4. Travel Demand and Forecasting

This section describes the major steps taken to develop the travel demand model for the Ohio Hub System. The demand model predicts public responses in the Ohio and Lake Erie region to various rail service characteristics including train frequency, travel time, train and station amenities, and fares.

The creation of the travel demand model for the Ohio Hub Study required the delineation of the study area and definition of a zone system; collection of data including stated preference survey data, socioeconomic data and origin-destination data; and development of transportation networks for the competing intercity modes of travel (auto, air, bus, and rail). Additionally, a feeder bus network was defined to extend the reach of the rail network.

4.1 The Zone System

The first step in the development of the travel demand model was establishing a zone system that would reflect both the Ohio Hub Stand-Alone and the MWRRS travel market areas. The only difference between the Stand-Alone and the MWRRS scenarios was in the transportation network characteristics, not in the zone system. The same zone system was used in all analyses.

The zone system provides a reasonable representation of the market area where travel would occur between origins and destinations. Most zones represent county-level census information; however, where it is important to identify more refined trip origins and destinations, some counties are split into two or more zones. The travel demand model forecasts the total number of trip origins and destinations by each zone.

The Ohio Hub Zones were developed based on three components: the MWRRS Phase 4B zone system, the approved rail alignments, feeder bus services and the proposed station stops. In addition, the study included airport-specific zones based on the twenty-five major airports within the study area. The airports are identified in the Appendices. By creating interconnectivity between the region's airports and passenger rail stations, the airports serve as trip generators within the travel demand model.

Two hundred fifty-six zones were identified for the Ohio Hub Study. Exhibit 4-1 illustrates the study area's internal zone system. A much larger area that encompasses the study's external zone system is illustrated in Exhibit 4-2. The external zone system generates trips with origins and/or destinations that are *outside* the immediate service area of the Ohio Hub. As part of the national passenger rail network, the Ohio Hub interconnects with other regional passenger rail corridors. To the west, the Ohio Hub connects with the MWRRS, which generates external trips that contribute to the Ohio Hub network. To the east, existing Amtrak service connects to the Ohio Hub – the *Empire*, *Keystone* and VIA Rail corridors. Therefore, the external zone system includes areas that are northeast, east and southeast of the Ohio Hub. These external zones include New York City, Philadelphia, Harrisburg, Washington, D.C., Albany, Montreal, Quebec City and others.

