

5 THE ECONOMIC EVALUATION DATABASES

Introduction: The purpose of the Ohio Hub System Economic Impact Study is to explore the full range of economic impacts that will result from the development of the Ohio Hub passenger rail system. As previously described, two major tools are being developed to facilitate this process²³. These are –

- Consumer Surplus Analysis of User Benefit
- Economic Rent Analysis of Producer Benefits

To meet this need a series of databases calculation processes were developed for the study. See Exhibits 5.1 through 5.3. The following section outlines the development and calibration process adopted by the study.

Economic Impact Study process: Both Consumer Surplus and Economic Rent analyses are highly integrated. They use overlapping databases that reflect both supply and demand sides of the Ohio Hub intercity passenger rail system. The modeling and calibration process for both, the Consumer Surplus and Economic Rent assessments are shown in Exhibit 5.1. This overall process has four main stages –

- **Stage 1:** Four-mode transportation network, origin-destination and socioeconomic databases were developed in order to provide input to the evaluation tools, so that they can meet the assessment requirements. Those databases are related to a comprehensive zone system that defines specific geographic areas. See Exhibit 5.4.

- **Stage 2:** A transportation demand analysis using the calibrated demand functions in the COMPASS™ travel demand model to provide traffic volumes and the cost of travel (generalized cost) that are used in both Consumer Surplus and Economic Rent analysis.

- **Stage 3:** Economic Rent modeling and supply curve calibration is developed using the RENTS™ model.

- **Stage 4:** Detailed Consumer Surplus and Economic Rent analysis with user benefits and producer benefits results are generated.

Economic Rent modeling and calibration process has its own specific features, illustrated in Exhibit 5.2.

Developing the databases: This process is illustrated in Exhibit 5.3. A very important factor here is the availability of information gathered for the RightTrack™ system used to develop and evaluation the Ohio Hub system. These databases include –

- **Infrastructure Investment Plan:** This plan specifies the infrastructure requirements of the Ohio Hub system. It identifies the physical inventory of the system, capital needs, and ongoing infrastructure renewal.

- **Operating Plan:** This plan specifies the character of Ohio train operations, including labor, equipment, cash flows and secondary activities such as parcel system,

²³ In addition to the use of these major assessment tools, further analysis was completed to assess the impact of increased government receipts from increased taxes, changes in tourism visits and spending and changes in Ohio potential as a business center for manufacturing, commercial and service industry.

onboard services, equipment maintenance, track maintenance, and administrative and sales services.

- **Travel Data:** This demand database specifies the origin destination of travel by four modes; air, auto, intercity bus, and intercity rail, and by two purposes, business and community.

- **Network Data:** This supply side data specifies the cost and time of travel (generalized cost) by each mode and purpose for the Ohio Hub region - 256 internal and external zones in the system.

- **Socioeconomic Data:** This database specifies the base and forecast year levels of population, employment and income for each travel zone. This provides an understanding of the change in the economy of Ohio and the Ohio Hub study over the next thirty years.

In access to the data developed specifically for the Ohio Hub System Consumer Surplus Analysis, additional Economic Rent datasets include -

- **Property Data:** specifying the commercial and residential value of individual properties, as well as the number of different types of property (i.e. – households, housing units) in each zone.

- **Tax Data:** specifying the level of sales of personal taxation in each zone.

- **Station Data Base:** an analyzing the location of station sites and alternatives in the Ohio Hub system; collecting socioeconomic base year data for cities/towns that might serve as station sites.

Database development process illustrated in Exhibit 5.3 provides the geographic framework of transportation network and socio-economic and transportation data that are to be obtained from various sources.

Socio-economic database is prepared using mainly North American Census data (from the U.S. Bureau of Economic Analysis, Department of Commerce²⁴ and Statistics Canada²⁵). 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. Socio-data obtained from Census and used in Economic Rent analysis include base year employment, aggregate and average household income, aggregate and average residential property value, number of households and number of housing units. While base socio-data is obtained from Census, forecasted data is calculated using corresponding long-term projections, prepared by respected organizations, i.e. Woods & Poole Inc²⁶, Ontario Ministry of Finance, Quebec Statistical Institute (Institut de la Statistique²⁷). Socio-economic data used in the study is presented in Appendix E.

²⁴ See: <http://factfinder.census.gov/>

²⁵ See: <http://ceps.statcan.ca/english/census01/home/Index.cfm>

²⁶ 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.

²⁷ See: Ontario Ministry of Finance (<http://www.fin.gov.on.ca/english/>), Institut de la Statistique du Quebec. (http://www.stat.gouv.qc.ca/default_an.htm).

