Chapter 2
The Transportation Planning Process

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TRANSPORTATION PLANNING

Contents

INTRODUCTION

- New to know how decisions to build transportation facilities are made, and to highlights the major elements of the process
- The system in place is the product of many individual decisions to select projects to implement
- Among the factors that may justify a transportation project are improvements in traffic flow and safety, energy, travel time, economic growth, accessibility,...
- In some instances, transportation projects are not selected because of opposition from those who would be adversely affected
- Whatever the reason for selecting/rejecting a project, a specific process is followed to lead to the decision

- The process for planning transportation should provide unbiased information on the effects of a proposed project on affected community and users. Example: state what noise/air pollution will occur.
- The process must be flexible enough to be applicable to any transportation project or system
- The process must consider society’s needs and concerns. Examples: include energy conservation, traffic congestion, environmental impacts, safety, …
- Transportation planning process is not intended to give a decision or to give a single result that must be followed, although it can do so in relatively simple situations. Rather, the process is intended to provide the appropriate information to those who will be affected and those responsible for deciding whether the transportation project must go forward

BASIC ELEMENTS OF TRANSPORTATION PLANNING

- TP Comprises seven basic interrelated elements, which are not necessarily carried out sequentially:
  - Situation definition
  - Problem definition
  - Search for solutions
  - Analysis of performance
  - Evaluation of alternatives
  - Choice of project
  - Specification and construction
- TP process is illustrated (Fig. 11.1) using an example involving the feasibility of constructing a new bridge.

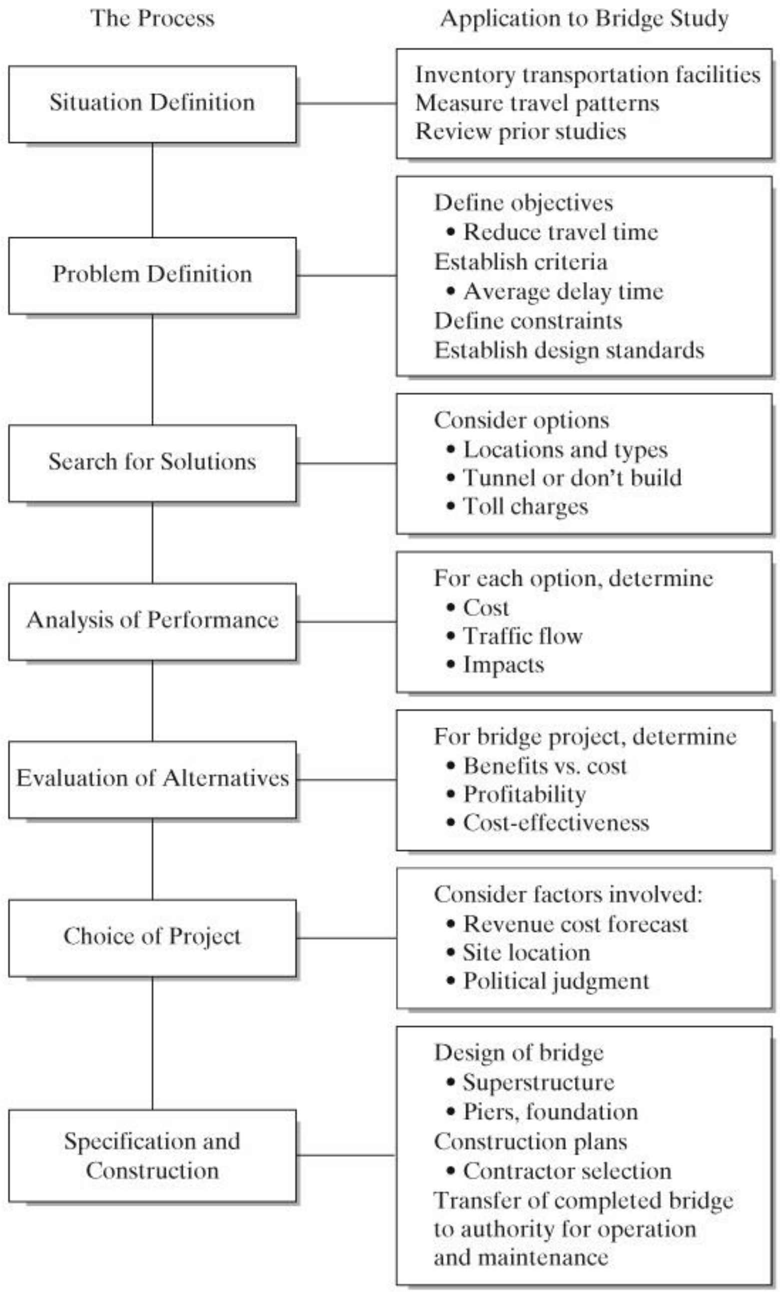


Figure 11.1 Basic Elements in the Transportation Planning Process Applied to Consider the Feasibility of a New Bridge

Situation Definition

Involves all the activities required to understand the situation that led to the perceived need for a transportation improvement

- **The aspects of the present situation are described**
- **The scope of the system to be studied is delineated**
- **The present system is analyzed and characterized**
- **Information about the surrounding area, people, etc.**
- **Relevant previous reports and studies are reviewed**
- **Example: Situation definition involves developing a description of the present highway/transportation services in the region; measuring present traffic volumes; reviewing prior studies, geological maps; and defining scope of the study and affected area**

Problem Definition

Describes the problem in terms of the objectives to be accomplished by the project and to translate those objectives into criteria that can be quantified

- **Objectives state purposes, e.g., reduce traffic congestion; to improve safety; to maximize benefits**
- **Criteria are the measures of effectiveness (MoE) used to quantify to what extent a proposed project will achieve the stated objectives**
- **Identify limitations and standards to conform to**
- **Example: the objective "to reduce travel time", may use "average delay time" as the MoE**
- **limitations/constraints may be topography, standards (width, clearances, loading), capacity, …**

Search for Solutions

Consider a variety of ideas, designs, locations, etc., that may provide solutions to the problem

- **A brainstorming stage, in which many options may be proposed for later testing and evaluation**
- **Alternatives can be proposed by any group/agency, such as adding bike lanes to reduce traffic volumes**
- **A variety of options can be developed for a particular situation, which may be considered in this phase**
- **Options may include diff. modes, roads, network, operations, demand management, land-use changes, to narrow the choices to most promising**
- **Data, field testing, and cost estimates may be needed**
- **Example: variety of options including locations, types**

Analysis of Performance

Estimate how each of the proposed alternatives would perform under present and future conditions

- **The criteria are calculated for each option**
- **Involve the use of models to estimate travel demand**
- **Determine the construction cost of the alternatives, and annual costs for maintenance and operation**
- **Determine information on the use of the system (e.g., trip length) to calculate user benefits for various MoE**
- **Impacts/Environmental effects are to be estimated**
- **Referred to as the transportation planning or systems analysis process, that integrates network supply with travel demand forecasts to get equilibrium flows**
- **Example: estimates of the traffic and prepare preliminary cost estimates and impacts per option**

Evaluation of Alternatives

Determine how well each alternative will achieve the objectives of the project as defined by the criteria

- The performance data produced in the analysis phase are used to compute the benefits and costs per option
- Find benefit–cost ratio for each option to examine which option would result in a sound investment
- Other economic tests may be applied, e.g., NPV
- Alternatively, a weighted ranking for each option may be produced and compared, where cost-effectiveness matrix (e.g., project cost vs. number of homes displaced) will give better understanding as to how each option performs for each criteria, at what cost, ...
- Example: determine the B/C for each option, then evaluate environmental impact

Choice of Project

Select the project alternative after considering all the factors involved

- **In a simple situations, a single criterion (cost) might e used and to chosen the project with the lowest cost**
- **In more complex project, many factors have to be considered, and selection is based on how the results are perceived by those involved in decision-making**
- **Usually need for community participation**
- **It is possible that no alternative will meet the criteria/ standards, and additional Investigation is necessary**
- **The engineer is to act professionally/ethically, to provide all information on feasible alternatives to DM**
- **Example: DM look carefully at the revenue-cost forecasts and consider financially sound project**

Specification and Construction

After selection of the project, it moves into a detailed design phase where each components is specified

- **This involves the physical location, geometric dimensions, and structural configuration**
- **Design plans are produced that can be used by contractors to estimate the project construction cost**
- **When a construction firm is selected, these plans will be the basis on which the project will be built**
- **Example: Once option is selected, design is produced (superstructure, piers and foundations, widths, traffic signals, and lighting). These plans are given to contractors to submit bids for construction. Upon completion, the facility is turned over to the local authority for operation and maintenance.**

Example 11.1 Planning the Relocation of a Rural Road

To illustrate the transportation planning process, a situation that involves a rural road relocation project is described. Each of the activities that are part of the project is discussed in terms of the seven-step planning process previously described. This project includes both a traffic analysis and an environmental assessment and is typical of those conducted by transportation consultants or metropolitan transportation organizations. (This example is based on a study completed by the engineering firm, Edwards and Kelsey.)