Exhibit 4-1: Study Area's Internal Zone System

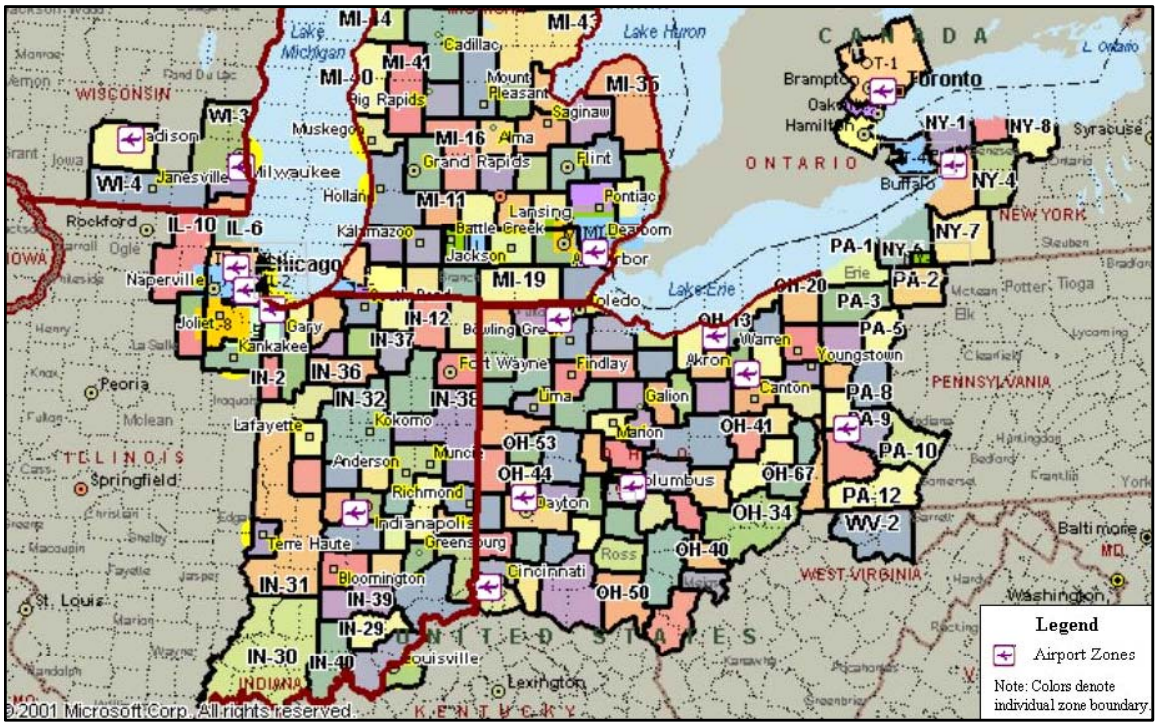
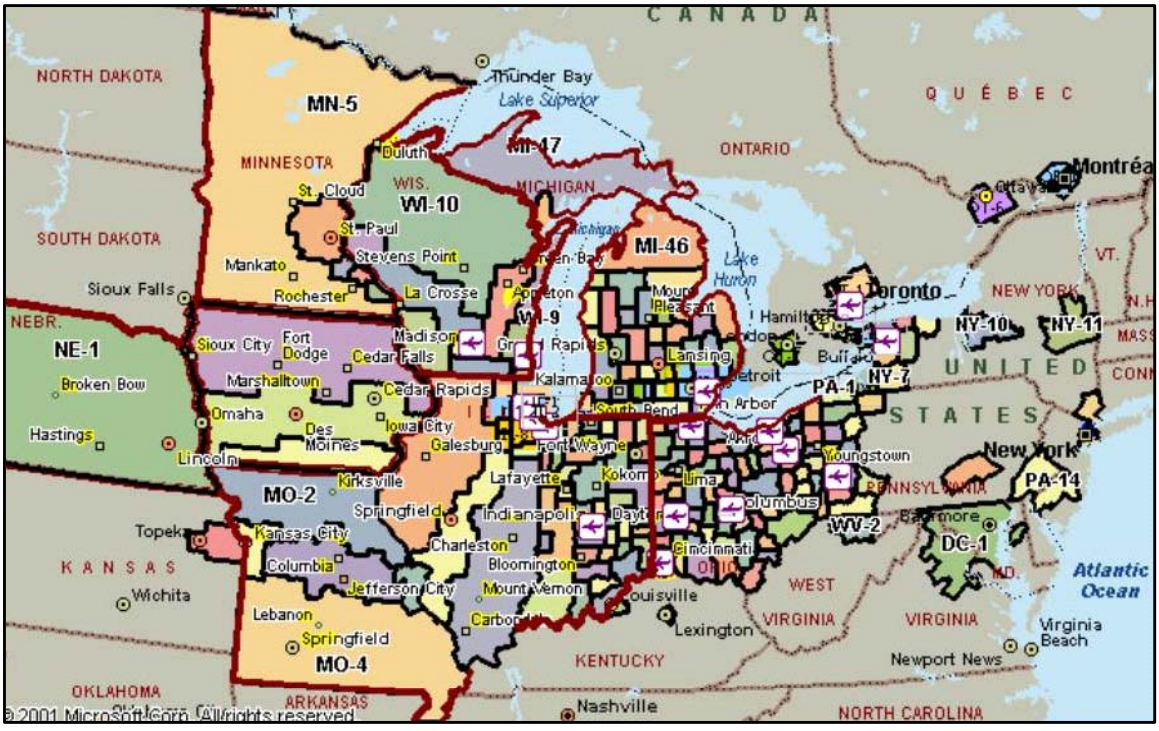
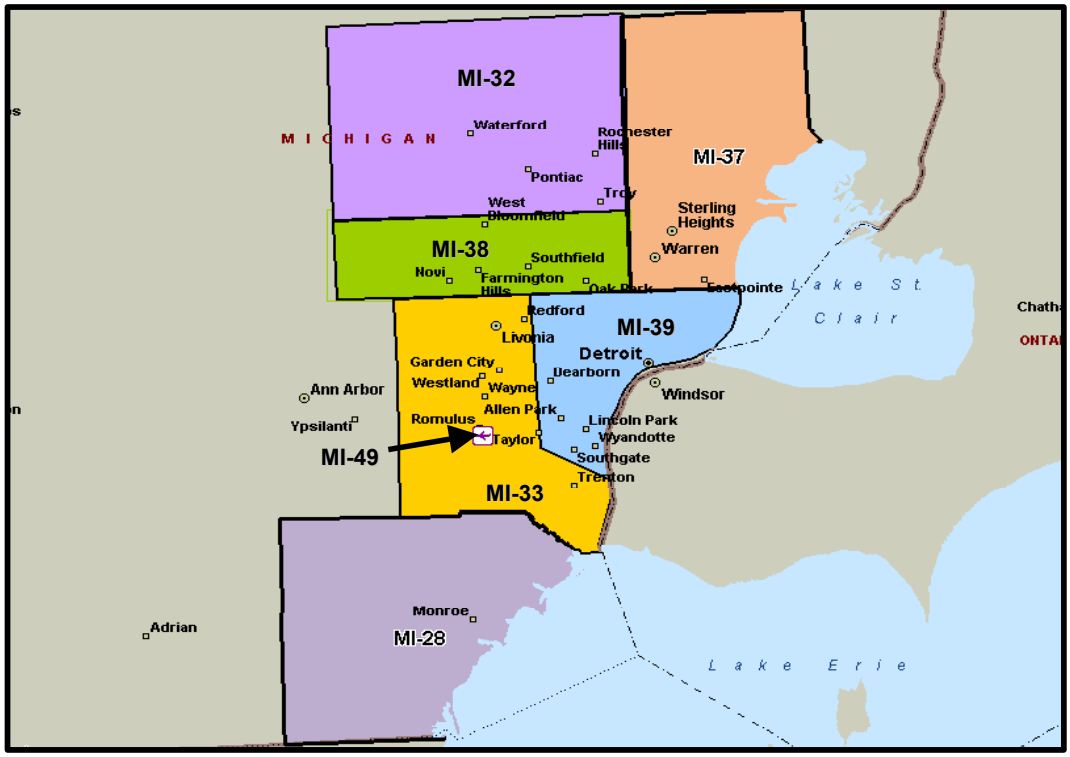


Exhibit 4-2: Study Area Internal and External Zones



Zones in Michigan are based on the MWRRS zone system. Exhibit 4-3 identifies zones in southeastern Michigan that were used in the trip-purpose break down on the Toledo-Detroit route segment discussed in Chapter 5. However, the full set of Michigan zones were used in predicting ridership in all scenarios, including Ohio Hub Stand-Alone scenarios. The only difference is in the quality of rail connectivity provided. In the base case that includes the MWRRI System, rail and auto access was provided across a wide area of southern Michigan. In the Ohio Hub Stand-alone Scenario, the network connection only included existing Amtrak service and traffic was largely generated from the six zones of southeast Michigan that are shown in Exhibit 4-3.

Exhibit 4-3: The Predominant Michigan Zones Used in the Toledo-Detroit Segment and Stand-alone Analysis



In Ohio, the zone system is based almost entirely on the MWRRS zone system, with some changes where zones were disaggregated to a county level. Examining potential markets served by Ohio Hub rail stations required the inclusion of the zones in western New York, Pennsylvania, and southeastern Ontario, Canada. A detailed zone description is provided in the Appendices.

4.2 Stated Preference Survey

Stated preference surveys provide critical insight into travel markets and travel behavior. Stated preference surveys were conducted in the corridors connecting Cleveland to Buffalo, Detroit, Pittsburgh and in Columbus and Cincinnati. Additionally, the Ohio Hub Study relies heavily on regional market research data from similar surveys conducted for the Midwest Regional Rail Initiative (MWRRI). A full description of previously conducted market research is available in the *Midwest Regional Rail Initiative Project Notebook*.

The purpose of conducting the surveys was to collect specific attitudinal data by interviewing travelers within the Ohio and Lake Erie Region. The travelers were asked to identify how they value travel times and frequencies associated with particular modes of transportation. These values were then combined with previously collected MWRRI data and incorporated into the calibration process for the travel demand model. The calibration process adapts the model to the specific characteristics of the travel market within the Ohio and Lake Erie Region.