Exhibit 5.1: Economic Impact Study - Modeling and Calibration Process

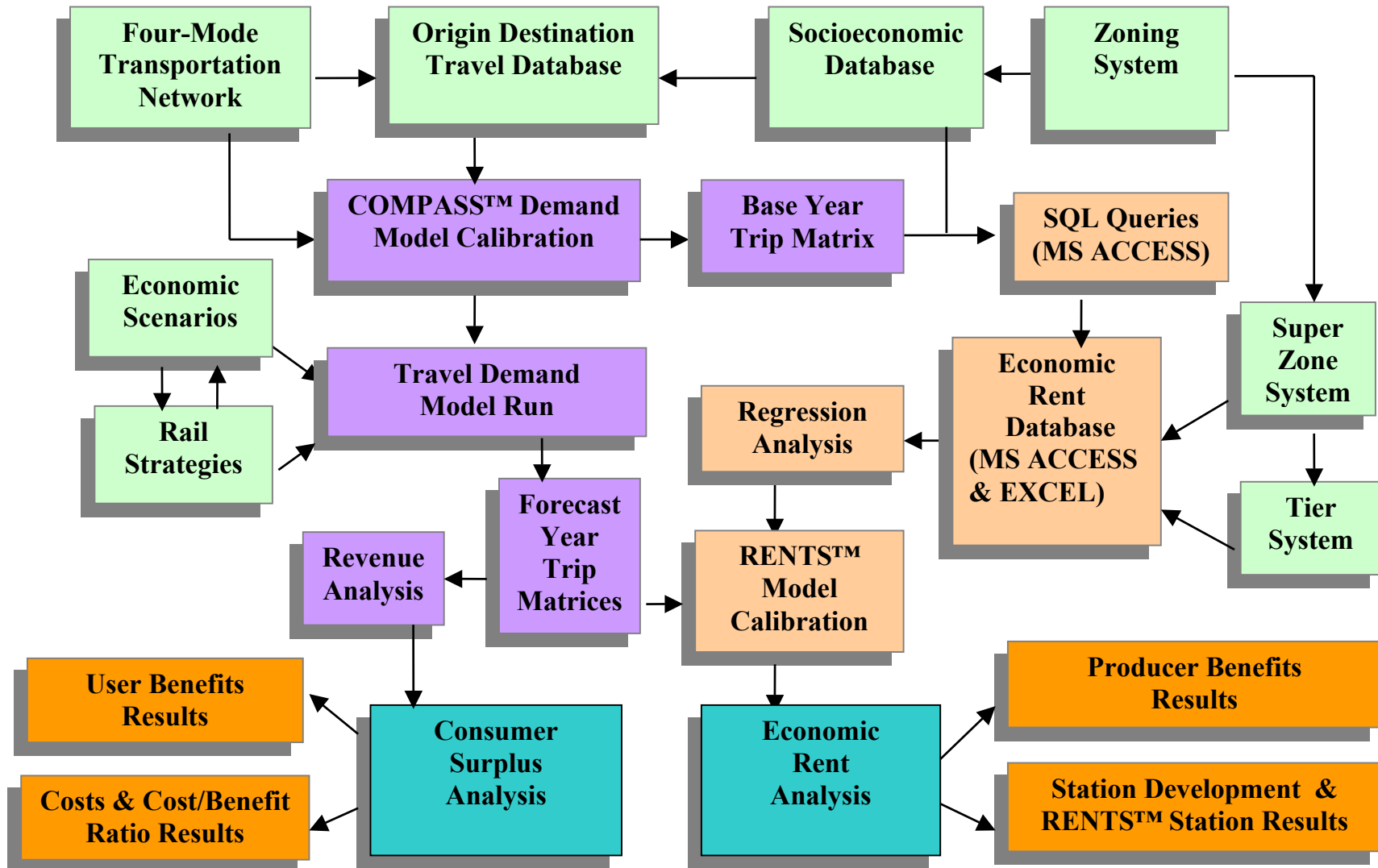


Exhibit 5.2: Economic Rent Study – Modeling and Calibration Process