Step 1. Situation definition. The project is a proposed relocation or reconstruction of 3.3 miles of U.S. 1A located in the coastal town of Harrington, Maine. The town center, a focal point of the project, is located near the intersection of highways U.S. 1 and U.S. 1A on the banks of the Harrington River, an estuary of the Gulf of Maine. (See Figure 11.2.) The town of Harrington has 553 residents, of whom 420 live within the study area and 350 live in the town center. The population has been declining in recent years; many young people have left because of the lack of employment opportunities. Most of the town's industry consists of agriculture or fishing, so a realignment of the road that damages the environment would also affect the town's livelihood. There are 10 business establishments within the study area; 20 percent of the town's retail sales are tourism related. The average daily traffic is 2620 vehicles/day, of which 69 percent represent through traffic and 31 percent represent local traffic.

Step 2. Problem definition. The Maine Department of Transportation wishes to improve U.S. 1A, primarily to reduce the high accident rate on this road in the vicinity of the town center. The problem is caused by a

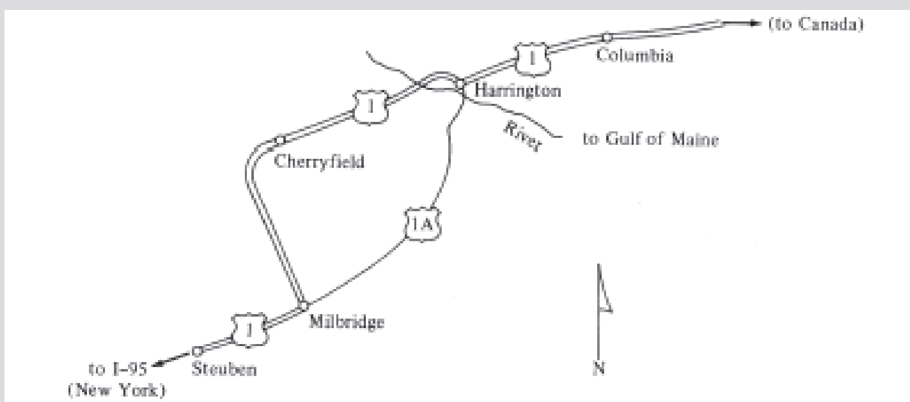
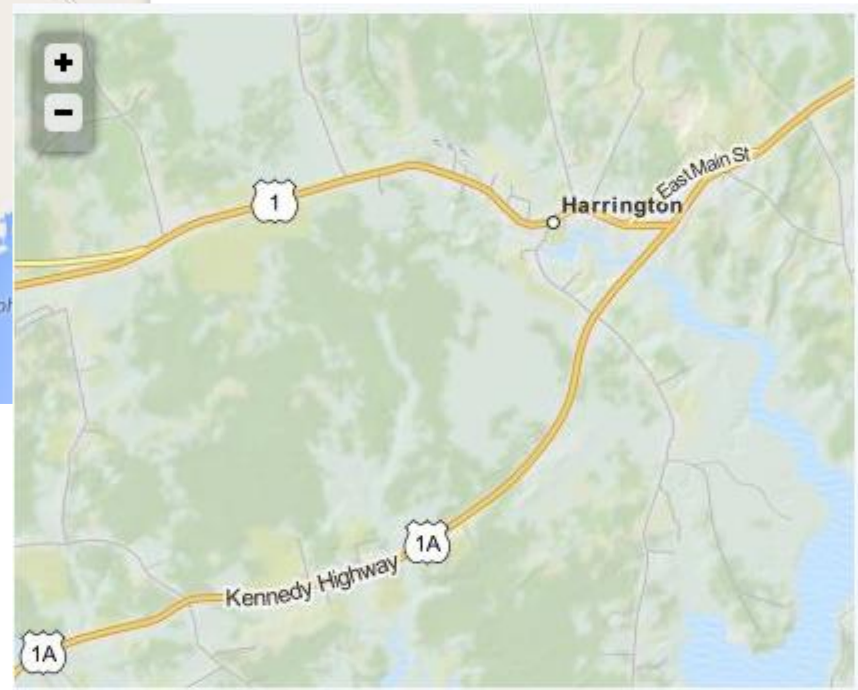


Figure 11.2 Location Map for Highways U.S. 1 and U.S. 1A



You can access info. on the town on
http://www.city-data.com/city/Harrington-Maine.html

narrow bridge that carries the traffic on U.S. 1A into the town center, the poor horizontal and vertical alignment of the road within the town center, and a dangerous intersection where U.S. 1A and U.S. 1 meet. The accident rate on U.S. 1A in the vicinity of the town center is four times the statewide average. A secondary purpose of the proposed relocation is to improve the level of service for through traffic by increasing the average speed on the relocated highway.

The measures of effectiveness for the project will be the accident rate, travel time, and construction cost. Other aspects that will be considered are the effects that each alternative would have on a number of businesses and residences that would be displaced, the changes in noise levels and air quality, and the changes in natural ecology. The criteria that will be used to measure these effects will be the number of businesses and homes displaced, noise levels and air quality, and the acreage of salt marsh and trees affected.

Step 3. **Search for solutions.** The Department of Transportation has identified four alternative routes, as illustrated in Figure 11.3, in addition to the present route—Alternative 0—referred to as the null or "do-nothing" alternative. All routes begin at the same location—3 miles southwest of the center of Harrington—and end at a common point northeast of the town center. The alternatives are as follows:

- *Alternative 1:* This road bypasses the town to the south on a new location across the Harrington River. The road would have two lanes, each 12-ft wide with 8-ft shoulders. A new bridge would be constructed about one-half mi downstream from the old bridge.

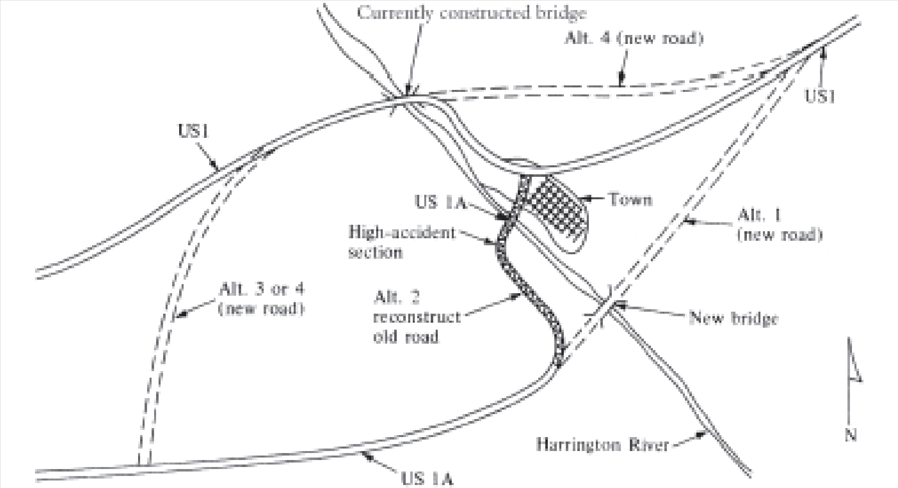


Figure 11.3 Alternative Routes for Highway Relocation

- *Alternative 2:* This alternative would use the existing U.S. 1A into town, but with improvements to the horizontal and vertical alignment throughout its length and the construction of a new bridge. The geometric specifications would be the same as for Alternative 1.
- *Alternative 3:* This new road would merge with U.S. 1 west of Harrington, and then continue through town. It would use the Route 1 Bridge, which was recently constructed. Geometric specifications are the same as those for the other alternatives.
- *Alternative 4:* This road would merge with U.S. 1 and use the Route 1 Bridge, as in Alternative 3. However, it would bypass the town center on a new alignment.

