FINAL REPORT

Developing Long Range Traffic Projection Models for Illinois

Project IVA-H1, FY 03

Report No. ITRC FR 03-1

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16. Abstract

The project objective was to develop a PC-based tool to assist Illinois Department of Transportation (IDOT) traffic forecasters to meet FHWA reporting requirements for 2,400 HPMS sections and 27,000 structures in the State of Illinois, and to produce construction forecasts for highway improvement projects. The research included a review of current IDOT traffic forecasting procedures, study of the IRIS database in which roadway information, including HPMS and structures forecasts, are stored, development of tables and search strategies to organize IRIS data efficiently for forecasting, and development and verification of a computer model to project historical traffic data to future dates for FHWA reporting. The resulting computer program, the Illinois Traffic Projection Tool (ITPT) uses regression techniques to project historical traffic data for evaluation and use by IDOT traffic forecasters. Area-wide and county-wide growth rates are computed by applying a weighting function to representative locations in each county. Forecasters can use these growth rates when extrapolation of historical trends is not indicated by the data. The ITPT will make routine reporting on HPMS sections and structures, and special reporting on highway improvement projects significantly faster and more easily documented for future retrieval.

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EXECUTIVE SUMMARY
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June 2004

The IDOT Office of Planning and Programming is annually required to report to the Federal Highway Administration (FHWA) future annual average daily traffic (AADT) volumes for all Highway Performance Monitoring System (HPMS) sections, forecast 18 to 25 years from the current year. Traffic volumes on structures are forecast 17 to 22 years from the date of the last inspection for the National Bridge Inspection program. Future AADTs forecasts are entered into the Illinois Roadway Inventory System (IRIS) and the Illinois Structure Inventory System (ISIS). Due to the difficulty in making the necessary number of traffic volume projections to maintain the valid AADT year range, not all future AADTs on file are consistently revised with the frequency mandated by FHWA.

To estimate the future AADT for each of the approximately 2,400 HPMS sections and 27,000 structures on file statewide, District traffic forecasters traditionally have researched the traffic history for each location, then used the observed trend to extrapolate current AADT to a future year. The future AADT is adjusted as necessary to reflect special circumstances such a planned commercial development that might alter the trend. The precise methodology employed in this procedure is not consistent among IDOT District offices.

A research team from Southern Illinois University Edwardsville (SIUE) with consultants Crawford, Bunte, Brammeier Traffic & Transportation Engineers (CBB) was selected to perform the research outlined in a Request for Proposal for the Illinois Transportation Research Center (ITRC) project "Developing Long Range Traffic Projection Models for Illinois," ITRC project FY IVA-H1-03. The Illinois Department of Transportation (IDOT) had identified a need to develop a statewide traffic projection model to assist the Central and District Offices in meeting Federal Highway Administration (FHWA) reporting requirements for Highway Performance Monitoring System (HPMS) sections and structures and forecasting traffic growth for highway

improvements. The research resulted in the development of a computer program named the Illinois Traffic Projection Tool (ITPT). The traffic projection tool will expedite the forecasting process so that Districts can maintain a current forecast for all future AADTs on HPMS sections and structures. In addition, the tool will enable the Districts to rapidly provide traffic forecasts for District highway improvement projects.

The project began on August 16, 2003 and the contract was terminated due to state budget constraints on June 30, 2004. Training of IDOT personnel in the use of the tool, more detailed testing and development of ITPT, and research into other mathematical models for more refined trend projection were deleted from the scope of work as a result of the shortened time frame.

Objectives

The objective of this study was to develop a simplified, low-maintenance traffic projection tool for Illinois to ease the workload of the Districts and Central Office while providing a consistent procedure to address traffic volume projections.

Methodology

The research methodology consisted of a review of the relevant literature on traffic forecasting methods, observation of the methods of traffic data collection and entry, retrieval, and usage currently employed by IDOT district personnel, and design of a PC-based traffic projection tool that utilizes the available IRIS/ISIS database and the ArcView Data Verification project maintained by the Office of Planning and Programming Data Management Unit. Design of the traffic projection tool required development and documentation of a database search strategy for the IRIS database and development of tables for efficient search of the data. The traffic projection tool is based on trend analysis of the historical traffic data using regression techniques. Results obtained by the traffic projection tool were checked against the HPMS traffic forecasts previously developed by IDOT and found to give consistent results. Countywide growth rates were computed for use in cases where the scatter of the traffic data did not support extrapolation from a linear or exponential regression model.

Results

The resulting tool, named the Illinois Traffic Projection Tool (ITPT), enables IDOT traffic forecasters to access historical traffic counts by entering an HPMS, Structure, or Key Route code. The IRIS database is searched and all data points associated with that roadway section are displayed in a plot of AADT versus time, beginning with 1970. Two default regression models are displayed for projecting the data into the future based on either simple growth (a fixed number of vehicles per year) or compound growth (a percentage growth per year). The historical data and the computed data for both default models are displayed in tabular form, and statistics on the regression models are given to assist the user in evaluating the appropriate use of the models. The user can use the default model(s) or create new ones based on individual knowledge of the area, and print or save a report documenting the decisions that led to the selection of a model. A mapping tool assists the user in locating the roadway section under study and reviewing the historical traffic counts on adjacent roadways. A countywide growth model allows the user to see the average rate of traffic growth on all roadways in the county to identify regions of higher growth rates, a feature especially useful in urban or suburban fringe areas. The results of research on historical data indicate that, in general, the linear regression model should be the preferred method of traffic projection. The exponential model may be useful in areas still undergoing rapid growth and development, but in general may significantly over-predict traffic growth on most roadways.

Conclusion

The ITPT will make routine reporting on HPMS sections and structures and special reporting on highway improvement projects significantly faster and more easily documented for future retrieval. The results indicate that the overall forecast traffic volumes reported to the FHWA should not change significantly when forecasters begin using the ITPT, as the average error of forecasts made with ITPT compared to forecasts stored in the IRIS database is near zero. Average error remains low when at least 10 years of data are used. The standard deviation of the error between the model forecasts and the IRIS forecasts is about 30%. When only the sections with valid linear trends

were compared to the IRIS forecasts, the average error was 9% with a standard deviation of 26%. This result indicates that when forecasters are presented with data showing a strong linear trend, they may tend to report 5 to 10% higher forecasts than they have produced using current methods.

The use of a regression model for traffic projection has limitations when the data is extrapolated to dates beyond the range of the historical data, and should be supplemented with other sources including projections based on network models where available near urbanized areas, trends in traffic growth drivers such as population, motor vehicle registrations, and vehicle miles traveled (VMT). Comparison of results generated by ITPT with five District 1 forecasts generated by the Chicago Area Transportation Study (CATS) indicated that ITPT may tend to over-predict traffic volumes as compared to the network model that accounts for factors other than simple trend analysis. However, for rural and suburban areas in Illinois, the linear regression model used by ITPT appears to give reasonable results that are consistent with the HPMS forecasts stored in IRIS.

Further research is needed on the use of other mathematical models for forecasting, including a logarithmic growth model that projects increasing growth at decreasing rates. The data supports use of a model that uses declining rates of growth over time for long-term forecasting.

CHAPTER 1

INTRODUCTION

The safe, efficient, and economical movement of traffic on the state's highways is one of the primary objectives of the Illinois Department of Transportation (IDOT). IDOT is continuously seeking ways to more efficiently and effectively plan, build, and manage the system (IDOT, 2001).

The state, and indeed the nation, is in the midst of an era of major reconstruction of the highway infrastructure put into place during the twentieth century. At the same time, increased usage, changing trip patterns in the journey to work, increased intermodal freight transportation, and other dynamic changes require expansion of the system to alleviate congestion and improve safety (USDOT, 1990, TRB, 1993, FHWA, 1998). With current shortfalls in both state and federal budgets, it has become increasingly important to allocate highway repair and construction resources to produce the greatest benefit to the public. The Highway Performance Monitoring System (HPMS) was designed to assemble data and information to support highway planning and decision making at all levels of government (FHWA, 2000). The system requires regular, accurate updating from state DOT's to be effective and current. This reporting requires a significant effort that can strain personnel resources. The capability to satisfy technically challenging reporting requirements, such as forecasts of future Annual Average Daily Traffic (AADT), are being further challenged by the loss of experienced personnel.

IDOT is required to report forecasts of AADT on thousands of HPMS sections. The nominal projection is 20 years in the future, but the system allows up to a 25-year projection that must be updated before the forecast date is fewer than 18 years in the future. Forecasts should be performed using a "technically supportable State procedure" or data developed by a Metropolitan Planning Organization (MPO) or other valid local sources (FHWA, 2000). Traffic forecasts for structures are also reported for the National Bridge Inspection program (NBI). Illinois currently does not have a well-documented, formal procedure used statewide. Each district makes long-range traffic projections using any of a variety of procedures that reflect the personal experience and preferences of the

personnel responsible for traffic forecasting. Although the results obtained using current methods are acceptable, a tool to produce forecasts that are more easily documented, assessed and updated as new data becomes available was desirable. The tool must be applicable to conditions commonly experienced across the state while providing districts the flexibility to adjust for local conditions. Because most of the data is available in an electronic format either through the Illinois Roadway Inventory System (IRIS), Illinois Structure Inventory System (ISIS) or other databases maintained by IDOT, the long range projection tool should be implemented in a computer program that can greatly increase the efficiency of the traffic forecaster in order to satisfy FHWA reporting requirements with current personnel. A well-developed forecasting tool should also be available for other requirements such as district highway improvement projects.

A research team from Southern Illinois University Edwardsville (SIUE) with consultants Crawford, Bunte, Brammeier Traffic & Transportation Engineers (CBB) was selected to do the work outlined in a Request for Proposal (RFP) for the Illinois Transportation Research Center (ITRC) project "Developing Long Range Traffic Projection Models for Illinois," ITRC project FY IVA-H1-03. In the RFP, the Illinois Department of Transportation (IDOT) had identified a need to develop a statewide traffic projection model to assist the Central and District Offices in meeting Federal Highway Administration (FHWA) reporting requirements for Highway Performance Management System (HPMS) sections and structures and forecasting traffic growth for highway improvements.

Current traffic forecasting methods range in complexity from time series methods in which future traffic volumes are estimated by extrapolating from historical data to complex network models that attempt to predict demand over a multimodal transportation system by modeling trip choices of individuals or groups of travelers (FHWA, 1999). This research effort focused on developing time series methods because they are easy to use, sufficiently accurate to accomplish the research objectives, familiar to most IDOT traffic forecasters, and well suited for the available data. Development of a statewide network model was not indicated in the Request for Proposal.

When a forecasting requirement is identified, one typical practice is to research the traffic history near the required location, estimate a growth rate based on this data and

any special circumstances that would cause the traffic growth to deviate from a smooth growth trend, and calculate the future traffic using either a linear equation of the form:

$$Y = aX + b$$

where a and b are constants, and X represents years, or an exponential curve of the form:

$$Y_{t+n} = Y_t(1+i)^n$$

where i is the annual growth rate (usually 1%-2% in low growth areas) and n is the number of years from the current value Y_t (IDOT, 2001).

For a plot of data points that clusters around a straight line, least squares linear regression can be used to describe the line that has the smallest sum of squared vertical differences between the data points and the line (Figure 1.1). The correlation coefficient, R, indicates the degree of correlation between the single independent variable (years) with the dependent variable (AADT). The regression coefficient R^2 is the proportion of the variation that is "explained" by the model.
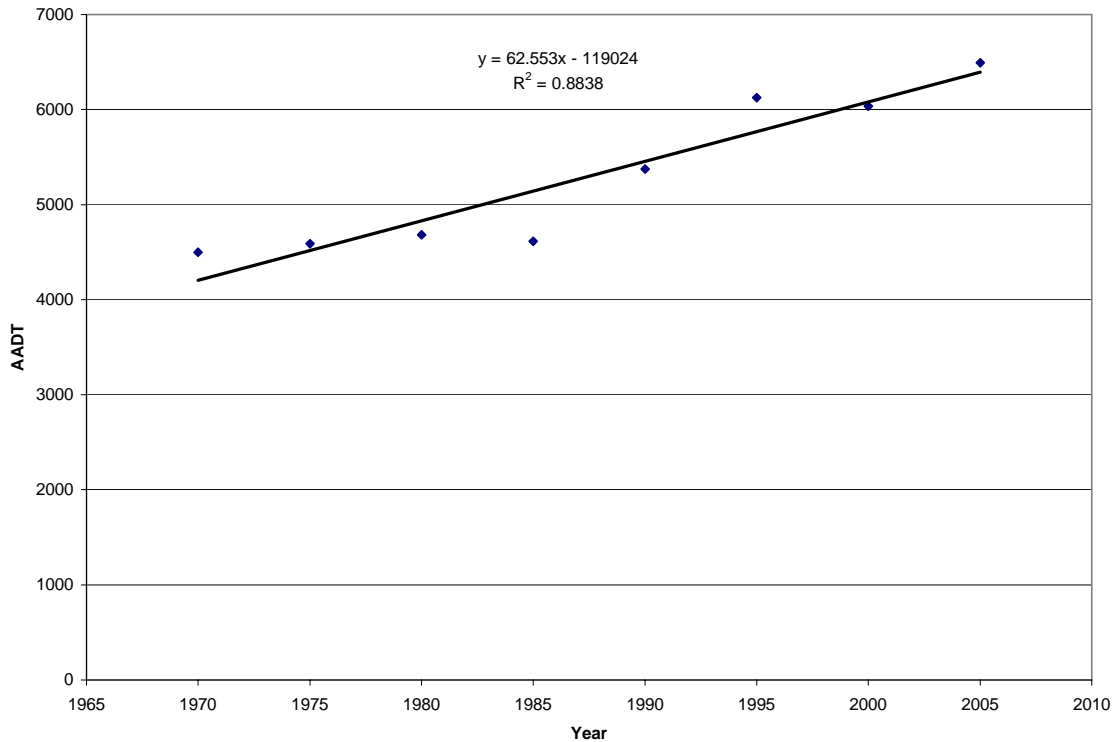
Figure 1.1. Example of linear regression of data.

A regression line is valid for estimating the dependent variable over the range of values for which data has been observed. Projecting the trend beyond the range of data values given is justifiable only if the conditions that produced the observed trend were to continue unchanged. In estimating changes in annual average traffic volume over time, the long-term observed trend of positive increase is correlated with many independent variables such as per capita licensed driver and vehicle ownership growth, increased vehicles miles traveled per licensed driver, land use changes, increase in the driving age population, increase in number of vehicles per driver, the costs of driving versus other transportation options, and other social and economic factors. While it is unlikely that all the conditions that led to traffic growth on a particular roadway section in the past will remain constant over the next 25 years, it is impractical for the purposes of HPMS forecasting to attempt to consider all the possible factors for all locations. Linear projection, using historical traffic growth versus the single independent variable "Years" as a proxy for the complex social and economic factors that drive traffic growth is a simplification, and does little to explain the variation in traffic volume as a function of those factors. However, linear projection of long-term historical trends is an objective and rational approach to producing a rapid forecast of traffic at future dates, and meets the needs of IDOT for the purposes expressed in the Request for Proposal.

The principal objective of this research was to provide IDOT with a long-range traffic projection tool implemented in a computer application that would facilitate data retrieval and standardize forecasting methods to meet HPMS requirements. The tool that was developed, the Illinois Traffic Projection Tool (ITPT), will assist forecasters by giving a graphical representation of historical traffic trends, indications of the strength of the trend, and provide additional tools such as mapping of area-wide and countywide growth trends on roadways of various functional classifications. With ITPT, traffic forecasters will be able to produce fully documented forecasts in substantially less time than required in the current system, and be able to easily retrieve the results of past forecasts to increase the efficiency of future forecasts.

In Chapter 2, a review of the factors that affect traffic growth and the various methods and models used for forecasting traffic growth are summarized. Chapter 3 describes the research methodology, the development of a computer model, and the

testing and verification of that model using historical data and the current HPMS forecasts stored in the IRIS database. Chapter 4 summarizes the research and gives direction for further development of a more refined computer model. The ITPT User Manual is included in Appendix A. Search algorithms for creating tables in the Microsoft Access database in which IRIS data is available are described in Appendix B. Results of the verification testing of ITPT are given in Appendix C. A description of system architecture, specifications and technical documentation is provided in Appendix D.

CHAPTER 2
REVIEW OF TRAFFIC PROJECTION MODELS

In developing a model for projecting the growth of traffic on Illinois highways, the researchers considered general conditions that drive traffic growth, long-range traffic forecasts developed by Metropolitan Planning Organizations (MPO) and Regional Planning Commissions (RPC) and general long range forecasting methodologies.

Traffic Growth Drivers

Traffic volumes have been increasing on U.S. roadways for as long as traffic data has been collected. While the reasons for these increases are seemingly apparent, the set of factors behind these increases is quite complex as it reflects the changing American society. Conducting long-range travel forecasts, therefore, requires an appreciation of these traffic growth drivers to better understand how an ever-changing society will impact traffic volumes in the future. Three basic traffic growth drivers are discussed in the following sections, namely: 1) per capita licensed driver and vehicle ownership growth, 2) increased vehicles miles traveled per licensed driver, and 3) land use changes.

Per Capita Licensed Driver and Vehicle Ownership

The rate of growth in both the number of licensed drivers and the number of registered vehicles has far outpaced the U.S. population growth rate over the past 25 years. While our population is growing at about 1.3% annually, the population of drivers and vehicles is growing at about 2.3% annually (USDOT, 1988). The historical growth of the population, vehicles and drivers is shown in Figure 2.1.
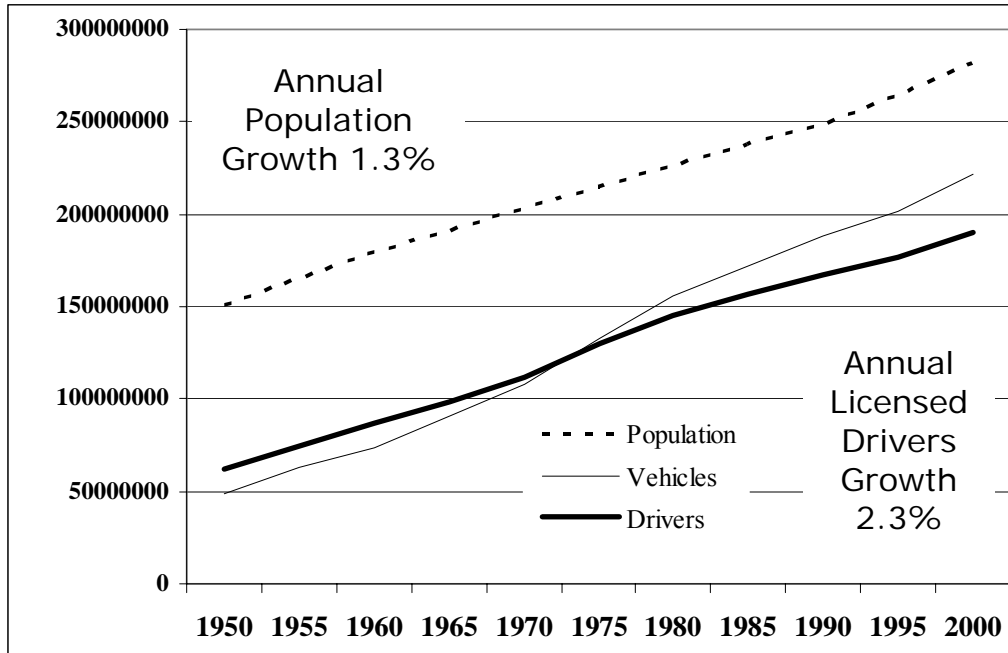
Figure 2.1. Historical growth of population, vehicles and drivers in the US.
(Source: Our Nation's Highways, FHWA, 2000)

Vehicles Miles Traveled per Licensed Driver

Not only are the licensed driver and vehicle populations in the U.S. growing and resulting in more vehicles and drivers on the roadways, the average number of annual miles per driver has also been increasing. The increase in the annual Vehicle Miles Traveled (VMT) per driver in the U.S. has been about 2% per year over the past 30 years and can be attributed to several factors such as:

- Increase in the number of 2 worker families
- Urban sprawl resulting in longer commutes
- Increasing regional shopping and "big box" development
- Consolidated manufacturing operations resulting in additional need for freight transport

The historical growth of the vehicles miles of travel (VMT) per person is shown in Figure 2.2.
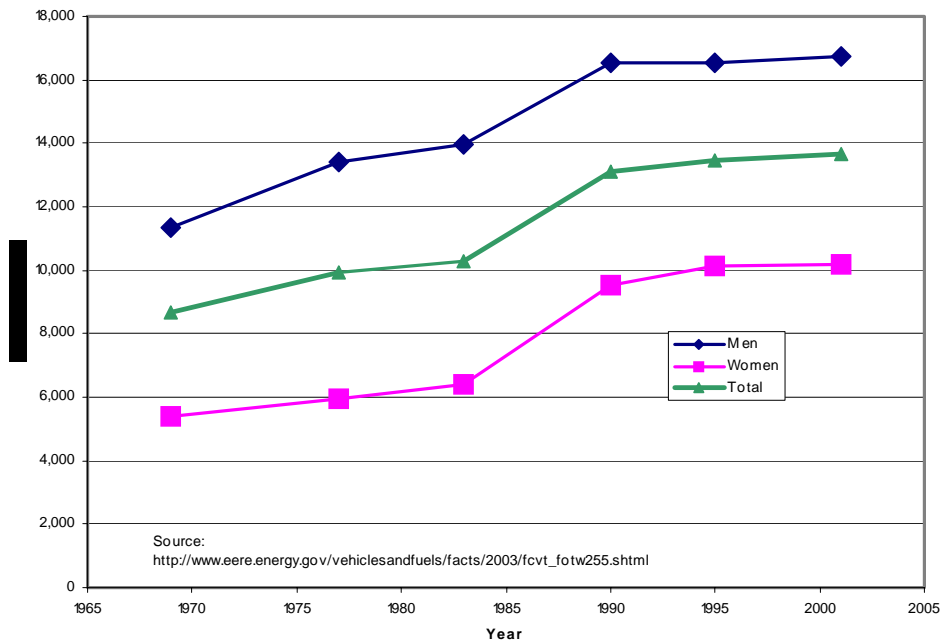
Figure 2.2. Historical growth of average annual miles per licensed driver.

Land Use Changes

In addition to global background traffic growth factors, changing land use patterns (e.g., population changes and economic development) also can have local and regional impacts on traffic volumes. As mentioned earlier, the U.S. population has been growing at about 1.3% annually. However, this growth is not uniform across the nation; rather it is focused and concentrated in higher growth areas that experience corresponding traffic volume growth due to more trip generations and attractions. These changing land uses can have a dramatic effect on traffic volumes in developing areas.

Net Effect

The net effect of these traffic volumes is that traffic volume growth has outpaced population growth by more than a 2:1 ratio in the past 30 years. The historical growth of the total annual VMT in the U.S., which has been about 3.1%, is shown in Figure 2.3.

Annual Growth
of About 3.1%

Billion VMT

Rural Travel   Urban Travel   Total Travel

1970 1971 1972 1973 1974 1975 1976 1977 ... 1988 1989 1990 1991 1992 1993 1994 1995
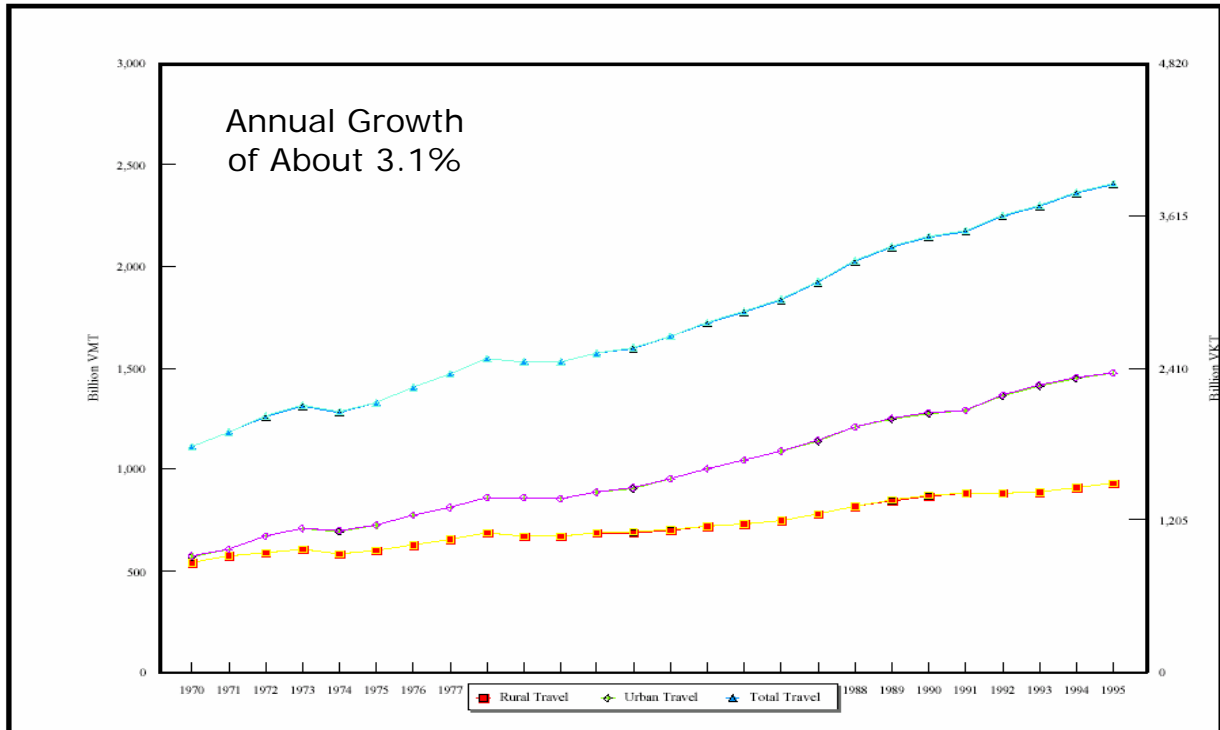
Figure 2.3. Historical growth of the average annual travel in the US.