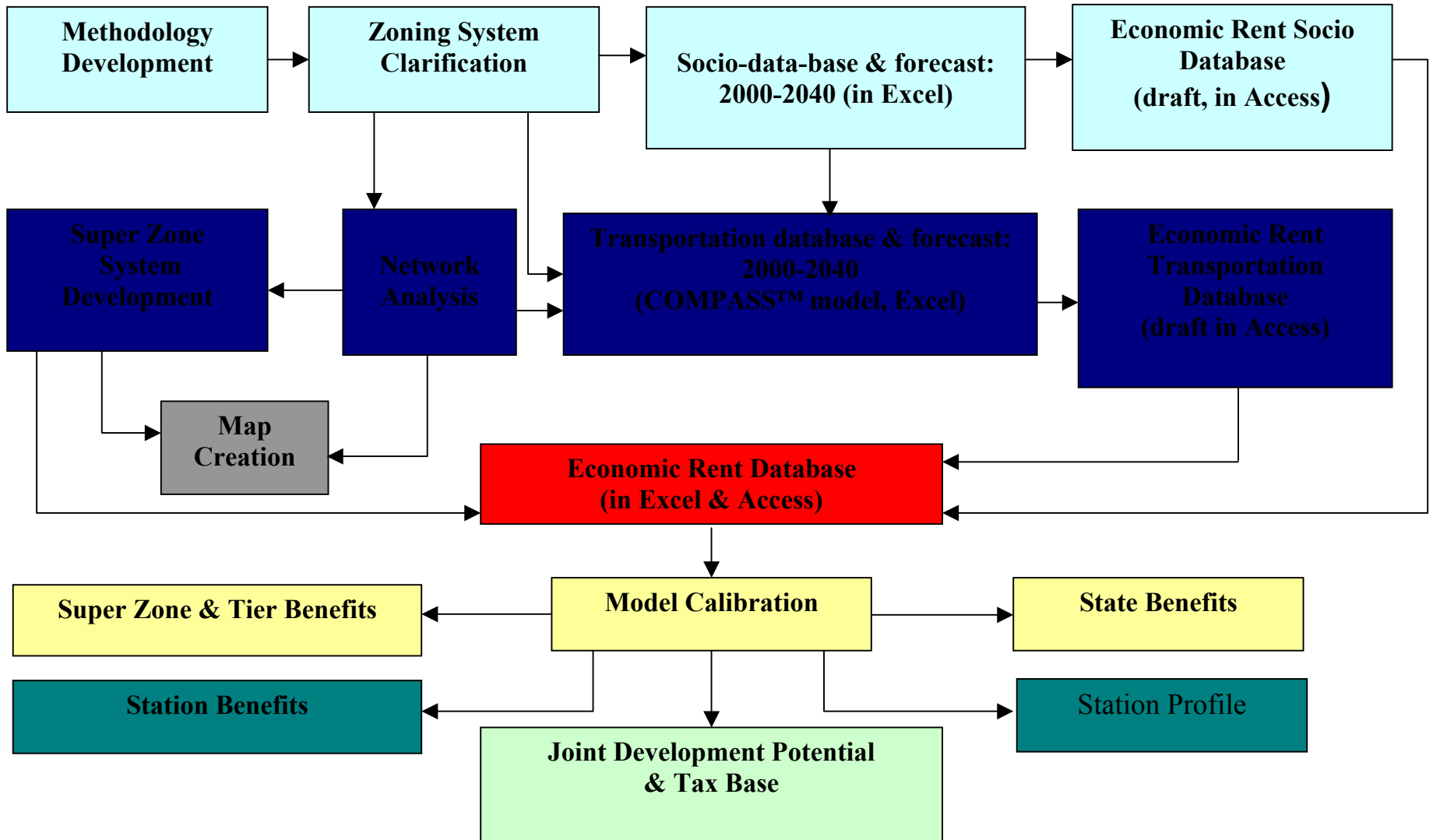


Exhibit 5.3: Economic Impact Study – Database Development

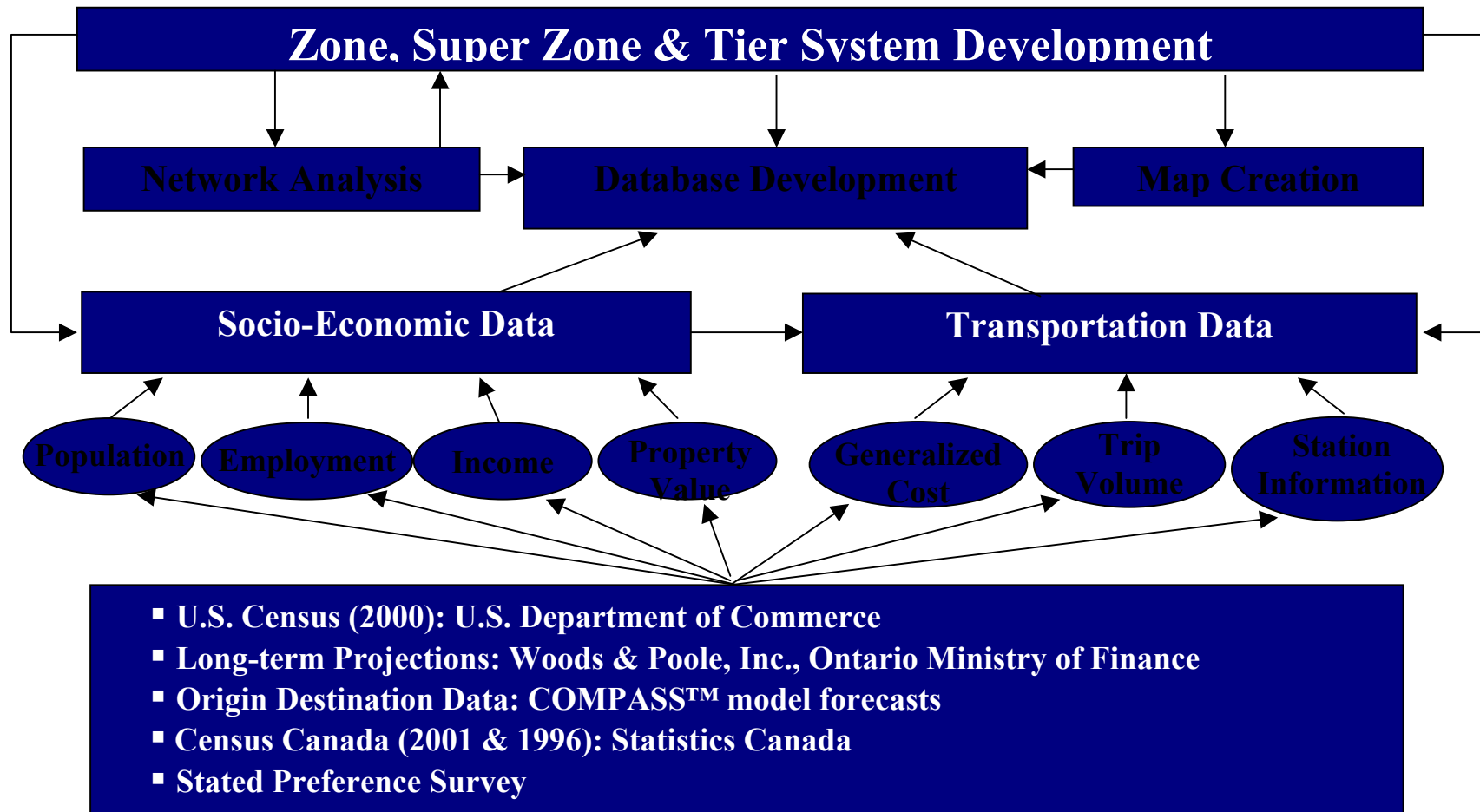
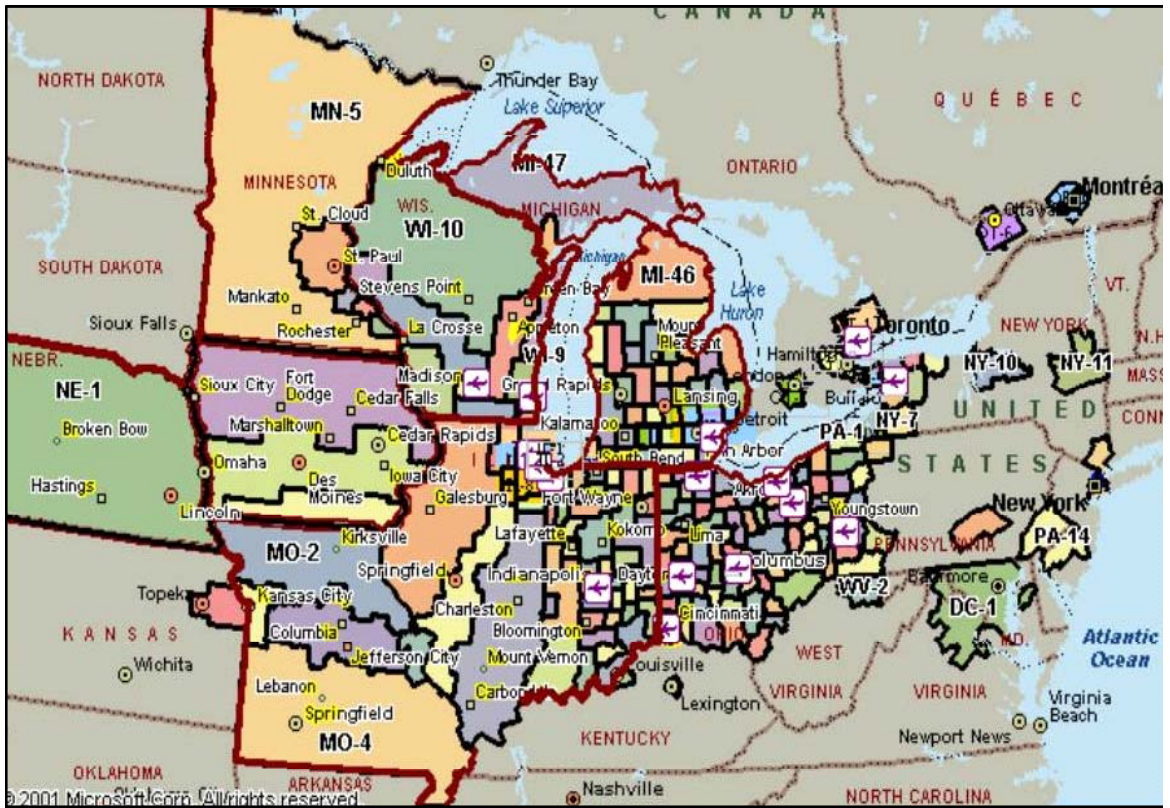


