from survey results that a small share (about 9%) of AT riders come to the system from towns outside the service area. Some of these riders probably transfer to AT buses from these other services. Coordination with and among these other public transit providers – through marketing, location of transfer stops, and other means – helps improve everyone's boardings even without adding new services.

8.3 Saturday Service

Advance Transit does not currently operate any bus service on weekends. AT estimates that, if it were to operate its existing routes and frequencies for ten service hours on Saturdays, the annual cost would be $218,400.[86]

In the 2004 Crikelair Study, 61 of 347 survey respondents indicated that they would benefit from the availability of bus service on weekends. A large share of these comments specifically asked for service on Saturday and many indicated that they would appreciate even limited service that did not operate as frequently or extensively as weekday service. How frequently these passengers would utilize Saturday service was not determined and, as there would likely be a smaller share of commuting and a larger share of trips for shopping and personal reasons, it is difficult to predict.

Advance Transit operated a limited Saturday bus service until September 2000. The service was characterized by low ridership. **Figure 14** displays average daily ridership on AT compared to average Saturday ridership for the two years prior to cancellation of Saturday service. Daily boardings are computed according to monthly boardings divided by 24 operating days per month.

[85] Methodology was for academic study and is not necessarily consistent with transit industry practices.
[86] Source: Advance Transit memo to UVTMA of May 11, 2005.

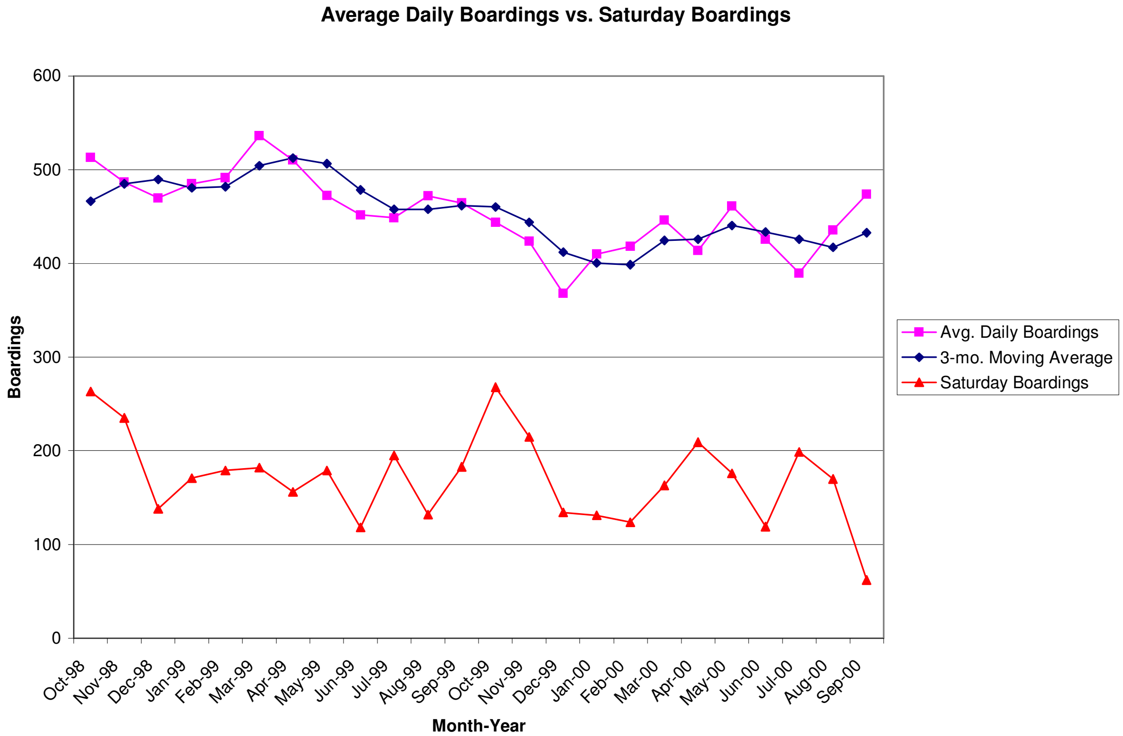

Figure 14. Average Daily Boardings vs. Saturday Boardings, Oct. 1999 - Sept. 2000

As already mentioned, prior to 2000 the growth in boardings was weak. AT management made the decision to enact significant system-wide service changes in order to reverse this trend. Because Saturday ridership was significantly lower than weekday ridership and weak by any reasonable standard -- averaging around three passenger trips per hour – AT management concluded that those resources would be more productive if used to improve weekday service. Therefore, Saturday service was discontinued.[87] The savings resulting from this decision were reallocated to improving weekday service through increased service frequency and scheduling improvements. The service changes implemented in 2000 were followed by a period of high growth in total system ridership commencing in 2001.

Any future Saturday service should be designed to maximize ridership and consider the utilization of at least two buses in order to provide reasonable scheduled headways. Consideration might be given to operating a route design that differs from any of the existing weekday service and by attempting to address opportunities to serve people who are working Saturday shifts at some of the region's larger employers. The 2004 Crikelair Study has already provided AT management with a possible service concept for potential future Saturday service, so any additional speculation here would be inappropriate or redundant.

[87] E-mail from Van Chesnut dated April 26, 2005.

8.4 Demand Response Services

AT may want to consider adding services other than fixed-route. On-demand paratransit services using smaller lift-equipped buses can be used to increase mobility for persons with disabilities. Such services are expensive to operate, particularly on a per-passenger basis, given typical capacity for this service type is around three passenger trips per vehicle per hour. Such services require a more intensive dispatch support as well.

Currently, agencies such as Grafton County Senior Citizens Council and United Developmental Services provide some of these services to certain populations in the Upper Valley.

All Advance Transit buses are equipped with lifts or ramps.[88]

[88] Source: Advance Transit.

9. Issues of Potential Alternative Sources of Supplemental Funding

UVTMA's modest research into the subject of alternative (non-traditional) sources of transit funding has revealed that other rural bus system managements have either considered or have implemented novel means of soliciting money to help defray increasing operating expenses. Or, sometimes, funds are solicited to provide services that have very low boardings per hour or per mile but are demanded by certain segments of the public. Other innovative approaches involve partnering with employers, who either provide direct cash infusion or offer transit passes to employees at a subsidized price. This can be either via payroll deduction (pre-tax or after-tax), or by direct cash payments. Advertising or sponsorships is another possible mechanism.

Rare is the case, for example the seasonal *Island Explorer* at Acadia National Park in Maine, where a single sponsor steps forward to subsidize most or all of the operating expenses of the service. More typically, alternative revenue sources generate modest amounts of supplemental income. There may be certain tax consequences to non-profit corporations that are beyond the scope of this study, and certain costs of administering such programs. Finally, transit operators must comply with requirements and stipulations on the use of Federal and state funds. This level of detail is beyond the scope of this study.

A brief overview of some of the above-mentioned possible methods of developing supplemental revenue sources is presented in the following subsections.

9.1 Voluntary Fares

One option for raising additional revenue for Advance Transit is to institute a means for riders to contribute funds on a voluntary basis. While voluntary contributions cannot be expected to provide a large enough source of revenue to significantly offset the need for other revenue streams, they could help offset rising operating costs. One component of a voluntary fare program would allow riders to pay something at their discretion anytime they ride the bus, and the amount would be at their sole discretion.