(Source: Urban Transportation Planning in the United States: An Historic Overview, USDOT, 1988)

Some analysts, such as the USDOE Energy Information Administration (EIA) and the USDOT Federal Highway Administration (FHWA) predict the rate of increase in VMT to slow to rates ranging from 1.4 to 2.0% as the population ages (Table 2.1). FHWA reported that analysis of long-term trends showed a gradual decrease in the annual VMT growth rate when computed over 5-year intervals. Although the VMT growth rate varies regionally, the national 5-year growth rate slowed from 3.2% (1987-1992) to 2.6% (1992-1997) (http://www.fhwa.dot.gov/igun/hiqjnun99.htm). Other factors also point to a decrease in the rate of VMT growth in the future. In 2001, the number of vehicles per licensed driver in the U.S. was 1.19, and the ratio of drivers to driving age population was 88% (FHWA, 2003), indicating that there may be a saturation point in the growth in vehicular travel as most persons of driving age are licensed and have vehicles.

Table 2.1. Projected Growth of VMT (1995-2015)

Source	Projected VMT Growth Rate
EIA/AEO 95	1.8%
EIA/AEO 96	1.4%
EIA/AEO 97	1.4%
EIA/AEO 98	1.5%
DOT/FHWA (5/96)	2.2%
Cartalk	~1.9%

(Source: Schaper, V. and P. Patterson, USDOE, "Factors that Affect VMT Growth," 1998.)

Metropolitan Planning Organizations (MPO) & Regional Planning Commissions (RPC)

The Federal-Aid Highway Act of 1962 created the federal requirement for urban transportation planning largely in response to the construction of the Interstate Highway System and the planning of routes through and around urban areas. The Act required, as a condition attached to federal transportation financial assistance, that transportation projects in urbanized areas of 50,000 or more in population be based on a continuing, comprehensive, urban transportation planning process undertaken cooperatively by the states and local governments—the birth of the so-called 3C "continuing, comprehensive and cooperative planning process." By July 1965, all the 224 existing urbanized areas had an urban transportation planning process underway. At that time, qualified planning agencies to conduct the transportation planning process were lacking in many urban areas. Therefore, the Bureau of Public Roads (predecessor to the Federal Highway Administration) required the creation of planning agencies or organizational arrangements that would be capable of carrying out the required planning process. Hence, Metropolitan Planning Organizations (MPOs) quickly came into being because of the growing momentum of the highway program and the federal financing of the planning process (USDOT, 1988).

Illinois has several Metropolitan Planning Organizations (MPO) and Regional Planning Commissions (RPC) that can play a role in traffic forecasting efforts as many of these agencies maintain regional travel demand forecasting models. More information about MPOs and RPCs is provided by the Association of Metropolitan Planning Organizations (http://www.ampo.org).

Travel Demand Forecasting Methodologies

Traffic forecasting is the process of developing future traffic volumes on roadways based on anticipated changes in land use and socioeconomic characteristics. Travel demand forecasts are conducted to assess the adequacy of the existing transportation infrastructure to handle future needs and to help determine the improvements necessary to address any transportation deficiencies identified through the forecasts. Traffic forecasts are often based on several approaches or methods. The resulting projection is validated using available data sources and engineering judgment. This report discusses the traffic forecasting methodology commonly used in practice.

4-Step Travel Demand Modeling

A travel demand model is one that incorporates rigorous mathematical techniques that replicate travel behavior. Travel demand models are driven by socioeconomic data aggregated by Traffic Analysis Zones (TAZs). The most commonly accepted procedure for performing travel demand modeling is the 4-step process of trip generation, trip distribution, mode split and trip assignment. Trip generation is the process of estimating the number of trips produced and attracted to a particular land use. Trip distribution is the process of estimating the distribution of trips generated by one land use to other land uses, or in other words, determining the origin and destination of trips. Mode split is the process of determining the transportation modes that are used to travel between the origins and destinations. Trip assignment is the process of loading the trips onto the roadway network based on travel time or some other measure of impedance. Common applications of travel demand models are forecasting traffic volumes under several transportation improvement alternative scenarios, predicting changes in travel patterns that result from changes in demographic characteristics and transportation supply, and performing congestion management and air quality analysis.

Although the "Long Range Traffic Projection Models for Illinois" project does not propose to make use of travel demand models, many of the MPOs and RPCs do maintain them. This modeling output can often be made a part of the manual forecasting process.

Trend Analysis

In the absence of a Travel Demand Model, manual traffic projections are often developed based on historical trends in traffic volumes and anticipated land use changes. Several types of mathematical curves can be fit to the historical data in order to extrapolate the growth trends to the future.

Growth Curves - A linear growth trend curve that represents a constant growth in land use (and hence traffic) each year could be used to predict future traffic. An exponential growth trend curve could also be used that represents a constant percentage growth each year. The type of curve to be used depends on the nature of the growth in development that is expected to occur in the future. A typical growth pattern in developing areas is shown in Figure 2.4.
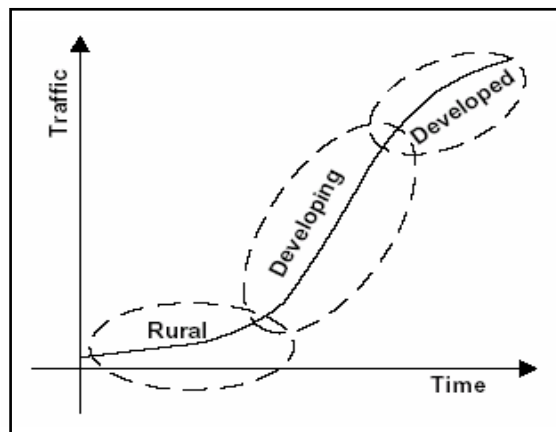
Figure 2.4. Typical Growth Patterns in Developing Areas

Initially, when a city or urban area is founded, the growth in land use is moderate; this is later followed by a more intensive development. When the area approaches full development, the growth in traffic tends to taper off. Therefore, the type of growth expected to occur in the future (and therefore the type of growth trend curve to use) depends on which phase of development the area is currently experiencing. When the anticipated growth in land use cannot be accurately determined, both the linear and the exponential curves can be used to determine a range of forecasts. Figure 2.5 shows an example using historical traffic to predict future trends in traffic.
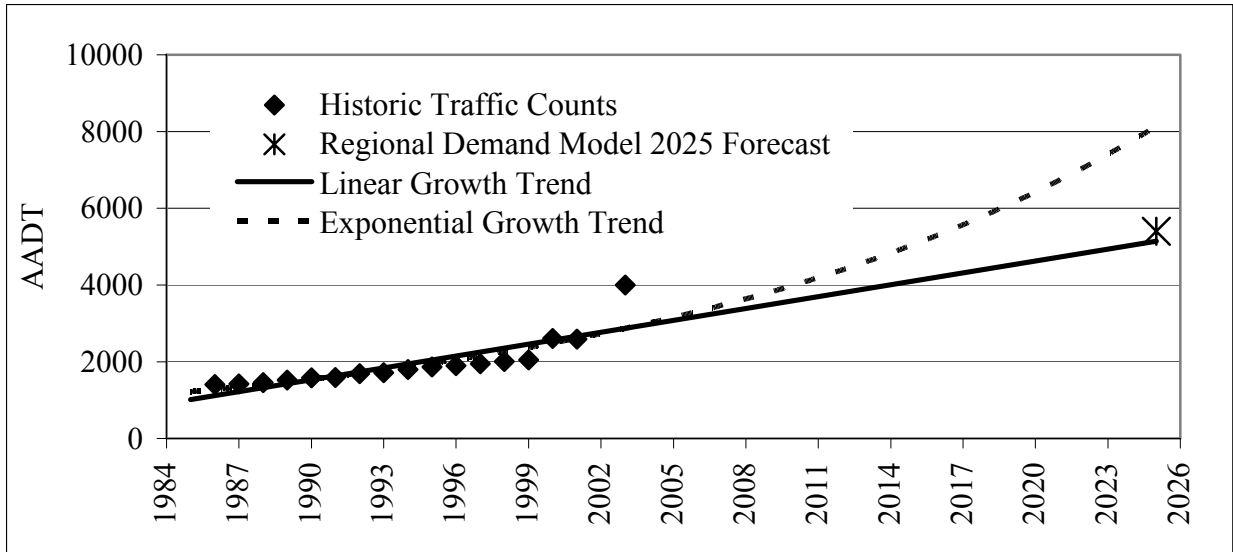
Figure 2.5. Example of trend analysis used to forecast traffic

In some instances historical traffic volume trends cannot be used to determine future trends. One such example is shown in Figure 2.6 for a location in St. Louis, Missouri. In this case, only 3 actual field counts occurred in this location since 1986 - those occurring in 1986, 1991 and 2003. Other field counts were conducted in 1994 and 2000 that were used to derive the reported AADTs, but these counts were taken at another location. Adding to the inconsistencies in counting locations, this area is near a major automobile manufacturing plant and traffic volumes on area roadways are highly sensitive to national economic conditions. Due to the erratic trends seen in the historical counts, historical growth patterns clearly could not be used to project future traffic volumes.
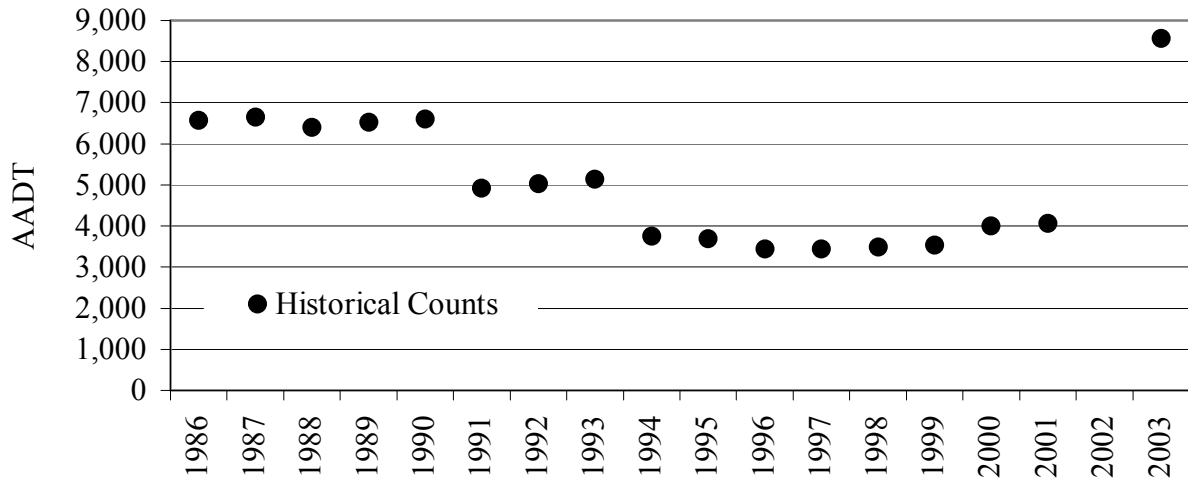
Figure 2.6. Example of inability of trend analysis to predict future traffic growth.

Box-Jenkins Methods- Box-Jenkins models are a large family of time series models that are able to track very complex historical data patterns in order to predict future data values. The type of Box-Jenkins model to use depends on the data series to be analyzed. Application of these models require at least 50 data points, so they are probably not applicable to the analysis of yearly traffic data but to monthly, daily or hourly data (USDOT, 1999). The 4 main variations of this class of models are mentioned briefly below:

Autoregressive (AR) Models: In this type of model, the value of the data series is estimated with one or more earlier values of the data series. This is based on the assumption that the time series rarely has abrupt changes and the best predictors of a period are its immediate past periods.

Integrated (I) Models: Here the model utilizes the difference in data values in the series or the difference of differences in order to estimate a future value. These models work best when the long-term trend is stable but the variation from period to period contain strong random influences.

Moving Average (MA) Models: In a MA model, the data series is estimated using knowledge of the error in a recent estimate. Exponential Smoothing models are a type of moving average model in which weights are applied to the errors in order to forecast data. This type of model is applicable to time series data without cyclical patterns. Central

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Moving Average models are another type of moving average models in which data to each side of the current time period is used to develop an estimate of a future value. This is applicable to times series data that have cyclical patterns.

Autoregressive Integrated Moving Average (ARIMA): ARIMA models combine the above three types of models. In a study conducted by Wisconsin Department of Transportation (WisDOT), ARIMA models were used to forecast daily traffic based on traffic on the previous day, previous week, previous year, total personal income and other variables.

Combined Approach

The corridor for which traffic projections are being developed should be compared with other similar corridors in the area that are almost fully developed. The growth pattern and therefore the traffic growth rate for the developed corridor could be used as a reliable benchmark to estimate the future traffic on the corridor under consideration. Traffic projections developed for the area through other traffic studies should also be referred to for comparison purposes.

The traffic forecasts developed through travel demand models, trend analysis and other studies for the area should be put together on a single graph to understand the results in the context of historical trends and anticipated development trends and to finalize the forecasts based on a consensus of all the approaches. One such example is shown in Figure 2.7.
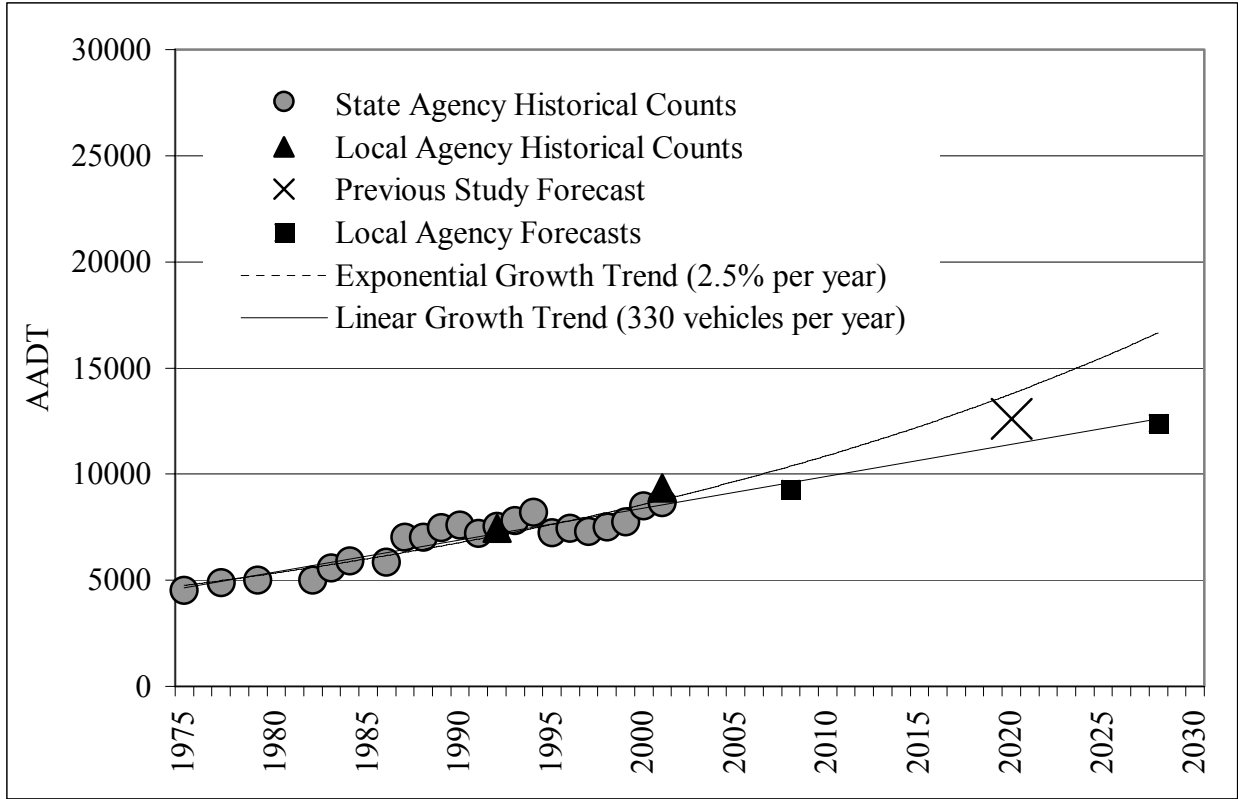
Figure 2.7. Traffic Forecasts: comparison of several approaches.

Conclusion

The results of the literature review indicate that no single method is sufficient for developing a reliable long-range traffic forecast. Network models that attempt to reproduce travel behavior and predict travel demand and trip distribution are better suited to urban areas. Ongoing maintenance of the model as the road network changes and land uses evolve is necessary and would be difficult for a detailed statewide network model. Simple projection from historical data is better suited to rural locations with stable land use patterns but can be unreliable due to insufficient or inconclusive data. Differing assumptions can be used to extrapolate historical trends into the future yielding widely differing projections. The use of historical traffic data should be supplemented, when feasible, with additional information on regional traffic trends, population growth and land development, especially in urbanizing areas.

CHAPTER 3
METHODOLOGY

In order to develop a long-range traffic projection model to meet IDOT needs for Federal Highway Administration (FHWA) reporting requirements for HPMS sections, NBI reporting requirements for structures, and forecasting traffic growth for highway improvements, the researchers first reviewed the current IDOT procedures for traffic projection by interviewing the IDOT personnel involved in traffic forecasting. The results of this interview process and the review of literature were used to develop a PC-based traffic projection model that incorporated available historical traffic count data, was flexible, easy to use, allowed users to review the results and adjust the parameters, was compatible with IRIS/ISIS and the HPMS reporting system, and could be easily maintained.

The researchers conducted personal or telephone interviews with IDOT personnel in eight of the nine districts, the Chicago Area Transportation Study (CATS) and the IDOT Central Office beginning in late September 2003 and concluding in early January 2004. To gain additional perspective on urban traffic forecasting, CATS provided the researchers with a written summary of its procedures, and the forecast manager for the East-West Gateway Coordinating Council, MPO for the greater St. Louis metropolitan area, was personally interviewed. Interviews were conducted in the offices of traffic forecasters in IDOT Districts 3, 4, 6, 7 and 8. District 5 was interviewed by telephone. The District 9 traffic forecaster attended the meeting held in the District 7 office, and District 2 personnel joined the meeting held in the District 3 office. District 1 uses the traffic forecasts provided by CATS and so was not separately evaluated. However, District 1 participated in a preview of the computer program at the annual traffic forecasters meeting in March 2004 in Springfield.

The purpose of the interviews was to establish the current procedures and data resources used by each District in completing the traffic forecasts for both Highway Performance Monitoring System (HPMS) sections and structures, as prompted by direct requests for such forecast updates by the IDOT Office of Planning and Programming Data Management Unit. Observing the physical facilities, records, maps, files, and computer resources available in the District offices was important in estimating the time

currently required to complete the HPMS and structures traffic forecasts as well as in observing the methodology used by the various District personnel. The discussions with IDOT District and Central Office personnel were structured to elicit information in several key areas necessary for developing a computer model of the forecasting process, including the input required, output required or desired, functions required or desired, database information, and the forecasting methods or models currently used.

Data Collection

Traffic is counted on state-maintained routes every other year, while county highways and township roads are generally counted every five years. The counts are typically made during the months of April through October, and the data entered by District personnel into the Illinois Road Improvement System (IRIS) mainframe computer at the end of the year after the counts are entered and reviewed. The counts include coverage of the 2,400 HPMS sections and 27,000 structures throughout the state.

Traffic counts from the past 30 years on all state-maintained routes, county highways, and township roads are currently available in a Microsoft Access database maintained by the Office of Planning and Programming Data Management Unit in Springfield. These traffic counts, formerly available only on individual countywide maps, now can be easily used as a historical basis for traffic forecasting.

The objective of this research was to develop a simple, low maintenance computer model that uses historical data as a forecasting basis, but allows the Districts the flexibility to apply individual knowledge of specific local conditions affecting traffic. In order to develop the computer model for traffic forecasting, the researchers questioned the traffic forecasters in each of the following areas.

Input

The Districts are prompted to update the structures traffic forecasts by error reports issued by the IDOT Central Office, which also alerts Districts of the need to update HPMS section forecasts. The error reports indicate that the forecast year in the database is out of the acceptable range (18-25 years from the current year for HPMS sections, or 17-22 years from date of last inspection for structures). The error reports are

issued from the Central Office to the Districts in the fall, and updates are required in time for the files to be closed in February. The Central Office uses the files to provide inventory data to FHWA on HPMS sections and structures. FHWA's review of the inventory data may result in a request for verification of AADT counts that appear to be at variance with past counts or trends, but there is no requirement for verification of the traffic forecasts. Because of this, the researchers found that District personnel currently keep few records of the manner in which their HPMS forecasts are made.

Each roadway in the state system is given a Key Route code. The Key Route code is a unique identifier that establishes the roadway type (federal aid, state routes, county, township and municipal routes), and other characteristics (i.e. ramp, spur, frontage road) that describe the roadway. Stationing along the Key Route begins at the county line. The county in which the roadway is located is identified in a separate field in the IRIS database. Changes in Key Route stationing occur primarily on urban fringe areas as corporate boundaries expand. A database search strategy was devised to determine whether significant length changes in the Key Route had occurred over time, which would make uncertain whether traffic counts at a particular station were taken at the same physical location on the roadway.

The HPMS section code identifies a section of highway on which information is collected for reporting to the FHWA. The HPMS section number is a seven-digit code that uniquely describes the section within each county. HPMS sections with uniform characteristics were randomly selected along Key Routes when the program began in 1978. Changes in roadway characteristics (i.e. lane additions, addition of shoulders) within the original HPMS section may have required that the section be broken into multiple segments, each with uniform characteristics, or be shortened. However, the HPMS code number has consistently been applied to the same physical location of roadway, which allows the tracing of traffic data on that roadway back to 1981, the first year traffic counts on HPMS sections appears in the IRIS database.

The procedure for updating traffic forecasts on HPMS sections typically starts at the District level with a request for updates on specific sections from the Central Office of Planning and Programming. However, some Districts reported updating all HPMS sections within a particular county or District on an intermittent basis before being

requested to do so. The methodology for responding to the request varied, but most Districts begin the update by locating the latest traffic information for the HPMS section in question using a Geographic Information System (GIS). The statewide GIS is centrally maintained and available in each of the District main offices; the traffic forecaster in one District, located in a satellite facility, currently did not have desktop access to the GIS, and not all computers in each District are loaded with the necessary software. Traffic data from 1997 forward is available on GIS, but most forecasters reported using paper maps to trace historical traffic counts. Storage and organization of the map collection varied, but finding the historical traffic counts for a specific roadway section appeared to be one of the most time-consuming steps in the current process for most forecasters.

Determining the projected traffic growth is also a time-consuming process. Most Districts had automated the process using a spreadsheet to establish traffic growth trends after the historical counts had been established and entered. Records of past calculations varied among the Districts. There is no requirement to save calculations for forecasting HPMS sections, but forecasts for construction on adjacent roadways were kept in paper files or spreadsheets, typically filed by county. The method used for forecasting traffic growth was not standard, varying from application of a linear growth factor to the most recent traffic count to linear regression of the data for all the available years. In some Districts, typical rates of growth for each functional class of roadway are applied, and calculated values may be checked against these "rule of thumb" values for reasonableness. For example, rural highways may be assumed to have 1.5% growth per year, urban highways 2%, and rapidly growing urban areas 3% or more. These values varied by District based on observation of historical trends.