Exhibit 5.4: Ohio Hub Study Area Internal and External Zoning System



Travel Demand database is prepared using the framework of the COMPASS™ demand model. It includes the analysis of origin destination data by two purposes in relation to different transportation networks, stated preference data and socio-economic data.

The main strength of the COMPASS™ Model System is in its capability to provide comparative evaluations of alternative socioeconomic scenarios and network strategies (transport systems and costs). Travel forecasts are made for 30-40 year-period for different transportation modes (i.e. car, air, bus and rail) and different trip purposes (business and non-business). Trip volume forecasts (T_{ijp}) - the total number of trip origin and destination for each zone pair, - are made in COMPASS™ using base and projected socio-economic data (SE_{ijp}) on population, employment and average household income for each zone. As shown in Equation (8) the total number of trips between any two zones for all modes of travel (T_{ijp}) segmented by trip purpose is also a function of the total travel utility of the transportation system between these two zones.

As a result the model considers not just socioeconomic growth, but also the quality of service offered by all modes between all zones. Increasing travel costs and lower economic growth mean reductions in relative trip making, while falling travel cost and higher economic growth increases the growth of trips between zones. In this respect the COMPASS™ model behaves like a typical demand model, but differs from the typical 'four step' model, which has a fixed origin-destination matrix and is insensitive in terms of total demand to rising or falling travel costs.

(The coefficients β_{0p} , β_{1p} , β_{2p} , for each purpose p are to be estimated in the frame of the regression analysis).

$$T_{ijp} = e^{\beta_{0p}} (SE_{ijp})^{\beta_{1p}} e^{\beta_{2p} U_{ijp}} \quad (8)$$

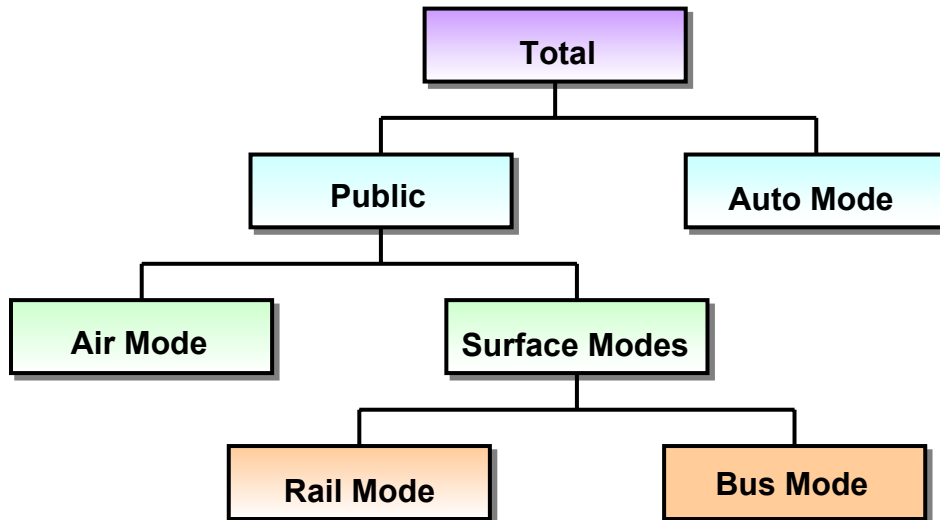
Travel utility (U_{ijp}) is generated as a function of the weighted sum of the generalized cost, see (9), and provides a measure of the quality of the transportation system in terms of time, cost, reliability and level of service provided by all modes for a given trip purpose. Generalized cost is a specific metric for transportation efficiency defined in terms of time (see equations 1 and 7 in chapters 3-4). Base generalized cost corresponds to the existing network, while projected generalized cost correspond to the network after Ohio Hub project implementation.

$$U_{ijp} = f(GC_{ijp}) \quad (9)$$

Data on average (weighted) generalized cost (i.e. travel utility) and average weighted volume of trips is required by Economic Rent model and is calculated later in the frame of this model applying database and statistical analysis programming tools.

Travel utility used in the total demand model is a logical and intuitively sound method of assigning a value to the travel opportunities provided by the regional transportation system. The travel utility function is different for different types of modes. Total utility of the regional transportation system is an aggregate function. It is generated by a level-by-level combination of travel utilities calculated for each different type of mode. Relative modal shares of each travel mode included in the total utility function are derived by comparing the relative levels of service offered by each of the travel modes. The Modal Split structure for Ohio Hub regional transportation is presented on Exhibit 5.5.