4.2.1 Survey Methodology

Travel options in a stated preference survey enable respondents to consider the trade-offs among desirable travel attributes, such as time, comfort, cost, speed and accessibility without regard to travel mode. Trade-offs included a range of service options that were presented in such a way as to induce the individuals to respond realistically without specifying a mode of travel. More specifically, stated preference surveys ask travelers to choose between a changing travel cost and another value, such as travel time or service frequency. The choice the traveler makes demonstrates his or her preference between cost, time or other travel aspects of the rail mode.

The stated preference surveys for this study were conducted using a quota group sampling approach. The information collected from the respondents in a specific quota sampling category was then expanded to the overall quota sample population based on known socioeconomic and traveling characteristics. Quota surveys, which are now widely used in commercial, political and industrial surveying, have the advantage of being relatively inexpensive to implement while providing expanded coverage and more statistically significant results than random sample surveys.

With input from the ORDC, the study team developed surveys for each travel mode. Each survey collected information on origin and destination, trip purposes, demographics, values of time (VOT) and values of service frequency (VOF). A minimum sample from each travel market segment (by mode and trip purpose) was required to ensure statistical confidence. Using the Central Limit Theorem[19], it was determined that a minimum sample size of 20 to 40 participants ensures the statistical validity to each quota sample. For this study's stated preference surveys, the desired quota target was set at 80-100 interviews, with an established minimum quota of 30 interviews per trip purpose/travel mode. The Appendices contain a sample survey form.

[19] The Central Limit Theorem states that the sampling distribution of the mean of any distribution with mean μ and variance σ2 approaches a normal distribution with mean μ and variance σ^2/N as N the sample size increases. Spiegel, M.R., Theory and Problems of Probability and Statistics, NY McGraw Hill, pp. 112-113, 1992

4.2.2 Survey Implementation

Stated preference surveys were conducted at various locations within the study region in a manner designed to reach a broad sample of the potential users of an intercity passenger rail system. Approximately 1,320 surveys were completed. The surveys were conducted between January and April of 2002, using handout, mail-out and interview techniques. The surveys captured data from a broad mix of business travelers, tourists and resident leisure travelers.

Air mode surveys were conducted at five major airports in the region – Buffalo Niagara International Airport, Cleveland Hopkins International Airport, Port Columbus International Airport, Detroit Metro Wayne County Airport and Pittsburgh International Airport. The surveys targeted passengers traveling among cities served by the proposed Ohio Hub System. Airports were not modeled individually, but rather the surveys were used to calibrate a single set of mode-specific model parameters, by trip purpose and length, that were applied throughout the entire study region.[20]

Most auto mode surveys were conducted at the Interstate 71 rest areas north of Columbus and northeast of Cincinnati; at the rest area on Interstate 90 in Angola, New York and at the rest area on Highway 2 near Vermilion, Ohio. Additionally, auto surveys at the Columbus (Ohio) State House and Ohio Turnpike Commission were conducted.

Rail mode surveys were conducted onboard Amtrak's *Three Rivers* trains operating between Toledo and Pittsburgh[21], and the *Maple Leaf* trains operating between Buffalo and Niagara Falls.

The study team was unsuccessful in obtaining permission to conduct surveys onboard Greyhound buses. Accordingly, the bus survey form that is included in the Appendix could not be used. After discussion with the ORDC, it was agreed that the study would use the results of the survey of bus travelers previously conducted for the MWRRI. Exhibit 4-4 describes this study's survey sites, type of survey and the number of responses to each.

[20] Average gasoline fuel costs were raised to $2.25 in the latest Ohio Hub forecasts. However, this fuel price increase didn't affect the validity of the surveys that were collected earlier, because the surveys primarilty focused on identifying customers Value of Time tradeoffs in a manner that is independent of fuel price or mode.

[21] These Amtrak surveys that were conducted in the middle-of-the-night on a long-distance train produced some results that were ultimately deemed not representative of the travel behavior that would be seen in a short-distance daytime corridor service. These behavioral parameters were ultimately replaced along with the base-line travel demand forecast for a daytime corridor service, setting aside some of the ticket lift data on existing long-distance train service. This resulted in boosting the demand forecast for the Detroit, Niagara Falls and Pittsburgh corridors and making the forecasts for these corridor more consistent with forecasts elsewhere.

Exhibit 4-4: Stated Preference Survey Locations and Number of Responses

Survey Sites/Type of Survey	Mode	Trip Purpose	Number of Responses
Buffalo Airport	Air	All Purposes	109
Cleveland Airport	Air	All Purposes	51
Columbus Airport	Air	All Purposes	242
Pittsburgh Airport	Air	All Purposes	21
Detroit Metro Airport	Air	All Purposes	12
Amtrak: Toledo to Pittsburgh	Rail	All Purposes	91
Amtrak: Harrisburg to Pittsburgh	Rail	All Purposes	79
Amtrak: Buffalo to Niagara Falls	Rail	All Purposes	86
Columbus State House	Auto	All Purposes	46
Highway 2 – Vermilion, OH	Auto	All Purposes	118
Interstate 71 Rest Area North of Columbus	Auto	All Purposes	122
Interstate 71 Rest Area Northeast of Cincinnati	Auto	All Purposes	165
Interstate 90 (NY State Thruway) – Angola Rest Area	Auto	All Purposes	107
Ohio Turnpike Commission	Auto	All Purposes	68
		Total Responses	***1317***

4.2.3 Survey Demographic Characteristics

Distinct demographic characteristics exist for all travelers who participated in the survey. For example, air passengers generally have the highest income and rail passengers are slightly younger than the travelers on other modes are. A comparison of age distributions (Exhibit 4-5) shows that the age distribution for air and auto travelers peaks between the ages of 35 and 64, while the rail age distribution peaks between the ages of 19 and 24. The peak household income distribution (Exhibit 4-6) for auto and rail travelers is between $30,000 and $59,999. On the other hand, the air traveler category peaks at the $100,000 or greater level.