Historical growth rates are modified by the forecaster based on knowledge of local conditions, including population growth or decline, commercial growth or decline, road openings or closings and other factors. None of the Districts reported a formal process for integrating data such as Census information, number of registered vehicles or licensed drivers, retail sales figures, or even road construction plans, although they reported considering some or all of these factors in an informal way. Some Districts are making use of aerial photography in studying land development and estimating traffic growth in urbanizing areas. Most forecasters made some provision for known large

commercial or retail developments, such as including a large one-time increase in traffic in the year the development will open. Input on land development was gained from a number of sources, including newspapers, personal contacts, County Highway engineers, and others. More time and energy are spent on construction forecasting than for the routine reporting for HPMS sections, which are of lower priority at the District level due to resource availability.

Output

The output required for HPMS reporting is an AADT for a year from 18 to 25 years in the future. For practical purposes, the forecast is projected the full 25 years to delay the next required forecast update as far as possible. A single AADT value is projected, with no breakdown by vehicle type. The projected values are rounded according to IDOT policies (Table 3.1) and are entered into the IRIS database. No record of the method by which the forecast was made is needed for FHWA reporting or review.

Table 3.1. Rounding rules for AADT counts.

AADT	Round to Nearest
0-399	25
400-4,999	50
5000+	100

Functions

In order to model the process by which IDOT traffic forecasters produce their output, the researchers asked the interviewees for information regarding functions that would be helpful in developing a projected AADT value. The most useful function of a computer program appears to be in gathering the historical data for a particular HPMS section. There was also a desire for assistance in completing the traffic projection using a graphical representation of the data. The user input should be simple, preferably the 7-digit HPMS or structure code. The forecasters also requested the ability to override or modify the projections developed when the projections did not match their expectations

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or knowledge of local conditions. Knowledge of traffic counts on nearby roads, particularly those of similar functional classification, was also considered desirable.

Model Development

Model development began with the investigation of techniques currently used by IDOT districts for completing the traffic forecasting for HPMS sections and structures. In all districts except District 1, which uses forecasts generated by the CATS network model, the current methods used for forecasting data include:

- extrapolating from the most recent AADT count using
  - a linear growth factor based on policy or past experience (Figure 3.1)
  - an exponential or compounded annual growth rate (Figure 3.2)
- extrapolating from historical data using
  - linear regression (Figure 3.3)
  - an exponential or compounded annual growth rate (Figure 3.4)

The results obtained from each of these methods may be modified based on the experience of the forecaster, particularly in areas undergoing rapid land use change and commercial development. Forecasters sometimes introduce a "step," or one-time increase associated with an isolated commercial development anticipated to create a significant increase in traffic in its opening year, followed by a return to a steady rate of increase. It is sometimes desirable to compute a step decrease in volume, applicable for one-time events such as the opening of a new transportation facility such as a bridge or new alignment.
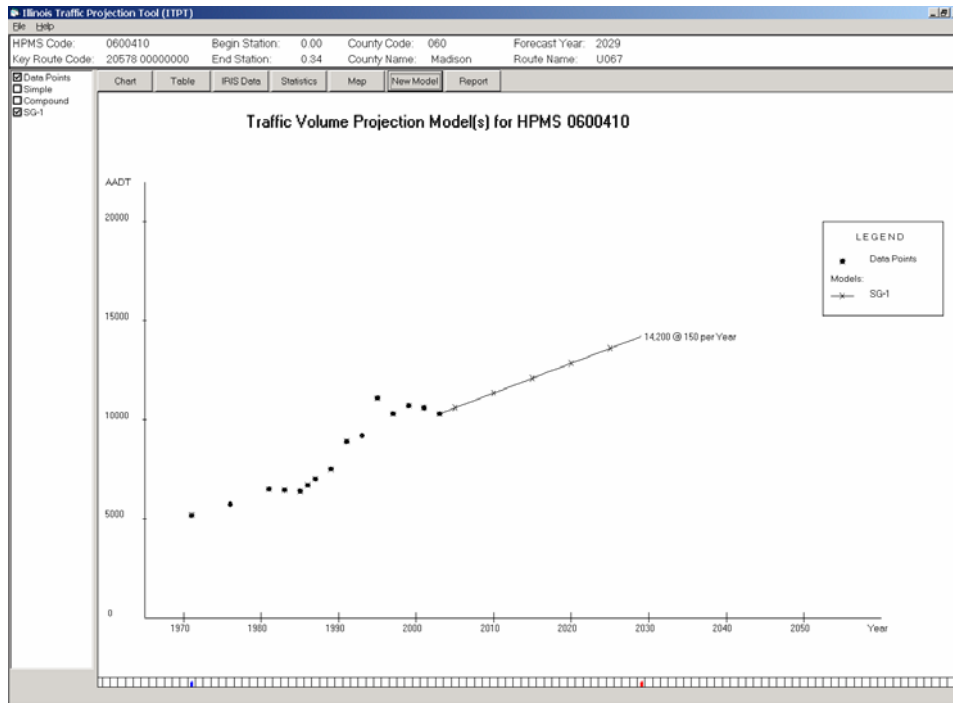
Figure 3.1 Linear growth model, 150 vehicles per year.
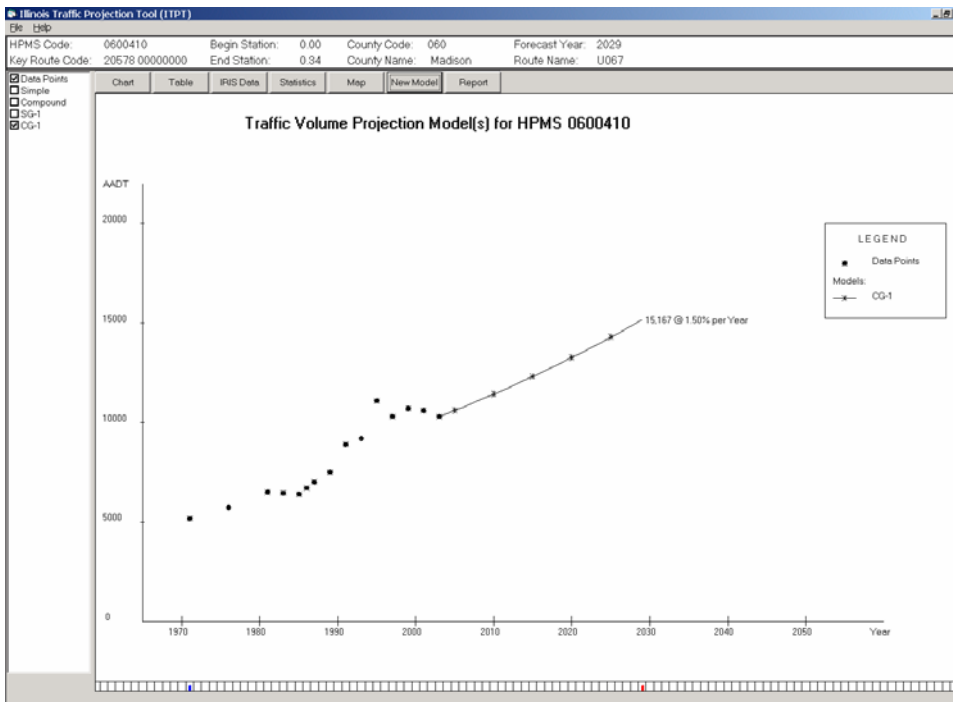
Figure 3.2. Exponential (compound) growth model, 1.5% per year.
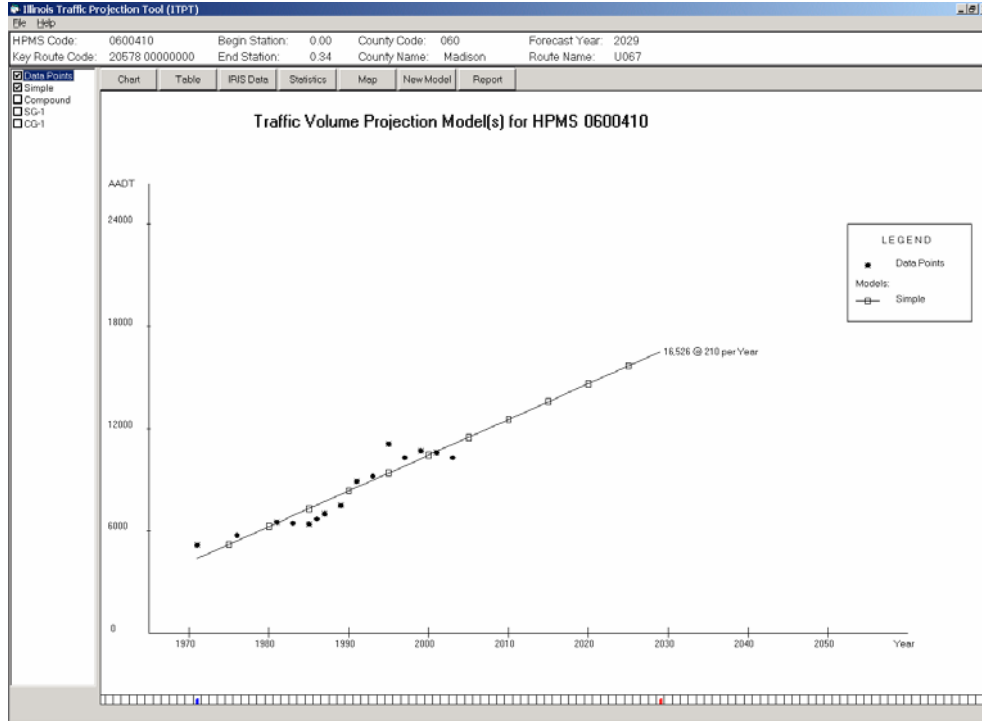
Figure 3.3. Linear regression model, 210 vehicles per year.
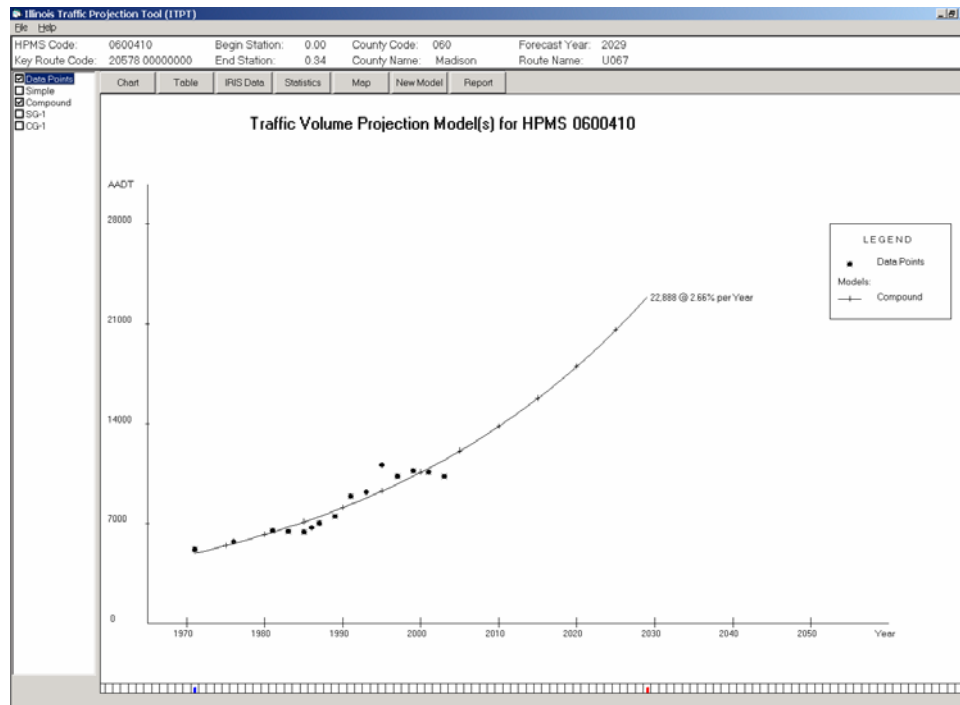
Figure 3.4. Exponential (compound) growth model, 2.66% per year.

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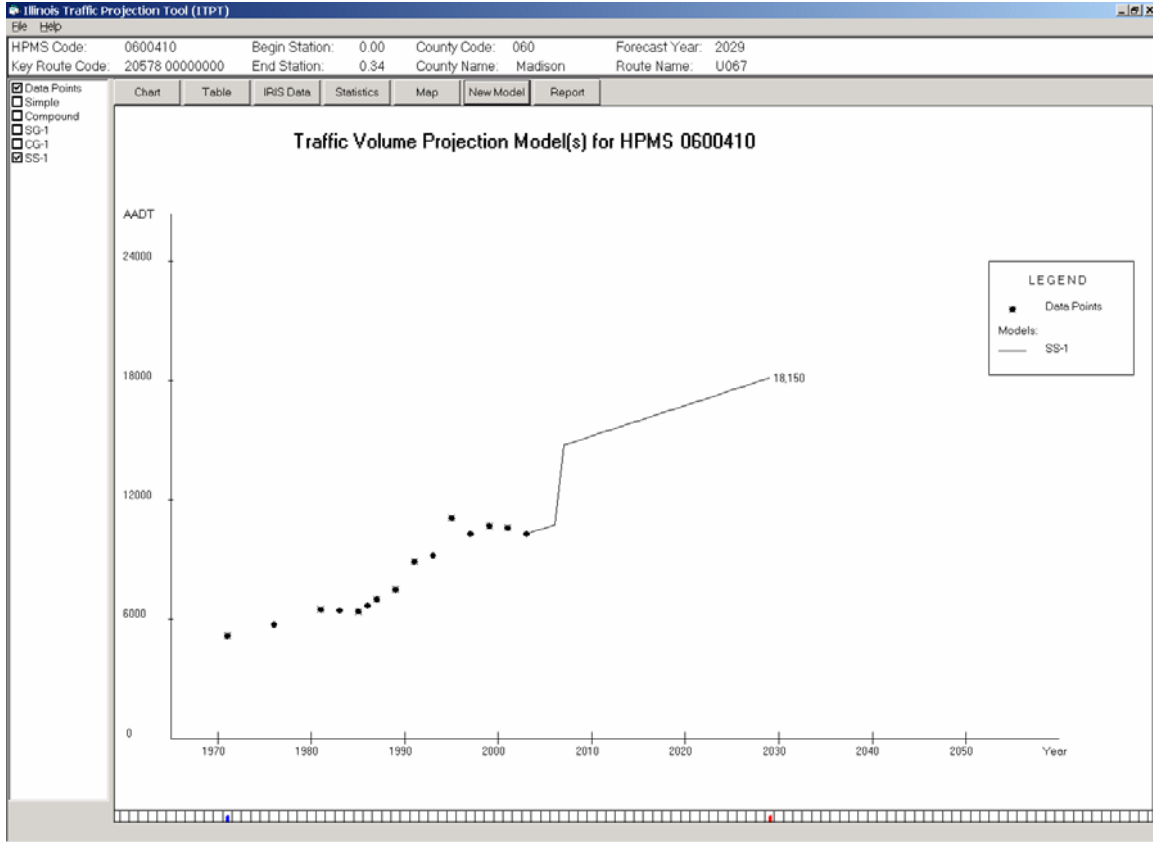
Figure 3.5. Linear growth with step at future date.

Linear Growth Rate Model

In the development of a computer model, therefore, the researchers first studied the ability of a linear growth model to predict future traffic values. Since 30 years of data are available in the Access database, a procedure was developed by which trends in the historical counts from one time period were used to predict actual AADTs in later years. The researchers initially used traffic data from Madison County, Illinois as a test case for this and several other data verification procedures, for several reasons. Madison County is part of the rapidly urbanizing St. Louis metropolitan area, and has over 200 HPMS sections, nearly 10% of the state total. Several major interstates that converge to cross the Mississippi River at St. Louis pass through the county. Finally, the researchers had

familiarity with the road system in the county, which is also home to Southern Illinois University Edwardsville. Later, the method was applied to statewide data.

The researchers used the traffic counts stored in the IRIS database and performed a series of analyses to determine how well the data fit a linear regression trend line. Using a variable Start Year and a variable number of years of data, the linear fit of data was tested against actual traffic counts in later years. A linear projection of the historical data was used when there were a sufficient number of AADT counts and they followed a linear trend. In the research a minimum of 4 data points was required with a regression coefficient (R^2) value of at least 0.5 to be considered an acceptable linear trend. The linear projection gave good results with an average error of near zero, but tended to over-predict total traffic counts by approximately 10%. The exponential model gives higher values than the linear model for long-term projection of trends, and therefore is not recommended for long-range traffic projections. However, because of the familiarity of the exponential method and terminology (a percentage increase per year, compounded) among the IDOT traffic forecasters, and its potential applicability in areas of rapid development and increasing traffic, the exponential model was included as an option for forecasters.

The development of the computer program therefore included both linear and the exponential growth projections of the historical traffic data to be used as input in making a forecast. However, traffic forecasters will be able to study a plot of actual data for each point, view statistics on the fit of the data to the trend line, input information based on knowledge of local factors that may affect the traffic growth, and make other judgments, such as eliminating older data from the projection.

Other models for describing the historical traffic data were explored, but the small number of data points limits the use of such methods as Box-Jenkins models. Given the limited number of data points (generally fewer than 20 on interstates to as few as 2 on some low AADT structures), there was no justification for use of a more sophisticated model. The default models selected therefore were linear regression through the data points (simple growth model) and non-linear regression (compound growth model). The regression coefficient is displayed for the user to determine whether the linear model

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should be used, or if additional information on local conditions is required to supplement the projection and make the forecast.

When historical data at a point is insufficient to estimate a reliable linear trend, the average of growth rates in the region can be obtained for additional input into the forecast. Several options are available. The forecaster can use an estimated state wide or countywide growth rate, use a refined regional growth rate based on the functional class of the roadway, or find a more localized growth rate based on growth rates near the roadway. Many different computational approaches may be used to determine these growth rates. The method described in Area Growth Rate Model was implemented in the ITPT program.

Area Growth Rate Model

An algorithm was developed to generate a contour plot of growth rates across an entire county based on a weighted average of rates calculated at representative points. This procedure is computationally intensive so results are derived once for an entire county and stored for later retrieval. New growth plots should be calculated after the annual database update, for various Start Years or for different functional classes of roadways. The user selects a Start Year at the beginning of the analysis and indicates which functional classes to include in the calculation. The growth rates are calculated using all traffic count data in and after the Start Year for roads of the designated functional classes. In order to include an adequate number of road sections in the model that would be distributed throughout a county, all Key Route segments that include Structures are surveyed.

The compound growth rate is determined by a regression analysis using the applicable data ($\geq$ Start Year) and returned along with the number of data points used and the correlation coefficient. In order to be used in the model, the growth rate must be "valid." Valid growth rates are defined as those derived from at least four points with an R^2 value of at least 0.5. When two or more structures on the same Key Route have identical growth rates because they are based on the same set of counts, only one point is used and the location is set at the centroid of all identical segments. Models with a limited number of data points and a limited number of functional classes may not produce

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an adequate number of valid data sets to produce a plot that represents the actual variability across the county.

The contour plot is developed by calculating the growth rates over a 100 by 100 grid of points across the entire county. The weight applied to the growth rate at each representative point is based on the distance from the representative point to the grid point and the latest traffic count. An exponential function of distance multiplied by the traffic count is used.

$$W_i = A_i e^{-Cd_i}, \quad d_i > 2640 \; feet$$
$$W_i = A_i e^{-C(2640)}, d_i \leq 2640 \; feet$$

where A_i is the latest traffic count at Point i and d_i is the distance to Point i in feet. The coefficient C is set to a maximum value of 0.0001/foot.

Figure 3.6 shows the relative weight with various values for C. A uniform weight for distances less than 0.5 miles (2640 feet) was used to prevent excessive influence from one point. All weight values are scaled so that the uniform weight is one. Additionally, the value of the coefficient is reduced incrementally until the contribution from any one point is less than 25% of the total weight in order to insure that the growth rate from one location does not dominate a region of the plot. The minimum value of C is set to 0.00001/foot. The maximum value for C would give significant weight to all points within roughly a four mile radius. Areas where representative points are sparse may consider data from a large part of the county.

Distance Weighting Function
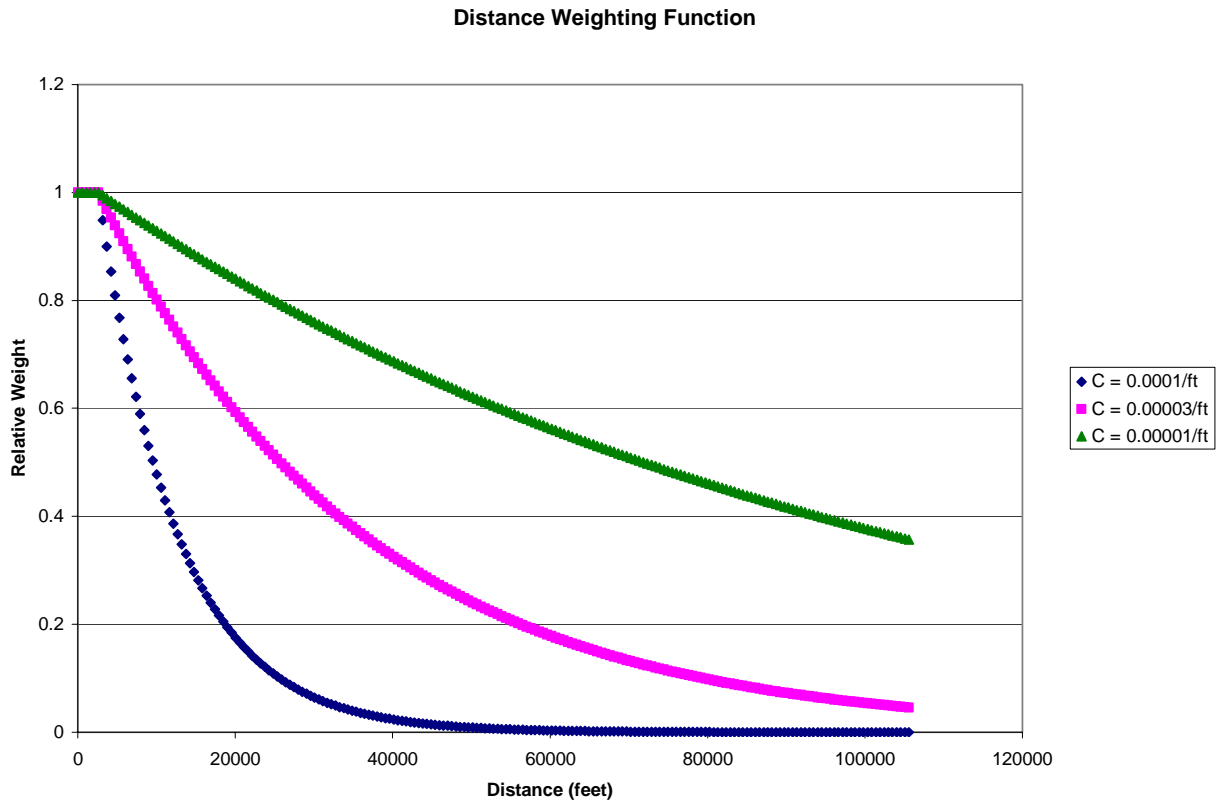
Figure 3.6. Distance weighting function.