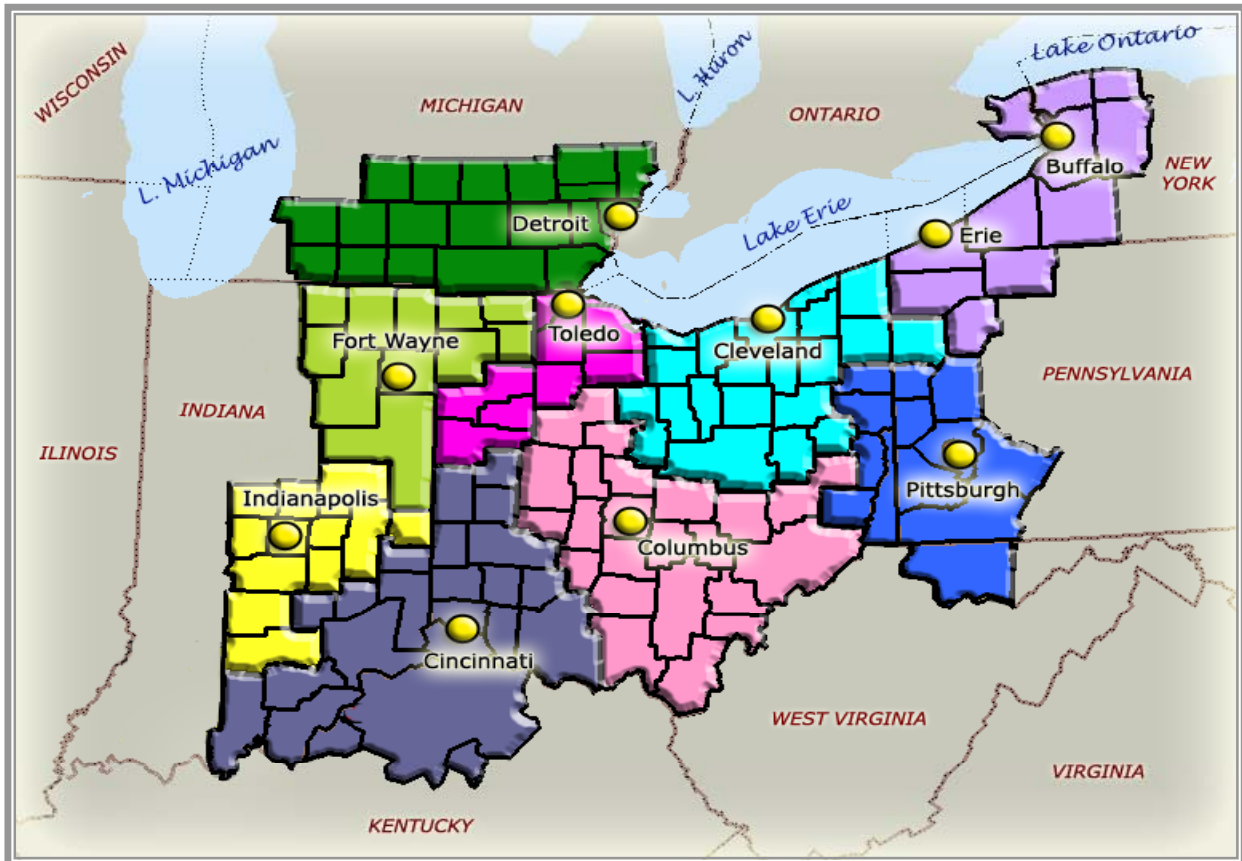
Exhibit 5.5: Total Demand and Model Split Structure



Super Zone & Tier System. The development of a super zone and urban tier structure is a critical input for measuring the economic rent 'profiles' and 'tents' that exist today in the study area. The economic rent profile and tents provide an understanding of the local economy and the interdependence of cities, towns and urban areas along the rail corridors of the study area. Within any settlement pattern the largest markets will tend to dominate hinterlands that will include other cities. Using Christalla [9] Location Theory it is likely that different urban areas will belong to a hierarchy of settlements within a market area of a dominant city. In Ohio for example Cleveland's market area, hinterland includes Ashtabula. As a result, to develop the relevant economic rent 'profiles' or 'tent' it is necessary to divide the study area into Super Zones that describe the economic rent tent of the dominant city and its supporting urban areas.

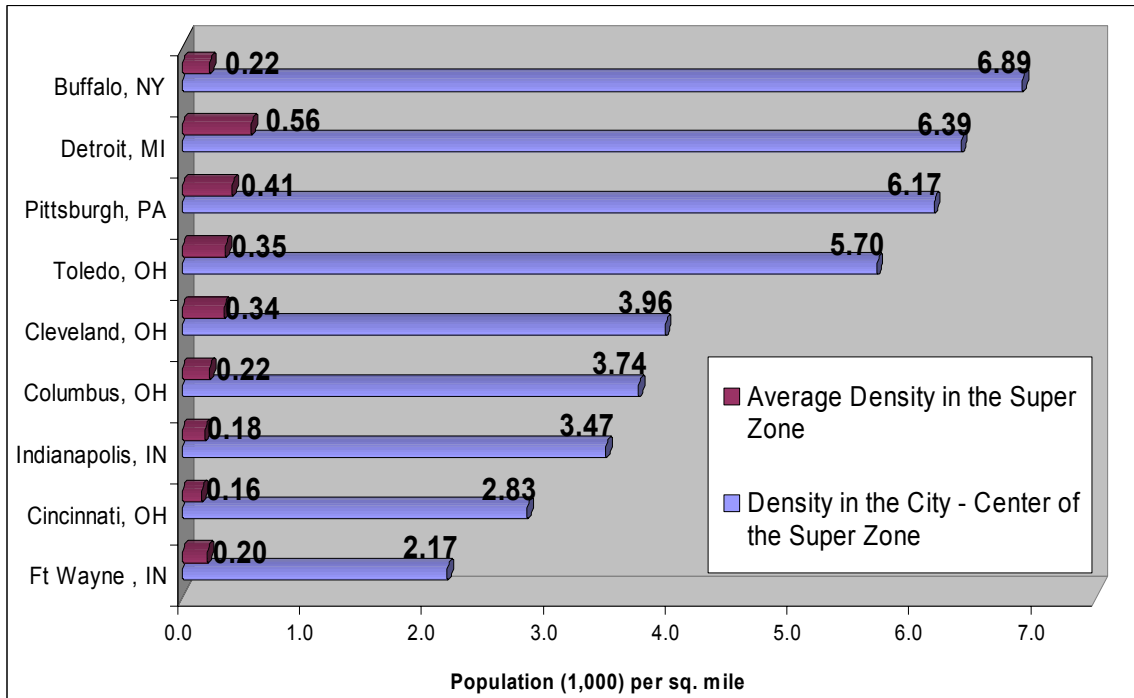
By evaluating the role of each city, the Ohio Hub region was partitioned into 9 'super zone' regions (or market areas), as shown in Exhibit 5.6. Because of the hub-and spoke structure of the Ohio Hub passenger rail system, Cleveland was selected as the major city for the system even though in socio-economic terms it is smaller than Detroit and Columbus and only marginally larger than Pittsburgh and Cincinnati. The Toledo super zone was separated from the Cleveland super zone as it is also influenced by Detroit, Columbus as well as Cleveland, but the Erie and Buffalo areas were combined together.