Such a voluntary fare program was recently instituted on the buses of Addison County Transit Resources (ACTR) of the Middlebury region of Vermont. ACTR, a significantly smaller public transit system than AT (about 34,000 boardings vs. AT's 2004 boardings of over 280,000), has collected approximately $3,000 per year through its voluntary fare program.

A voluntary fare program has a number of important drawbacks. There are significant operating costs to an on-board voluntary fare program, including the installation of safe and secure fare boxes on all AT buses. A system of processing and accounting would have to be developed and implemented. It is at least questionable whether contributions made on the bus would be eligible as tax-deductible donations because the donor is directly receiving a service by riding the bus.

Because of concerns about service quality if the boarding process were to be slowed down by the process of collecting voluntary fares on the bus, AT has determined that it will not collect cash or checks on board its buses at this time.[89]

Based on the UVTMA's April 2005 survey, 47% of active Advance Transit passengers said they would participate in a voluntary contribution program. 12% said they would *not* participate, and 39% responded that they are "not sure (or) don't know." The remaining 2% either did not answer or gave an ambiguous response.[90]

9.2 Tax-Advantaged Incentive Programs

Some employers and institutions subsidize transit passes on a pre-tax or after-tax basis, or both, to encourage employees to use public transportation. For example, at a recent Association for Commuter Transportation conference in Boston[91], representatives of Harvard University described their commuter incentive program that includes direct website-based marketing of MBTA passes at reduced rates. Moreover, Harvard representatives indicated that parking is at or near capacity, so the University has a strong incentive to divert auto trips to public transit and other modes. For example, the University also has a program that encourages use of bicycles by making them available for local transportation and by constructing roofed bicycle racks. Harvard's campus in Cambridge, Massachusetts is served by multiple MBTA bus routes and by rapid transit (Red Line) and is hemmed-in by developed University and third-party properties and the Charles River.

A detailed review of tax-advantaged employer incentive programs is beyond the scope of this study.

9.3 Private-Sector Contributions

As outlined in **Section 2**, Advance Transit is a not-for-profit organization operating under Section 501(c)(3) of the Internal Revenue Service Code. As such, AT could accept tax deductible contributions from individuals, corporations and other organizations. AT's tax Board of Directors has made a strategic decision to plan for and implement a comprehensive philanthropy program which may, over time, provide a portion of the resources AT needs in order to maintain and potentially expand fixed-route services.[92]

According to AT, its philanthropy program will utilize several fundraising tactics as described below:

- On-board voluntary contribution opportunities will allow riders to pick up brochures describing the program. The brochures will include a self-mailer with suggested contribution levels for riders to make their contributions at any time. AT believes this

[89] Advance Transit e-mail May 16, 2005
[90] Interpretation of these results must be made with caution - responses to questions asking about a hypothetical situation carry an additional margin of uncertainty.
[91] April 12, 2005, World Trade Center, Boston MA.
[92] Advance Transit Memo to UVTMA dated May 16, 2005.

low-cost procedure will be easy to administer, and will not impede efficient rider flow on and off the bus. Implementation of this program is imminent.

- Sponsorships will be sought from corporations and foundations to help underwrite the cost of the philanthropy program as well as to support attractive components of AT's services. Sponsors will be appropriately recognized on buses and on brochures, schedules and other materials. An active effort to secure charitable sponsors has begun. (See **Section 9.5** for more about advertising and sponsorship programs.)

- Comprehensive Direct Mail Appeals: A program of multiple, personalized direct mail appeals is in the planning stages and will be used to attract numerous contributions and to build a solid base of donor support.

- Major gifts – A process of identifying and cultivating donor prospects will be undertaken for special personal solicitation to support specific AT needs.

- Capital Campaigns will be considered in the future to support significant capital needs.

A successful AT philanthropy program could, over time, serve to offset some of the effects of rising operating costs, and free up unrestricted funds to be used where most needed.[93] At this juncture, the program appears to be just getting underway and it would be inappropriate for this study to speculate on its impact.

9.4 Consideration of Formulas for Allocating City and Town Subsidy Contributions

Public transit systems that receive Federal funding are required to fund a portion of their costs from local sources. This is usually described as the "local match". Approaches to allocating all or part of the local match among communities served must address two key issues: (1) What share of total costs shall be supported by municipalities, and (2) how to allocate this share among municipalities.[94]

The Federal Transit Administration (FTA) "Section 5311" subsidy program is a key mechanism of financial support for rural transit services. The match for this money comes from the state and local level, including municipalities – hence the term "local match". According to a review published in 2001, "eighty-one percent of FTA Section 5311 transit providers reported receiving some level of state or local transit funding [in 2000], accounting for 44 percent of their average operating budget."[95] Due to the variety of rural transit

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[93] Ibid.

[94] A detailed discussion of Federal "local match" requirements is not included here and would be redundant to readily available public materials. A minimum local match of 20% of administrative costs and 50% of operating expenses is typically required. Recipients of Federal funds for public transit *must* comply with Federal regulations for local matching funds. The reader is referred to appropriate sections of the Federal Transit Administration (FTA) website or that of the Community Transportation Association of America (www.ctaa.org) for more information on FTA "Section 5311" and other Federal transit funding programs and requirements.

[95] Status of Rural Public Transportation – 2000, prepared for the Federal Transit Administration by the Community Transportation Association of America, April 2001, http://www.ctaa.org/ntrc/rtap/pubs/status2000/

management models – including both private nonprofit and public agencies – no established standard exists for allocating local funding, except what is required by the Federal government. The share of total revenue provided from local sources varies from agency to agency according to the specific nature and circumstances of each. The same 2000 study of 142 rural transit providers[96] determined that, *on average*, local funds account for 21% of those agencies' total operating revenue. However, the range was 2% to as much as 25%.[97] The study included public agencies as well as nonprofit operators and included a category labeled "Other Revenues" that ranged from 10% to 22% of total funding. Moreover, the study found that nonprofit carriers as a group were deriving 27% of operating revenues from Human Services Programs (e.g., Medicaid). The latter does not describe Advance Transit, which does not operate on-demand services.

Total municipal contributions to Advance Transit are 8.6% of AT's overall FY2005 budget.[98] Subtracting the cost of shuttle services paid for by DHMC and Dartmouth College, this represents 13% of the costs of the fixed-route system. In this respect, AT's funding structure is not typical of rural nonprofit transit operators generally, nor is it typical of public agency operators. For example, the above-cited study showed that public agencies tend to rely heavily on farebox revenue (20% of funding).[99] We note, however, that AT's reliance on local funding is well within the percentage range identified by the cited FTA study completed in 2001.

In allocating funding shares among municipalities, transit systems employ a variety of approaches. These range from unsystematic allocations to adherence to strict formulas. Rural bus systems frequently do not use strict formulas, but rather work with each town they serve to reach an equitable share of funding from each.

For example, one popular approach is to allocate local funding contributions (or "match") according to the population base of each town. This is typically measured by the population of each town relative to the total population of all towns -- a straightforward approach, with population figures available from the U.S. Census. But there can be problems with allocating funding by population, including the potential for large discrepancies in the actual availability of service in each town. This problem could be addressed by counting residents living within some specified distance of routes, though this approach proves exceedingly hard to calculate and may be costly to keep up-to-date by uniform methods and procedures.

Accounting for the relative presence of transit service in each town and could be more easily measured by route mileage, service hours, and number of bus stops. However, these measures only reflect the opportunities for using the service and not the actual utilization of the service.