Step 4. **Analysis of performance.** The measures of effectiveness are calculated for each alternative. The results of these calculations are shown in Table 11.1 for Alternatives 1 through 4 and for the null alternative. The relative ranking of each alternative is presented in Table 11.2. For example, the average speed on the existing road is 25 mi/h, whereas for Alternatives 1 and 4, the speed is 55 mi/h, and for Alternatives 2 and 3, the speed is 30 mi/h. Similarly, the accident factor, which is now four times the statewide average, would be reduced to 0.6 for Alternative 4 and 1.2 for Alternative 1. The project cost ranges from $1.18 million for Alternative 3 to $1.58 million for Alternative 2. Other items that are calculated include the number of residences displaced, the volume of traffic within the town both now and in the future, air quality, noise, lost taxes, and acreage of trees removed.

Table 11.1 Measures of Effectiveness for Rural Road

	Alternatives				
Criteria	*0*	*1*	*2*	*3*	*4*
Speed (mi/h)	25	55	30	30	55
Distance (mi)	3.7	3.2	3.8	3.8	3.7
Travel time (min)	8.9	3.5	7.6	7.6	4.0
Accident factor					
(Relative to statewide average)	4	1.2	3.5	2.5	0.6
Construction cost ($ million)	0	1.50	1.58	1.18	1.54
Residences displaced	0	0	7	3	0
City traffic					
Present	2620	1400	2620	2520	1250
Future (20 years)	4350	2325	4350	4180	2075
Air quality ($\mu g/m^3$ CO)	825	306	825	536	386
Noise (dBA)	73	70	73	73	70
Tax loss	None	Slight	High	Moderate	Slight
Trees removed (acres)	None	Slight	Slight	25	28
Runoff	None	Some	Some	Much	Much

Table 11.2 Ranking of Alternatives

	Alternatives				
Criterion/Alternative	*0*	*1*	*2*	*3*	*4*
Travel time	4	1	3	3	2
Accident factor	5	2	4	3	1
Cost	1	3	5	2	4
Residences displaced	1	1	3	2	1
Air quality	4	1	4	3	2
Noise	2	1	2	2	1
Tax loss	1	2	4	3	2
Trees removed	1	2	2	3	4
Runoff	1	2	2	3	3

Note: 1 = highest; 5 = lowest

Step 5. Evaluation of alternatives. Each of the alternatives is compared with the others to assess the improvements that would occur based on a given criterion. In this example, we consider the following measures of effectiveness and their relationship to project cost.

Comparison of Each Criterion

- *Travel time:* Every alternative improves the travel time. As shown in Figure 11.4, the best is Alternative 1, followed by Alternative 4. Alternatives 2 and 3 are equal, but neither reduces travel time significantly.
- *Accident factor:* Figure 11.5 shows that the best accident record will occur with Alternative 4, followed by Alternatives 1, 3, and 2.
- *Cost:* The least costly alternative is simply to do nothing, but the dramatic potential improvements in travel time and safety would indicate that the proposed project should probably be undertaken. Alternative 3 is lowest in cost at $1.18 million. Alternative 2 is highest in cost, would not be as safe as Alternative 3, and would produce the same travel time. Thus, Alternative 2 would be eliminated. Alternative 1 would cost $0.32 million more than Alternative 3, but would reduce the accident factor by 1.3 and travel time by 4.1 minutes. Alternative 4 would cost $0.04 million more than Alternative 1 and would increase travel time, but would decrease the accident factor. These cost-effectiveness values are shown in Figures 11.4 and 11.5. They indicate that Alternatives 1 and 4 are both more attractive than Alternatives 2 and 3 because the former would produce significant improvements in travel time and accidents.
- *Residences:* Three residences would be displaced if Alternative 3 were selected; seven residences would be displaced if Alternative 2 were selected. No residences would have to be removed if Alternatives 1 or 4 were selected.

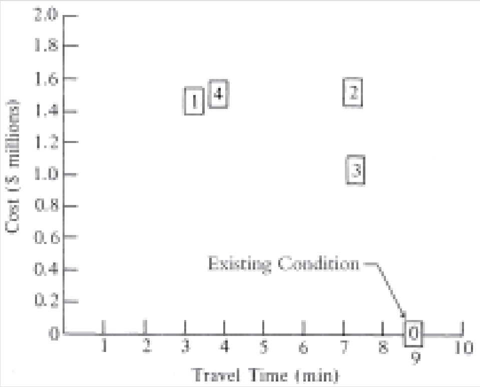


Figure 11.4 Travel Time between West Harrington and U.S. 1 versus Cost

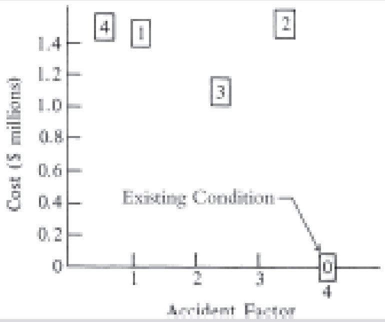


Figure 11.5 Accident Factor (relative to statewide average) versus Cost

- *Air quality:* Alternative 1 would produce the highest air quality, followed by Alternatives 4, 3, and 2. The air quality improvement would result from removing a significant amount of the slow-moving through traffic from the center of the city to a high-speed road where most of the pollution would be dispersed.
- *Noise:* Noise levels are lower for Alternatives 1 and 4.
- *Tax loss:* Tax losses would be slight for Alternatives 1 and 4, moderate for Alternative 3, and high for Alternative 2.
- *Trees removed:* Alternatives 3 and 4 would eliminate 25 and 28 acres of trees, respectively. Alternative 1 would result in slight losses; Alternative 2, no loss.
- *Runoff:* There would be no runoff for Alternative 0, some for Alternatives 1 and 2, and a considerable amount for Alternatives 3 and 4.

Step 6. **Choice of project.** From a cost point of view, the Department of Transportation would select Alternative 3, since it results in travel time and safety improvements at the lowest cost. However, if additional funds are available, then Alterative 1 or 4 would be considered. Since Alternative 1 is lower in cost than Alternative 4 and is equal or better than Alternative 3 for each criterion related to community impacts, this alternative would be the one most likely to be selected. In the selection process, each alternative would be reviewed. Also, comments would be received from citizens and elected officials to assist in the design process so that environmental and community effects would be minimized.

Step 7. **Specifications and construction.** The choice has been made, and Alternative 1, a bypass south of Harrington, has been ranked of sufficiently high priority so that it will be constructed. This alternative involves building both a new bridge across the Harrington River and a new road connecting U.S. 1A with U.S. 1. The designs for the bridge and road will be prepared. Detailed estimates of the cost to construct will be made, and the project will be announced for bid. The construction company that produces the lowest bid and can meet other qualifications will be awarded the contract, and the road will be built. Upon completion, the road will be turned over to the Department of Transportation, who will be responsible for its maintenance and operation. Follow-up studies will be conducted to determine how successful the road was in meeting its objectives; where necessary, modifications will be made to improve its performance.

Assignment No. 1

Examine the study:
Draft Final Report for the Transportation Feasibility Study Linking the West Bank and Gaza Strip, which you may find on the internet.