Exhibit 5.6: Ohio Hub Passenger Rail Super Zone System



Each 'super zone center' is a highly urbanized area (large city) ²⁸. The population density in principal each city (center of the super zone) is much higher than the average density in this super zone (see Exhibit 5.7). Super zones show the area of primary economic influence of specific cities and do not necessarily conform to state boundaries. For example, Lexington and Northern Kentucky are clearly part of the Cincinnati super zone region. The areas in the states of Pennsylvania and New York, which influenced by Erie or Buffalo, are all parts of the Buffalo-Erie super zone²⁹. Major cities in the center of a state like Indianapolis can easily be seen to dominate much of their state. However, it is not so clear whether areas like North East Pennsylvania belong to Cleveland or Pittsburgh or whether Dayton and the surrounding areas are more a part of Columbus or Cincinnati. In these circumstances, the super zone boundaries must be somewhat arbitrary and for analysis purposes we have used an allocation that gives the most conservative result.

Exhibit 5.7: Population Density, 2005. Super Zone Center vs. Average in Super Zone



The super zone system developed for the Economic Rent study contains 141 travel zones selected from the 256-zones system. Travel zones included in the super zone system connected either to Ohio Hub stations or to the selected MWRRI stations. Only those MWRRI stations (and corresponding zones) that substantially benefit from Ohio Hub Passenger Rail project were included in the super zone system³⁰.

²⁸ The exception is Buffalo-Erie super-zone that has two market centers.

²⁹ Erie-Buffalo super zone is actually an aggregation of two separate super zones with the centers in Buffalo and Erie. The aggregation was made for study purposes.

³⁰ As it can be seen from Exhibit 5.6 these MWRRI stations are located in the States of Indiana or Michigan and are parts of Indianapolis or Fort Wayne super zones. About MWRRI see: [20].

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In addition, each super zone is to be broken down into a hierarchy of cities that reflect their relative interaction with each other and with the principal city of the Super Zone. Each zone is categorized within the tier system based on its socio-economic characteristics and its connectivity in the transportation network. The role of Cleveland as a hub of the Ohio Passenger Rail system (see Exhibit 5.8) defined its primary role in the tier system developed for the study (see, Exhibit 5.9). The "Cleveland Regional System" is shown in Exhibit 5.10. The hierarchy contains four levels (tiers) underneath Cleveland.

Regional systems were developed for the Ohio Hub study in accordance with Economics of Location and Central Place Theory [9], [10]. The classification of cities in a hierarchy system was made using both population and population density as a criteria. (See Exhibits 5.11-5.12 as examples).