[96] Ibid.
[97] Ibid.
[98] This is in line with the findings of the Status of Rural Public Transportation document cited above for the year 2000. It found that for private nonprofit operators, "state and local government spending accounted for only 7 percent of their operating budgets…".
[99] Ibid.

Benefits from the service is the most appealing approach because it considers the actual return a municipality receives for its funding. It can be difficult to determine *all* benefits, and how the benefits of the service should be allocated. (Air pollution mitigation, for example, is difficult to allocate locally by an objective standard, if only because "downwind" municipalities might perceive less benefit than "upwind" municipalities.)

However, ridership is by far the most important measure of benefit. People must use the service to accrue benefits. Ridership is also closely related to congestion relief, and economic impact to the local employment and residential tax base. The question becomes: how do we allocate the benefits of transit ridership to each town?

Residency of riders is one measure and provides a clean breakdown of where the system's riders live and pay taxes. It does not, however, account for the benefits that accrue to towns when nonresidents travel in for shopping and employment purposes. Trip destination accounts for these economic returns. However, data for both residency and trip destination can be difficult to gather, requiring frequent ridership surveys to gauge year-to-year changes in the use of the service or a more sophisticated method of collecting this information. For example, in 2003 Concord Area Transit (Concord, New Hampshire) received a quotation of nearly $58,000 for a magnetic card-swipe stored fare collection system that could be capable of tracking boardings, trip destination and the like. This figure does not include CAT staff time that would be needed to monitor the system and maintain, store and retrieve data and reports.[100]

The following paragraphs conclude this section by presenting some metrics for Advance Transit that show to what extent service is offered and utilized within each municipality. The last part of this section describes different methods of local funding allocation: one is for the largest nearby transit system (the Massachusetts Bay Transportation Authority); others are for smaller "regional transit authorities" in Massachusetts, New Hampshire and Vermont.

For Advance Transit, numbers of boardings[101] in each town are readily available because this information is collected by each bus driver and is reported daily. However, boardings figures by themselves do not present a complete picture because a passenger who transfers to another AT bus is counted again by the second bus driver. Surveys indicate that 14% of AT's passengers make such a transfer. Transfers within the AT fixed-route system take place at two locations within the City of Lebanon and at one location in Hanover. (See **Appendix C** for more information.) Also, nonresidents can and do enter the AT system after traveling to a served town via other transportation modes, including Park and Ride (P&R) lots, "kiss and ride" and connecting transit buses operated by others. Therefore, it is helpful to examine different types of ridership metrics. **Table 21** below, shows some of these metrics. Requests for local matching funds from municipalities pursuant to AT's FY 2005 budget cycle were based on "Boardings Within Municipality" shown in the middle of the Table.

[100] Telecon Concord Area Transit, June 22, 2005.
[101] The reader is reminded that a Boarding is defined as a passenger entering a bus. If the passenger transfers to a second AT bus to complete his or her trip, that event is counted as another Boarding.

Table 21 - Boarding & Service Metrics in the Six Municipalities with AT Service						
Municipality	Number of Routes	Boardings by Residents (1)	Boardings within Municipality (2)	Boardings by Destination (1)	Percentage of Bus Stops (3)	Percent of Fixed Route Miles (2)
Lebanon	4	44.2%	52.9%	59.9%	40.8%	45.9%
Hanover	4	18.8%	27.0%	32.0%	17.1%	22.1%
Hartford	2	17.7%	13.4%	5.1%	30.3%	15.1%
Enfield	1	8.2%	1.5%	0.4%	3.3%	2.8%
Canaan	1	7.3%	2.6%	1.8%	1.3%	5.1%
Norwich	2	3.8%	2.7%	0.8%	7.2%	9.0%
		100.0%	100.1%	100.0%	100.0%	100.0%
Note (1): UVTMA Survey, April 2005						
Note (2): Source: Advance Transit. Route Miles metric is based on projected miles FY 2005.						
Note (3): 152 bus stops on AT fixed routes per AT boarding records.						

The data above show that Lebanon generates, and benefits from, about half the ridership on AT's fixed-route buses and enjoys roughly half of the service delivery and infrastructure as measured by route miles within its borders. Also, it is directly served by four of AT's five fixed routes. Lebanon is a destination for 60% of passengers surveyed in April, 2005. This reflects more intensive use of AT than a boardings, route-miles or number-of-bus-stops basis, due to the high housing density found in Lebanon compared to the other served municipalities and the fact that Lebanon is the largest employment center in the region. Hanover, with its strong population growth and the presence of Dartmouth College, is second behind the City of Lebanon in all categories shown above except the number of bus stops. Hartford is second in bus stops due to its relatively large area and the fact that its villages (White River Junction, Wilder) constitute activity centers.

Two examples of formulas used by other transit agencies provide some insight into how formulas can be applied. The Massachusetts Bay Transportation Authority (MBTA), serving the Boston metropolitan area, uses a long established formula for allocating municipal contributions. Massachusetts General Law (MGL) Chapter 161A, Section 9 establishes a fixed amount which total municipal contributions must equal, with that amount indexed to inflation. The 64 towns and cities served by the MBTA system are then assessed a share of this total according to a weighting formula based roughly on the relative populations of the cities and towns. Very minor adjustments are made according to other factors, including whether paratransit service is provided to a town.

MGL Chapter 161B, Sections 9 and 9A, govern the allocation of costs to the cities and towns in Regional Transit Authorities (RTAs) outside of the MBTA district. Some important departures from the MBTA allocation formula include bus mileage within a municipality, the fully allocated cost of service of the bus miles, and the number of riders resident in the town. Some Massachusetts RTAs operate in large Massachusetts cities such as Worcester and Springfield.

There are several important differences between the MBTA and AT and between Massachusetts RTAs and Advance Transit. These include the fact that AT, unlike the MBTA, is not a state agency, and the drastically different nature of AT's service provision. The distinctions make both of the foregoing Massachusetts approaches inappropriate for AT, although the metrics set forth by Chapter 161B come closer to the Advance Transit case than the mechanism for funding the MBTA – a major metropolitan public transit agency. They also provide examples of formal systems in a neighboring state that has a very long history of public transit service.

Green Mountain Transit Agency (GMTA), operating fixed-route service within six municipalities including Montpelier, recently instituted a new approach to soliciting municipal contributions. As a starting point, the transit agency determined that it needed 10% of total operating costs to be covered by municipal contributions. The share provided by each town was determined according to four indicators of based on population: town population, disabled population, elderly population, and population below the poverty line. The influence of total population on municipal contribution share was weighted at 50%. The other three variables composed the remaining 50%, with each given equal weight. Green Mountain has found towns to be receptive to this approach, allowing total municipal contributions to rise from $49,000 in FY05 to $90,000 in FY06. Formerly, each town's contribution was determined through a subjective assignment of amounts, contingent on approval by the towns

A potential pitfall of this approach, we believe, is that the metrics employed to support the allocation of local contributions must be kept up-to-date. Another Transit provider using similar metrics, the Cooperative Alliance for Seacoast Transportation (COAST), operating in the Portsmouth, New Hampshire area, utilizes the services of two Regional Planning Commissions (RPCs) to maintain metrics that are used to determine municipal funding:

> 25% based on population within ½ mile of a bus route;
> 25% based on employment within ½ mile of a bus route;
> 25% based on service miles in each municipality;
> 25% based on ridership in each municipality.

These metrics are updated annually. Eleven towns contribute a total of $340,000 toward a budget of $2.1-million.