Exhibit 4-5: Age Distribution of Survey Respondents

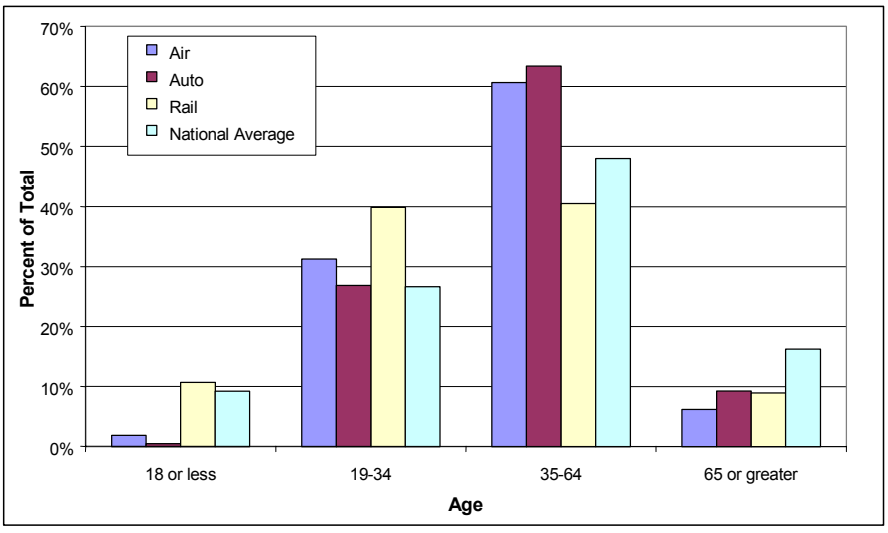
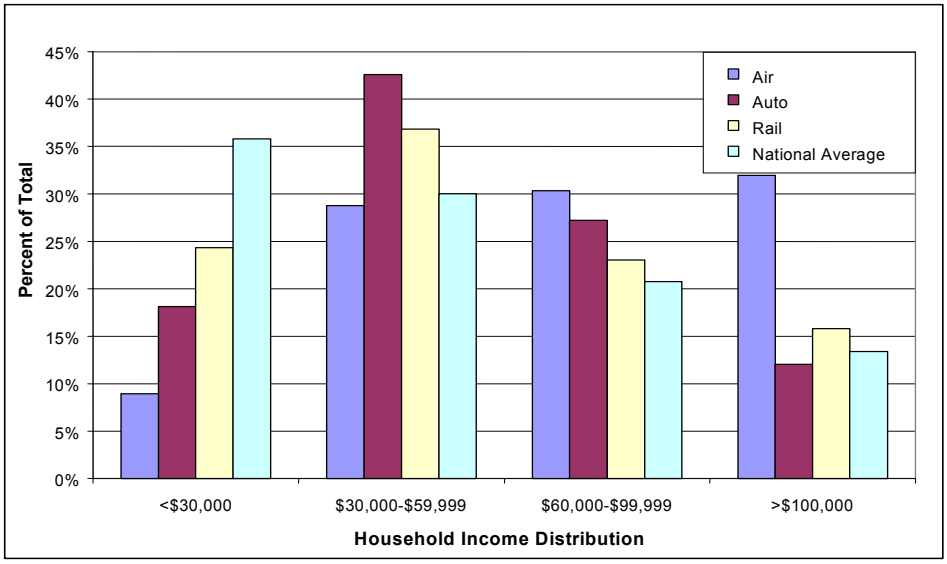


Exhibit 4-6 Income Distribution of Survey Respondents



4.2.4 Comparison with Other Studies

As shown in Exhibits 4-7 and 4-8, survey responses were collected for various modes and trip purposes. Survey findings were differentiated between *Business* travelers and *Other* travelers for air, auto and rail modes. These two exhibits provide comparison tables of this study's survey results to four similar studies, which are presented in year 2000 constant dollars.

Values obtained from the survey data are consistent and comparable across all modes with those obtained from similar studies previously conducted in the region. For example, the findings in the Boston-Portland (*i.e.*, *Restoration of the Portland-Boston Commuter Rail Service Study,* completed by TEMS in 1997*),* values of time and frequency closely resemble the findings in this Study, with few exceptions.

Air and rail values of time are slightly higher in the Ohio Hub Study area than in other related MWRRS corridors. This may be attributable to a lower level of discount airline operations in the Ohio and Lake Erie Region and a higher population density than that of the MWRRS region (Exhibit 4-9). However, the higher air values do not change the relative ranking-across-modes within each study and, in general, there is a strong consistency in the results. For example, air business travelers consistently respond with the highest values of time, while auto and rail travelers respond with lower values. The overall character of the model's results remains the same since relative values between modes rather than absolute values are the more influential factors affecting a model.

Exhibit 4-7: Comparison of Value of Time with Other Studies ($/hour in 2000$)

Modes	Trip Purpose	Ohio Hub [1]	Wisconsin SRP [2]	MWRRI [3]	Illinois[4]	Boston[5]	Portland-Boston[6]
Air	Business	79	70	59	66	85	70
	Other	31	45	30	42	47	27
Auto	Business	26	21	24	36	33	31
	Other	19	17	18	21	23	18
Bus	Business	16*	20	16	20	24	20
	Other	11*	13	11	11	18	17
Rail	Business	33	20	27	30	24	31
	Other	16	15	20	21	18	17

[1] The Ohio and Lake Erie Regional Rail – Ohio Hub Study (2004)
[2] Wisconsin State Rail Plan 2020 Corridors Feasibility Study (2001)
[3] Midwest Regional Rail Initiative Business Plan (1997)
[4] Illinois Rail Market Analysis (1996)
[5] MBTA North Station-South Station Rail Link Project (1996)
[6.] Restoration of Portland-Boston Passenger Rail Service (1994)
***** MWRRS Value used for Ohio Hub

Exhibit 4-8: Comparison of Value of Frequency with Other Studies ($/hour in 2000$)

Modes	Trip Purpose	Ohio Hub[1]	Wisconsin SRP[2]	MWRRI[3]	Illinois[4]	Boston[5]	Boston-Portland[6]
Air	Business	40	44	30	44	45	48
	Other	28	32	20	31	36	17
Bus	Business	13*	11	13	13	24	15
	Other	11*	9	11	9	22	12
Rail	Business	22	14	14	14	37	19
	Other	13	10	10	10	37	13

[1] The Ohio & Lake Erie Regional Rail – Ohio Hub Study (2004)
[2] Wisconsin State Rail Plan 2020 Corridors Feasibility Study (2001)
[3] Midwest Regional Rail Initiative Business Plan (1997)
[4] Illinois Rail Market Analysis (1996)
[5] MBTA North Station-South Station Rail Link Project (1996)
[6.] Restoration of Boston-Portland Passenger Rail Service (1994)
***** MWRRS Value used for Ohio Hub

4.3 Socioeconomic Data

Socioeconomic data in the COMPASS™ demand model was upgraded with the most recent data, as well as the latest economic forecasts, for the 2007 Business Plan update. This update was performed in conjunction with the Ohio Hub Economic Impact study, to ensure the consistency of modeling assumptions and results. The update produced minor adjustments to a few of the previous model assumptions but did not result in any radical revisions.