The growth rate at the point (X_j, Y_j) is calculated as:

$$R_j = \sum_{i=1}^{N} R_i A_i e^{-C_j \sqrt{(X_j - X_i)^2 + (Y_j - Y_i)^2}}$$

where N is the number of valid data points and R_i is the growth rate at the valid, representative point (X_i, Y_i). Growth rates greater than 10% are considered to be 10% to eliminate unrealistic growth rates caused by irregular data. The information available to the forecaster using the area wide growth rate is shown in Figure 3.7. Brighter colors indicate areas of higher growth and darker areas have lower growth. The use of the area wide growth rate is more fully explained in the ITPT User Manual (Appendix A).
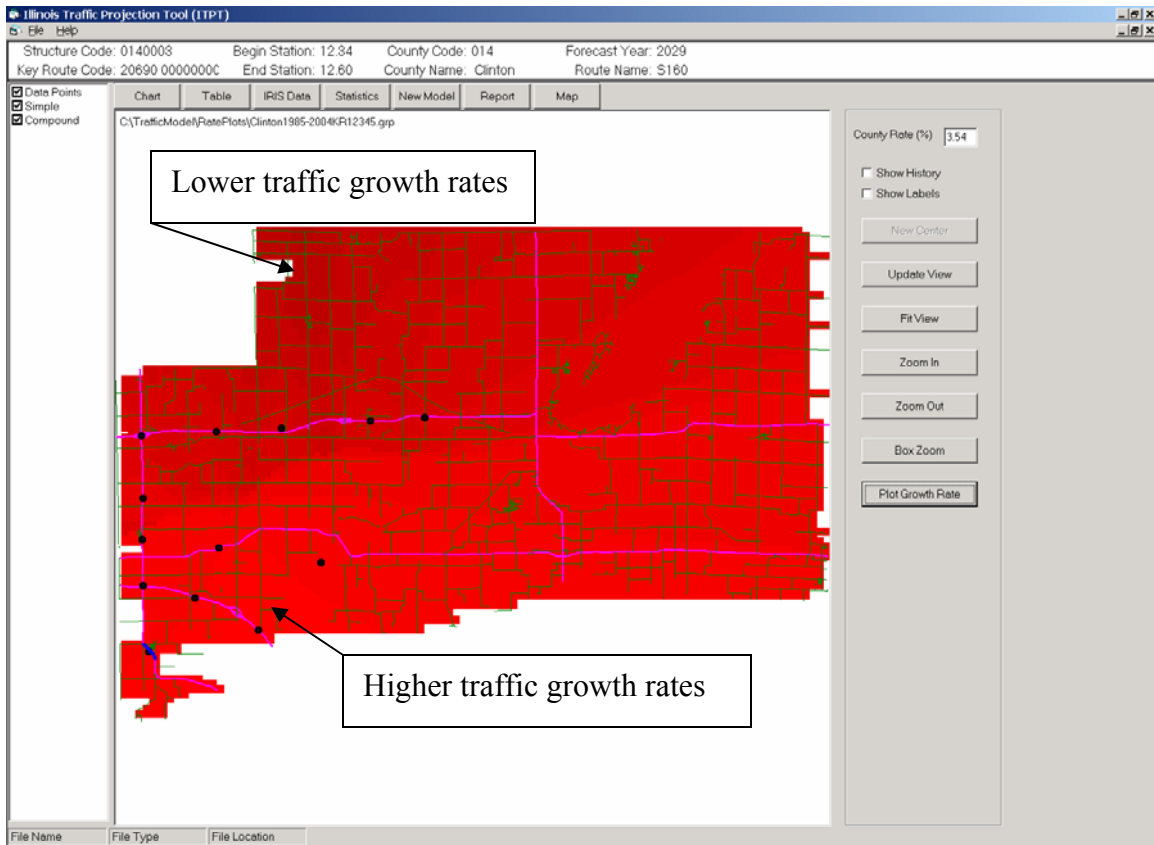
Figure 3.7. Plot of area-wide growth rates, Clinton County.

Countywide Growth Rate Model

A countywide growth rate is calculated using a similar approach but ignoring the location of the traffic counts. This value is simply determined from:

$$R_j = \sum_{i=1}^{N} R_i A_i$$

The countywide rate can be calculated without access to GIS data for the county. However, functional class information is not currently available in the reduced Access database used by ITPT (only in the ArcView files) so all functional classes must be included in these calculations. The countywide growth rate for Clinton County is shown in Figure 3.7 as 3.54%. Details of the calculation are given in in the ITPT User Manual (Appendix A).

Model Verification

The modeling approach described above was tested by comparing the model results to current IRIS forecasts and by applying the model to a partial set of early historical data points to forecast the latest AADT count.

Comparison of Model Results to Current IRIS Forecasts for HPMS

IRIS forecasts current at the end of 2003 for all HPMS sections were obtained from IDOT to compare with model results. Two analyses were performed: 1) forecasts were generated manually for 20 HPMS sections randomly selected throughout the state and 2) all HPMS sections were forecast automatically using the approach described below. All available data was considered and the forecasts were made for the year of the IRIS forecast.

In the manual exercise, 20 HPMS sections were randomly selected. The forecast years varied from 2015 to 2028. Some of the IRIS forecasts were out of date since they should be no less than 18 years in the future, or 2021. Researchers ran the ITPT program for each HPMS section, generated a projection, and made a forecast based on their best judgment. Most plots seemed consistent with a linear trend and the forecast was made using the projection given by the Simple Growth model, but the researchers used judgment when historical trends showed a negative growth, or appeared to show exponential growth. The resulting Table 3.2 is a summary of the results. As expected, the model-generated forecasts varied from the IRIS forecasts, but there was no general trend in which the researchers using the ITPT program over- or under-predicted the forecast produced by the IDOT districts. Ten of the 20 forecasts over-predicted the value recorded in IRIS, while the other 10 under-predicted the values (Figure 3.8). The average error of the ITPT forecasts, standardized on the IRIS forecast, was a 5.6% over-prediction in relation to the forecasts stored in IRIS. However, it is interesting to note that the errors of largest magnitude tended to occur when the ITPT forecast was compared to District 1 forecasts (Figure 3.9), which are generated by the network model maintained by CATS. On these sections, ITPT over-predicted in four of the five cases. More research is needed to study the reasons for this divergence. The preliminary indication is that a network

model, which considers such variables as capacity constraints on existing roadways in the network, may give more conservative forecasts in urban areas. However, it may be useful for District 1 forecasters to have the additional information on trends that will be available from ITPT for consideration. The reports generated for these forecasts are included in Appendix C.

Table 3.2. Comparison of ITPT and IRIS projections.

HPMS Code	ITPT Projection	IRIS Projection	Error	Standard Error
0168310	29500	17600	11900	0.6761
0490150	37500	23000	14500	0.6304
0161060	61100	41000	20100	0.4902
0690030	9700	7300	2400	0.3288
0160170	204000	166000	38000	0.2289
0841360	8600	7000	1600	0.2286
0928302	31500	25800	5700	0.2209
0101350	10200	9200	1000	0.1087
0920240	13400	12350	1050	0.0850
0170040	800	750	50	0.0667
0720480	7700	7934	-234	-0.0295
0841480	3600	3950	-350	-0.0886
0710060	4150	4700	-550	-0.1170
0570260	31200	36400	-5200	-0.1429
0848314	11400	14000	-2600	-0.1857
0821790	4450	5500	-1050	-0.1909
1018404	44800	58000	-13200	-0.2276
0810420	18900	25000	-6100	-0.2440
0161560	14200	21000	-6800	-0.3238
0840250	9700	15700	-6000	-0.3822
			Mean Std. Error	0.0566
			Std. Dev. Of Std. Error	0.3071
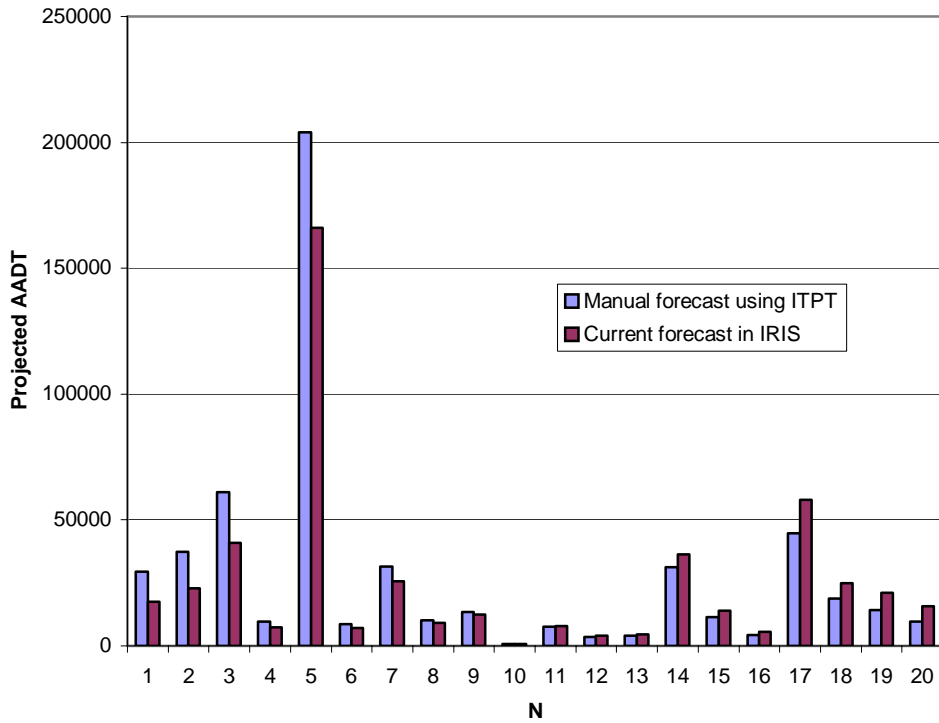
Figure 3.8. Comparison of ITPT and IRIS forecasts for 20 HPMS sections.

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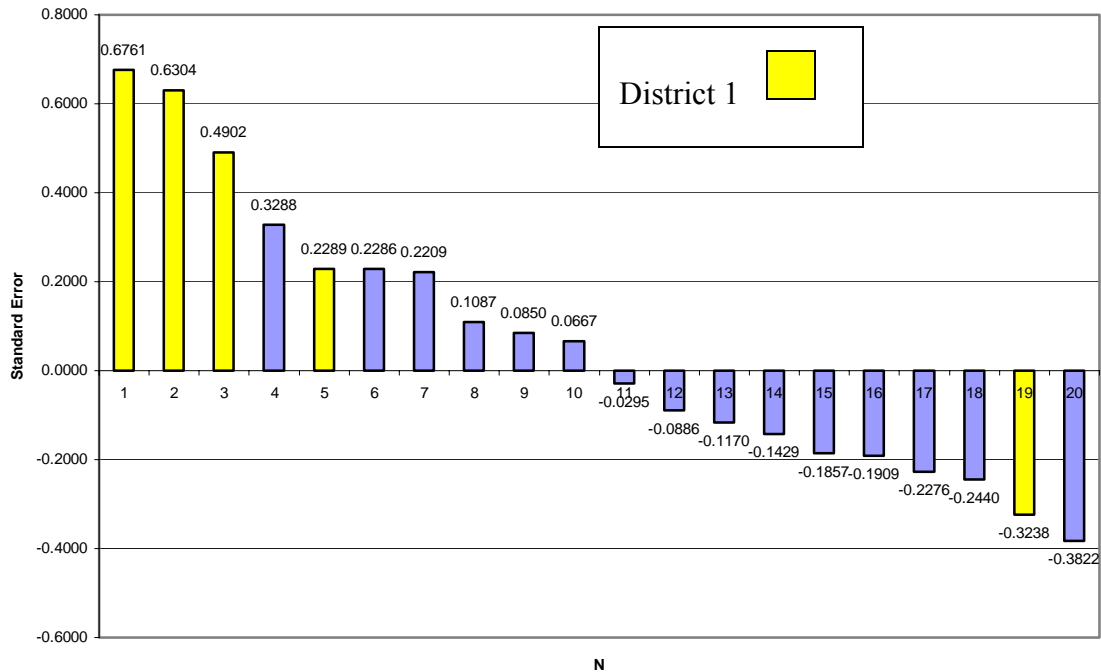
Figure 3.9. Prediction error for District 1 and downstate districts.

In a second, more generalized verification test, traffic history for all HPMS sections with more than one AADT count was analyzed using a simple computer algorithm to automatically generate a projection. These were compared with current IRIS forecasts to determine whether or not the use of the ITPT program will cause a significant change in the results reported to the Federal Highway Administration (FHWA). The analysis was also used to study how the number of years of historical data used in the analysis affects the result and the use of average county growth rates for forecasts when the historical trend is not linear. Thirty forecasts were generated for each HPMS section using Start Years from 1971 to 2000. In most cases the linear regression of all AADT counts from the Start Year to the present was extrapolated to the year of the IRIS forecast. When the linear regression indicated a negative growth rate, the growth was assumed to be 0 and the last AADT count was used as the forecast. The error of the model forecast relative to the IRIS forecast was then calculated as:

$$Error = \frac{ITPT - IRIS}{IRIS}$$

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Figure 3.10 is a plot of the average error and standard error for all HPMS sections. Although individual forecasts will vary with changes in the Start Year, the average of many forecasts is relatively insensitive to the Start Year as long as at least 10 years of data are used. The standard deviation of the error between the model forecasts and the IRIS forecasts is about 30% when at least 20 years of data is used.

Comparison of Model Results to Current IRIS Forecast for HPMS Sections
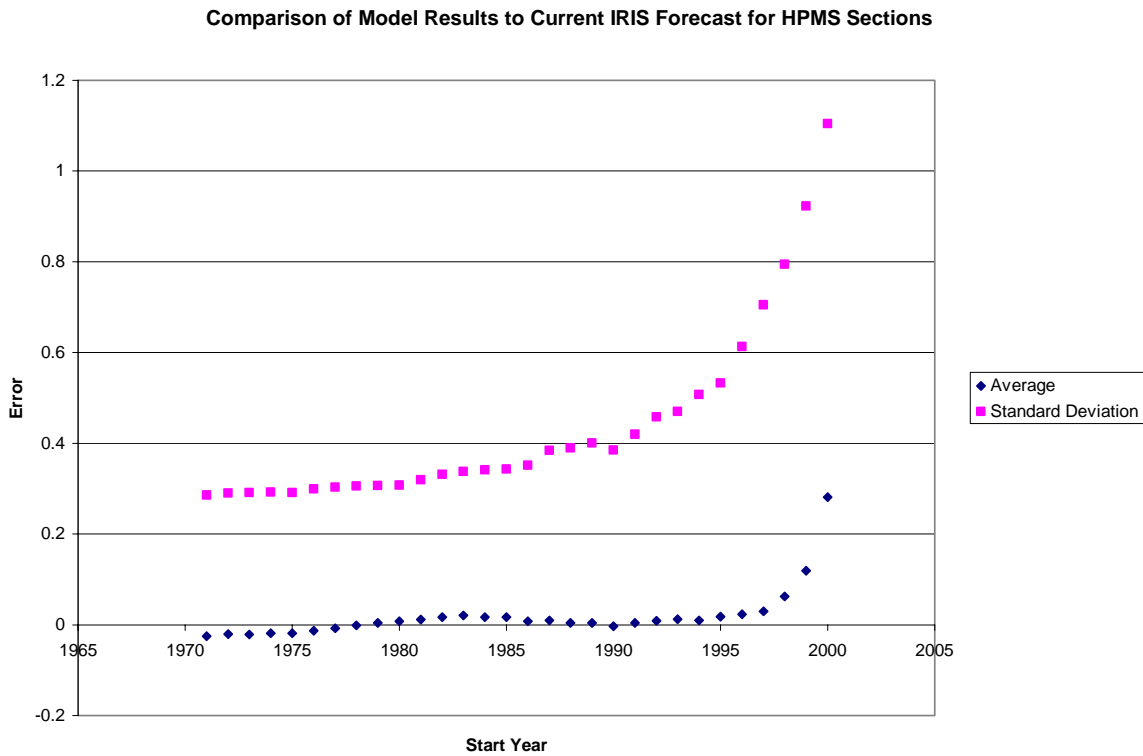
Figure 3.10. Comparison of ITPT Projection to Current IRIS Forecast.

The model was modified to reject the linear regression result when the trend did not meet the criteria specified in the Model Development for adequate linearity. Roughly one-half of the HPMS sections had $R^2 < 0.5$. When only the sections with valid linear trends were compared to the IRIS forecasts, the average error was 9% with a standard deviation of 26%. This result indicates that when forecasters are presented with data showing a strong linear trend, they may tend to report higher forecasts than they have produced using current methods.

The model was further enhanced to provide forecasts for HPMS sections with poor linear trends based on a calculated county wide average growth rate. Countywide rates were calculated using the approach described in Area Growth Rate Model. This

growth rate was multiplied by the latest AADT count to determine the expected growth in vehicles per year. The forecast was then calculated by adding the vehicles per year times the number of years in the future to the last AADT count. Countywide growth rates used in the model are summarized in Table 3.3. These results were 12% higher than the IRIS forecasts on average. The standard deviation of the error was 27%.

Table 3.3. Summary of countywide growth rates, 1971-2003.

County	Rate	County	Rate	County	Rate	County	Rate
Adams	3.66%	Ford	2.22%	Livingston	2.02%	Putnam	1.31%
Alexander	2.61%	Franklin	3.43%	Logan	3.37%	Randolph	1.65%
Bond	2.74%	Fulton	1.86%	McDonough	1.71%	Richland	1.60%
Boone	2.94%	Gallatin	3.17%	McHenry	3.06%	Rock Island	2.52%
Brown	2.25%	Greene	1.53%	McLean	3.82%	St. Clair	3.08%
Bureau	1.41%	Grundy	2.79%	Macon	1.05%	Saline	1.48%
Calhoun	0.10%	Hamilton	1.22%	Macoupin	2.50%	Sangamon	3.20%
Carroll	1.33%	Hancock	2.07%	Madison	3.19%	Schuyler	2.25%
Cass	1.99%	Hardin	1.87%	Marion	2.84%	Scott	1.61%
Champaign	2.91%	Henderson	2.23%	Marshall	3.25%	Shelby	2.31%
Christian	1.58%	Henry	1.91%	Mason	1.30%	Stark	2.76%
Clark	2.82%	Iroquois	2.03%	Massac	5.61%	Stephenson	2.58%
Clay	2.68%	Jackson	2.47%	Menard	1.75%	Tazewell	2.72%
Clinton	4.30%	Jasper	1.56%	Mercer	2.28%	Union	2.32%
Coles	2.31%	Jefferson	3.39%	Monroe	5.75%	Vermilion	2.35%
Cook	2.92%	Jersey	1.78%	Montgomery	3.51%	Wabash	-0.49%
Crawford	1.55%	JoDaviess	1.86%	Morgan	2.43%	Warren	1.48%
Cumberland	2.45%	Johnson	4.99%	Moultrie	0.90%	Washington	4.38%
DeKalb	3.57%	Kane	5.58%	Ogle	5.19%	Wayne	2.29%
DeWitt	3.06%	Kankakee	2.70%	Peoria	2.60%	White	1.68%
Douglas	2.16%	Kendall	4.26%	Perry	0.25%	Whiteside	3.36%
DuPage	4.14%	Knox	2.13%	Piatt	3.29%	Will	4.21%
Edgar	1.65%	Lake	4.25%	Pike	0.80%	Williamson	3.79%
Edwards	1.25%	LaSalle	2.34%	Pope	2.02%	Winnebago	3.48%
Effingham	3.07%	Lawrence	1.66%	Pulaski	2.33%	Woodford	4.05%
Fayette	2.46%	Lee	4.71%				

A second error calculation was performed to determine the expected change in the overall forecast volume on all HPMS sections in Illinois. If the percentage errors on high volume roads, for example in the Chicago area, tended to be higher or lower than the statewide average, the minimal average error reported in Figure 3.10 would not extend to a prediction of overall volume. This approach yielded somewhat larger errors as shown in Figure 3.11.

Error in Overall HPMS Volume Prediction with ITPT vs. IRIS
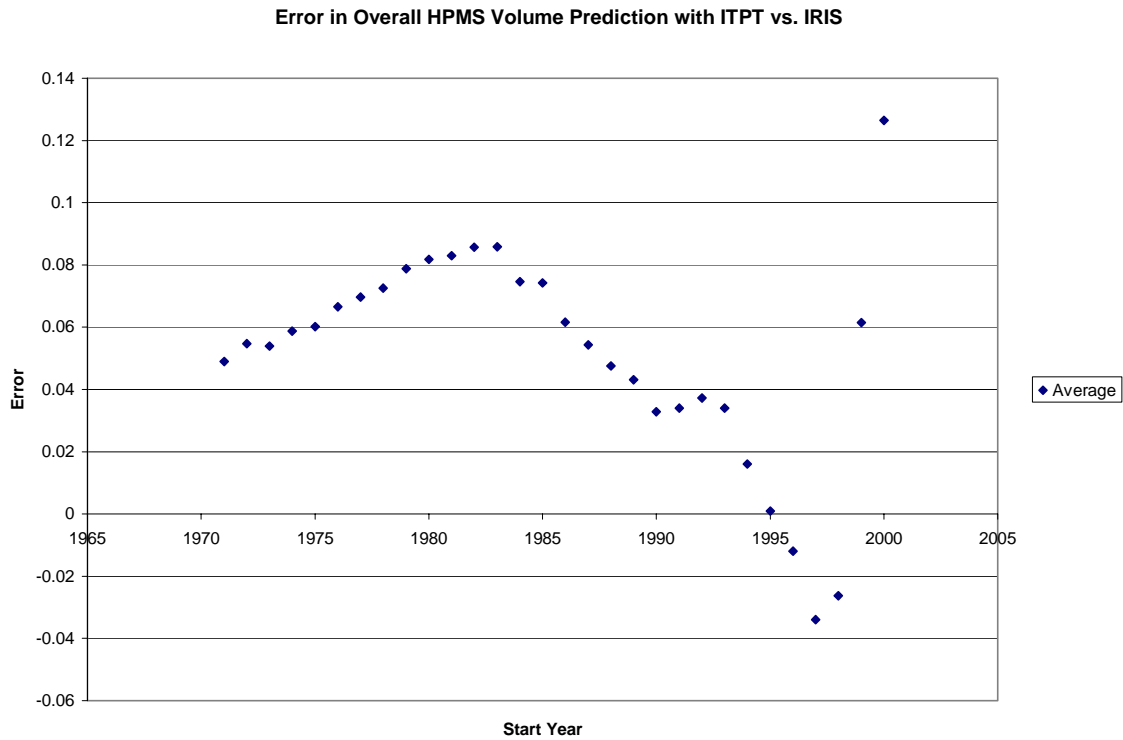
Figure 3.11. Comparison of error between ITPT and IRIS forecasts for all HPMS sections.

A refined analysis of changes in the overall HPMS volume prediction was then conducted using the countywide growth rates for HPMS sections with poor linear tends (as described above) and removing the HPMS sections in District 1. Because forecasts in the Chicago area are produced by CATS using a network model and one of the assumptions for this research was that the CATS model would still be the primary means of forecasting HPMS sections in District 1, the implementation of ITPT should not greatly affect those forecasts. This analysis produced an average error of 7.9%; that is, the total forecast volume from IRIS for the HPMS sections outside District 1 was 27,566,137 while the ITPT forecasts for those sections to the year of the current IRIS forecast, assuming that the forecaster would use a countywide growth rate when there was a weak linear trend, yielded a total of 29,756,966 vehicles.

The comparison of model results to current IRIS forecasts indicate that the implementation of ITPT by IDOT forecasters will not produce a significant change in the magnitude of traffic forecasts. Results may tend to be 5% to 10% higher.

Forecast Verification

With over thirty years of data it is possible to evaluate trends in the early data to test the ability of models to predict actual counts recorded in later years. Studies were conducted using the data for HPMS sections to evaluate the selected models. An algorithm was developed to calculate 5, 10, 15 and 20-year forecasts of the latest data count for each HPMS section. The linear regression of all earlier data was projected to the last year of data. For example, the 2003 AADT for HPMS section 1010520 was 15,906. The earliest AADT was in 1975. A projection of the linear regression through all counts between 1975 and 1998 gives a 5-year forecast of 16,502 in 2003 while a similar projection through all counts between 1975 and 1993 predicts 16,021 vehicles 10 years later in 2003. The prediction error was 3.7% and 0.7% for the 5 and 10-year forecasts, respectively. This analysis was run for all HPMS sections, and forecasts were calculated when the linear regression met the standard for a valid trend (at least 4 data points and $R^2 > 0.5$). Predictions with errors greater than 100% of the actual traffic count were eliminated from the statistical analysis of the results. Errors of this magnitude indicate that some event that could not be anticipated by studying historical data caused the traffic volume to change dramatically.

Table 3.4 shows a summary of the errors in the forecast verification analysis. The average error indicates that the linear projection tends to over predict the actual traffic counts by 5% – 10% in all cases. The standard deviation of the error is between 22% and 32%. The number of cases (of 2,339 HPMS Sections) with valid linear trends decreases for longer forecasts primarily because the number of data points used to form the projection is smaller. Since 20-year forecasts are based on data collected between 1971 and 1983, a relatively small number of the HPMS sections have at least 4 data points over this time span.

Table 3.4. Forecasting ability of linear regression applied to historical data.

	5-Year	10-Year	15-Year	20-Year
Average	0.0738	0.0960	0.0676	0.0480
Std. Dev.	0.225	0.273	0.321	0.295
Number of Observations	1192	1074	622	408

These results indicate that the linear regression model may tend to over-predict future traffic counts in Illinois in the early 21st century. A model that allows a declining absolute growth may be more appropriate.