In summary, a number of different methodologies are utilized for allocating fiscal responsibilities to municipalities for public transit. Each provider has unique circumstances that make specific, tailored approaches appropriate and even necessary, especially with rural systems like AT. However, it is beyond the scope of this study to identify and recommend a specific approach to the allocation of local funding for Advance Transit.

9.5 Advertising and Sponsorship

Advertising is a potentially untapped revenue stream for Advance Transit. However, for tax purposes there is an important difference between "advertising" and "sponsorship" since AT is a not-for-profit corporation. Advertising revenue may be deemed "unrelated business income" and taxed accordingly, whereas sponsorship revenue is treated differently and thus is likely to be more advantageous to AT. While unlikely to provide a large enough stream of income to offset the need for any of its existing income sources, this revenue might marginally contribute to meeting the increased needs brought on by rising operating costs.

Some other transportation systems in the region have found advertisements or sponsorships by local businesses to provide valuable supplemental income to their systems. For example, in fiscal year 2002, the CityExpress bus system of Keene, NH said it raised $10,500 from "advertising", or 4.4% of its total revenue.[102]

The Chittenden County Transportation Authority (CCTA) of Burlington, VT provides an example of an on-bus advertisement program that is easily accessible to local businesses. From the CCTA website, interested businesses can download a "Media Kit" that highlights the value of advertising on the outside of buses and explains the costs and process for doing so. CCTA bus ads cost $200 per month for a single bus side and $150 per month for the rear, with discounted rates for long-running ads and for multi-bus purchases.[103] Businesses are responsible for designing and printing their own ads, with contact information for local vendors that have experience producing bus ads cited in the Media Kit.

Advertising on public bus systems can take a variety of forms. One form is advertisements placed on the outsides of the buses themselves – as panels affixed to the sides or rear of a bus or as full bus "wrap" advertising. Advertisements can also be placed inside buses, printed in schedules and other publications, and posted in bus shelters.

The *Island Explorer* bus system, serving Acadia National Park in Maine, provides an outstanding example of sponsorship use by a rural transit system. In this case, L.L. Bean pays for exclusive display rights on *Island Explorer* buses, supporting most or all of the service's operating costs. There is little if any direct application to AT, however, due to the seasonal and almost unique nature of the successful *Island Explorer,* its targeting directly at tourists in a very seasonal tourism area, and the lack of any obvious single business in the Upper Valley that stands out as large enough to be a sole sponsor.

It is beyond the scope of this study to recommend or not recommend advertising or sponsorships as a viable source of revenue for AT now or at some time in the future. Preliminary research and inquiry suggests that an advertising or sponsorship program might generate a modest amount of supplemental revenue. We regard the experience of the above-cited neighboring bus systems as the best evidence, however anecdotal, that such programs may be worth pursuing on a limited basis and with realistic expectations.

[102] CityExpress Cost/Benefit Analysis, New Hampshire Department of Transportation and Southwest Region Planning Commission, Keene, NH, December 2001, p.7.
[103] CCTA website: www.cctaride.org (28 April 2005)

10.Conclusions

Advance Transit's presence in Lebanon contributes a very conservative minimum of some $530,000 to the local economy every year that stays with area residents who can save or spend it.. Surveys suggest that it moves at least half of its passengers during peak periods – precisely when the local road system is the most crowded. About 60% of trips on AT are work-related.

AT bus service helps alleviate pressure for more parking facilities by taking work and shopping trips off the road from among the 75% of AT's passengers who said they have access to transportation alternatives – notable the automobile – and would employ them if the bus didn't exist.

Advance Transit's fixed-route bus system saved over 38,000 gallons of gasoline and more than 156,000 miles of local automobile operation last year. With about one-and-a-half times that amount of diesel fuel, AT moved over 281,000 boarding passengers an average of 5.4 miles per trip or over 1.5-million passenger-miles in 2004. Boardings for the first third of 2005 are up at least 6.2% over 2004.

AT makes a modest but net positive contribution to air quality as measured by the mass of particles and gases released into the atmosphere. Every time AT attracts a new customer out of his or her automobile, this net effect improves.

AT plays a direct role in helping some local residents who can't drive, don't have access to a car or can't afford repetitive taxi trips access to employment opportunities they say they wouldn't otherwise reach.

Lebanon contributes over 40% of AT's fixed-route boardings. Importantly, the Lebanon area is relatively compact such that about one-quarter of full-time employees who work in Lebanon live in Lebanon. Hanover-Lebanon is the most popular origin-destination pair.

Analysis of the subject of fares indicates that AT has attracted considerable additional boardings by going fare-free, at that reinstating a fare would discourage an important number of passengers. Fare elasticity analysis suggests that AT passengers would behave much like their counterparts around the country who use rural transit bus service. If so, implementing fares that would be high enough to cover 10% of operating expenses would have a deleterious effect on ridership.

Despite frequent requests for reinstatement of Saturday service, the prior Saturday service was not well utilized. Given the circumstances at the time, AT's decision to re-allocate those resources to improving weekday service appears to have been both appropriate and successful. If Saturday service is reinstated in the future, the route structure and scheduled headways should be designed to attract work-related trips to help maximize ridership, if this can be done within a tolerable inconvenience to passengers riding for other purposes – notably shopping and other personal errands. This and all other service expansion choices have an opportunity cost in terms of long-term financial commitments and other, foregone or deferred opportunities.

If AT expands, data suggest that it do so cautiously because likely potential boardings fall off precipitously with distance away from the Lebanon area and with distance away from key concentrations of residency. For example, it is unclear at this time that even the most probable emerging area – to the south along US 5, NH 120 or NH 12A – would generate enough actual boarding persons to justify expansion just yet. Other prospects such as upgrading existing services appear more attractive and deserving of resources, at least in the near term.

Finally, the experience of some neighboring transit bus systems suggests – at least tentatively – that there is value in trying some strategies to recover at least a modest portion of ever-increasing operating costs from the private sector in the form of voluntary fares, advertising/sponsorship and direct solicitation of employer participation.

Appendices

A	-	**Advance Transit Fleet Roster**
B	-	**UVTMA 2005 Survey Form with Raw Results**
C	-	**An Estimate of AT Boardings vs. Persons and Analysis of Survey Samples**
D	-	**Boardings Trends By Route, 2002-2004**
E	-	**Two Approaches to Estimating Ridership Effects of Fares vs. Fare-Free on Advance Transit**
F	-	**Air Quality Analysis Assumptions**
G	-	**TDM at Dartmouth College**
H	-	**Estimate of Fare Collections Costs**
I	–	**Advance Transit Insurance and Fuel Costs**
J	–	**Yellow Route ("Hartland") Boardings History 1998-2003**

Appendix A - Advance Transit Bus Fleet Roster

Advance Transit, Inc. Bus Fleet - April 2005						
Quantity	**Model Year**	**Vehicle Description**	**Passenger Capacity**	**Useful Life (years)**	**Useful Mileage**	**Notes**
1	1996	Ford Eldorado Aerolite	9	5	150 K	Maintenance vehicle
2	1996	Bluebird	33	10	300 K	
1	1997	Bluebird CS	37	10	300 K	
6	2000	International 3400 Bus	27	7	200 K	
1	2000	Ford E450 Phoenix Bus	9	5	150 K	
6	2001	Int'l 3400 Bus	27	7	200 K	
1	1998	Int'l 3400 Bus	27	7	200 K	transferred from HCS in Keene in 2004
8	2004	Gillig Low Floor Bus	35	12	500 K	

Gross Vehicle Weights (per Advance Transit):

Ford Eldorado Aerolite: 10,500 pounds
BlueBirds: 31,220 pounds
Ford Phoenix: 14,050 pounds
Internationals: 23,500 pounds
Gillig Low Floor Bus: 39,600 pounds

Appendix B - UVTMA 2005 Survey Form and Raw Results

Upper Valley Transportation Management Association (UVTMA)
Advance Transit Survey

Raw Survey Results For Questions 1 thru 5 Are Shown In Parentheses

The Upper Valley Transportation Management Association (UVTMA) is preparing a study of Advance Transit for the City of Lebanon. Would you please take a minute to answer the following five questions?