- **State whether the study had followed the transportation planning process you have studied.**
- **State what basic elements of Transportation Planning you have seen in the study.**
- **How many alternatives were identified and give an brief summary on each?**
- **Is there any recommended alternative? What was the criteria to select such alternative? What do you think?**
- **What is your overall assessment?**

Groups of 2-3 students can work together.. DL: 1 week

URBAN TRANSPORTATION PLANNING PROCESS

- Involves the evaluation and selection of highway or transit facilities to serve present and future land uses
- For example, new residential development or industrial area will generate additional traffic requiring the creation or expansion of roads and transit service
- The process must consider proposed developments and improvements that will occur within the planning period
- Urban transportation planning is concerned with two separate time horizons:
  - Short-term
  - Long-term

Urban Transportation Planning Process ...

- **Short-term** emphasis intended to select projects that can be implemented within a one- to three-year period. These projects are designed to provide better management of existing facilities by making them as efficient as possible (Trans. System Management-TSM).
  Examples: traffic signal timing to improve flow, car/van pooling to reduce congestion, park-and-ride facilities to increase transit ridership, and transit improvements, ..
- **Long-term** transportation needs of an area and identifies the projects to be constructed over a 20-year period.
  Examples: adding new highways, bus lines or freeway lanes, new rapid transit systems, or access roads, ..

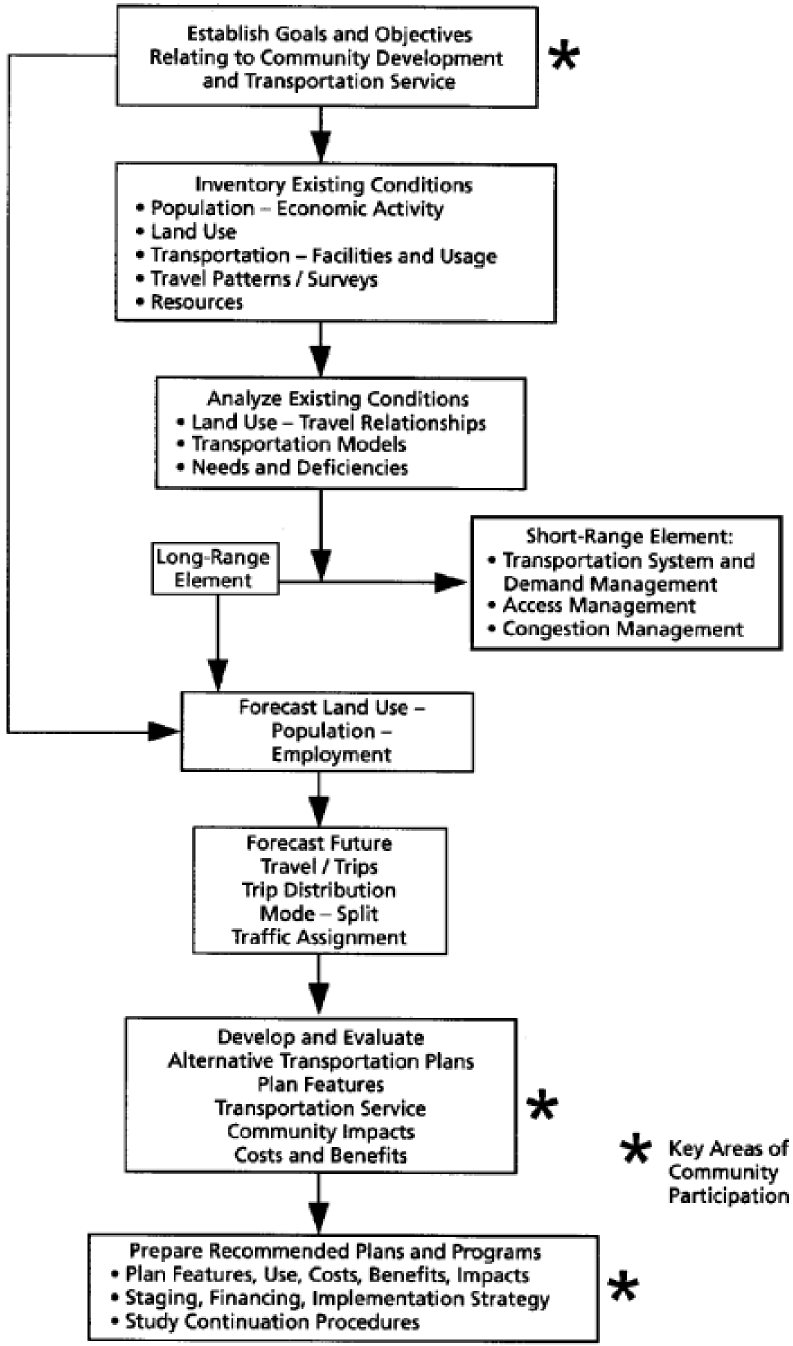


Figure 11.7 Comprehensive Urban Area Transportation Planning Process

Urban Transportation Planning Process ...

- Inventory of Existing Travel and Facilities
- Establishment of Goals and Objectives
- Generation of Alternatives
- Estimation of Project Cost and Travel Demand
- Evaluation of Alternatives
- Choice of Project

Inventory of Existing Travel and Facilities

- **Data-gathering activity to describe urban travel characteristics for each geographic unit (traffic zone)**
- **Inventories/surveys needed to determine traffic volumes, land uses, travelers origins/destinations, population, employment, and economic activity**
- **Inventories needed for transport facilities (highway/ transit), capacity, speed, travel time, and traffic volume**
- **Summarize data by unit; traffic analysis zones (TAZ)**
- **Size TAZ depends on the nature of the study; the number of TAZs be adequate for the study**
- **Statistical districts are used as traffic zones because population data are easily available by this designation**

Establishment of Goals and Objectives

- Urban transportation study is carried out to develop projects that should be completed in the future
- A statement of goals, objectives, and standards is prepared that identifies deficiencies in the existing system, desired improvements, and what is to be achieved by the transportation improvements
- For example, if a transit authority is considering the possibility of extending an existing rail line into a newly developed area, its objectives for the new service might be to maximize its revenue from operations, maximize ridership, promote development, and attract the largest number of auto users so as to relieve traffic congestion

Generation of Alternatives

- The alternatives to be analyzed will be identified
- Need to analyze the travel effects of different land-uses
- The options available to the urban transportation planner include various technologies, network configurations, vehicles, operating policies, etc.
- In case of a transit line extension, alternatives include:

  - technologies could be rail rapid transit or bus

  - network .. a single line, two branches, radial or grid

  - guideways .. vary in length, speed, capacity, direction

  - intersections .. transit station or terminal

  - vehicles .. singly driven buses or multicar trains

  - operating policy.. 10-min hw peak, 30-min off-peak ..

Estimation of Project Cost and Travel Demand

- The alternatives to be analyzed will be identified
- Analyze the travel effects of different land-use plans
- Involves two separate tasks:

  - The first is to determine the project cost

  - The second is to estimate the traffic in the future

  The estimation of facility cost is relatively straightforward, whereas the estimation of future traffic flows is a complex undertaking requiring the use of mathematical models and computers

Planning-Level Cost Estimation

- Project cost estimation at the planning stage may be restrained either because the project has not yet been well-defined or because a significant amount of time has passed since the project's cost was estimated
- To address the first, agencies maintain a set of unit costs to allow for a quick determination of cost, where these may be stratified by area type (rural or urban), number of lanes, and roadway design
- To address the second, of costs being out of date, cost indices may be used which convert costs from a historical year to a current year by accounting for inflation. Consumer Price Index (CPI) provides an average rate of inflation for all goods and services

Example 11.2 Updating Costs for a Rail Feasibility Study

Table 11.3 on page 570 shows indices for 2001 and 2005 for railroads, highways, and the *Consumer Price Index*. A study of a freight rail improvement project was completed in 2001 that recommended improvements such as siding, track extension, and track maintenance and estimated a total cost of $120 million in 2001 dollars. The study cost $250,000 to perform, and the state agency would like to convert this cost estimate to 2005 dollars without redoing the entire study. How much should the improvements cost in 2005 dollars?