Forecasting travel demand between the model's zones required base year estimates and forecasts of three socioeconomic variables – population, employment and household income – for each of the Ohio Hub model zones. To allow for assessment of the financial and operational feasibility of the system over its full life-cycle of 30 years, socioeconomic variables were forecasted through 2040.

For the U.S. zones, base-year estimates were developed using county-level and census-tract level data from the U.S. Census Bureau (Bureau of Economic Analysis, U.S. Department of Commerce)[22]. For Canadian zones, base year data were estimated by using census division-level and CMA-level [23] data from 2001 Census of Canada database (Statistics Canada) [24]. For the U.S. zones future year forecasts were obtained by applying the Woods & Poole, Inc[25] county-level growth rates to the base-year levels for all three variables, with projections beyond 2025 based on 2001-2025 trend lines. For Canadian zones the socio-economic forecasts were based on the projections from multiple official Canadian sources and historic trends as well [26].
Exhibit 4-9 summarizes the upgraded base-year and forecast-year socioeconomic data for the primary Ohio Hub System study area. This area includes the zones of the internal zone system that are directly connected to Ohio Hub rail stations. Here we have zones located in four American states – Ohio, Michigan, New York and Pennsylvania and in the Canadian Ontario province. It is important to note that a large portion of southern Michigan is included into the primary study area of the Ohio Hub system. These zones are connected to the Ohio Hub System through Michigan's feeder bus network and the MWRRS Chicago-Detroit rail corridor [27]. Exhibits 4-10, 4-11 and 4-12 illustrate the forecasts by State/Province for three key socioeconomic variables – population, employment and average household income- within the Ohio Hub Study area.

The population and employment charts highlight the similarity in growth rates for zones in Ohio and Michigan. The western portions of New York and Pennsylvania show relatively slower growth rates, while the Toronto area of Ontario province shows higher growth rates. Income growth rates for zones in the U.S. are similar (ranging between 1.1-1.2 per cent a year), while the corresponding annual growth rates in an analyzed part of Ontario province is only slightly less.

[22] See: http://factfinder.census.gov/
[23] CMA – Census Metropolitan Area.
[24] See: http://ceps.statcan.ca/english/census01/home/Index.cfm
[25] Woods & Poole, Inc. is an independent, widely respected firm that specializes in long-term economic and demographic projections. Its clients include public and private institutions from a number of different industries, e.g., the Wisconsin Department of Transportation, AOL/Time Warner, Coca-Cola, McKinsey & Co. and PricewaterhouseCoopers.
[26] See: Ontario Ministry of Finance (http://www.fin.gov.on.ca/english/), Institut de la Statistigue du Quebec (http://www.stat.gouv.qc.ca/default_an.htm).
[27] Socioeconomic data for all zones – both internal and external, - is given in Appendices.

Exhibit 4-9: Summary of Base and Projected Socioeconomic Data
Population

	Base and Forecast Years					Ave. Annual Growth Rate 2000 - 2040
	2000	2010	2020	2030	2040	
Michigan*	9,268,738	9,701,935	10,139,648	10,557,361	11,015,075	0.43%
New York*	2,277,124	2,296,983	2,317,964	2,338,945	2,359,926	0.09%
Ohio	11,353,140	11,786,791	12,226,077	12,665,362	13,104,648	0.36%
Ontario*	5,994,251	7,085,854	8,140,028	9,194,201	10,248,375	1.35%
Pennsylvania*	3,086,940	3,105,535	3,125,652	3,145,768	3,165,885	0.06%
Total	31,980,193	33,977,098	35,949,368	37,921,638	39,893,908	0.55%

Exhibit 4-9 (continued):
Employment

	Base and Forecast Years					Ave. Annual Growth Rate 2000 - 2040
	2000	2010	2020	2030	2040	
Michigan*	4,343,209	4,801,005	5,246,394	5,694,791	6,142,857	0.87%
New York*	1,051,811	1,111,730	1,176,628	1,241,527	1,306,426	0.54%
Ohio	5,402,175	5,982,655	6,512,379	7,049,889	7,586,542	0.85%
Ontario*	3,041,005	3,756,640	4,481,080	5,205,521	5,929,961	1.68%
Pennsylvania*	1,396,742	1,507,126	1,619,934	1,732,742	1,845,551	0.70%
Total	18,320,266	17,159,156	19,036,416	20,924,470	22,811,337	1.01%

Exhibit 4-9 (continued):
Average Household Income (in 2005 $)

	Base and Forecast Years					Ave. Annual Growth Rate 2000 - 2040
	2000	2010	2020	2030	2040	
Michigan*	$70,421	$80,228	$89,939	$99,667	$109,426	1.11%
New York*	$59,981	$68,297	$77,021	$85,545	$94,076	1.13%
Ohio	$62,350	$71,678	$80,862	$89,990	$99,045	1.16%
Ontario*	$66,092	$72,947	$79,906	$86,911	$93,864	0.88%
Pennsylvania*	$57,228	$66,206	$75,621	$84,749	$93,839	1.24%
Average	$64,634	$73,579	$82,463	$91,231	$99,909	1.09%

Note: Asterisk (*) mark indicates the states with base and forecast year socioeconomic data that are smaller than state/province totals.