Date: April ___, 2005 Approximate time: ___________ AM/PM

Route: (circle one) BLUE RED GREENORANGE BROWN

1. What town do you live in?

A. Lebanon/West Lebanon (198)
B. Hanover (84)
C. Canaan (33)
D. Enfield (37)
E. Norwich (17)
F. Hartford/WRJ/Wilder (79)
G. Other NH (25) (Specify: _____________)
H. Other VT (18) (Specify: _____________)

2. Where are you going on this or a connecting AT bus?

A. Lebanon/West Lebanon (294)
B. Hanover (157)
C. Canaan (9)
D. Enfield (2)
E. Norwich (4)
F. Hartford/WRJ/Wilder (29)

3. What is the purpose of your trip?

A. Work (292)
  A.1. If 'Work', do you work for DHMC? (Yes / No) (81 = 'Yes')
  A.2. If 'Work', do you work for Dartmouth College? (Yes / No) (73 = 'Yes')
B. Shopping (67)
C. Medical or other specific appointment (47)
D. School, including employment training (36)
E. Other (Specify: _____________) (67)

4. Would you still make this trip if the bus service didn't exist?

A. No (120)
B. Yes (366)
  If 'Yes', How?
  B.1. Automobile or motorcycle (by myself) (139)
  B.2. Carpool or get a ride with someone (117)
  B.2. Taxi (62)
  B.3. Walk (55)
  B.4. Bicycle (41)
  B.5. Other (Specify: ______________) (17)

5. Would you be willing to participate in a voluntary contribution program to help support Advance Transit?

A. Yes (238)
B. No (63)
C. Not sure/don't know (196)

End of Survey. Thank you!

Appendix C - An Estimate of AT Boardings vs. Persons and Analysis of Survey Samples

The following narrative analyzes the survey sample sizes from the 2004 Crikelair survey and the April 2005 UVTMA survey. The analysis also develops a reasonable factor that enables an estimate of individual persons to be made from raw boardings data, since significant travel on AT involves a round-trip and, moreover, survey results have shown that some repetitive travel occurs five days a week while other repetitive travel occurs 1 to 2 or 3 to 4 days a week.. The analysis concludes that this factor should be 1.56, meaning that every 156 boardings recorded by AT bus drivers each week represents approximately 100 actual persons.

1. Estimates of number individuals riding AT, and percent of riders surveyed in the October 2004 Crikelair survey:

AT ridership statistics measure the number of passenger boardings for each bus on each route (i.e., "unlinked trips"). For example an individual might start on the Blue route, then transfer to the Red route for a destination in West Lebanon. This would be recorded as two boardings, increasing ridership for that day by two. Similarly, an individual riding the Blue route to work at DHMC in the morning and from DHMC to home at the end of the day accounts for two boardings. Using ridership statistics alone, it is therefore not possible to develop an estimate of the number of individuals served by AT in a given period.

In contrast, considerable effort was made in both the October Crikelair Associates survey and the April UVTMA survey to ensure that an individual was not interviewed more than once. This allows survey results to be offered reliably in terms of percentage of individuals responding. However without an estimate of the total number of individuals served by AT on that day it is not possible to draw conclusions about the percentage of total passengers surveyed.

What follows is an attempt to take advantage of the survey results, combined with the ridership statistics and some assumptions, to develop an estimate of the number of actual riders on the system when the surveys were being conducted.

Let's first start by assuming that every rider makes one trip (home to destination and return) riding just one route each day. With this assumption each rider accounts for exactly two boardings per day. However, from the Crikelair survey results we know that not every rider uses AT every day and we have information about how many days per week they ride the bus. Using this data we can make an estimate of how many boardings on average each survey respondent makes per day. **Table C1** summarizes the October survey data, makes an estimate of how that relates to boardings per week, and calculates a weighted average number of boardings per respondent.

Table C1 -- Weekly Use Pattern Adjustment				
Survey		Estimated		Weighted Avg.
Days per week	%	Boardings/week	Boardings/day	
5	52.0%	10	2	1.04
3 to 4	31.0%	7	1.4	0.43
1 to 2	12.0%	3	0.6	0.07
< 1	6.0%	1	0.2	0.01
				1.56

Knowing that the fixed-route ridership totals for October 27, 2004 (the day that the surveys were handed out) was 1161 and dividing that by 1.56 gives us an estimate of approximately 750 individual riders (i.e., unique persons) that use the system over the course of a week. Similarly, knowing that we received 346 completed surveys back, we can estimate that we surveyed approximately 45% of these riders.

We can examine the sensitivity of our rider estimate by considering what factors might impact our 2 boardings per trip assumption. The AT system is deliberately structured to facilitate connections between different routes, and the survey tells us that at least14% of the respondents use more than one bus to go from starting point to destination. In addition we can assume that some respondents use the bus for additional trips during the day (DC or DHMC going to meetings, noon time shoppers, etc.) Both of these have the effect of increasing the average boardings per day per rider, together by perhaps 25-30%.

On the opposite side, we have reason to believe that not all riders use the bus both ways which would have the effect of reducing the average boardings per day per rider. Estimating the effect of this pattern is difficult, but **Table C2** shows one attempt.

Table C2 -- One Way Estimate			
Purpose	% Responses	% One-way	Wtd. One-way
Work	62%	15%	9.3%
Shopping	14%	0%	0.0%
School	11%	20%	2.2%
Medical	6%	0%	0.0%
Recreation	4%	75%	3.0%
Other	4%	50%	2.0%
			16.5%

The October Survey provides data on the purpose of the trip. It is reasonable to assume that the purpose of the trip may provide some insight into the probability that the trip is a one-way trip or a round trip; e.g. it is more likely that a recreational or social trip is more likely to be one way than a shopping or trip to the doctor. In **Table C2** we've made some assumptions and again calculated a weighted average. Clearly since almost 2/3's of the trips on AT are to and from work, this estimate is heavily driving by the trip patterns of employees. In this case we've assumed that a fair percentage of employees use AT only in one direction – what we would consider to be a very conservative assumption.

Table C3 brings all of these estimates together to provide a feeling for the sensitivity of our estimates of the number of individuals who use the AT system on a regular basis and the corresponding proportion of those individuals represented in our survey. The lower average boardings per day number reflects only the use pattern (number of times the individual used AT per week) and the one way adjustments. The higher number reflects only the use pattern adjustment and the transfer and a multiple trips per day adjustment together totaling 0.25.

Table C3 - Estimated Riders		
Boardings/day	Riders	% Surveyed
1.40	830	42%
1.56	750	46%
1.81	640	54%

While this analysis has at it base several key assumptions, it does suggest that a rider population estimate in the range of 750 over the course of a week seems consistent with our understanding of both the survey and ridership data. In addition, it suggests that we can confidently state that our survey results are representative of a significant portion of our riders.