Logarithmic Projection

Analysis of the results of the model verification phase of the research indicated that another model that considered declining growth rates should be considered. A logarithmic projection was studied to evaluate its ability to describe traffic growth trends on HPMS sections in Illinois. The traffic trend is modeled as

$$AADT = a + b\log(Year - BaseYear)$$

This could be treated as a three-parameter model using an algorithm to calculate the values of a, b, and BaseYear which minimize error. For this example a BaseYear of 1960 provided good results as shown in Table 3.5. Fixing a Base Year simplifies the calculation to a simple linear regression analysis of AADT on the log of the normalized year. Figure 3.12 shows this model applied to the data for HPMS Section 1010520 to check the 5-year forecast of the 2003 count using data before 1998. Therefore, the forecast AADT value is:

$$5162.6Ln(43) - 3822.9 = 15,595$$

which produces an error of -2.0% when compared to the actual 2003 count of 15,906.

Declining Growth Rate Model - HPMS 1010520 through 1998

$y = 5162.6\text{Ln}(x) - 3822.9$
$R^2 = 0.6543$
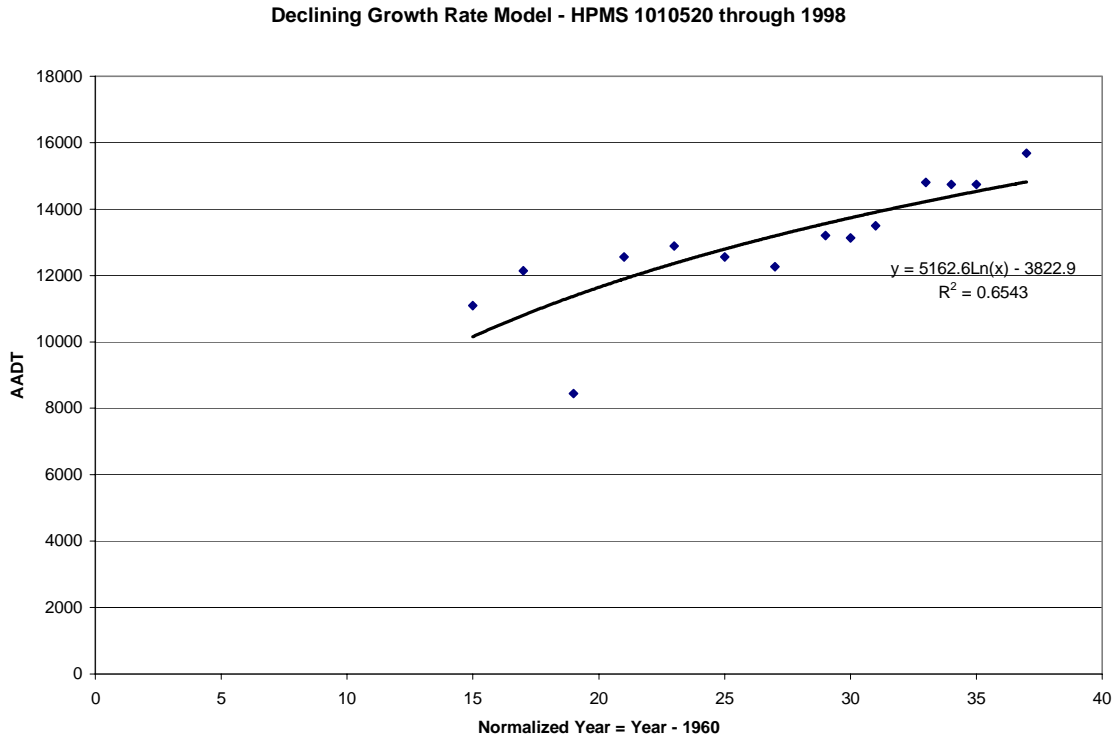
Figure 3.12. Logarithmic growth curve.

Applying this model to all HPMS sections in a replication of the test done for linear regression resulted in an average error of near zero for all cases, while the standard deviation of the error (varying between 20 and 30%) and number of valid HPMS sections for the 5-year, 10-year, 15-year and 20-year projections was similar to the linear regression model (Table 3.5).

Table 3.5. Average error using logarithmic projection.

	5-Year	10-Year	15-Year	20-Year
Average error	0.0061	0.0097	-0.0254	-0.0340
Std. Deviation	0.2108	0.2518	0.2932	0.2954
Observations	1166	1061	635	436

Based on these results, the researchers recommend that this model should be considered for inclusion in future upgrades to the ITPT program. The logarithmic model would be more difficult for traffic forecasters to interpret because it is a three-parameter model and there is no simple way to express annual growth rate. However, if traffic growth rates continue to decline, this type of model may become more widely accepted in the future.

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CHAPTER 4
CONCLUSIONS AND RECOMMENDATIONS

The Illinois Traffic Projection Tool was successfully developed to facilitate traffic forecasting by the Illinois Department of Transportation. This Microsoft Visual Basic program extracts data from a Microsoft Access database derived from IRIS data and plots a time history of the traffic volume. Regression analyses are performed on the data to calculate historical growth rates using both simple and compound growth models. The forecaster can then modify the data to add current traffic counts and remove data points that do not fit the overall trend. Growth rates at nearby roads in the county and countywide growth rates can also be viewed through a graphical map interface. The forecaster may use the regression results or define a different model based on other available information to complete the forecast. Results can be printed or stored in a Microsoft Word format for easy retrieval.

Studies to determine the effect of the implementation of ITPT on statewide FHWA reporting and to validate the accuracy of various modeling approaches indicate that if forecasters generally use an extrapolation of the simple growth model the average statewide results in Districts outside the Chicago area will not change substantially – an increase of 5 to 10% may be expected. When the simple growth model was tested using earlier data to predict the most recent traffic count, it also over predicted the actual counts by 5 to 10%, on average. Standard errors of 20 to 30% were observed between individual forecasts in most tests of the model. This level of natural randomness is expected with 24-hour traffic counts. The principal function of ITPT is to provide easy access to information from which the traffic forecaster will make experience-based judgments. The user will ultimately decide how to apply the available models.

The research indicates that actual traffic growth rates are probably declining in many regions and that the 3% rates experienced in the 1980's and 1990's are unlikely to continue. Additional research and education on declining growth rate models and their implementation should be considered. Additionally, where Metropolitan Planning Organizations have detailed models of traffic growth, an interface between ITPT and these models would be useful. ITPT can be used to give MPO forecasters additional historical data to help validate network models.

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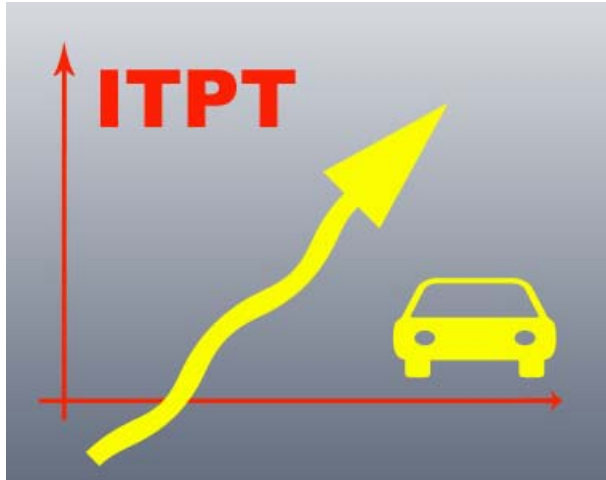
Illinois Traffic Projection Tool

User's Manual
Version 2.0 – June 2004

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PREFACE

Illinois Traffic Projection Tool (ITPT) is a Windows-based software program used for projecting historical traffic data to future dates. The tool is designed to make reporting for Highway Performance Monitoring System (HPMS) roadways and National Bridge Inspection (NBI) structures easier and more efficient. However, the tool can also be used for projecting traffic for district construction projects.

ITPT was developed by researchers at Southern Illinois University Edwardsville (SIUE). The program is the product of research sponsored by the Illinois Transportation Research Center (ITRC) and SIUE. Principal researchers on the project were Kerry T. Slattery, Ph.D., P.E., Yansong Wang, Bryon Ehlmann, Ph.D., and Dianne H. Kay, P.E. Illinois ITPT was designed and written by Kerry Slattery, Yansong Wang and Bryon Ehlmann. Program documentation and a user manual were written by Kerry Slattery and Dianne Kay. Project guidance was given by a Technical Review Panel consisting of members from the Illinois Department of Transportation. Special thanks is due to committee chairman Rob Robinson, and to committee members Ryan Petersen and Ron Hegwood, to Steven J. Hanna, Ph.D., P.E. of the ITRC, and to Shawn Leight and Jiji Kottommannil of Crawford, Bunte and Brammeier Traffic and Transportation Engineers, who provided technical consultation throughout the project. Traffic forecasters from each of the nine IDOT district offices met or spoke with the researchers and provided information about forecasting methods currently in use. Their input was instrumental in the development of this forecasting tool, and is gratefully acknowledged.

DEFINITIONS AND ACRONYMS

AADT – Annual average daily traffic

FHWA – Federal Highway Administration

GIS – Geographic Information System

HPMS – Highway Performance Monitoring System

IDOT – Illinois Department of Transportation

IRIS – Illinois Roadway Inventory System

ISIS – Illinois Structure Inventory System

ITPT – Illinois Traffic Projection Tool

BACKGROUND INFORMATION

A research team from Southern Illinois University Edwardsville (SIUE) with consultants Crawford, Bunte, Brammeier Traffic & Transportation Engineers (CBB) was selected to do the work outlined in a Request for Proposal for the Illinois Transportation Research Center (ITRC) project "Developing Long Range Traffic Projection Models for Illinois," ITRC project FY IVA-H1-03. The Illinois Department of Transportation (IDOT) had identified a need to develop a statewide traffic projection model to assist the Central and District Offices to meet Federal Highway Administration (FHWA) reporting requirements for Highway Performance Monitoring System (HPMS) sections and structures and to forecast traffic growth for highway improvements.

The objective of this research was to develop a simple, low maintenance computer model that used this historical data as a forecasting basis, but that would allow the Districts the flexibility to adapt the model by applying individual knowledge of specific local conditions affecting traffic. The research has resulted in a computerized traffic projection model, Illinois Traffic Projection Tool (ITPT). The project began on August 16, 2003 and the contract was terminated due to state budget constraints on June 30, 2004.

The researchers reviewed the current procedures and data resources used by each District in completing the traffic forecasts for both HPMS sections and structures, as prompted by direct requests for such forecast updates by the IDOT Office of Planning and Programming, Data Management Unit. Discussions with IDOT District and Central Office personnel elicited important information in several key areas necessary for developing a computer model of the forecasting process, including the input required, output required or desired, functions required or desired, database information, and the forecasting methods or models currently used.

TRAFFIC DATA COLLECTION

Traffic is counted on state-maintained routes every other year. County highways and township roads are generally counted every five years. District personnel enter traffic count data into the Illinois Roadway Inventory System (IRIS) mainframe computer. The counts include coverage of the 2,400 HPMS sections and 27,000 structures throughout the state.

Traffic counts from the past 30 years on all state-maintained routes, county highways, and township roads are currently available in a Microsoft Access database maintained by the IDOT Office of Planning and Programming, Data Management Unit in Springfield. These traffic counts, formerly available only on individual countywide maps, now can be easily used as a historical basis for traffic forecasting. Counts are also available in geographic information system (GIS) format.

INPUT

The Districts are prompted to update the structures traffic forecasts by error reports issued by the IDOT Central Office, which also alerts Districts of the need to update HPMS section forecasts. The error reports indicate that the forecast year in the database is out of the acceptable range (18-25 years from the current year for HPMS sections, or 17-22 years from date of last inspection for structures).

Each roadway in the state system is given a Key Route number. The Key Route number is a unique identifier that establishes the roadway type (federal aid, county, township and municipal routes), county in which the roadway is located, and other characteristics (i.e. ramp, spur, frontage road) that describe the roadway.

The HPMS section number identifies a section of highway on which information is collected for reporting to the FHWA. The HPMS section number is a seven-digit code that uniquely describes the section within the state. HPMS sections with uniform characteristics were randomly selected along Key Routes when the program began in 1978, and traffic on HPMS sections has been reported since 1981.

The currently used methods for performing HPMS section traffic projections varied, but most Districts begin the process by locating the latest traffic information for the HPMS section in question using GIS. The statewide GIS is centrally maintained and available in each of the District main offices. Traffic data from 1997 forward is available on GIS, but some forecasters also use paper maps to trace historical traffic counts.

The method used for projecting traffic growth varied among the Districts from application of a linear growth factor to the most recent traffic count to linear regression of the data for all the available years. Typical rates of growth for each functional class of roadway are applied in some Districts, and calculated values may be checked against these "rule of thumb" values for reasonableness. For example, rural highways may be assumed to have 1.5% growth per year, urban highways 2%, and rapidly growing urban areas 3% or more. Historical growth rates are often modified by the forecaster based on knowledge of local conditions, including population growth or decline, commercial growth or decline, road openings or closings and other factors.

OUTPUT

The output required for HPMS reporting is an AADT for a year from 18 to 25 years in the future. For practical purposes, the forecast is projected the full 25 years, to delay the next forecast update as far as possible. A single AADT value is projected, with no breakdown by vehicle type. The projected values are rounded according to IDOT policies and are entered into the IRIS database.

GETTING STARTED

System Requirements

ITPT will run on Windows 2000, Windows NT, or Windows XP operating systems. The program was designed to run from the hard drive of an individual PC. Minimum memory requirements are 128 MB RAM and 60 MB of hard drive space. Display resolution should be at least 800 X 600 pixels. The program uses default font sizes that are not adjustable. For information on your computer's current resolution, check *Settings* under your computer's *Display* option under the *Control Panel* menu. Contact your systems administrator for questions regarding your computer's display properties.

Installing ITPT

ITPT Version 2.0 is distributed on compact disc. Insert the ITPT CD into your computer's CD drive. Access the installation CD and copy the entire TrafficModel directory to the C: drive to create *C:\TrafficModel*. The user must have write privileges to the entire *C:\TrafficModel* directory. Run the setup file located in *C:\TrafficModel\Package\Setup.exe*. This will launch the ITPT setup program and guide you through the installation procedure. The default installation directory is *C:\TrafficModel\Installation*. The setup routine may warn you that the version that the setup program is trying to install is not newer than a file currently on your computer. Always choose the default response, Yes, to keep the newer version. Two database files should be located in *C:\TrafficModel\IRIS_database – county_code.mdb* and the IRIS data for the district. The path and name of the IRIS data must be correct in the first line of the file *C:\TrafficModel\Traffic.ini*. The second line of the *Traffic.ini* file is the default path to the GIS files. For example,

```
C:\TrafficModel\IRIS_database\District8.mdb
C:\TrafficModel\GIS\
```

Edit *Traffic.ini* if required using a standard text editor such as WordPad and insure that the database is unzipped. In order to use the Map option, two GIS files are required for each county – *hwy01xxx.dbf* and *hwy01xxx.shp* where *xxx* is the three-digit county number. Other program options are fully functional without GIS files.

Unistalling ITPT

To remove ITPT from your computer, use the *Add/Remove Programs* option under the *Control Panel* menu on your computer. This will remove all ITPT related program files on your computer. ITPT project files will not be removed.

Uses for ITPT

ITPT was designed to project future traffic on Illinois routes contained in the Illinois Roadway Inventory System (IRIS).

HPMS TRAFFIC PROJECTION USING ITPT

Opening ITPT

When you are ready to use ITPT, select the ITPT shortcut from the Programs folder on your Start menu. The program can also be launched from ArcView Data Verification project maintained by IDOT.

Initial Screen

Running ITPT will open a dialog box on your desktop that allows you to enter a few parameters to start a new traffic projection.
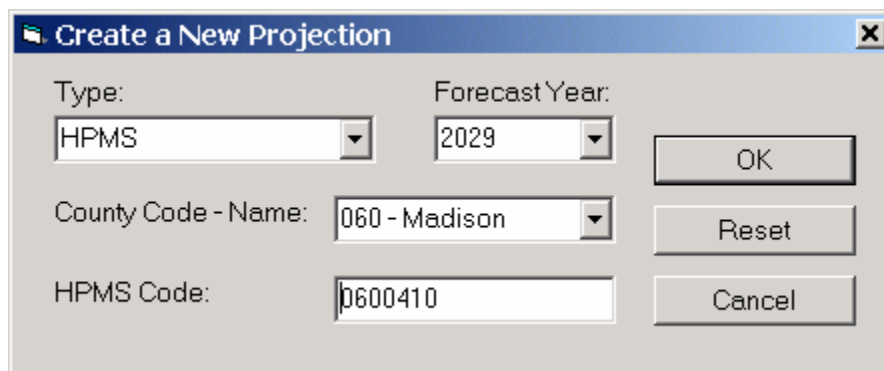
Figure 1. Initial screen.

The dialog box allows you to select the Type (Fig. 1). A drop-down menu lists HPMS, Structure, or Key Route. Parameters on this form will be automatically set to the last forecast viewed in ITPT, or to the selected section if you launched ITPT from ArcView. To do a forecast for an HPMS section select this Forecast Type, enter an HPMS code and click OK. The County Code will be filled automatically. The default Forecast Year is 25 years from the present. Use the drop-down menu to select a new Forecast Year, if desired.

To do a forecast for a structure, select Structure from the Type drop-down menu, enter a Structure code and click OK (Fig. 2). The County Code will be filled automatically. When you are finished, click OK. You will be prompted to make a selection if there are multiple Key Routes associated with that structure code.

Figure 2. Dialog box for structure forecast.

If you are starting a projection using a Key Route, complete the Key Route Information by entering the Type (1-character numeric) and Number (4-character numeric). The optional field Suffix (1-character alpha or numeric) may be left blank, and the remaining fields have a default entry of zeros as shown in Figure 3. The Key Route Code will be completed automatically. Select the County Code-Name from the drop-down menu, and enter a valid Station for the Key Route section on which you are making a forecast.

Figure 3. Dialog box for Key Route forecast.

Chart

After clicking OK in the completed Create a New Projection form you will see the historical traffic data for that roadway section in the Chart screen (Figure 4). The name of the program is shown in the blue Title section. Below the Title are the Menu tabs

containing the File and Help functions (the Help function is not active in this version of ITPT). In the Identification Header near the top of the screen, the identifying information for the section is shown, including the HPMS/Structure/Key Route Code, the corresponding Key Route Code and stationing, the County Code and County Name, the Forecast Year and a Route Name. The Command Buttons for moving to another screen are located under the Identification Header. To the left of the screen is the Model Selection Frame, which initially indicates that the Data Points and the two default models (Simple Growth and Compound Growth) are selected. The Data Points are plotted as annual average daily traffic (AADT) versus year, beginning with the year 1971. Data Points are weighted averages of IRIS data. The Year Selection Bar is located at the bottom of the plot.
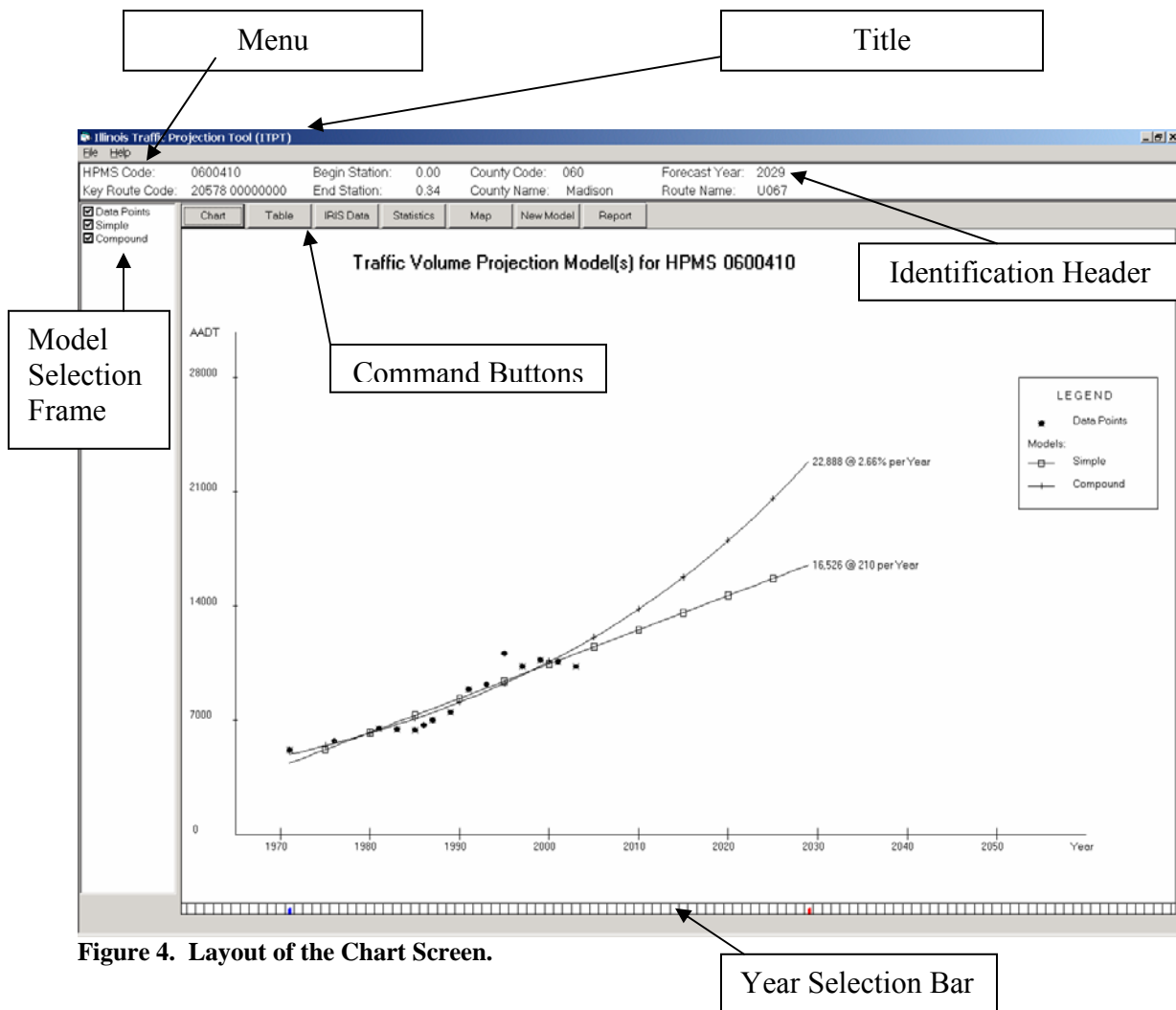
Figure 4. Layout of the Chart Screen.

The Chart shows a plot of all historical traffic data for the selected section from the derived IRIS database, places a best-fit linear regression line (Simple Growth model) and a best-fit exponential growth curve (Compound Growth model) through the data and projects the two models to the forecast year. The Simple Growth model is a constant

increase in traffic per year, and is labeled in units of vehicles per year. The Compound Growth model is a percentage increase, compounded annually, and is labeled in units of percent per year.

A frame on the left side of the Chart screen shows the curve-fit models that are available—check boxes indicate which models are active. Deselect the check box to remove one or both curve-fit models from the Chart. In Figure 5, Compound has been deselected, and only the Simple Growth model remains.
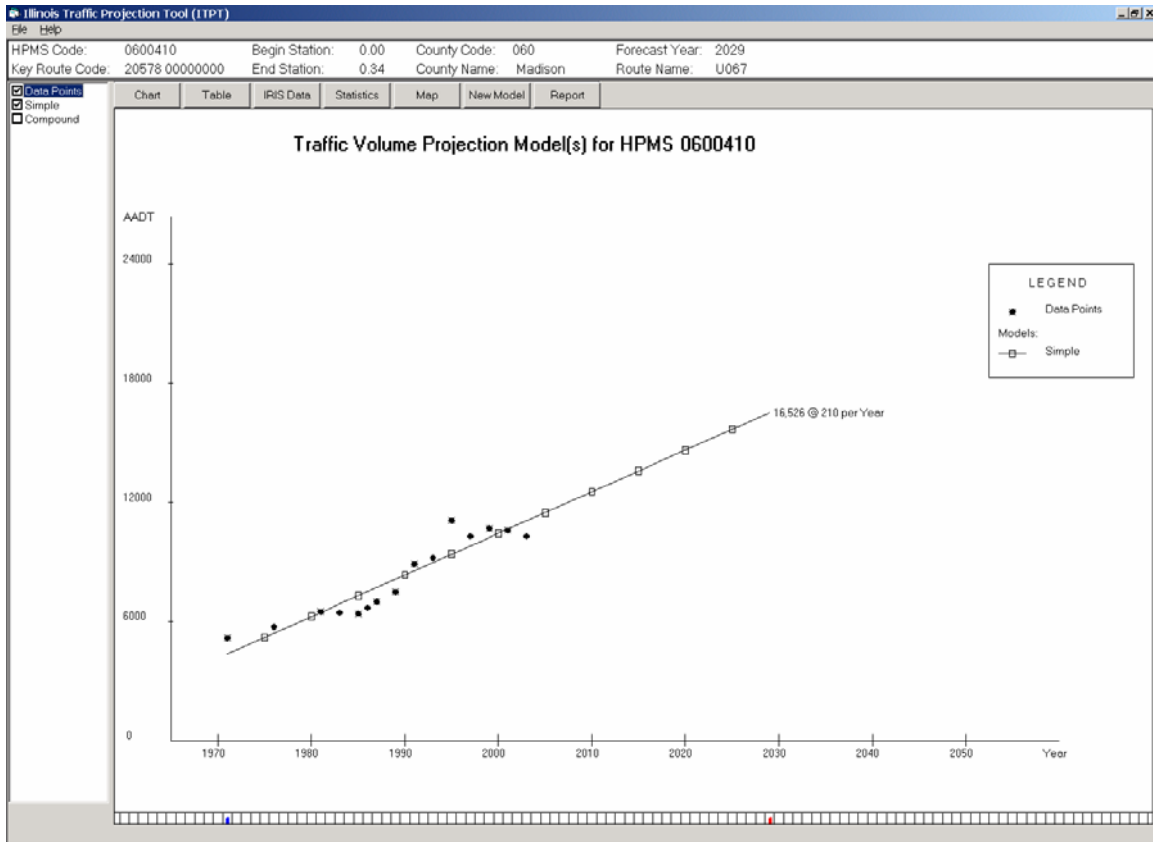
Figure 5. Simple Growth Model only.