Solution: Because these are all rail items, the *Railroad Cost Index* is appropriate. This index may be applied as follows:

$$\text{Estimate in 2005 dollars} = (\text{Estimate in 2001 dollars})\frac{\text{2005 index}}{\text{2001 index}} \tag{11.1}$$

Table 11.3 Indices for Railroad Projects, Highway Projects, and Consumer Prices

Index	*Applies to*	*Year 2001*	*Year 2005*
Railroad Index[a]	Rail construction	315.7	356.8
Highway Index[b]	At-grade rail highway crossings	144.8	183.6
Consumer Price Index[c]	All goods and services	177.1	195.3

[a] *American Association of Railroads* (2006) (materials prices, wage rates, and supplements combined, excluding fuel).
[b] *Federal Highway Administration* (2006a) (Federal-Aid Highway Construction Composite Index).
[c] *Bureau of Labor Statistics* (2006) (Consumer Price Index for each year).

$$\text{Estimate in 2005 dollars} = (\$120 \text{ million})\frac{356.8}{315.7} = \$135.6 \text{ million}$$

Thus, the improvements will cost $136 million in 2005 dollars.

Planning-Level Demand Estimation

- Future travel is determined by forecasting future land use in terms socio-economic characteristics (e.g., no. of jobs, population, auto ownership, income, in each TAZ
- Then, traffic that land use will add to the highway and transit facility can be determined
- This is carried out in a four-step process that includes:

  - **Trip generation:** number of trips generated

  - **Trip distribution:** the origin and destination of trips

  - **Modal split:** mode of transportation used by each trip

  - **Network assignment:** the route taken by each trip
- When the travel forecasting process is completed, road and transit volumes on each link will have be estimated

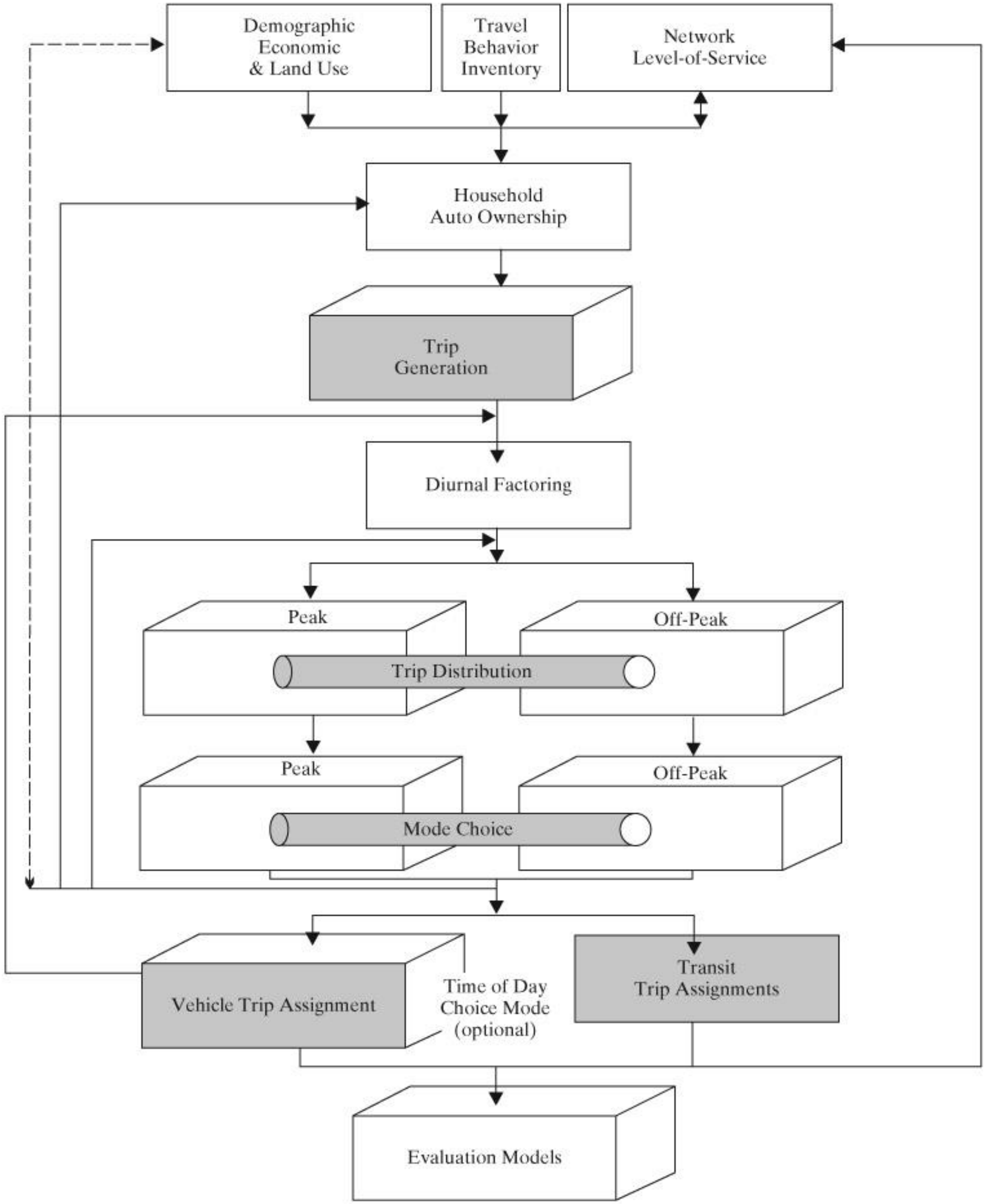


Figure 11.8 Travel Demand Model Flowchart

Evaluation of Alternatives

- Can be complex due to the conflicting objectives and diverse groups affected by an urban trans. project:

  - Traveling public (users).. improve speed, safety, comfort

  - Highway or transit agencies (operators) .. minimize cost

  - Non-traveling public (community) .. minimize social and environmental impacts

- Evaluation process is to:

  - identify feasible alternatives in terms of cost & capacity

  - estimate the effects of each alternative in terms of the objectives expressed

  - assist in identifying the alternatives that will serve the traveling public and be acceptable to the community (EIS)

Choice of Project

- Selection of a project will be based on a process that will ultimately involve elected officials and the public
- Funds to build an urban trans. project (such as a subway system) may involve a public referendum
- A vote by the legislatures may be required to commit funds
- A multi-year program then will be produced that outlines the projects to be carried out over the next years
- With approval in hand, the project can proceed to the specification and construction phase

FORECASTING TRAVEL

- To accomplish the objectives and tasks of the urban transportation planning process, urban transportation forecasting process is carried out to analyze the performance of various alternatives
- Basic elements and related tasks in the process:

  - Data collection (or inventories)

  - Analysis of existing conditions and calibration of forecasting techniques

  - Forecast of future travel demand

  - Analysis of the results

Define the Study Area

- Prior to collecting and summarizing the data, it is usually necessary to define the study area boundaries and to subdivide it into traffic analysis zones (TAZ)
- The selection of these zones is based on the following:

1. Socioeconomic characteristics must be homogeneous
2. Intrazonal trips should be minimized
3. Utilized physical, political, and historical boundaries
4. Zones should not be created within other zones
5. The zone system should generate and attract approximately equal trips, households, population, area
6. Zones should use statistical boundaries if possible
7. The total number of zones should not be so large