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2. April 2005 survey result weighting factors by route:

For several reasons during the April survey it was not possible to ensure that similar percentages of riders were surveyed on each route. The question is therefore raised as to whether the uneven population samples in some way bias the results. To evaluate this question we compare the ridership distribution between routes (assuming ridership is directly proportional to the rider population) with the distribution of surveys taken on each route.

Table C4 shows the distribution of ridership between the four routes surveyed over the three days when the survey was carried out. Note that the ridership on the Orange route on Day 2 and the Green route on Day 3 are not included. This is due to the fact that these routes were not surveyed on those days.

Table C4 - Distribution of Ridership					
	Blue	Red	Green	Orange	
%Ridership Day 1	16.1%	8.3%	3.7%	6.3%	34.4%
%Ridership Day 2	18.4%	10.3%	4.3%	0.0%	33.0%
%Ridership Day 3	18.0%	9.0%	0.0%	5.6%	32.6%
	52.5%	27.6%	8.0%	11.9%	100.0%
Note: percents adjusted to delete Green Day 3 and Orange Day 2					

Table C5 shows the distribution of surveys obtained on each route. It is clear that on a day to day basis there is considerable difference between the relative ridership numbers and the number of surveys obtained. However, when the ridership numbers are corrected as in **Table C4** to correspond to only those days and routes when surveys were conducted, there is a remarkably good match in the distribution of survey results between routes and the ridership distribution between the four routes. Given that we can assume that the rider population is similar in their attitudes and responses day to day, it is reasonable to argue that no adjustments are required in the survey results when comparing survey results on a route by route basis.

Table C5 - Distribution of Surveys					
Surveys Day 1	23.8%	13.9%	3.2%	6.9%	47.8%
Surveys Day 2	21.6%	3.0%	3.6%	0.0%	28.2%
Surveys Day 3	7.3%	12.1%	0.0%	4.6%	24.0%
	52.8%	29.0%	6.7%	11.5%	100.0%

3. Estimates of number individuals riding AT, and percent of riders surveyed in the April 2005 survey:

Estimating the number of riders and the percentage surveyed in the April 2005 survey is difficult. Unlike the Crikelair survey which focused on collecting surveys from a single days rider population, the April 2005 surveys were collected over a three day period where the number of survey/hours varied each day.

However, given that the April 2005 survey was careful to avoid sampling the same rider more than once over the three day period, it is possible to calculate a lower bound by focusing on the first days data where the survey effort was most intense. **Table C6** shows the actual ridership counts and the number of surveys collected on April 5, 2005. Ridership and surveys are distributed between the four routes in a relatively similar manner, with the Blue and Red routes having a slightly higher proportion survey count than the Green and Orange.

Table C6 - Distribution of Ridership & Surveys April 5, 2005					
	Blue	**Red**	**Green**	**Orange**	**Totals**
Ridership	473	244	109	184	1010
	46.8%	24.2%	10.8%	18.2%	100.0%
Surveys	120	70	16	35	241
	49.8%	29.0%	6.6%	14.5%	100.0%

Using the same factors developed in **Section 1** above we can estimate the number of riders on the four routes surveyed on April 5, 2005, and the percentage of total riders surveyed. **Table C7** provides those estimates in the same format as **Table C3**. Note that the total riders in this case are for only the Blue, Red, Green and Orange routes. It is clear that the percentage of total riders surveyed is good, in the range of 35 to 45 percent of all riders on these routes on that day.

Table C7 - Estimated Riders		
Boardings/day	**Riders**	**% surveyed**
1.40	720	33%
1.56	650	37%
1.81	560	43%

This concludes the analysis.

Appendix D - Ridership Trends of AT Fixed Routes, 2002-2004

Calendar 2002 Direction of Travel By Route					
Route	Northbound Boardings		Southbound Boardings		Total
Blue	51932	52%	48814	48%	100746
Red	19539	38%	31405	62%	50944
Orange	13360	36%	23467	64%	36827
Green	10011	58%	7330	42%	17341
Brown	13218	55%	10620	45%	23838

Calendar 2003 Direction of Travel By Route					
Route	Northbound Boardings		Southbound Boardings		Total
Blue	54999	51%	53288	49%	108287
Red	23196	39%	36756	61%	59952
Orange	14051	34%	27033	66%	41084
Green	12258	55%	10227	45%	22485
Brown	15435	57%	11434	43%	26869

Calendar 2004 Direction of Travel By Route					
Route	Northbound Boardings		Southbound Boardings		Total
Blue	60541	52%	55138	48%	115679
Red	27092	40%	40864	60%	67956
Orange	14181	33%	28191	67%	42372
Green	13984	53%	12279	47%	26263
Brown	17819	62%	11113	38%	28932

Appendix E - Two Approaches to Estimating Ridership Effects of Fares vs. Fare-Free on Advance Transit

An important question this study attempts to address is the increase in AT ridership (measured by boardings) since CY 2001 that can be attributed to AT not charging a fare. That is: What was the public's response to the elimination of fares absent other service improvements that have been described in detail elsewhere in this study?

The following material expands the discussion in **Section 5.3** to demonstrate an approach to estimating the number of 2004 boardings that were probably attracted because of the fare-free policy alone. This kind of estimate is inherently difficult because: (1) significant modifications were made to routes and schedules at the same time as the changes in fare policy; and (2) the fare was eliminated in stages that partly overlap this same time period.

Table E1, below, shows two estimates of FY 2004 fare-free and fare-paid boardings based on actual AT boarding data trends since Fiscal 1995.

Table E1 -- Predicted FY 2004 Boardings Based on Growth Trend Data (FY '95 thru FY '99 and FY '95 thru FY '02)

Projection Based on Boardings Growth from FY 95 thru FY 02 (Higher Growth)		
Actual Annual Growth Rate, Fare-Free Boardings:	8.35%	
Actual Annual Growth Rate, Fare-Paid Boardings:	6.56%	
Predicted FY 04 Fare-Free Boardings:	132,651	
Predicted FY 04 Fare-Paid Boardings:	99,533	
Predicted FY 04 Total Boardings:	**232,184**	
Actual FY 04 Total Boardings:	265,603	
Incremental Ridership Attributed to Fare-Free:	***33,419***	14.4%
Projection Based on Boardings Growth from FY 95 thru FY 99 (Low Growth)		
Actual Annual Growth Rate, Fare-Free Boardings:	5.97%	
Actual Annual Growth Rate, Fare-Paid Boardings:	0.28%	
Predicted FY 04 Fare-Free Boardings:	126,885	
Predicted FY 04 Fare-Paid Boardings:	88,144	
Predicted FY 04 Total Boardings:	**215,029**	
Actual FY 04 Total Boardings:	265,603	
Incremental Ridership Attributed to Fare-Free:	***50,574***	19.0%

From Fiscal 1995 through Fiscal 1999, fare-free boardings grew at an effective annual rate of 5.97%. During the same period, fare-paid boardings grew at an effective annual rate of just 0.28% -- i.e., almost zero. In marked contrast, from FY 1995 through FY 2002 fare-free boardings grew at an annual effective rate of 8.35% and fare-paid boardings grew at an annual effective rate of 6.56%. Using these two scenarios, called "Low Growth" and "Higher Growth", estimated FY 2004[104] boardings were computed *based on these actual growth rates* and the numbers compared to actual FY 2004 results.

- The "Low Growth" Scenario based on the four-year period from FY 1995 through FY 1999 predicts that FY 2004 fare-paid boardings would have been 88,144 and that total boardings would've been 215,029 – *i.e., 50,574 lower than actual FY 2004 boardings with no fare*.