Exhibit 4-10: Population Growth Forecasts

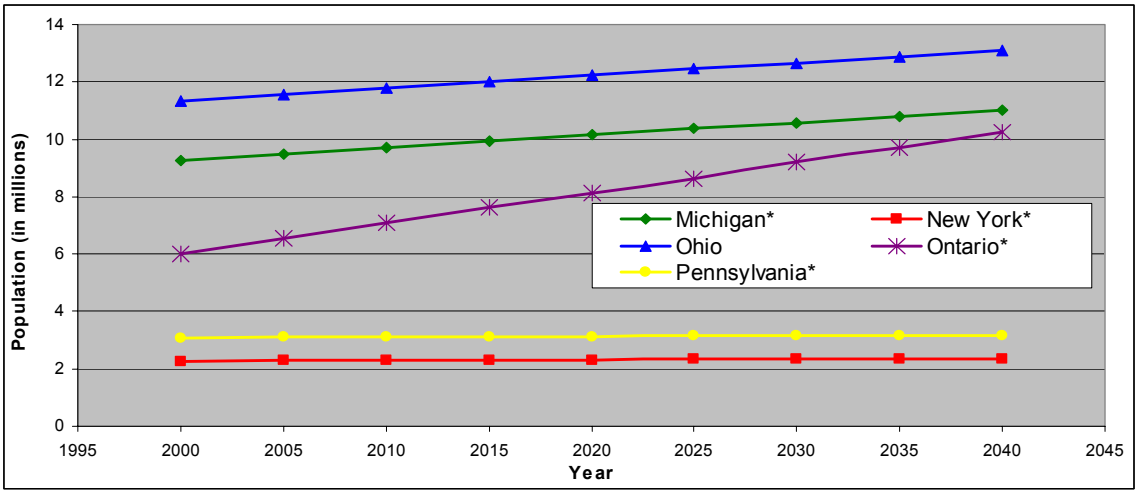


Exhibit 4-11: Employment Growth Forecasts

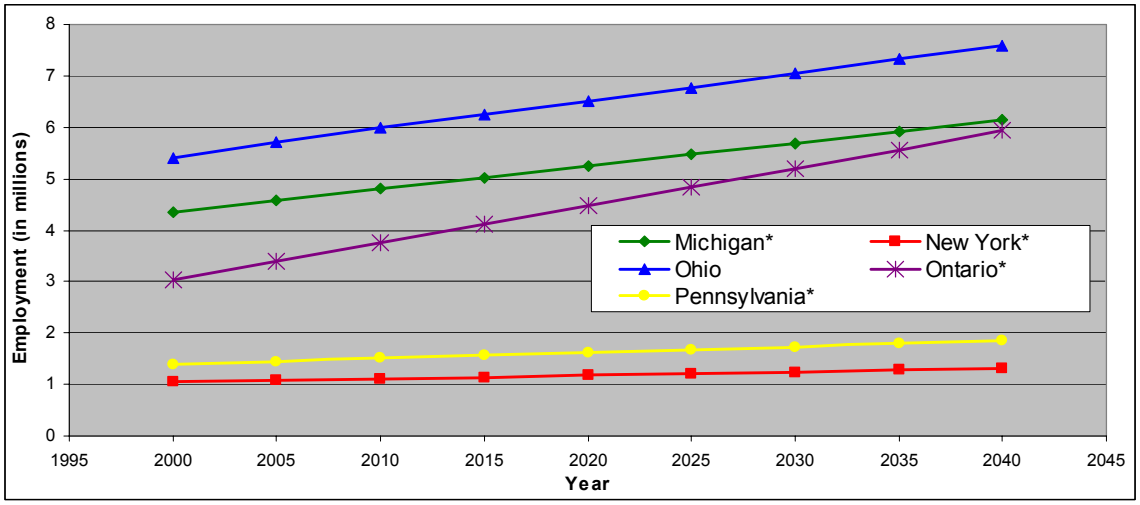
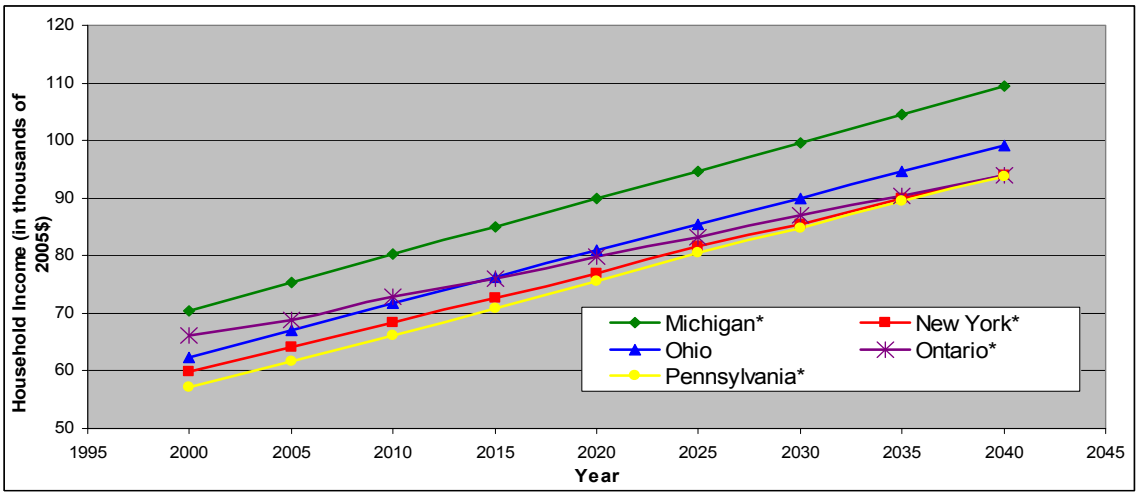


Exhibit 4-12: Average Household Income Growth Forecasts



Note: Asterisks indicate the states with base- and forecast-year socioeconomic data smaller than state/province totals.

4.4 Origin-Destination Data

The multi-modal intercity travel analyses developed from the *COMPASS*™ model required the collection of origin-destination (O-D) data describing annual passenger trips between zone pairs. For each O-D zone pair, the annual passenger trips were broken down by transportation mode (auto, air, rail and bus) and by trip purpose (*Business* and *Other*, where *Other* travel includes leisure and commuter trips). The *COMPASS*™ model is described in the Appendices.

Because the goal of the study was to evaluate intercity travel, the O-D data collected for the model reflected travel between zones (*i.e.*, between counties, neighboring states and major urban areas). Local traveling characteristics (short distance trips) were not included in the analysis in order to maintain accuracy in forecasting intercity trip making. The study team's experience with survey data gathered for MWRRI project provided a template upon which to base the data requirements for this study.