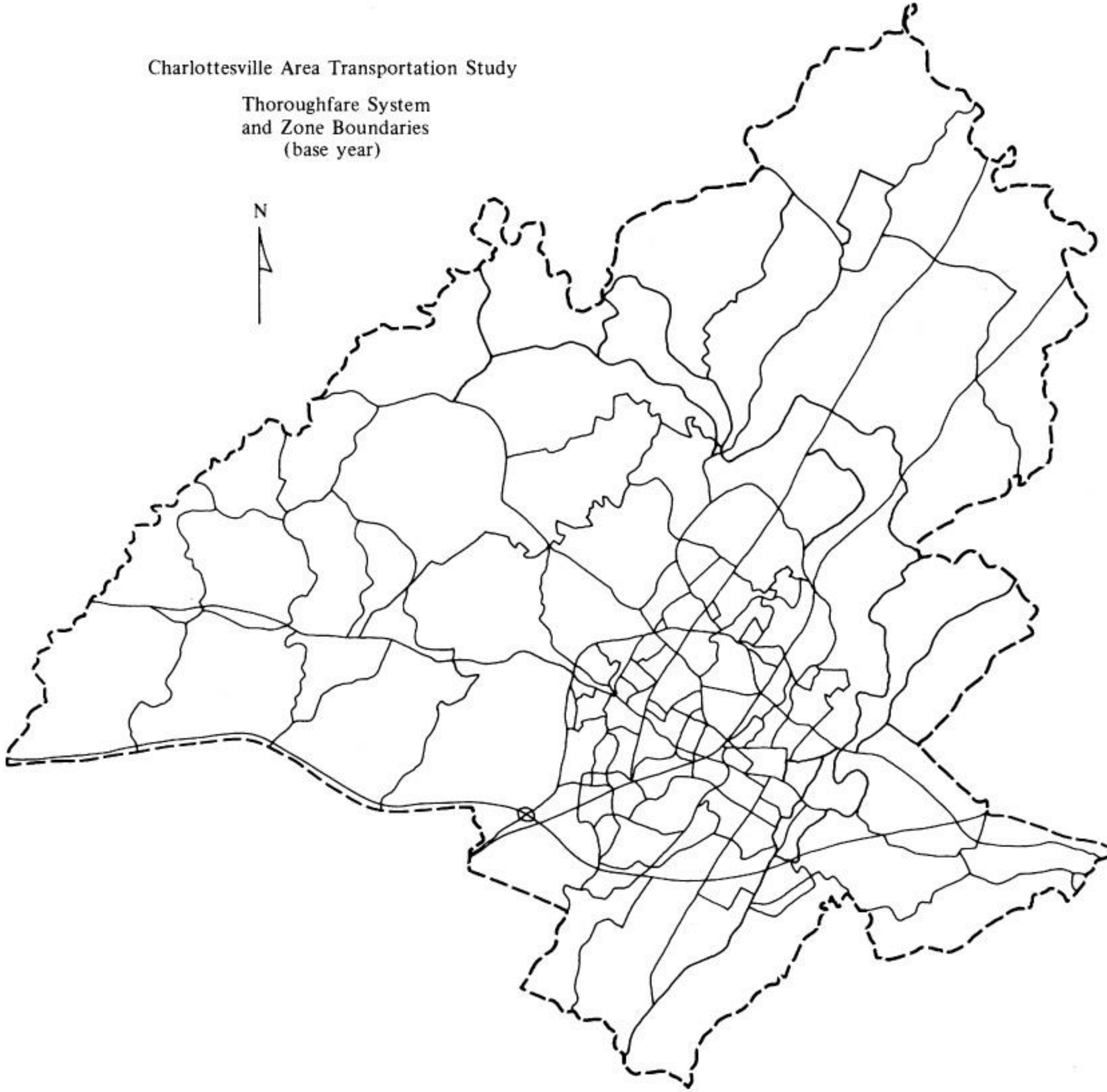


Figure 11.9 Traffic Analysis Zones for Transportation Study

Data collection

- The data collection phase provides information about the city and its people that will serve as the basis for developing travel demand estimates
- The data include:

  - Information about economic activity (employment, sales volume, income, etc.)

  - Land use (type, intensity)

  - Travel characteristics (trip and traveler profile)

  - Transportation facilities (capacity, travel speed, etc.)

  This phase may involve surveys and can be based on previously collected data

Population and Economic Data

- Once a zone system for the study area is established, population and socioeconomic forecasts are used
- These are allocated to the study area, then to each zone
- This process can be accomplished by using either a ratio technique or land-use allocation models
- The population and economic data usually will be furnished by the agencies such as MOP, PCBS, MONE
- Providing travel and transportation data is the responsibility of the traffic engineer
- For this reason, the data required to describe travel characteristics and the transportation system are described next

Transportation Inventories

- Involve a description of the existing transportation
- services; the available facilities and their condition; location of routes and schedules; maintenance and operating costs; system capacity and existing traffic; volumes, speed, and delay; property and equipment
- The types of data collected about the current system:

  - Functional classification of the road/transit system

  - Physical features of the system include number of lanes, pavement width, traffic signals, and TCDs

  - Street and highway capacity would be determined

  - Traffic volume data would be determined

  - Travel times along the arterials would be determined

Transportation Inventories …

- Prepare a computerized network of the existing system
- The network consists of links, nodes, and centroids:

  - **Link:** a portion of the highway system that can be described by its capacity, lane width, and speed

  - **Node:** the end point of a link; an intersection or where a link changes direction, capacity, width, or speed

  - **Centroid:** is the location within a zone where trips are considered to begin and end
- Coding of the network requires data from the highway inventory in terms of link speeds, length, and capacities
- The network is then coded to locate zone centroids,
- nodes, and the street system

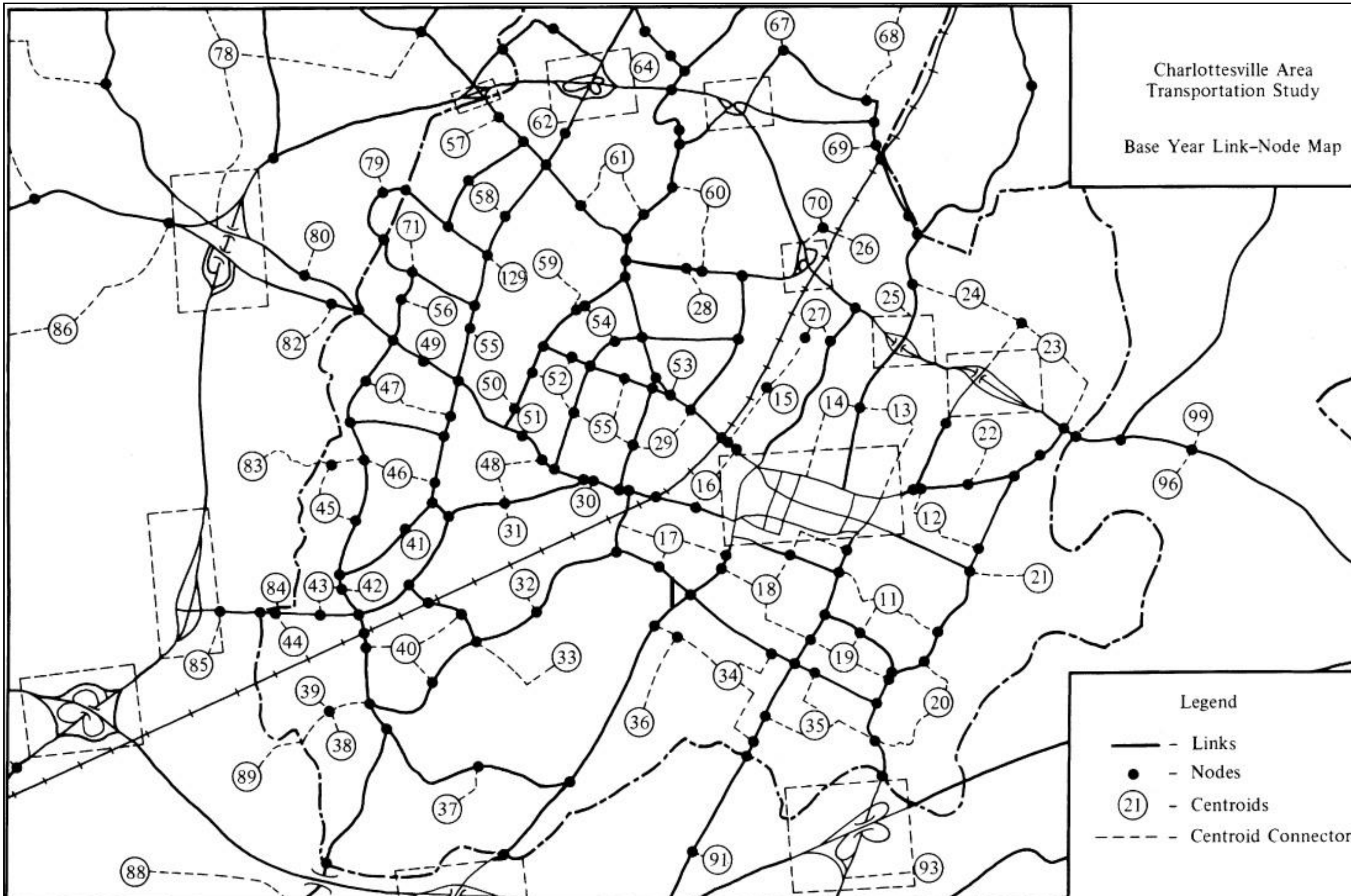


Figure 11.10 Link-Node Map for Highway System

Transportation Inventories …

- External stations are established at study area boundary
- At these stations traffic enters or exits the area, to account for the impact of changes outside the study area
- The transportation facility inventories provide the basis for establishing the network that will be studied to determine present and future traffic flows. Data include:

  - Streets and highways/transit system characteristics

  - Land use and zoning controls, laws and regulations

  - Traffic generators, and parking facilities

  - Traffic control devices

  - Traffic volumes and intersection and roadway capacities
  - Travel times

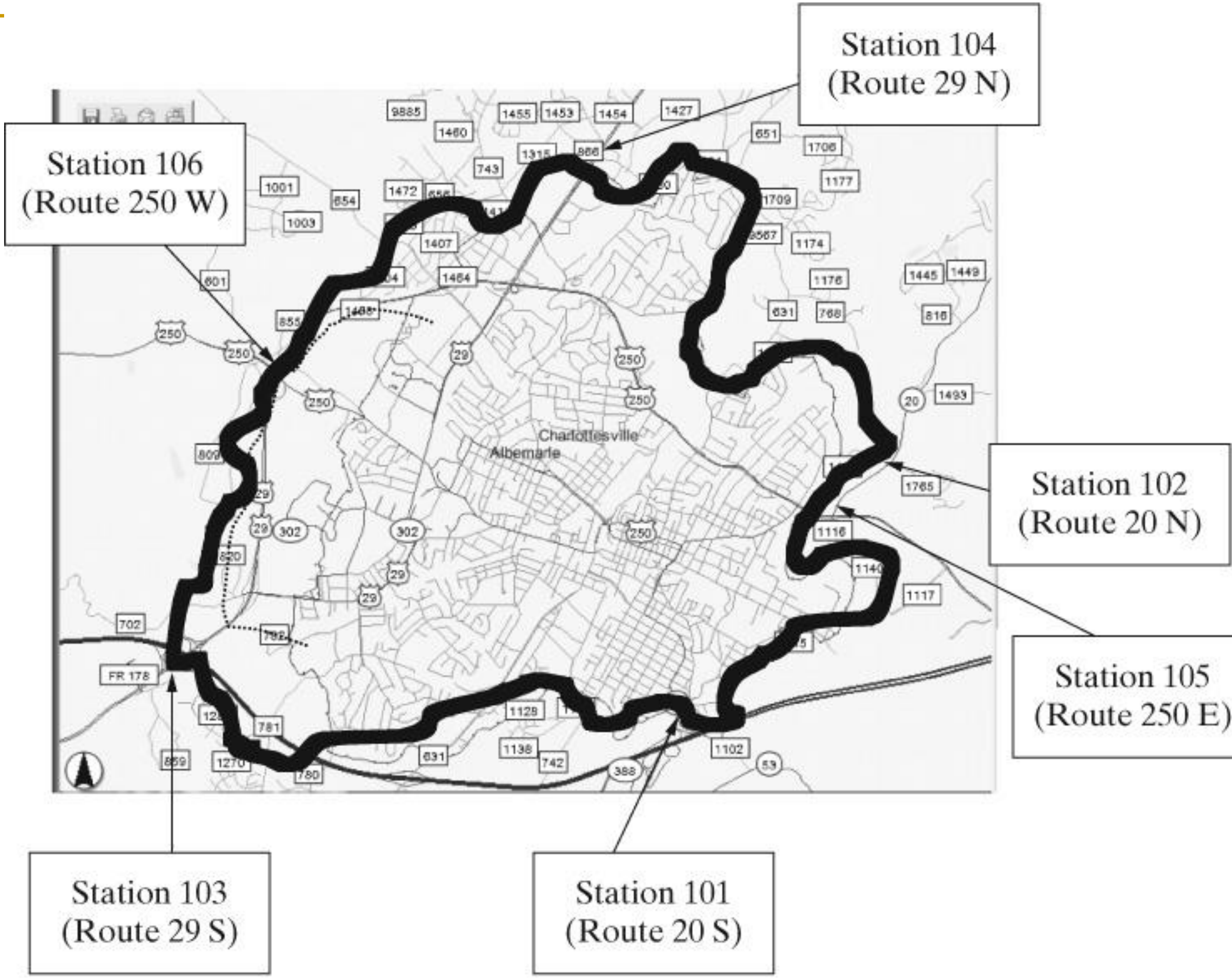


Figure 11.11 External Stations for a Study Area Boundary

Information Systems

- All network data are usually organized within GIS
- A GIS is a spatially-oriented database management processing system, containing location and attribute information and supporting queries with these features
- GIS is an integral component of transportation planning:

  - GIS is scaleable, supports analysis for a wide range of geographic scales; macroscopic level (state/region) to microscopic level (a single neighborhood)

  - GIS contains information used by other professions, enabling to access data collected for other purposes

  - GIS offers strong spatial analytical tool to make use of the point, line, and area features within the GIS