- The "Higher Growth" Scenario based on the seven-year period from FY 1995 through FY 2002 includes a three-year period when AT boardings grew at all-time-high rates. It predicts that FY 2004 fare-paid boardings would've been 99,533 and that total boardings would've been 232,184 – *still 33,419 lower than actual FY 2004 boardings with no fare.*

- Thus, at least **33,419** and up to **50,574** additional boardings in FY 2004 *are probably attributable to the removal of fares alone*, independent of other service enhancements. This represents 14 to 19% of actual FY 2004 boardings.

Based on the foregoing analysis, the true number of boardings attracted by the fare-free policy by itself is probably closer to the larger number (50,574). This is because the growth rates in fare-free and fare-paid boardings used to arrive at this figure are very conservative and are reflective of AT's long-term boarding trends prior to the service improvements implemented in 2000.

Fare Elasticity Analysis

There is another way to approach the question of rider reaction to fare changes, short of the development of a computer demand model. (An analysis utilizing a customized computer model has been done for some rural public transit systems but is well beyond the budget and time constraints of the current study.) This second approach uses fare elasticities, which measure the change in boardings for a given change in fare. Public transit systems exhibit an inverse relationship between the amount charged per ride and the number of people who use the system. For small changes in fare, fare elasticities for public transit systems range from –0.12 to about -0.40[105] where an elasticity of –0.4 means that ridership will decrease 4% from its existing level (that is, prior to the change) for every 10% increase in fare.

By comparison, the pioneering 1968 work by Simpson and Curtin[106] produced the formula:

$$Y = 0.80 + 0.30X, \text{ where}$$

[104] July 2003 through June 2004

[105] Fare Elasticity and Its Application to Forecasting Transit Demand, Larry H. Pham, Ph.D. and James Linsalata, loc. cit.

[106] Effects of Fares on Transit Riding, loc. cit.

Y = Percent loss in ridership as compared to the prior (before) ridership
X = Percent increase in fare as compared to the prior (before) ridership.

The Simpson-Curtin formula was widely adopted as a "rule of thumb" for its simplicity notwithstanding its limitations. Shortcomings of the formula, which predicts a 3.8% decrease in ridership in response to a 10% increase in fare, are at least threefold: (1) It is inaccurate when applied to large fare changes; (2) it fails completely if the percent increase in fare is infinity (i.e., the case of applying a fare to a fare-free system); and (3) it tends not to mirror the behavior of the rural transit user. It was, however, convenient in an era when computing power was expensive and analyzing the fare sensitivity of rural transit systems was uncommon.

The Arc Elasticity (AE) formula is the generally preferred elasticity metric that measures ridership response to fare changes. Unlike the Simpson-Curtin model, it contains no constants. Moreover, it does not become mathematically meaningless if the ending ("new") fare is zero. It is defined as:

AE = [Change in Ridership / Average Ridership] / [Change in Fare / Average Fare]

Further, the Working Group advised multiplying the result of the above equation by 50% when a fare is applied or increased compared to the case of fare removal or decrease.[107]

Due to the facts that: (1) some AT riders were paying a fare at the same time others were not, (2) the fare-free zone was expanded from Vermont routes to include New Hampshire routes that were not already within the Lebanon-Hanover fare-free zone, and (3) an interim arrangement was made with Dartmouth College to enable its students to ride "fare free", the following arc elasticity estimate treats all AT passengers the same in reaction to fares, but it does serve as an entry point to estimate of the effect of fares on this system. A more rigorous approach would attempt to separate riders who were already traveling "fare free" prior to AT's conversion to a completely fare-free system from those who were paying a fare.

Using AT boardings data for CY 2000 when a fare was still being charged to some passengers, and CY 2002 which is the first year the system was completely fare-free yields:

(229,696 – 127,582) / [(229,696+127,582) / 2] = AE x (-1.04)/0.52, where:

229,696 is the reported boardings figure for CY 2002 (see **Table 1** in the Executive Summary), 127,582 is the reported boardings figure for CY 2000, $1.04 is the reported average fare charged by AT in CY 2000 (average of cash fare, multi-ride tickets and monthly passes), and 0.52 (52 cents) is the average of this fare and zero (no fare).

- This yields an Arc Elasticity (AE) for Advance Transit of **–0.2858**.

If we multiply the AE of –0.2858 by the recommended 50% for the case of fare re-introduction or increase, the result is **–0.426**.[108] This value is remarkably consistent with studies of other rural transit systems and strongly argues that AT's customers are likely to behave similarly to

[107] E-mail D. Brand to UVTMA dated May 11, 2005.
[108] In other words, paying passengers are more sensitive to a fare introduction or increase than a fare decrease or removal.

those of other rural transit bus systems if confronted with a compulsory fare or a fare increase. Some of the recent work, in fact, finds that *on average*, the fare elasticity for rural transit systems for peak and off-peak periods combined is –0.43.[109]

Unfortunately, fare elasticities can't be directly used to estimate the ridership impact of going from a free fare to some finite fare level (an infinite percentage fare increase). An intermediate step is needed. To estimate the impact of instituting *any* fare, the following formula is applied to arrive at what CY 2004 fixed-route boardings *might have been* had an average fare of $1.04 remained in place:

CY 2000 boardings / CY 2002 boardings x CY 2004 boardings, or:

127,582 / 229,696 x 281,202 = **156,190** boardings

– *implying a loss of 125,012 boardings or 44.5%* of actual Advance Transit CY 2004 boardings if AT had never converted to fare-free.

Based on the above baseline for 2004, we can now use the value of –0.2858 as a Shrinkage Ratio[110] to compute the following for a hypothetical 25 cent fare and 55 cent fare as if it had been imposed as of January 1, 2004. We are still assuming that the AT system had never converted to fare-free. Let us also assume that AT had raised its fare by 2% each year since 2000 to keep its fare constant in real dollars. This means the average fare by 2004 would have been $1.12[111]:

(Revised Boardings – 156,190) / 156,190 = -.2858 x (.25 – 1.12) / 1.12 = **224,773**

and

(Revised Boardings – 156,190) / 156,190 = -.2858 x (.55 – 1.12) / 1.12 = **194,906**

where it will be recalled that 156,190 was the estimated CY 2004 boardings that *would have resulted* if AT had continued with its $1.04 average fare and the effect of this fare on boardings had not decreased as the value of the fare decreased in real terms due to intervening inflation.

The first of the pair of equations above indicates that revised CY 2004 boardings at a 25 cent average fare becomes **224,773**. This is **56,429** fewer boardings (-20%) than the actual CY 2004 boardings reported by Advance Transit.

The second of the pair of equations above indicates that revised CY 2004 boardings at a 55 cent becomes **194,906**. This is **86,296** fewer boardings (-30%) than the actual CY 2004 boardings reported by Advance Transit.

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[109] Pham and Linsalata, loc. Cit.
[110] To compare estimated boardings before and after a fare change (a decrease in this example).
[111] After accounting for the effect of multi-ride tickets and monthly passes vs. cash (or "walk up") fares.

The following questions can be at least partially answered from the foregoing analysis:

Q. Did the policy decision to remove all fares entice additional boardings on AT fixed-route transit bus services?

A. Yes. If AT had continued to charge the same fare, CY 2004 boardings might have been as low as 156,190 (vs. 281,202 actual). If AT had then, effective 1/1/04, reduced its fare to a token 25 cents, boardings would have been about 56,400 (or 20%) less than actual CY 2004 results. (i.e., 281,202 minus 224,773). This result is reasonably consistent with the separate analysis that utilized boardings growth rates instead of fare elasticities.