MWRRI data was used in conjunction with new Ohio Hub data to provide the overall 2000 O-D data requirements. The additional MWRRI sources included various private and public agencies' databases for trips within the nine-state Midwest system. Where data were not available, traffic volumes were simulated based on known travel behavior between pairs of zones with similar characteristics (*e.g.*, distance, population and available modes). The process used generalized cost pathskims for the respective modes and was based on the networks built for the model to determine zone-pair accessibility to the system and to allocate missing trips. A *pathskim* is the simulated travel cost between any pair of zones for a particular mode and a particular trip purpose. High impedance values are introduced within the pathskims to prohibit the allocation of trips to regions outside the external zone system or exceeding a designated, generalized cost difference between the respective modes of travel.

Additional sources, assumptions and methodologies used to develop the base Ohio Hub travel market data for each mode of travel are described below.

4.4.1 Air Mode

Origin-destination data for five major commercial airports in the study area was provided by the Federal Aviation Administration's (FAA) *10% Ticket Sample* (1999), which represented the latest-available data at the time this analysis was performed. The air passenger growth rates between 1996 and 1999 were then used to inflate the 1999 FAA *10% Sample* air trips to a 2000 base-year sample.

Only commercial air traffic is considered in this study. The data contains the number of existing (1999) air passenger trips for each respective O-D airport combination within the Ohio Hub Study zone system. Additionally, data were obtained that give the number of enplanements, or passenger trips, between airports in the study area and neighboring external zones. Connecting passenger trips, as well as trips to or from destinations beyond these boundaries, were excluded from the database as they do not reflect candidates for diversion to high-speed rail.

A trip purpose split analysis was performed on each respective O-D combination based on the collected survey data and by extrapolating the results of the surveys to similar routes. Finally, the

airport-to-airport data were distributed to the respective catchment zones based on generalized cost and socioeconomic characteristics to yield the final, zonal, O-D trip matrix by trip purpose.

4.4.2 Auto Mode

Auto trip data were derived from various state forecasting models. Where state forecasting models were lacking, models were applied to areas of similar socioeconomic and trip-making characteristics. Survey results were used to break down the trips produced by the individual state models by trip purpose (*i.e.*, *Business* and *Other*).

4.4.3 Rail Mode

For the 2004 Ohio Hub business plan, Amtrak provided a complete year 2000 station-to-station ridership matrix encompassing the entire study area. This matrix included O-D data culled from Amtrak's Cleveland-Pittsburgh (*Three Rivers*), Cleveland-Buffalo (*Lake Shore Limited*) and Buffalo-Niagara Falls (*Maple Leaf*) trains, from VIA Rail, and from Amtrak service data already provided in the MWRRI operating plan. It should be noted that the Amtrak data did not reflect any information for the 3-C corridor, so the base-line forecast for that corridor was model-derived, based on a benchmark comparison to other areas of similar socioeconomic and trip-making characteristics.

The Amtrak rail trip matrix was distributed on a zonal level based on a generalized cost distribution model and survey results. For the purpose of the study model, a *Business* and *Other* (leisure) trip purpose share was sought; therefore, surveys along the routes within the study area and previous trip purpose shares for the respective zones were used to allocate the total Amtrak passenger trips to obtain the complete trip purpose matrices.

Although the Amtrak station-to-station database contained a First and Coach Class classification, only total ridership characteristics were used. Rail surveys from previous studies have revealed that the First and Coach Class ridership did not provide sufficient definition to warrant a relationship between fare class and trip purpose. Both First Class and Coach Class have *Business* and *Other* travelers.

The 2007 Ohio Hub business plan update was conducted in conjunction with the Ohio Hub Economic Impact study. By comparing the rail trip generation rates to zonal socioeconomics in calibration of the economic models, as well as by benchmarking the performance of the rail corridors to each other, it became apparent that certain of the original Ohio Hub routes had been underforecasted in the 2004 Business Plan. In particular, the three corridors that had been underforecasted were the ones where Amtrak ticket lift data had been used in preparation of the forecast. It became apparent that Amtrak data used to initialize the Pittsburgh, Detroit and Buffalo corridors was reflective of demand for a long-distance train service in the middle of night. By benchmark comparison to other examples of daytime corridor services, we determined that the Amtrak base line data that we had been using bore little relation to the level of demand that would exist for a daytime Ohio Hub corridor service.

Therefore, for the 2007 Ohio Hub business plan update, the Amtrak long-distance train data was set aside and base line rail trips for all Ohio corridors were recalibrated on a consistent basis, using MWRRS benchmark comparisons that had already been developed. This reinitialization, along with upgrades to the the socioeconomic statistics that were described earlier, made the forecast for these three corridors more consistent not only with the earlier 3-C forecast, but also consistent with regard to the earlier MWRRS and new Incremental Corridors forecasts. The recalibration resulted in only a minor change to the 3-C forecast which had already been estimated based on benchmark comparisons. Howveer, the process raised the 2004 110-mph forecasts that had earlier been developed for the Ohio Hub Pittsburgh, Detroit and Buffalo corridors and for the east end of the MWRRS Chicago-Cleveland line.

4.4.4 Bus Mode

The study team developed an O-D database for intercity bus service using data provided by Greyhound Lines, Inc., which operates a variety of routes throughout the study area. Where Greyhound was not the intercity bus operator, trips were simulated based on socioeconomic characteristics and generalized costs.

A trip purpose breakdown was performed based on an analysis of survey results from a previous study. As in the other modes, the data obtained were station-to-station trips and needed to be transformed to a zone-to-zone descriptor. These trips were then distributed to their respective zones based on the generalized cost distribution obtained from the surveys and previous bus trip characteristic analyses.

4.4.5 Base Origin-Destination Data Summary

An external zone system was used to allocate all other trips going to areas outside the study area. As expected, auto is the most dominant mode; however, air service begins to take over some markets as the distance between city-pairs increases. The rail/bus market shares remain small for most city-pairs.

4.5 The Networks

Networks for the base and forecast years were developed for the four previously discussed modes of travel (air, auto, bus and rail).

Each network link was developed using schedule and fare information (for the air, bus and rail links) and for highway driving and access times (for highway connections to air, bus, and rail, as well as full auto trips). Fares and auto costs for each network link were also distinguished by trip purpose; for example, business trip costs are typically higher than leisure trip costs. Key attributes allocated to individual links by mode are shown in Exhibit 4-13; detailed networks for each mode are shown in the Appendices.