If both boxes are deselected, only the Data Points remain (Figure 6). This option is useful for viewing the data points to identify unusual or inconsistent data. Placing the cursor over any point shows the year the data was collected and the AADT (a weighted average of the IRIS data). You may remove an inconsistent data point by first left-clicking to highlight the point, then right-clicking to see a menu. Select "Delete Data Points" to remove the point. Note that once removed, the point cannot be replaced. If you delete a point and later decide to add it back, you must restart the projection or manually reenter the data in the Table.
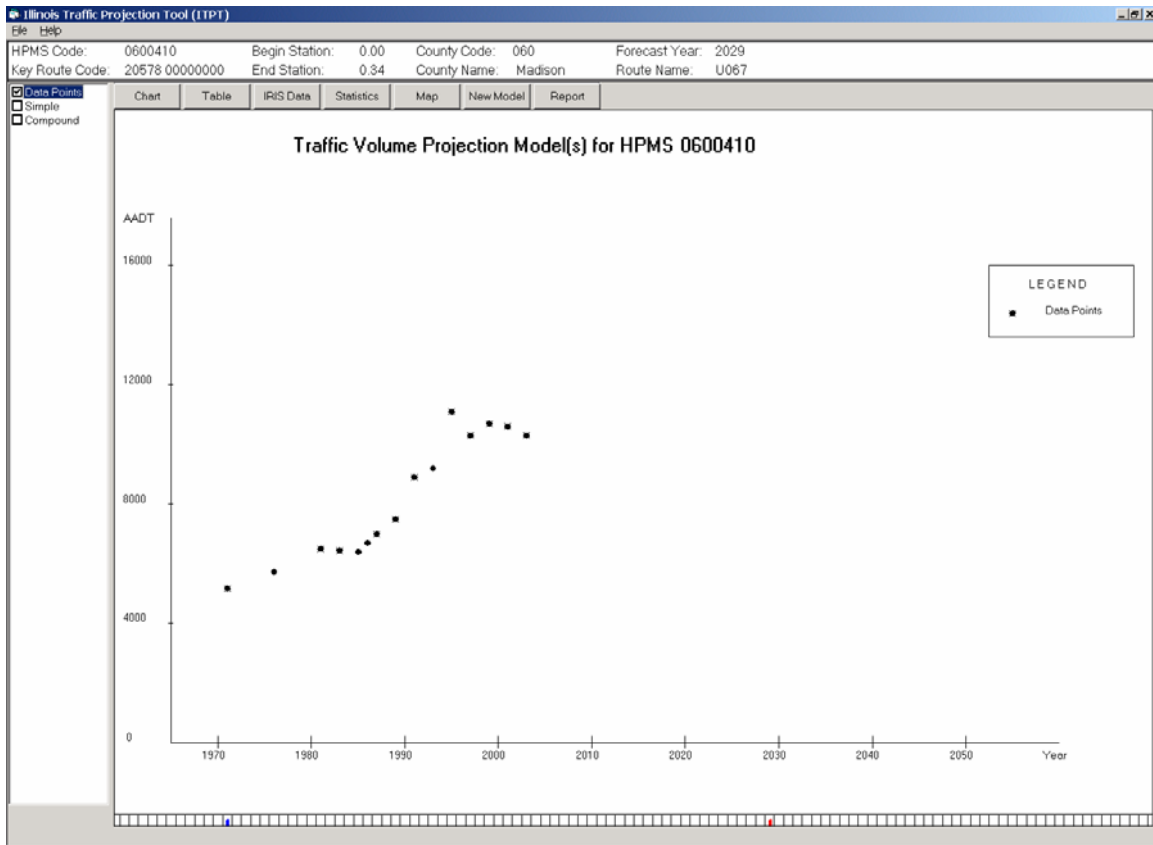
Figure 6. Data Points Only.

The Chart screen presents all historical data points for the selected section derived from the IRIS database—however, the user has the option to use all or only part of the data to make a projection. In the example chart above, you may determine that data before 1985 is not consistent due to the traffic data collection methods, changes in the roadway, or for other reasons. By using the Year Selection Bar on the bottom of the screen, you can limit the data used in the projection. Holding the cursor over a tick mark highlights the year. Clicking once makes the selected year the new "Start Year" for the projection. The blue line denoting the start year moves to the selected point. The red line on the right shows the forecast year, set by default 25 years from the current year (Figure 7). To find the projected traffic for any other year, move the red line by clicking once in the tick marks at the bottom of the chart. The forecast year can be moved to either the left (less than 25 years from current year) or to the right (more than 25 years from current year).
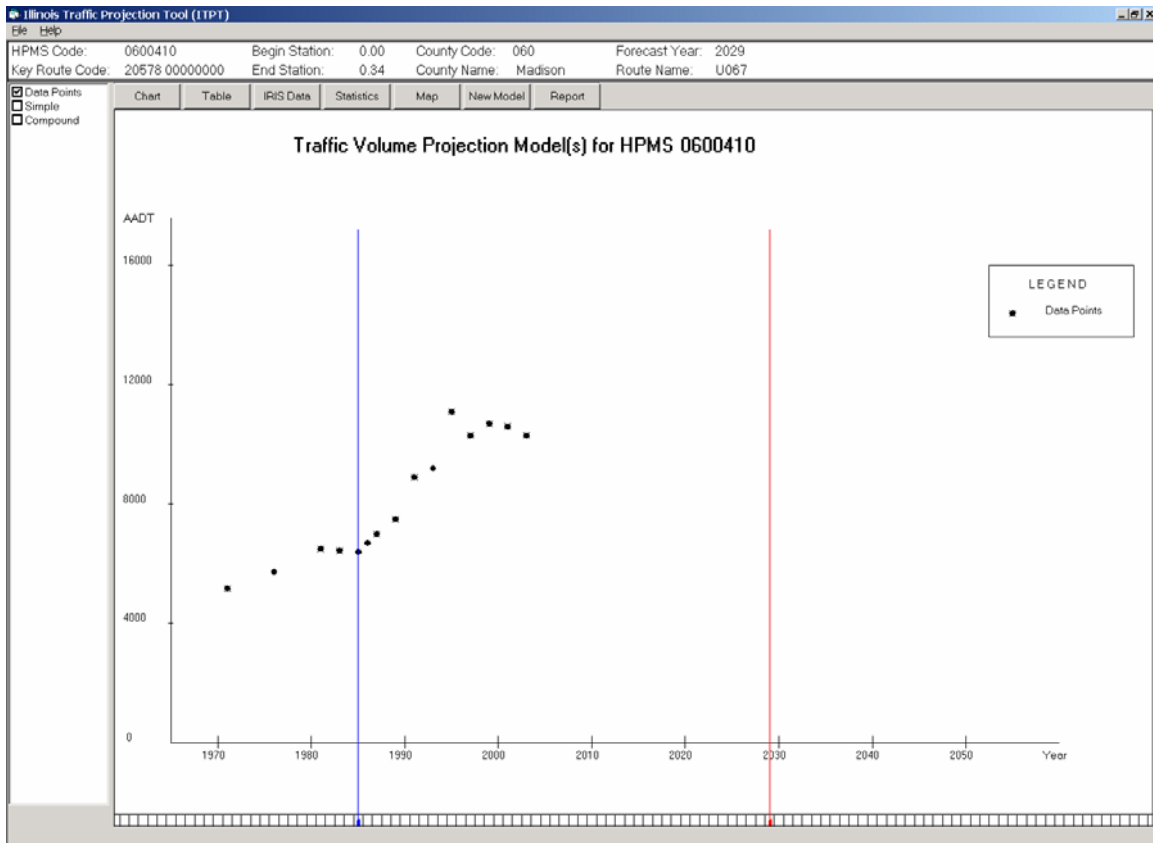
Figure 7. Using the Year Selection Bar to change the beginning year for the projection.

ITPT also identifies data points that may not be valid due to changes in the Key Route stationing over time. When the search algorithm detects changes in the Key Route stationing, data points before the year in which the change occurred will appear as open circles, as shown in Figure 8.
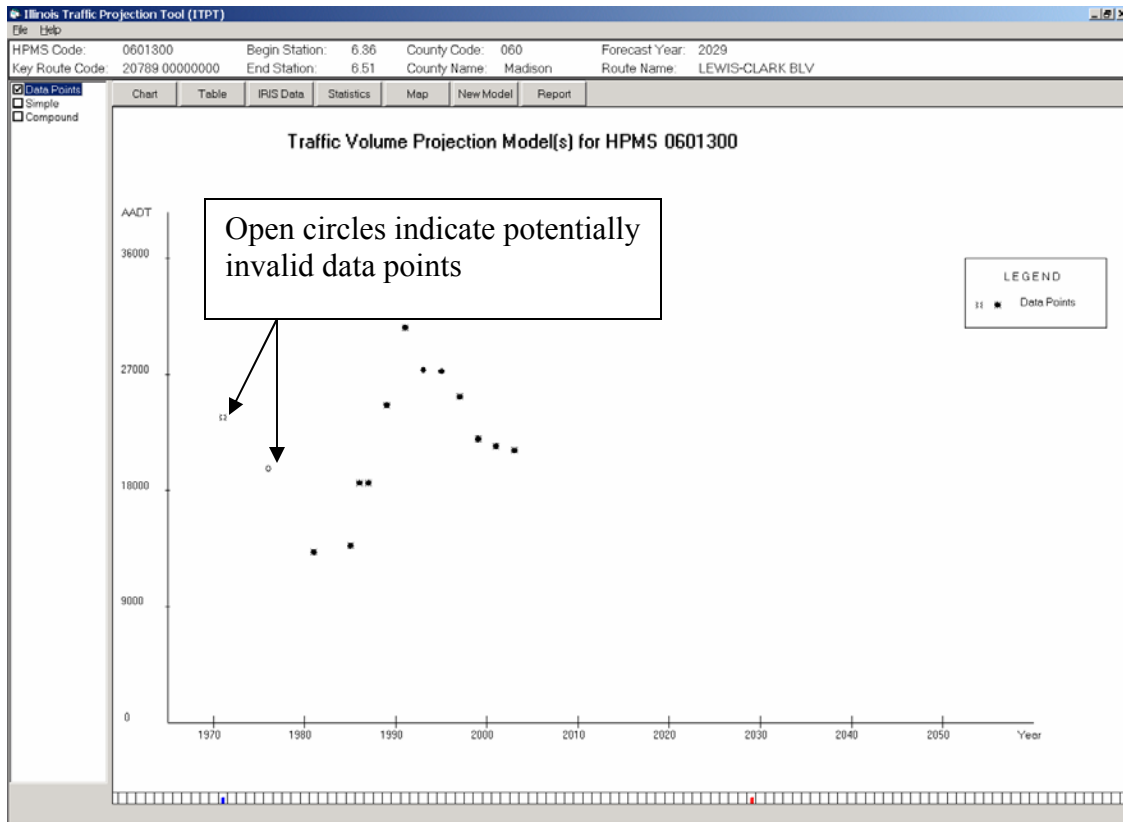
Figure 8. Potentially invalid data points.

Table

To see the data used to create the Chart view, click the [Table] command button at the top of the chart frame. This will open the data in tabular form, showing the year, the processed IRIS data, and the year-by-year data for all projections generated by ITPT (Figure 9).

The data shown in the table have been processed from the raw IRIS data by creating an average of the AADT counts on all segments of the HPMS section weighted by the relative length of the segment to the overall length of the HPMS section.

Figure 9. Table View of Data Points.

Top of screenshot (header area):

Illinois Traffic Projection Tool (ITPT)
File   Help

HPMS Code: 0600410   Begin Station: 0.00   County Code: 060   Forecast Year: 2029
Key Route Code: 20578 00000000   End Station: 0.34   County Name: Madison   Route Name: U067

Chart | Table | IRIS Data | Statistics | Map | New Model | Report

☑ Data Points
☑ Simple
☑ Compound

Year	Data Points	Simple	Compound
1971	5173	4369	4893
1972		4579	5024
1973		4789	5160
1974		4998	5299
1975		5208	5442
1976	5728	5417	5589
1977		5627	5739
1978		5837	5894
1979		6046	6053
1980		6256	6216
1981	6500	6465	6384
1982		6675	6556
1983	6450	6885	6732
1984		7094	6914
1985	6400	7304	7100
1986	6700	7513	7292
1987	7000	7723	7488
1988		7933	7690
1989	7500	8142	7898
1990		8352	8110
1991	8900	8561	8329
1992		8771	8554
1993	9200	8980	8784
1994		9190	9021
1995	11100	9400	9264
1996		9609	9514
1997	10300	9819	9770
1998		10028	10034
1999	10700	10238	10304
2000		10448	10582
2001	10600	10657	10867
2002		10867	11160
2003	10300	11076	11461
2004		11286	11770
2005		11496	12088
2006		11705	12413
2007		11915	12748
2008		12124	13092
2009		12334	13445
2010		12544	13807
2011		12753	14179
2012		12963	14562
2013		13172	14954
2014		13382	15357

The tabulated data can be edited to add new traffic counts not yet shown in the IRIS database, or to delete points you determine are not consistent. Points added or deleted in Table view will be reflected in the current projection only—the changes are not saved. However, changes will be reflected in the projection reports (described in the Report section) and can be stored in report format for future reference as MS Word documents.

For example, suppose a new 2004 traffic count of 12,000 is available on the HPMS section shown above. The count can be entered in the table (Figure 10). If you return to the Chart view, you can confirm that the new data point has been added, and is influencing the projections. Both the Simple and Compound growth projections (and any new models you have created) have changed in value. You can view the value and the year associated with the new data point (or any other data point) by holding the cursor over the point.

File   Help

HPMS Code:	0600410	Begin Station:	0.00	County Code:	060	Forecast Year: 2029
Key Route Code:	20578 00000000	End Station:	0.34	County Name:	Madison	Route Name: U067

☑ Data Points
☑ Simple
☑ Compound

Chart	Table	IRIS Data	Statistics	Map	New Model	Report

Year	Data Points	Simple	Compound
1971	5173	4369	4893
1972		4579	5024
1973		4789	5160
1974		4998	5299
1975		5208	5442
1976	5728	5417	5589
1977		5627	5739
1978		5837	5894
1979		6046	6053
1980		6256	6216
1981	6500	6465	6384
1982		6675	6556
1983	6450	6885	6732
1984		7094	6914
1985	6400	7304	7100
1986	6700	7513	7292
1987	7000	7723	7488
1988		7933	7690
1989	7500	8142	7898
1990		8352	8110
1991	8900	8561	8329
1992		8771	8554
1993	9200	8980	8784
1994		9190	9021
1995	11100	9400	9264
1996		9609	9514
1997	10300	9819	9770
1998		10028	10034
1999	10700	10238	10304
2000		10448	10582
2001	10600	10657	10867
2002		10867	11160
2003	10300	11076	11461
2004	12000	11286	11770
2005		11496	12088
2006		11705	12413
2007		11915	12748
2008		12124	13092
2009		12334	13445
2010		12544	13807
2011		12753	14179
2012		12963	14562
2013		13172	14954
2014		13382	15357

Figure 10. Table View with New Data Point Added.

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IRIS Data

The data displayed in tabular form in the Table view has been processed to account for multiple counts within a single HPMS section. To view the raw IRIS data, left-click the IRIS Data command button (Figure 11).

Figure 11. Raw IRIS Data.

Statistics

If you want to examine the statistics showing how well the regression models fit the data points, left click the Statistics command button at the top of the screen in any view. A new window will open showing the regression equations, the coefficient of determination R^2, the F-statistic, the standard error, and other diagnostic statistics (Figure 12).
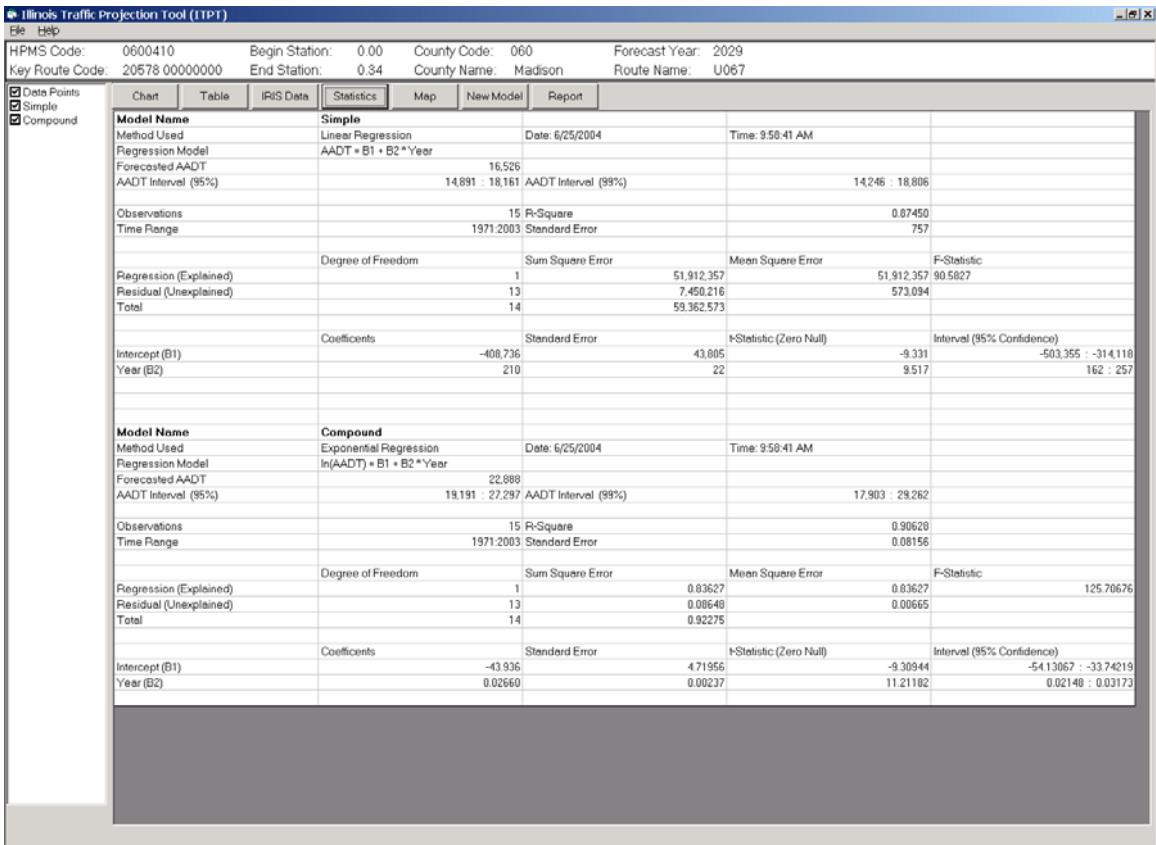
Figure 12. View of Statistics Screen.

The coefficient of determination, or regression coefficient, gives an indication of the power of the regression equation to explain the variation in the data. The value of R^2 ranges from 0 to 1.0. In assessing the "goodness of fit" of the data to the regression line, values of R^2 near 1.0 represent better fit. A second means of assessing the model is the F-statistic, which tests the overall significance of the regression model. The F value is the ratio of the mean regression sum of squares divided by the mean error sum of squares. Its value ranges from 0 (no significance) to an arbitrarily large number. The larger the value of F, the higher the significance of the regression model in explaining the variation in the data.

Map

The [Map] command button at the top of any screen allows you to view the location of the roadway section under study in relation to other roads in the county. The Map view highlights in blue the HPMS/Structure/Key Route on which you are forecasting and zooms in on it. Major routes of functional classes 10, 20, 30 and 40 are highlighted in pink (Figure 13).
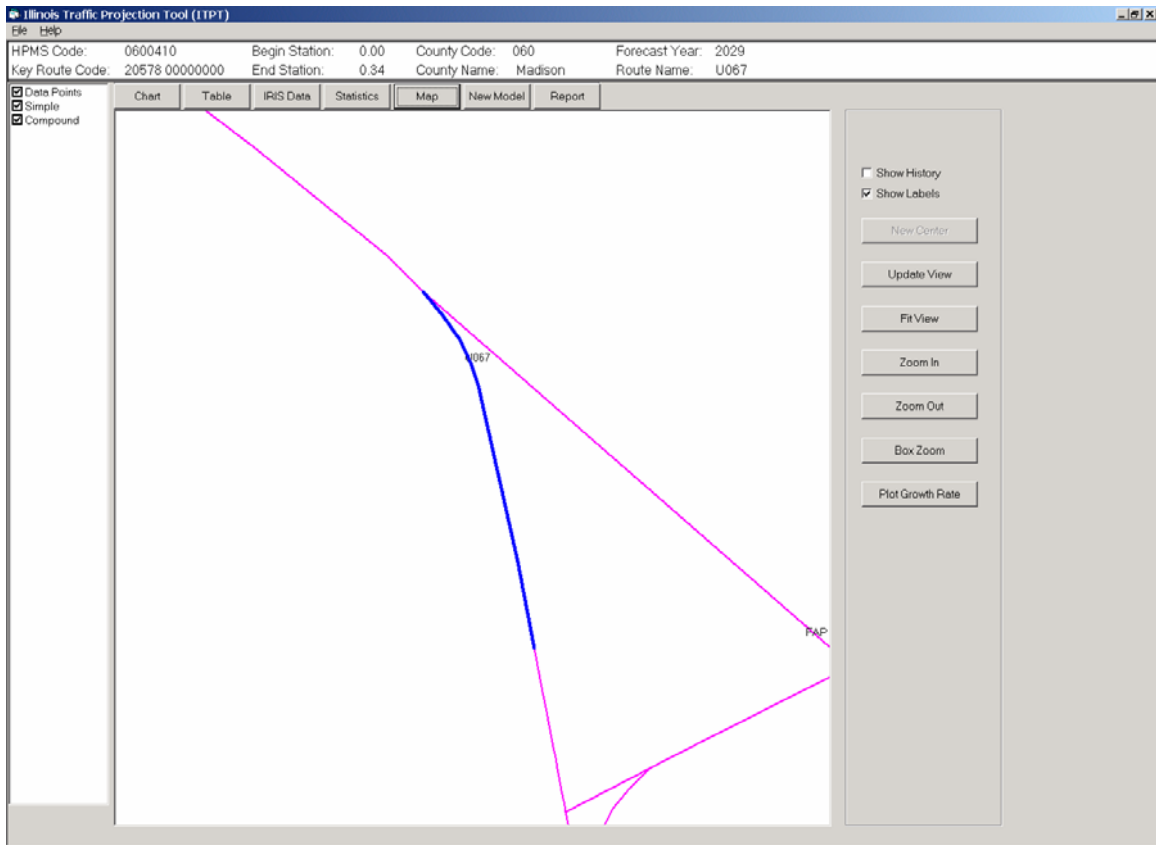
Figure 13. Map View.

The Map screen has two check boxes that allow you to turn features on and off, and seven command buttons that allow you to change the view of the map.