Q. Can a fare elasticity metric be estimated for Advance Transit?

A. Yes, subject to the caveats identified in this Appendix section.

Q. What will happen if a fare is put back on, applicable to the same routes, services and regions as until January 2002?

A. This would mathematically represent a fare increase of infinity. Ridership will decrease by an unknown amount. As cited earlier, experts have determined that fare elasticity is about 50% greater in the case of a fare increase (versus decrease). Therefore, one can expect based on the analysis that the response will exceed the estimated 56,400 riders that the fare-free policy has probably attracted, but in the opposite direction (i.e., a ridership loss).

Appendix F - Air Quality Analysis Assumptions

Following are the assumptions used for the air quality analysis presented in **Section 6**:

1 Average auto occupancy is based on the current NHDOT Congestion Mitigation and Air Quality standard of 1.1 passengers per vehicle.

2 Average trip length is estimated at 5.4 miles and is based on the average distance between primary origin and destinations along Advance Transit routes.

3 Average speed of traffic and buses along Advance Transit routes is estimated at 35 miles per hour.

4 Passenger vehicle emission factors are from the EPA Mobile 6.2 emissions model. New Hampshire conditions were modeled by the NH Department of Environmental Services, 2005. Vehicle classifications used include light duty gasoline vehicle and light trucks (LDGV & LDGV12) and diesel transit and urban bus (HDDBS). Other emission assumptions include:

4.1 EV phase-in data read from file NLEVNE.D

4.2 Calendar Year: 2004

4.3 Month: July

4.4 Altitude: Low

4.5 Minimum Temperature: 62.0 (F)

4.6 Maximum Temperature: 92.0 (F)

4.7 Absolute Humidity: 75. grains/lb

4.8 Nominal Fuel RVP: 6.8 psi

4.9 Weathered RVP: 6.6 psi

4.10 Fuel Sulfur Content: 121. ppm

4.11 Exhaust I/M Program: No

4.12 Evap I/M Program: No

4.13 ATP Program: Yes

4.14 Reformulated Gas: No

5 The percentage of passengers not using an automobile in the absence of transit is based on April survey results and equals 40 percent of average daily ridership.

Appendix G - TDM at Dartmouth College

In the summer of 2002 Dartmouth College implemented a Transportation Demand Management (TDM) program that sought to reduce the demand for parking in campus lots by providing incentives for employees to arrive by alternate means than driving single occupant vehicles (SOV's). The planning for future development of the campus infrastructure included new building sites that were current parking areas. This posed a challenge to either replace the parking by creating new surface lots or by building costly parking garages. While reviewing the alternatives it became obvious that investing in a multifaceted TDM program was a smart opportunity given that one parking space in a garage had a range of twenty to thirty thousand dollars to build given site challenges and configurations. The thinking became if you could reduce the number of cars arriving then it would slow or reduce the need for parking and help traffic congestion.

When reviewing what elements to include at the start of the TDM roll-out, it was important that transportation alternatives where in place in the region so that they could be relied on for commuting. Advance Transit was the primary resource to provide a busing solution and was viewed as a partner in the TDM effort. Currently there are 215 participants in the TDM program that are being subsidized or paid to leave their car at home and have given up their parking permit. For some AT is the link from home to campus and has afforded them to take advantage of the opportunity offered. The College has been a long time supporter of AT and has contributed to make the system fare free for all in its service region.

Appendix H - Estimate of Fare Collection Costs

(Source: Advance Transit. Note: Monthly cost must be multiplied by 12; weekly cost must be multiplied by 52; daily cost must be multiplied by 254)

Factors that affect cost of fare collection:

	One Time	Monthly	Weekly	Daily
Policy creation:				
a policy regarding types of fares, pricing, distribution must be written				
and a corresponding procedure adopted for the accounting manual				
Potential costs:				
one time 3hrs @ $69.64 p/hr w/benes	$208.92			
Script printing:				
tickets must be designed, and submitted to printer for setup and printing				
Potential costs:				
one time for design 3 hrs @ $26.60 p/hr w/benes	$79.80			
printing costs vary by form/quantity from .20 to .34 each				
printing costs for 10000 @ an avg cost of .27	$2,700.00			
Internal control mechanism for script:				
create and maintain system for tracking script				
Potential costs:				
clerical wages 1 hr p/wk @ $18.66 p/hr w/benes			$18.66	
Script issuance/cash bags:				
issue small amount of cash for change purposes to each driver				
interface with drivers to issue tickets as needed, and provide bill changing service				
Potential costs:				
clerical wages 1 hr p/wk @ $18.66 p/hr w/benes			$18.66	
one time for cash bags 28 drivers X 3 bags @ $5.65	$474.60			
Drivers handling of sales:				
time spent explaining & selling proper tickets				
end of day cash up				
Potential costs:				
wages for drivers .5 hr p/day X 14 routes @ $16.54 p/hr w/benes				$115.78
forms for tracking sales 14 routes @ .03 p/day				$0.42
Daily tally of sales receipts:				
clerk receives daily driver cash bags and tally forms				
verify each driver bag individually/track errors				
combine all daily cash and sales information to create summary report				
Potential costs:				
clerical wages 2 hr p/day @ $18.66 p/hr w/benes				$37.32
forms for tracking sales @ .03 each				$0.03
Daily deposit of cash:				
create daily bank deposit for farebox receipts				
trip to bank deposit cash				
Potential costs:				
clerical wages 1 hr p/day @ $18.66 p/hr w/benes				$18.66
trip to bank daily 10 miles @ .405 p/mile				$4.05
Cash Journal logging/S5311 tracking:				
accountant logs daily cash fares on cash journal				
maintains monthly summary of fares collected				
applies farebox revenue against operating costs for S5311 grant billing				
Potential costs:				
acctg wages 2 hrs p/mo $27.32 w/benes		$54.64		
Totals	**$3,463.32**	**$54.64**	**$37.32**	**$176.26**

Appendix I – Advance Transit Insurance and Fuel Costs

The following cost information was supplied courtesy of Advance Transit, Inc.

Table I1 - Advance Transit Insurance and Fuel Costs

	FY01 Actual	FY03 Actual	FY04 Projected	FY05 Budgeted	2001 to 2005 Percent Change
Health Insurance	$72,875	$108,251	$148,280	$169,752	133%
Workers Comp	$18,415	$27,589	$26,701	$36,951	101%
Business Insurances	$19,009	$47,096	$64,170	$67,139	253%
Vehicle Insurance	$25,870	$50,983	$65,213	$80,091	210%
Fuel	$61,370	$83,169	$87,588	$120,600	97%

Appendix J - Yellow Route ("Hartland") Boardings History, 1998-2003

The following data was supplied courtesy of Advance Transit.

HARTLAND

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
FY 05												
FY 04	1311	1191	950	1175	1068	1272	1067	1340	959	459		
FY 03	1591	1615	1325	1666	1455	1568	1388	1611	1018	545	587	1637
FY 02	1710	1712	1150	1515	1029	1507	1159	1482	511	217	367	1379
FY 01	1154	1145	901	1250	909	1232	1022	1404	469	124	436	1293
FY 00	1183	1171	843	1044	892	1055	636	845	402	209	315	1072
FY 99	997	840	728	897	747	969	778	846	564	275	281	1155
FY 98	1356	1160	991	1144	986	1255	905	1053	660	298	278	852

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