Exhibit 5.8: Ohio Hub Rail Lines - Preliminary Plan



Exhibit 5.9: Ohio Hub Hierarchy of Super Zones

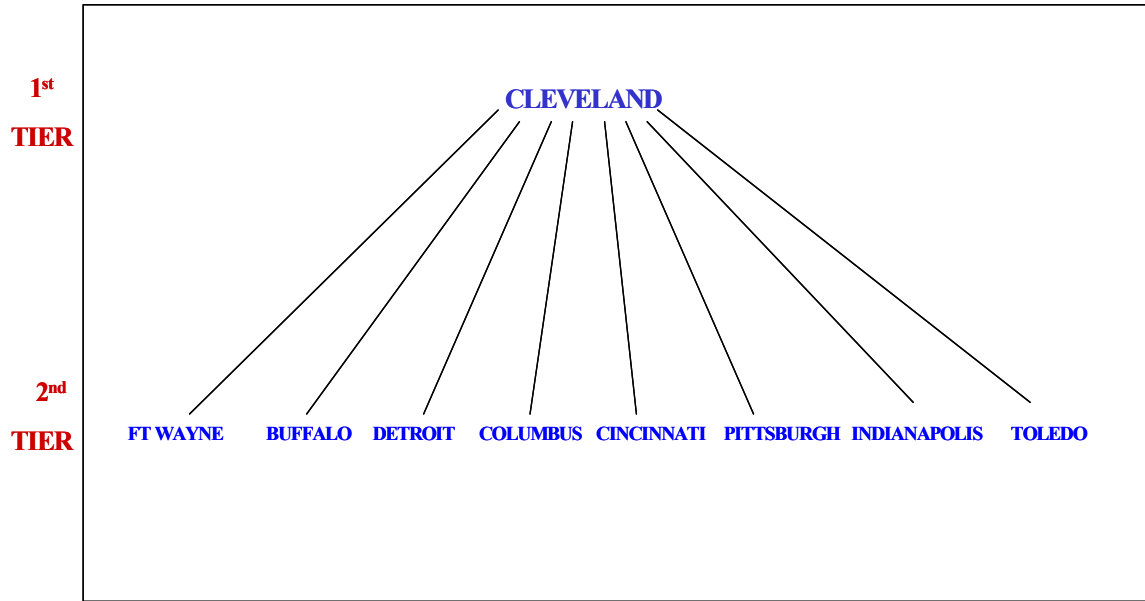


Exhibit 5.10 Cleveland Hierarchy of Settlement

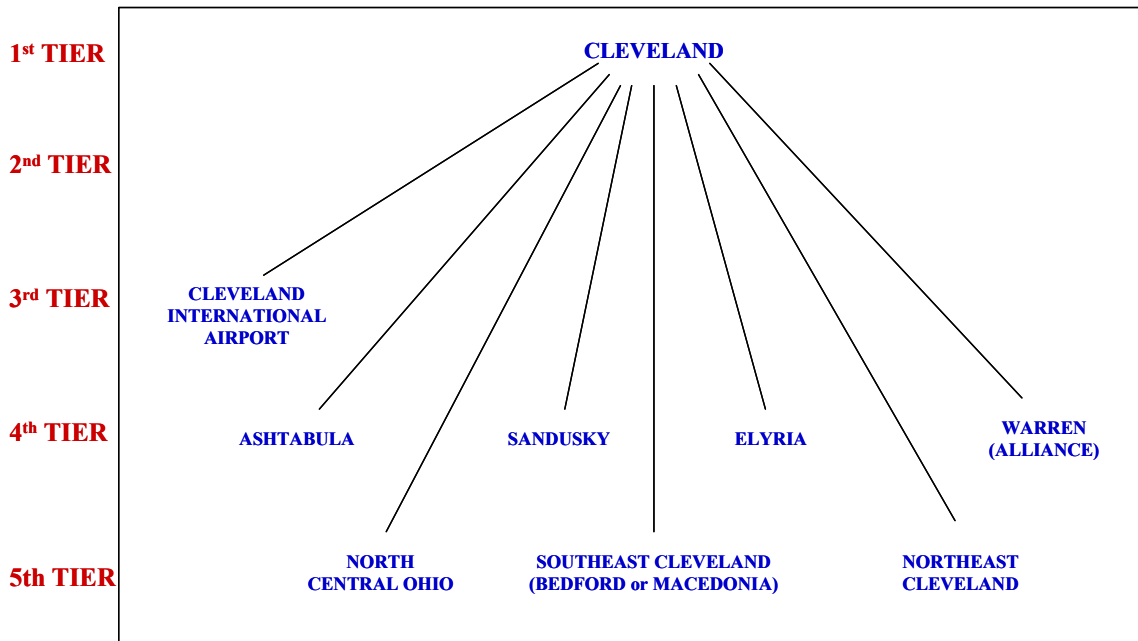


Exhibit 5.11: Cincinnati Super Zone. City Population (2005) by Hierarchy Level

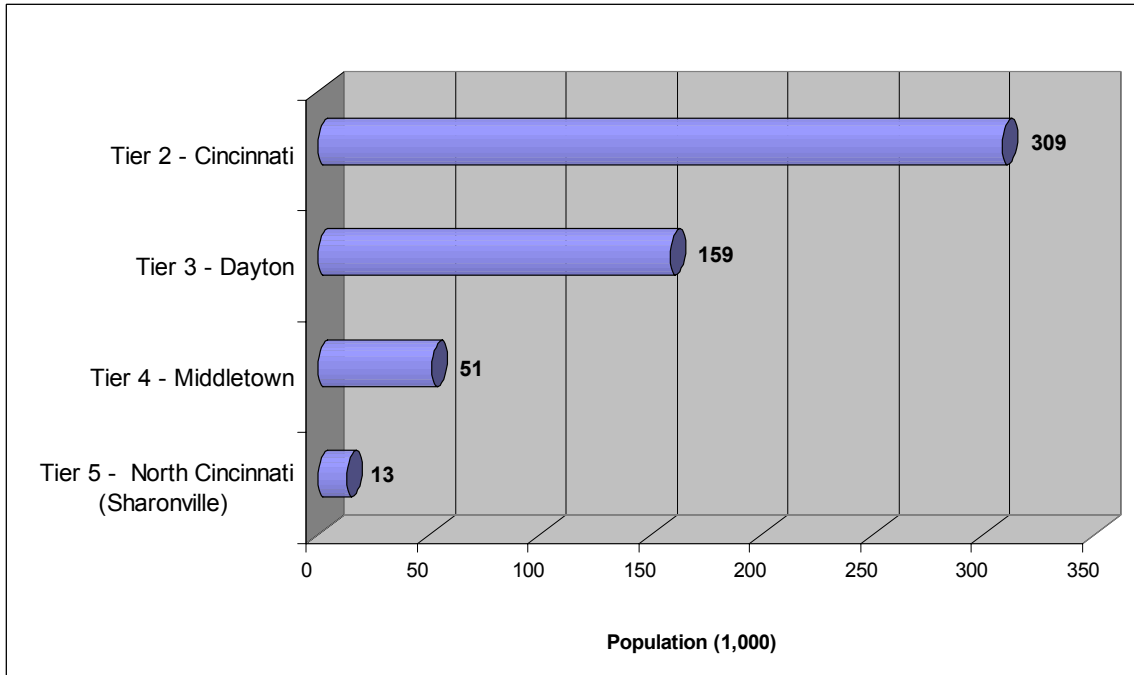
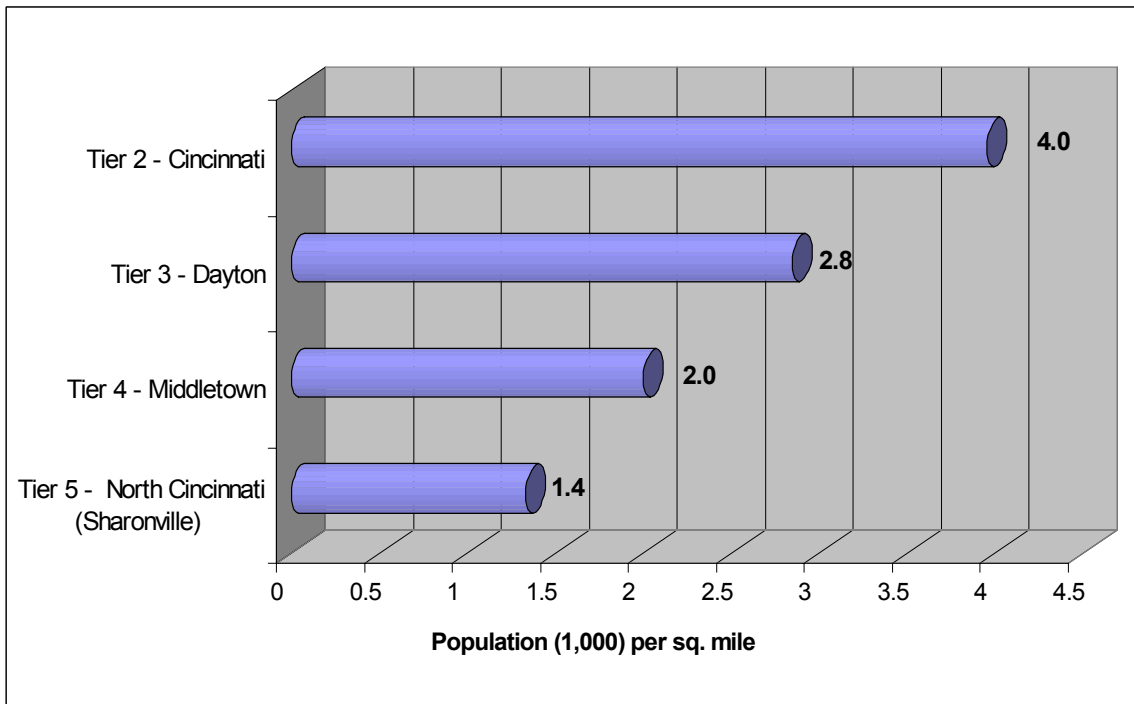