The Show History check box allows you to see locations in the county where previous forecasts have been made using ITPT. Check the Show History box and click Update View to add dots showing the locations and latest dates of other forecasts done in this county (Figure 14). Left clicking in these dots will open the forecast report in Microsoft Word for viewing.
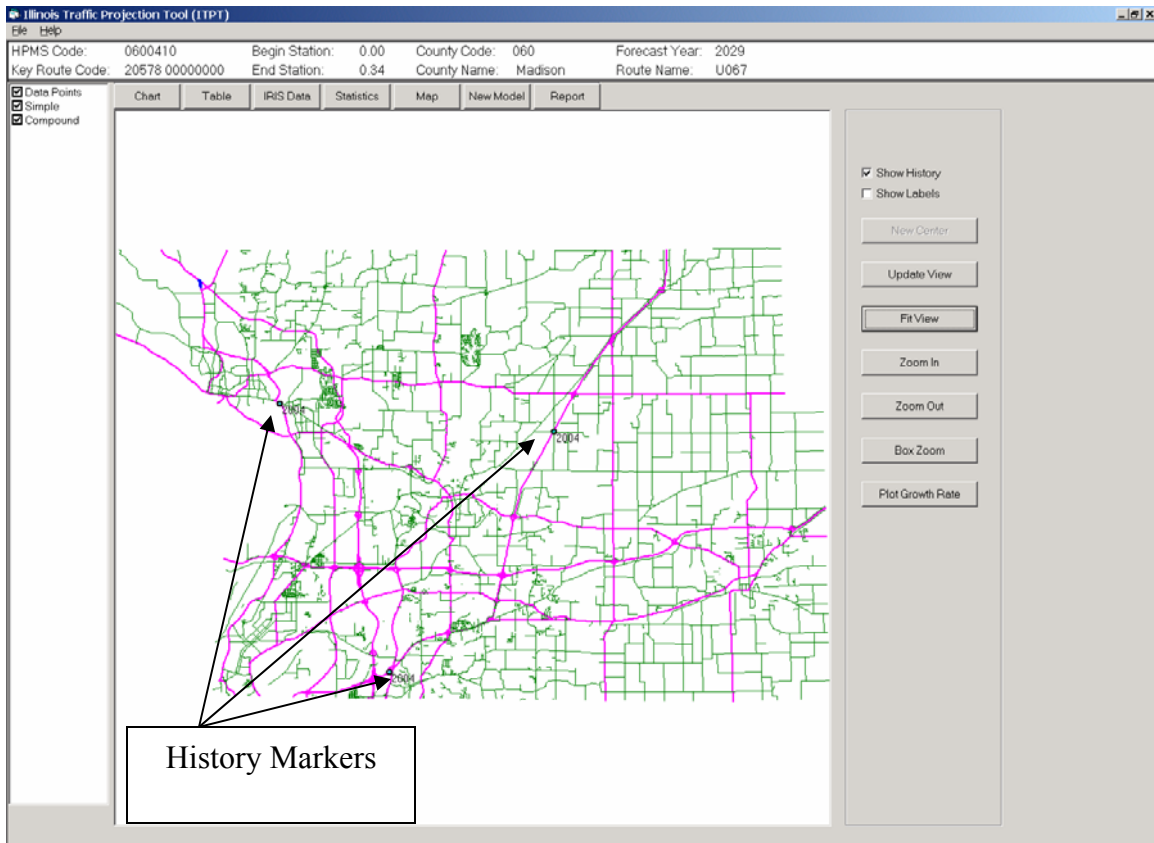
Figure 14. Show History View.

Labels showing street names are activated when the Map view is opened. These labels can be used to help you identify the location of the roadway section on which you are doing a forecast. In some areas, the density of labels may make viewing difficult. Turn off the labels by removing the check in the Show Labels box.

Left-clicking on any point highlights the Key Route at that location. Click New Center to center that point in the view.

Update View applies the changes you make when you add or remove a check to the Show History or Show Labels boxes.

Fit View centers the entire county in the window (Figure 15). The HPMS/Structure/Key Route on which you are doing a projection remains highlighted in blue.

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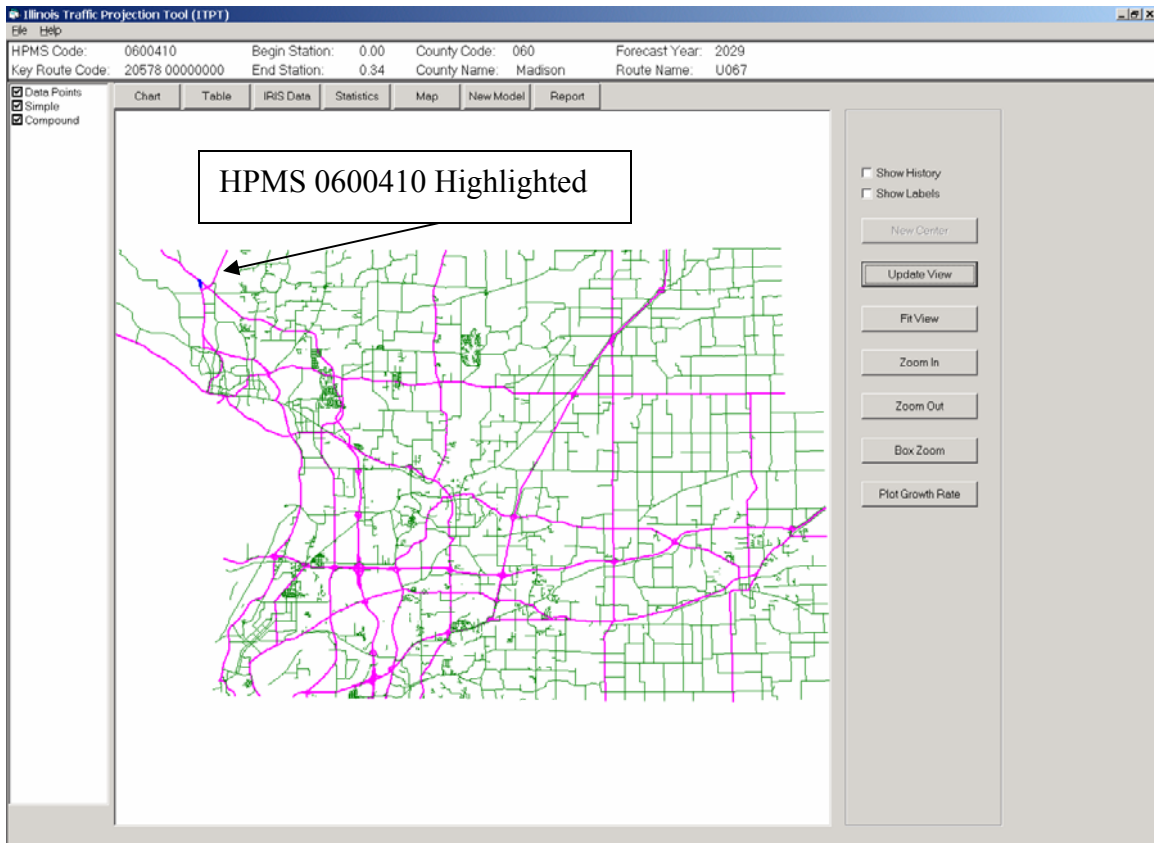
Figure 15. Fit View.

The command button Zoom In increases the scale of the map by a factor of two. The view zooms to the center of the screen. Zoom Out decreases the scale of the map by a factor of two.

Box Zoom allows you to zoom in on an area of interest. Click Box Zoom and use the cursor to draw a box around the area you wish to enlarge. The view zooms to the center of the box.

The Plot Growth Rate button generates a contour plot of growth rates throughout the county based on procedures described under Area Growth Rate Model in the report "Developing Long Range Traffic Projection Models for Illinois," Project IVA-H1, FY 03, Report No. ITRC FR 03-1. You are first asked whether you want to import an existing growth rate plot. A Yes response prompts you for the location of the stored *.grp file. If you have created growth rate plots using ITPT in the past, they are stored in the subfolder C:\TrafficModel\RatePlots that was created when ITPT was installed (Figure 16).

The Growth Rate file name format is *<County><StartYear>-<EndYear>FC <FunctionalClassCodes>*. For example, the data in file Clinton1985-2004FC12345 was based on data collected between 1985 and 2004 for all routes from functional classes 10, 20, 30, 40 and 50 in Clinton County. File Clinton1985-2004FCAll.grp is plotted in Figure 17. The Function Class Codes "All" indicates that all functional classes were considered.
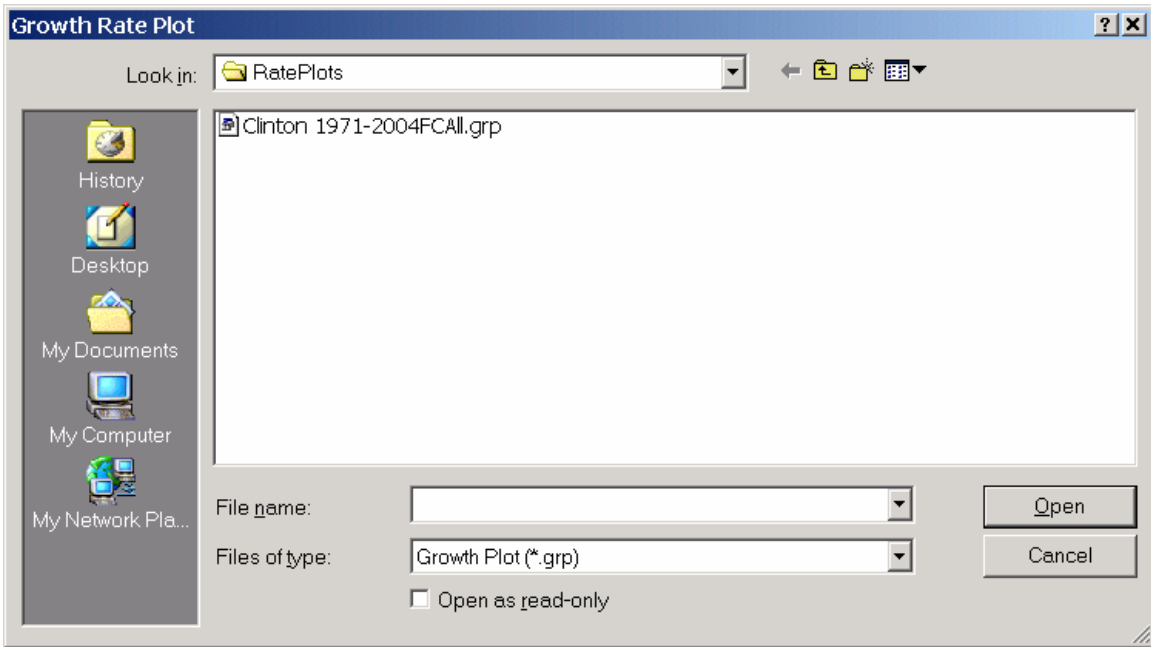
Figure 16. Finding stored Growth Rate Plots.
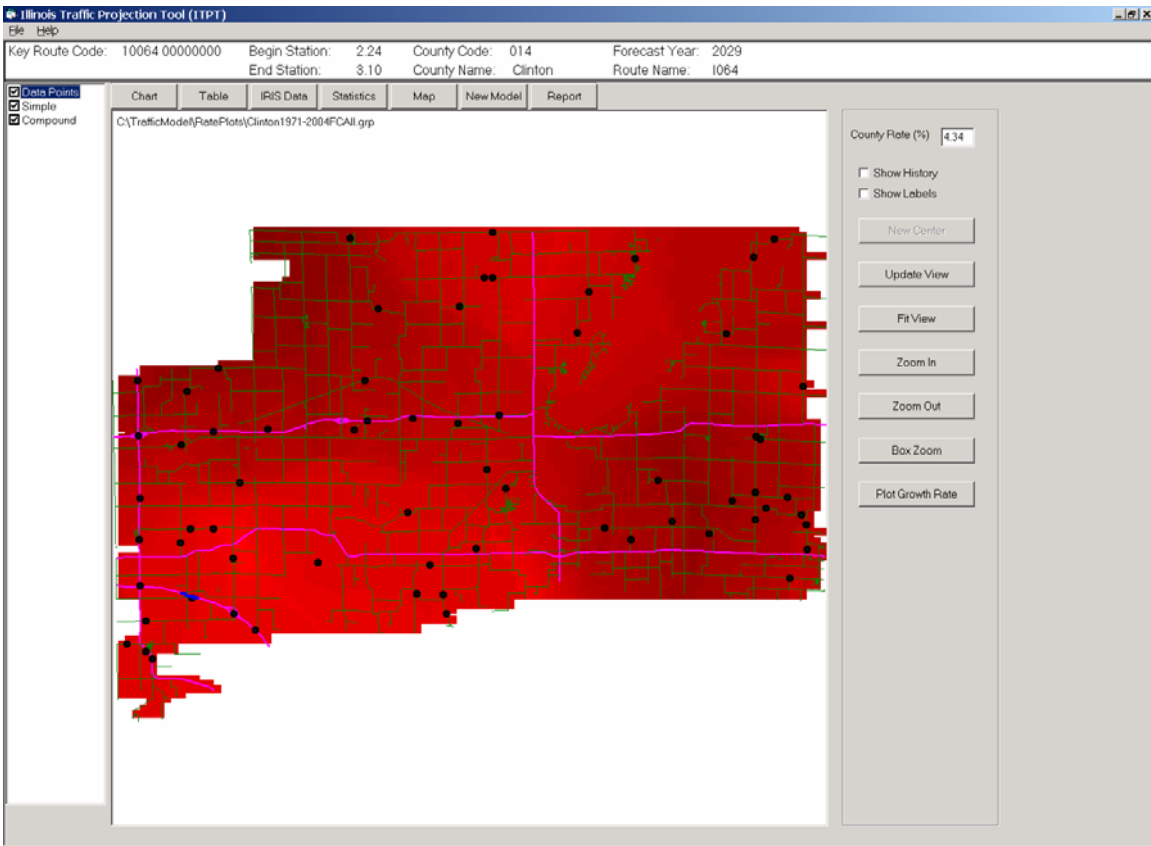
Figure 17. Countywide Growth Rate map.

Red areas on the plot have positive growth while blue shows negative growth. Brighter colors indicate higher rates. The Growth Rate (%) at the cursor location is displayed in the upper right hand corner. The average countywide growth rate is displayed when the cursor is over a white area of the plot, and the label will change to read "County Rate %". The black dots on the map are the points from which data was used to generate the plot.

If you select No when asked if you want to import an existing plot you will be prompted to input the Start Year and the functional classes. If you wish to include all functional classes (10 through 90), use All. **It may take several minutes to generate a new plot.** After the calculations are completed you will be asked to save the plot to a file in the C:\TrafficModel\RatePlots directory using the default filename format discussed above. It is strongly recommended that you simply save the plot under that name. The program then tells how many valid sets of data were used to construct the plot and displays the completed plot. You must judge whether or not the plot is useful based on the number and distribution of the valid sets.

Finding Previous Traffic Projections

Previous traffic projections can be found by using the Map screen with the Show History box selected, or by locating the MS Word report filed when the last projection was made. MS Word reports of previous ITPT projections will be filed in the folder C:\TrafficModel\Report*County Name\Forecast Type* on your local computer.

New Model

The user has the option of accepting either the Simple or Compound projections, or creating a new model. Click the New Model command button to open the Create a New Model dialog box. The Forecast Model type is selected as Simple Growth, Compound Growth, Step-Simple, or Step-Compound from the drop-down menu box. Selecting one of these choices brings up the appropriate check boxes to create the model and generates a default Model Name.

Simple Growth allows you to select a linear growth expressed either as a percentage of the latest AADT, or as a number of vehicles per year. In Figure 18, a Simple Growth Rate of 2% of the AADT in 2003 (the latest count for this section) has been selected.
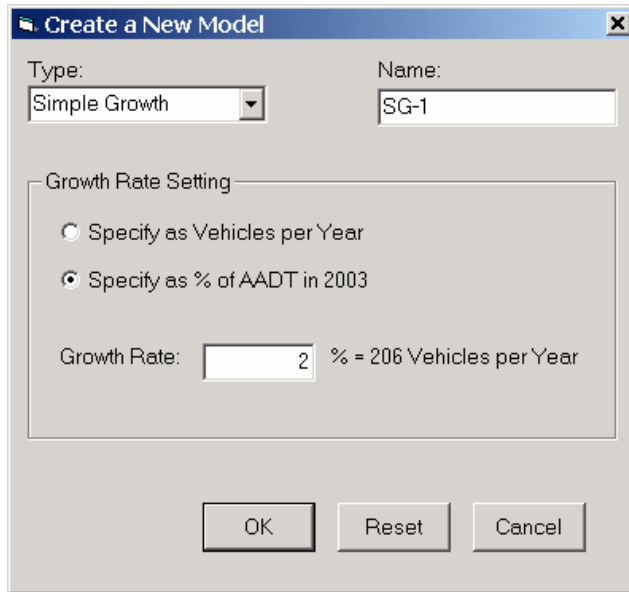
Figure 18. Creating a new Simple Growth model.

The default Model Name, SG-1, can be changed in the Model Name text box. When you are satisfied with your selections, clicking OK returns you to the Chart view, where model SG-1 is displayed on the Chart, and is now listed as one of the available models in the Model Selection Frame (Figure 19). The new model SG-1 is a linear extrapolation of the value of the latest AADT count of 10,300, increased at 2% (206 vehicles) per year.
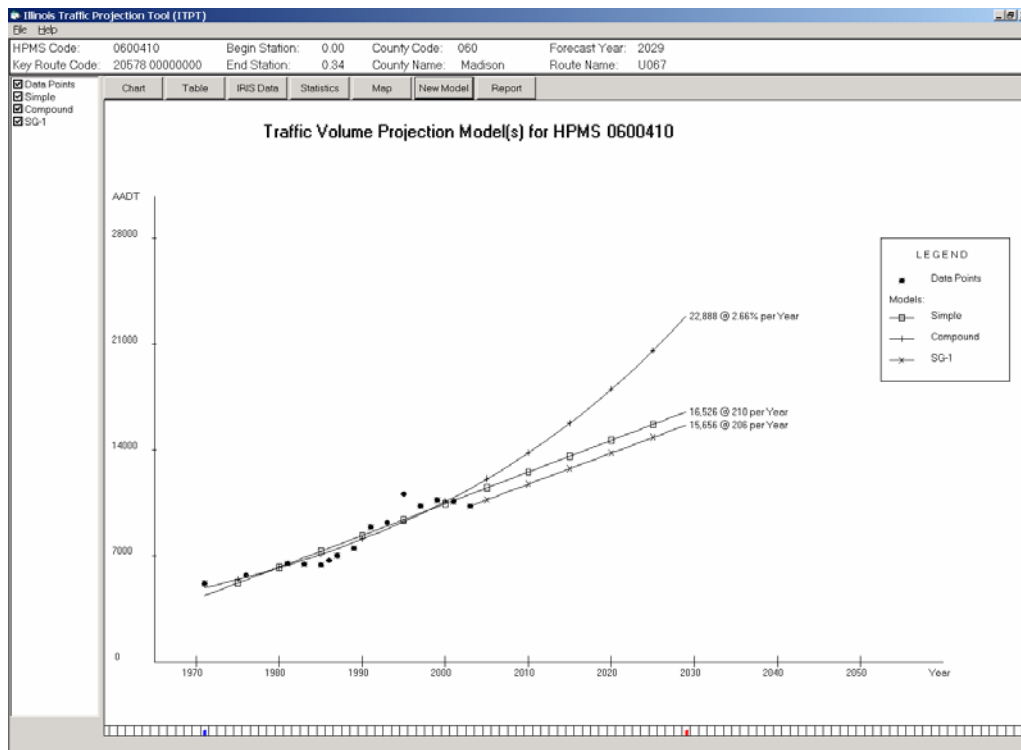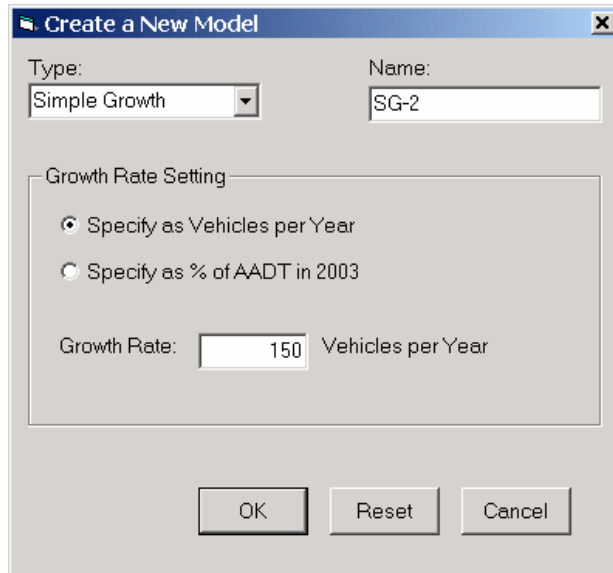
Figure 19. Addition of a new Simple Growth model.

A different projection can be made by creating a New Model, this time using the growth parameter of vehicles per year. In Figure 20, a Simple Growth rate of 150 vehicles per year has been selected. This model is given the default name SG-2, which can be modified by the user.

Figure 20. Simple Growth model using vehicles per year.

Clicking OK to return to the Chart view shows that SG-2 is superimposed on the other three models and the Data Points. Click the check boxes in the Model Selection Frame to turn off unwanted models. Note that the new model is linear projections starting from the last AADT count of 10,300 and increasing at 150 vehicles per year (Figure 21).
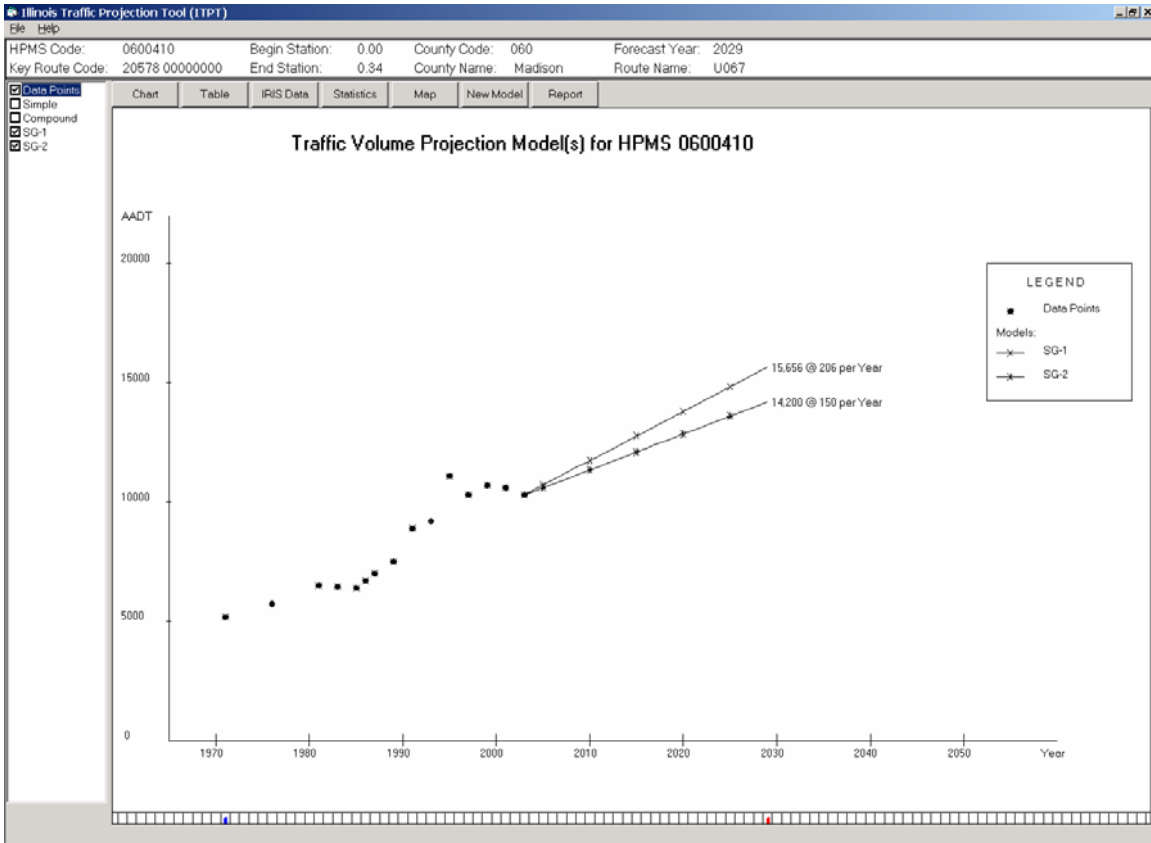
Figure 21. Viewing two new Simple Growth models.