Exhibit 4-13: Key Components of Typical Networks

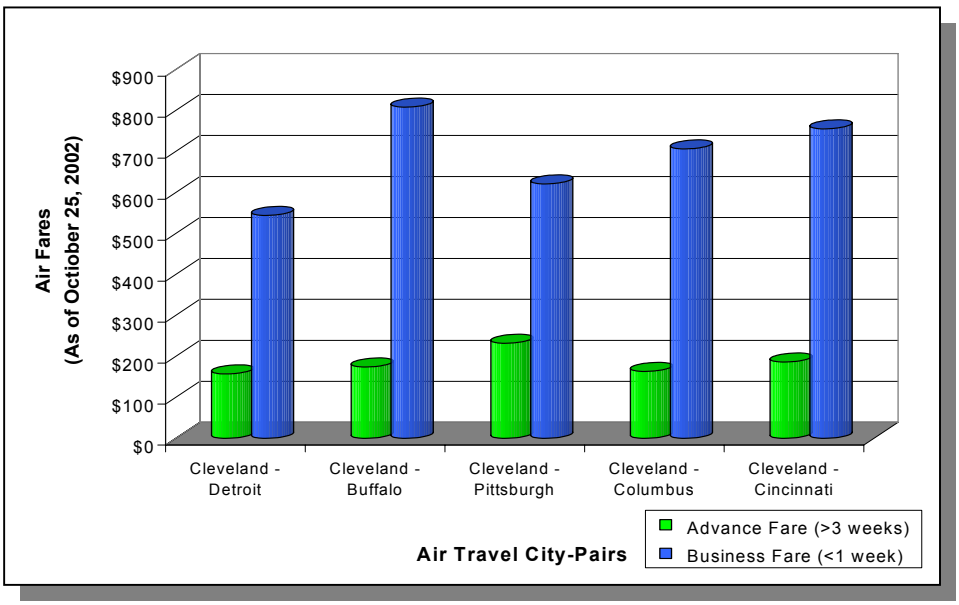
Attributes	Public Modes	Auto
Time	In-vehicle Time Access/Egress Times Number of Interchanges Connection Wait Times	Travel Time
Cost	Fare Access/Egress Costs	Operating Cost Tolls Parking (All divided by occupancy)
Reliability	On-time Performance	
Schedule	Frequency of Service Convenience of Times	

The auto network was developed to reflect the major highway segments within the study area. The Internal Revenue Service (IRS) Standard Mileage Rate was used to develop the auto network. The values provided by the IRS consist of an average cost of 32.5 cents per mile for *Business* and 10 cents per mile for *Other* travelers. The *Business* figure reflects the IRS estimate of the full cost of operating a vehicle because a business is required to pay the full cost for the use of an auto. *Other* costs are set at a marginal cost, which reflects how most social travelers perceive what their car costs to operate.

Air network attributes contain a range of variables that includes time and distances between airports, fares, on-time performance measures and connection times. Travel times and frequencies are derived from the Official Airline Guide (OAG). For travel time, the study team obtained the non-stop, shortest-path distance between airports. Airline fare information was provided by the official Internet websites of major airlines serving airports in the study area. This was cross-referenced with the Federal Aviation Administration's (FAA) revenue yields and average fares information obtained from the *Domestic Airlines Fares Consumer Report (Fourth Quarter 2000)* database. On-time performance measures were obtained from the FAA Delay and On-Time Statistics databases accessed from their website.

Exhibit 4-14 summarizes the average airfares of selected major city-pairs. Since most city-pairs in this study are relatively short-distance trips, travelers' airfares were found to be higher for business fares at 1-week advance booking ranging between $544 and $808, compared with 3-week advanced purchase fares ranging between $157 and $232. Thus, an alternative mode of transportation with a more reasonable cost than air would be an attractive option for many travelers in the region.

Exhibit 4-14: Average Air Fares for the Selected City-Pairs (in 2000$)



Bus network attribute data, such as fares, were obtained from official Internet websites (*e.g.*, Greyhound), while routes and schedules were obtained directly from Russell's *Official National Motor Coach Guide (2000)*. Fares were cross-referenced with fares obtained directly from Greyhound on selected routes within the study area. The rail network was developed from Amtrak schedules (year 2000) that provided travel times and distances for the routes within the proposed Ohio Hub Network. Fare-by-mile information was obtained directly from Amtrak ridership and revenue databases (year 2000) and was applied to the corridors based on their respective average fare by mile.

4.5.1 Feeder Bus Networks

In addition to the four network modes of travel, this study also considered the development of a feeder bus network for the rail system. The feeder bus network connects smaller communities, colleges and university towns to intercity passenger rail stations in the large urban centers. The feeder bus network will expand the service area and geographic reach of the Ohio Hub. Bus stations would include automobile passenger drop-off areas and small park-and-ride lots. Ideally, bus stations would be located in the center of a community, but must also be easily accessible to the regional highway system.

To be effective in diverting travelers from automobiles, rail feeder bus routes should be about 60 to 90 miles in length. An accepted guideline in the transportation industry suggests that feeder buses should operate over major roads and highways and should serve communities with a population of at least 20,000. The bus trip from the rail station to the last stop on the bus route should take no longer than 90 minutes. Each route would be served by at least one bus per day.

The feeder bus network for Michigan was identical to that proposed for the MWRRS. In Ohio, the feeder bus routes that have the greatest potential to contribute ridership to the Ohio Hub System shown in Exhibit 4-15 include:

- New Philadelphia-Canton-Akron-Cleveland
- Wooster-Ashland-Mansfield-Galion
- Wheeling/Steubenville-Pittsburgh
- Zanesville-Newark-Columbus
- Athens-Lancaster-Columbus
- Portsmouth-Chillicothe-Columbus
- Oxford-Hamilton-North Cincinnati
- Toledo-Findlay-Lima-Sidney-Troy-Dayton

For the incremental corridors assessment, the Newark-Columbus, Steubenville-Pittsburgh, and Lima-Fort Wayne feeder buses were replaced by rail services. Other feeder bus services were unchanged.

Exhibit 4-15: Ohio Hub Preliminary System Plan and Feeder Bus Routes