Exhibit 5.12: City Population Density (2005) by Hierarchy Level. Cincinnati Super Zone.

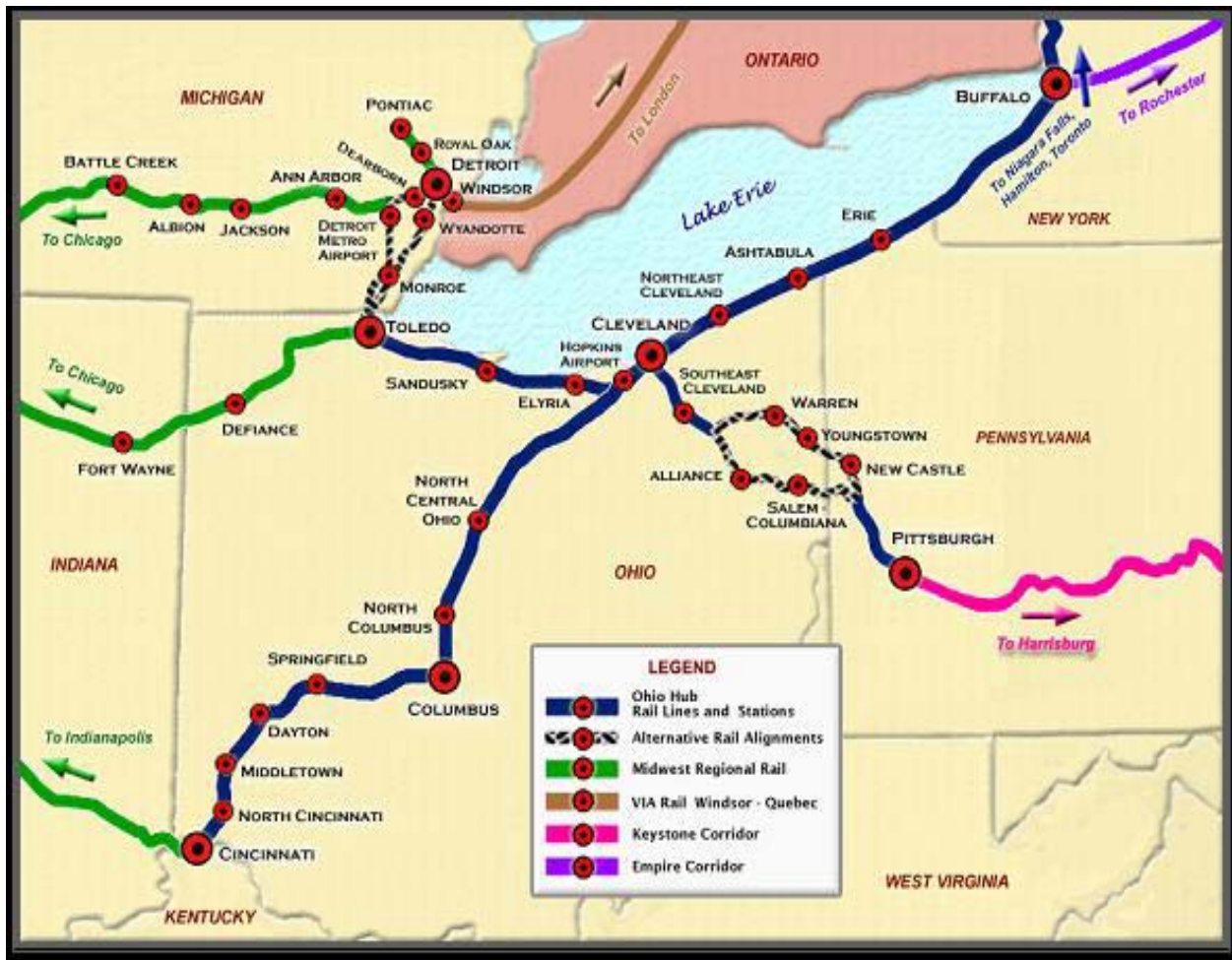


Economic rent analysis is calculated separately for each transportation zone in the frame of each super zone and for each level. Hierarchy structures of the cities in the super zone plays an especially important role in the final stage of Economic Rent analysis – for the process of distributing benefits between stations.

The Ohio Hub Rail System is to be integrated into the MWRRI system, Keystone and Empire Corridors and Canadian VIA rail system, as shown in Exhibit 5.13. In the process of Economic Rent analysis we support this integration by using both 9-super zone system with 141 travel zones (see Exhibit 5.6) and an internal and external zoning system with 256 zones. (See: Exhibit 5.4)³¹.

Conclusion: It was found that the socio-economic and transportation databases developed provided a solid basis for the evaluation of Economic Rent and Consumer Surplus. The use of these two techniques will allow an evaluation both demand side and supply sides of the economic benefits of project.

Exhibit 5.13: Ohio Hub and Other Rail Lines – Preliminary Plan



³¹ This issue will be also covered in the Economic Rent Model calibration section of Chapter 7.