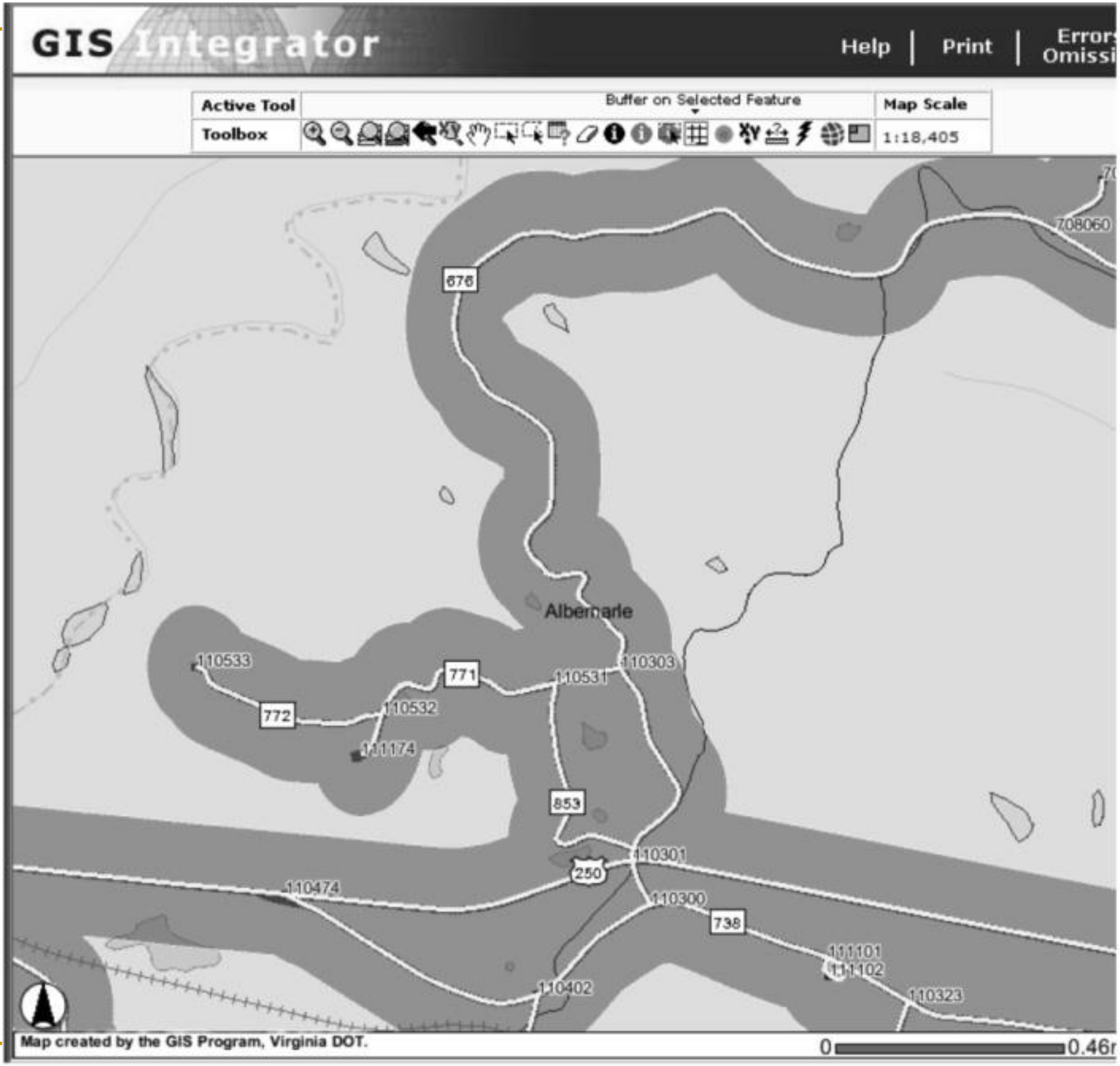


Figure 11.12 GIS Buffer Analysis to Identify Wetlands Impacted by Roadways

Travel Surveys

- Conducted to establish a complete understanding of the travel patterns within the study area
- For single projects (e.g., highway project): traffic counts
- To understand why people travel and where they wish to go, origin-destination (O-D) survey data can be useful
- Survey asks questions about each trip made on a specific day, through home interview, or at a roadside interview station, such as:

  - where the trip begins and ends

  - the purpose of the trip

  - the time of day, and the vehicle involved

  - person making the trip (age, sex, income, vehicle owner)

Travel Day ________ and Date

Sample Number

NORTH CENTRAL TEXAS
COUNCIL OF GOVERNMENTS
HOME INTERVIEW SURVEY

Section I: Household Data

A. Sample Address ________________ House Number, Street Name, Apt. No. ________ City/Town ________ County ________ Zip Code

B. Structure Type

C. Number of People Living at this Address

D. Number of People Age 5 and Over Living at this Address

E. Number of Out-of-Area Visitors Staying at this Address

F. Number of Passenger Cars, Vans, and Pickups Available for Use

G. Household Income: (Do Not Ask Until Interview Is Complete)

Section II: Data on Persons Age 5 and Over

A	B	C	D	E	F	G	H	I	J	K
Person Number	✓ If Interviewed	Relation To Head	Age	Sex	Licensed to Drive?	Occupation	Industry	Worked on Travel Day?	Made Trips While at Work?	Made Other Trips on Travel Day?
01		Head 1		1 M 2 F	1 YES 2 NO			1 YES 2 NO 3 Worked at Home	1 YES 2 NO	1 YES 2 NO
02				1 M 2 F	1 YES 2 NO			1 YES 2 NO 3 Worked at Home	1 YES 2 NO	1 YES 2 NO
03				1 M 2 F	1 YES 2 NO			1 YES 2 NO 3 Worked at Home	1 YES 2 NO	1 YES 2 NO
04				1 M 2 F	1 YES 2 NO			1 YES 2 NO 3 Worked at Home	1 YES 2 NO	1 YES 2 NO
05				1 M 2 F	1 YES 2 NO			1 YES 2 NO 3 Worked at Home	1 YES 2 NO	1 YES 2 NO
06				1 M 2 F	1 YES 2 NO			1 YES 2 NO 3 Worked at Home	1 YES 2 NO	1 YES 2 NO
07				1 M 2 F	1 YES 2 NO			1 YES 2 NO 3 Worked at Home	1 YES 2 NO	1 YES 2 NO
08				1 M 2 F	1 YES 2 NO			1 YES 2 NO 3 Worked at Home	1 YES 2 NO	1 YES 2 NO
09				1 M 2 F	1 YES 2 NO			1 YES 2 NO 3 Worked at Home	1 YES 2 NO	1 YES 2 NO
10				1 M 2 F	1 YES 2 NO			1 YES 2 NO 3 Worked at Home	1 YES 2 NO	1 YES 2 NO

Age Codes

1 5 - 10	6 36 - 45
2 11 - 15	7 46 - 55
3 16 - 20	8 56 - 65
4 21 - 25	9 65 - OVER
5 26 - 35	0 UNKNOWN

Relation Codes

1 HEAD	6 GRANDCHILD
2 SPOUSE	7 OTHER RELATIVE
3 SON	8 UNRELATED
4 DAUGHTER	9 OUT-OF-AREA VISITORS
5 GRANDPARENT	0 UNKNOWN

Section III: Trip Summary

A. Total Vehicular Trips Reported

B. Persons Age 5 and Over Making Trips

C. Persons Age 5 and Over Not Making Trips

D. Complete or Incomplete Interview Code

Section IV: Administrative

A. Household Telephone Number

B. Interviewer

C. Telephone Contacts (If Any):

Date Time Purpose/Outcome

D. Personal Contacts In Household:

Date Time Talked To/Comments

E. Completed Interview Submitted:

Date: ______ By: ______

I Certify That All Information On This Form Is Correct And True.

Signature of Interviewer

F. If Interview Submitted Incomplete

Interviewer's Reason:

Date Initials

Supervisor's Comments

Date Initials

G. First Edit: Fail Pass

Date Initials

H. Final Edit: Fail Pass

Date Initials

I. Coding Complete

Date Initials

Figure 11.13 Travel Behavior Inventory: Home Interview Survey

Travel Surveys …

- Compare O-D data with other sources to ensure accuracy
- **Screenline checks** can be made to compare the number of reported trips that cross a defined boundary (a bridge or two parts of a city) with the number actually observed
- After O-D checking procedure, a set of **trip tables** is prepared that shows the number of trips between each zone and every other zone in the study area
- These tables can be subdivided, for example, by trip purpose, truck trips, and taxi trips

Table 12.17 Present Trips between Zones

Zone	*A*	*B*	*C*	*D*
A	—	400	100	100
B	400	—	300	—
C	100	300	—	300
D	100	—	300	—
Total	600	700	700	400

Calibration

- Calibration is concerned with establishing mathematical relationships to be used to estimate future travel demand
- Usually, analysis will reveal the effect on travel demand of factors such as land use, socioeconomic characteristics, or transportation system factors
- Travel forecasts are made by applying the relationships developed in the calibration process
- These formulas rely upon estimates of future land use, socioeconomic characteristics, and transportation conditions

Example 11.3 Estimating Trips per Day Using Multiple Regression

A multiple regression analysis shows the following relationship for the number of trips per household.

$$T = 0.82 + 1.3P + 2.1A$$

where

T = number of trips per household per day
P = number of persons per household
A = number of autos per household

If a particular TAZ contains 250 households with an average of 4 persons and 2 autos for each household, determine the average number of trips per day in that zone.

Solution:

Step 1. Calculate the number of trips per household.

$$\begin{aligned} T &= 0.82 + 1.3P + 2.1A \\ &= 0.82 + (1.3 \times 4) + (2.1 + 2) \\ &= 10.22 \text{ trips/household/day} \end{aligned}$$

Step 2. Determine the number of trips in the entire zone.

$$\text{Total trips in TAZ} = 250\,(10.22) = 2{,}555 \text{ trips/day}$$

Other mathematical formulas establish the relationships for trip length, percentage of trips by auto or transit, or the particular travel route selected.

Steps in the Travel Forecasting Process

- **Calibration is concerned with establishing mathematical relationships to be used to estimate future travel demand**
- **Step 1. Population and economic analysis: the magnitude and extent of activity in the urban area**
- **Step 2. Land use analysis: where the activities are located**
- **Step 3. Trip generation: no. of trips each activity will produce or attract**
- **Step 4. Trip distribution: the origin or destination of trips that are generated at a given activity**
- **Step 5. Modal split: which mode of transportation will be used to make the trip**
- **Step 6. Traffic assignment: which route will be used when making the trip where a user seeks to minimize travel time**