Compound growth models also project from the last AADT count, but compound annually as a percentage of the previous year's value. To add a compound growth model, select the New Model button again and use the drop-down menu to choose Compound Growth. For this example, we selected a compound growth rate of 2% per year. The new model, named CG-1 by default, now appears in the Chart view. The Simple Growth models SG-1 and SG-2 can be turned off to compare the new compound growth model CG-1 to the best-fit curves generated by ITPT (Figure 22).
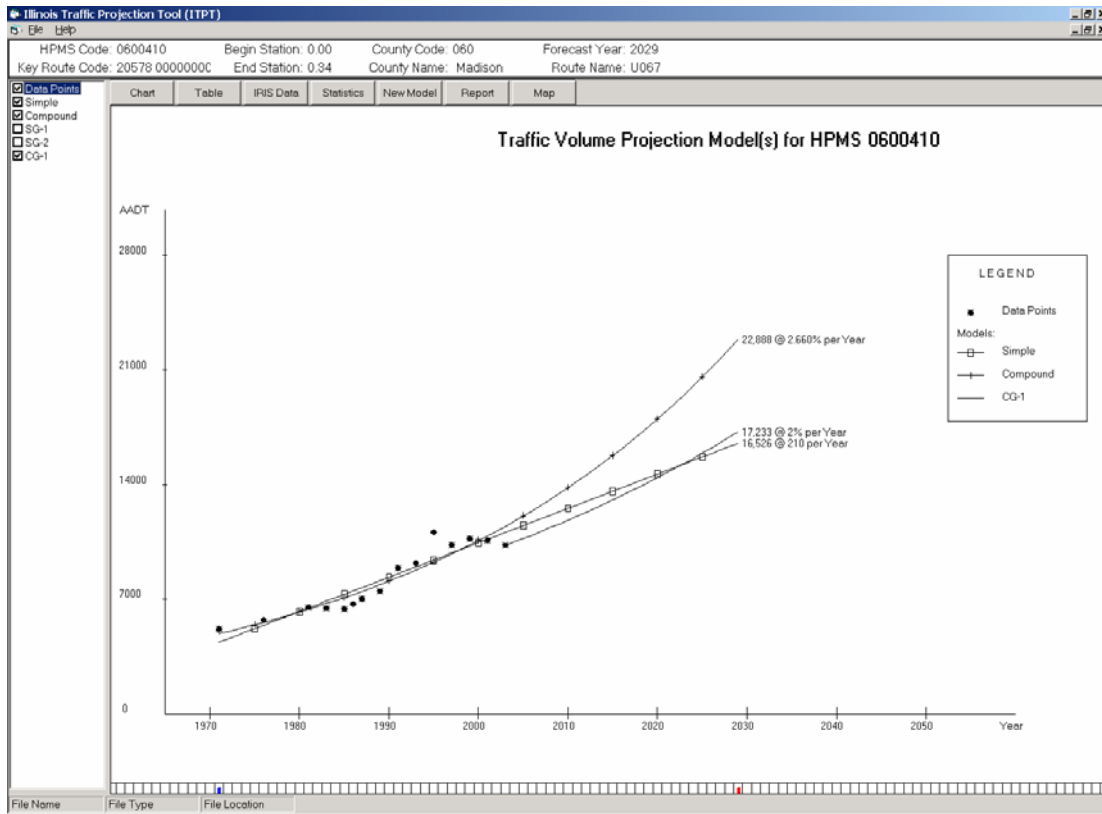
Figure 22. Viewing a new Compound Growth model.

The two Step-Function curves allow you to account for future growth from a new traffic generator opening at a future date. For instance, if a new retail facility will generate an additional 400 vehicles per day on opening in 2006, after which growth is expected to increase linearly at 2% per year, the Step-Simple function could be selected (Figure 23).

Figure 23. Creating a Step-Function Simple Growth Model.

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Clicking OK to return to the Chart view shows this new model, given the default name SS-1 (Figure 24).
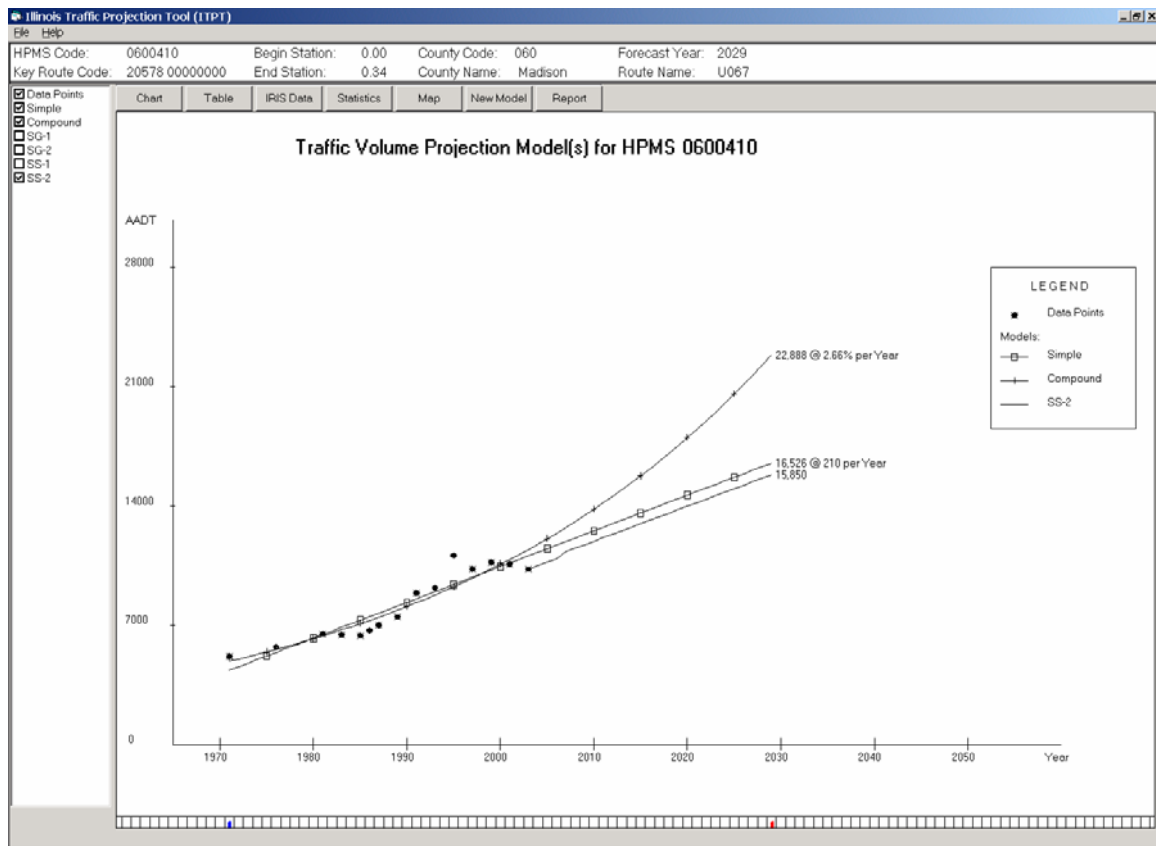
Figure 24. Viewing a New Step-Function Model (Simple Growth).

A step function with compound growth after the step can also be created. Select New Model and then choose the Step-Compound model from the drop-down menu. The new model is given the default name SC-1 (Figure 25) and can be viewed by returning to the Chart screen (Figure 26).
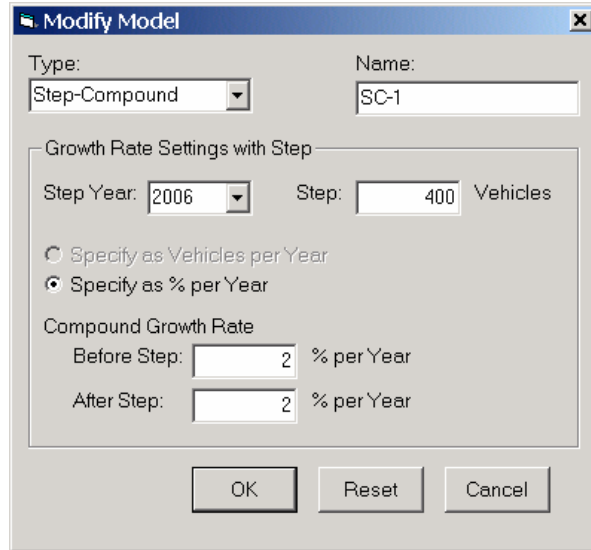
Figure 25. Creating a Step-Function Compound Growth Model.
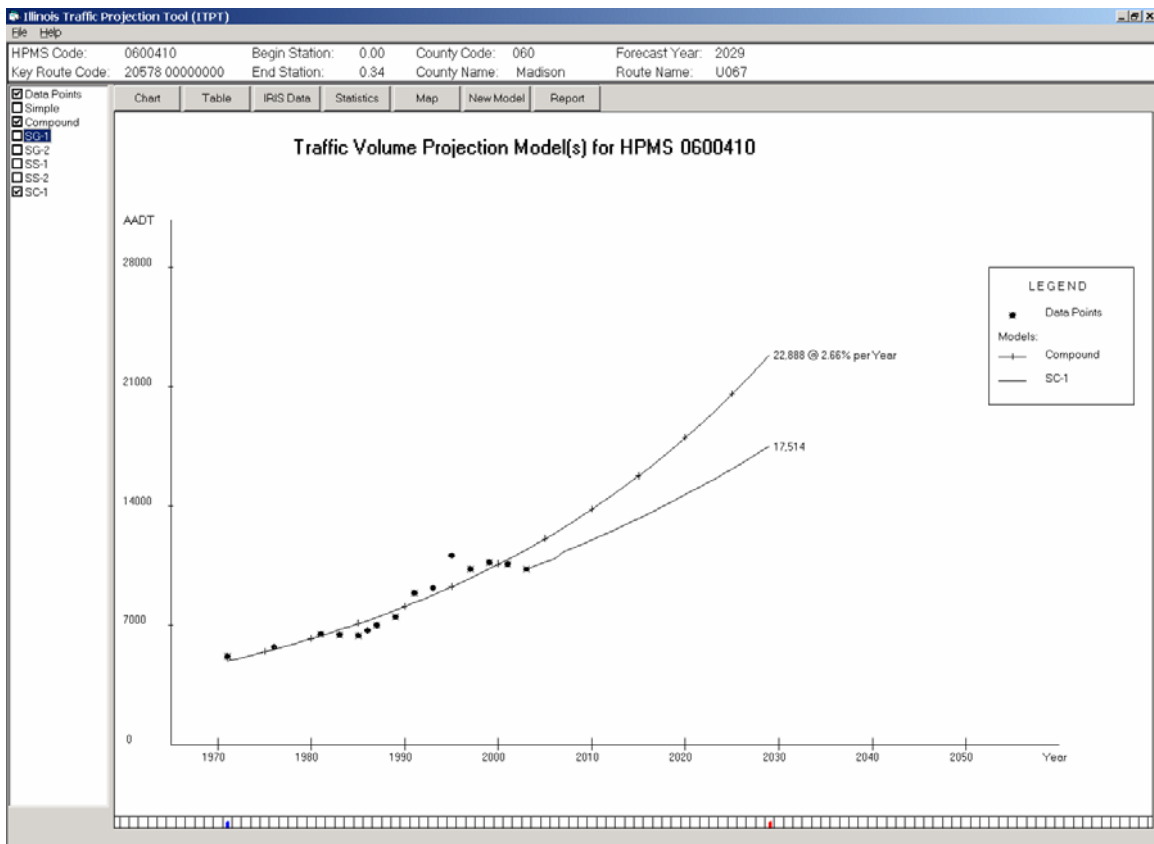
Figure 26. Viewing a New Step-Function Model (Compound Growth).

Modifying New Models

Any of the new models can be modified after you view the results. To modify a model, right click the model name in the list shown in the Model Selection Frame located on the left side of the screen to bring up a menu box (Figure 27), and select "Modify Model." This opens the Create New Model form you used to create the model. Make the desired changes to the parameters in the form and click OK when finished to return to the Chart screen.

Clicking Create New Model on the dialog box in Figure 27 opens a blank Create a New Model form.

Model List
Model Details
Create New Model
Modify Model
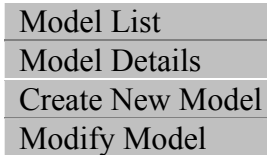
Figure 27. Menu Box for Model Editing.

Viewing Model Details

The dialog box shown in Figure 27 contains two additional choices. "Model List" is the default view, and refers to the current list of models shown in the Model Selection Frame. To view additional information about the models, left-click "Model Details." This opens an expanded view of the Model Selection Frame to reveal details about the methods used to create the models, a summary of the results, and the Root Mean Square Error (RMSE) of the two default models.
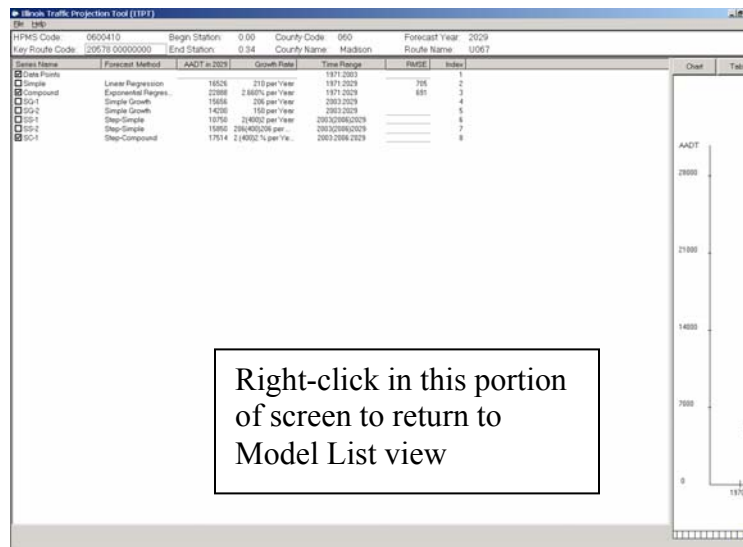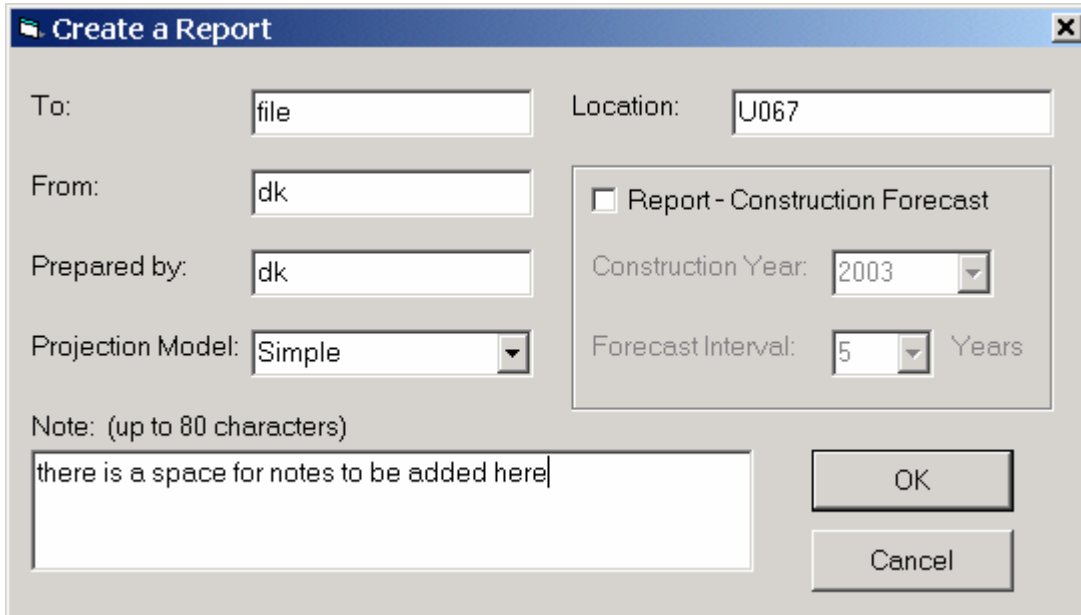
Figure 28. Model Details in Expanded Model Selection Frame.

To return to the Model List view, right-click anywhere in the lower portion of the screen (Figure 28).

Reports

When you are satisfied with a model and want to save the information you used to create the projection, select the ⬚Report⬚ command button from the top of the screen in any view. This will bring up a dialog box (Figure 29), allowing you to insert information identifying the name of the recipient and sender (if applicable), the forecaster who prepared the report, and explanatory notes (if desired). The street name of the forecast location is added by default and may be edited.

Figure 29. Report Dialog Box.

Click OK to create a report form (Figure 30). The report shows the information you provided in the dialog box along with today's date, the identifying information for the roadway section for which the projection was done, the forecast year, and information about the model that was used to perform the forecast.
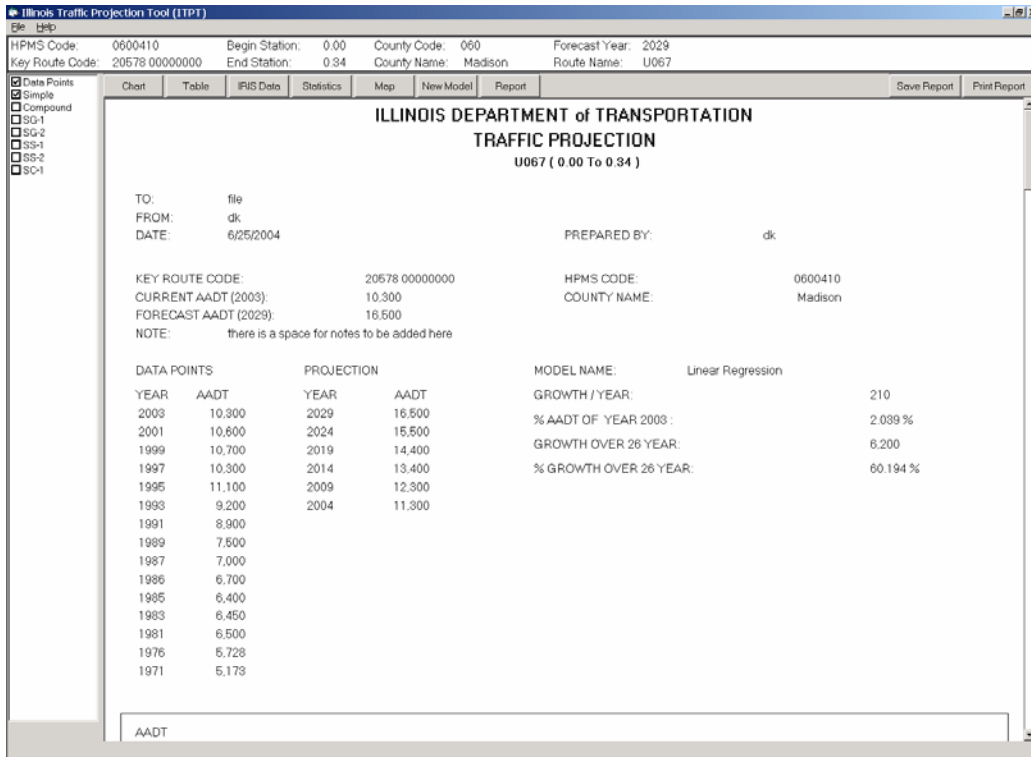
Figure 30. View of Report Form.

Use the scrollbar on the right to scroll down the form and view a graph of the selected model (Figure 31).
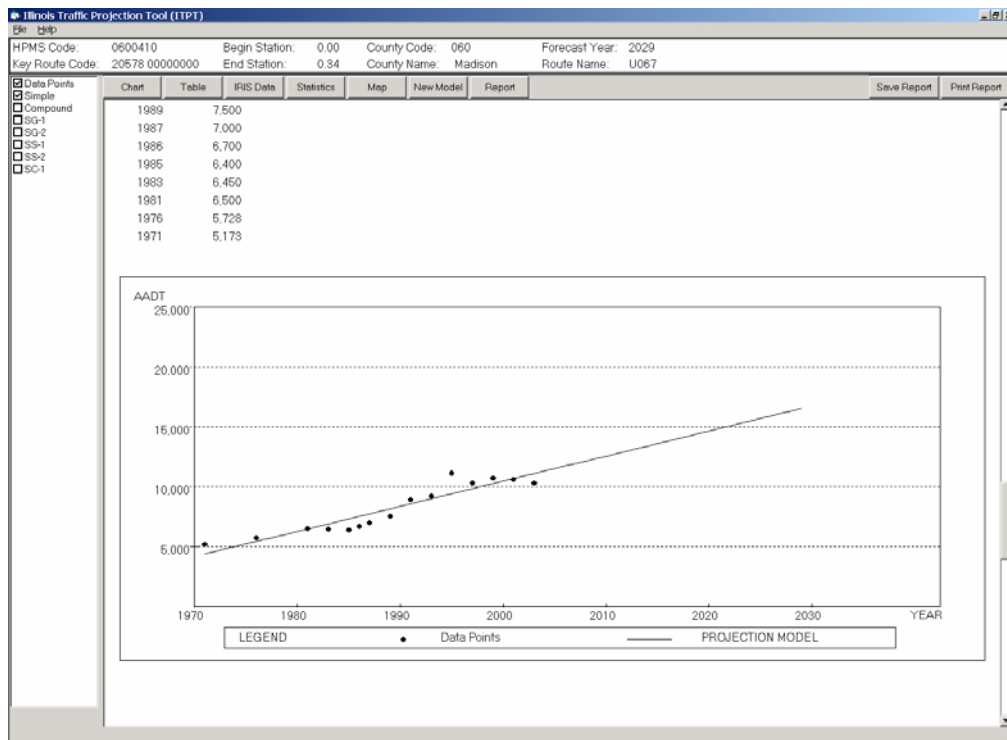
Figure 31. View of Bottom of Report Form.

Entries on the form cannot be edited. To change entries, select the [Report] command button, change the entries in the Create Report dialog box to reflect the desired information, and click OK.

When you are satisfied with the information you have added to the report form, you can save the report or print a hard copy. Two new command buttons appear with the Report view. Selecting Save Report opens MS-Word and places the report form, as a picture, in a new Word document. The document will be given a default file name corresponding to the way in which you designated the section of roadway (HPMS, Structure, or Key Route), the appropriate HPMS, Structure, or Key Route code, and the current year. In the example above, the default file name would be H0600410-2004 (Figure 32). ITPT also creates a folder in which to store your HPMS, Structure, or Key Route Projections. Once saved, these filenames should not be changed.
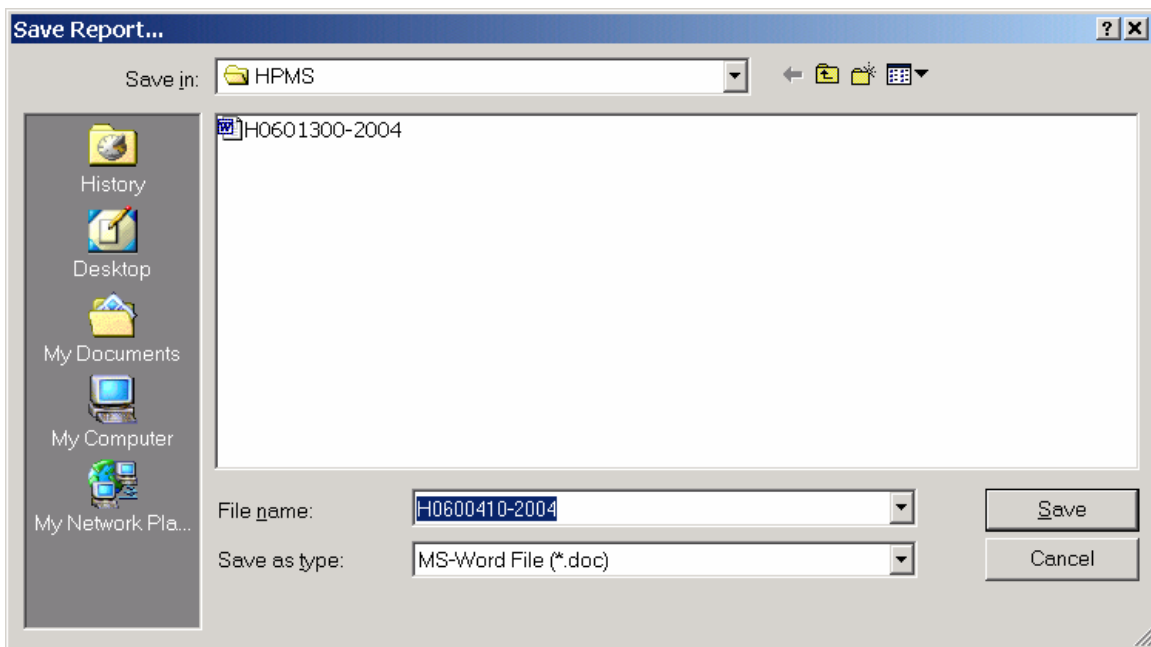
Figure 32. Saving a Report.

Selecting Save from the menu in MS-Word will save the file to the default folder C:\TrafficModel\Report created when ITPT was installed. You will be alerted when new sub-folders are created to store your projections by county for future reference (Figure 33).
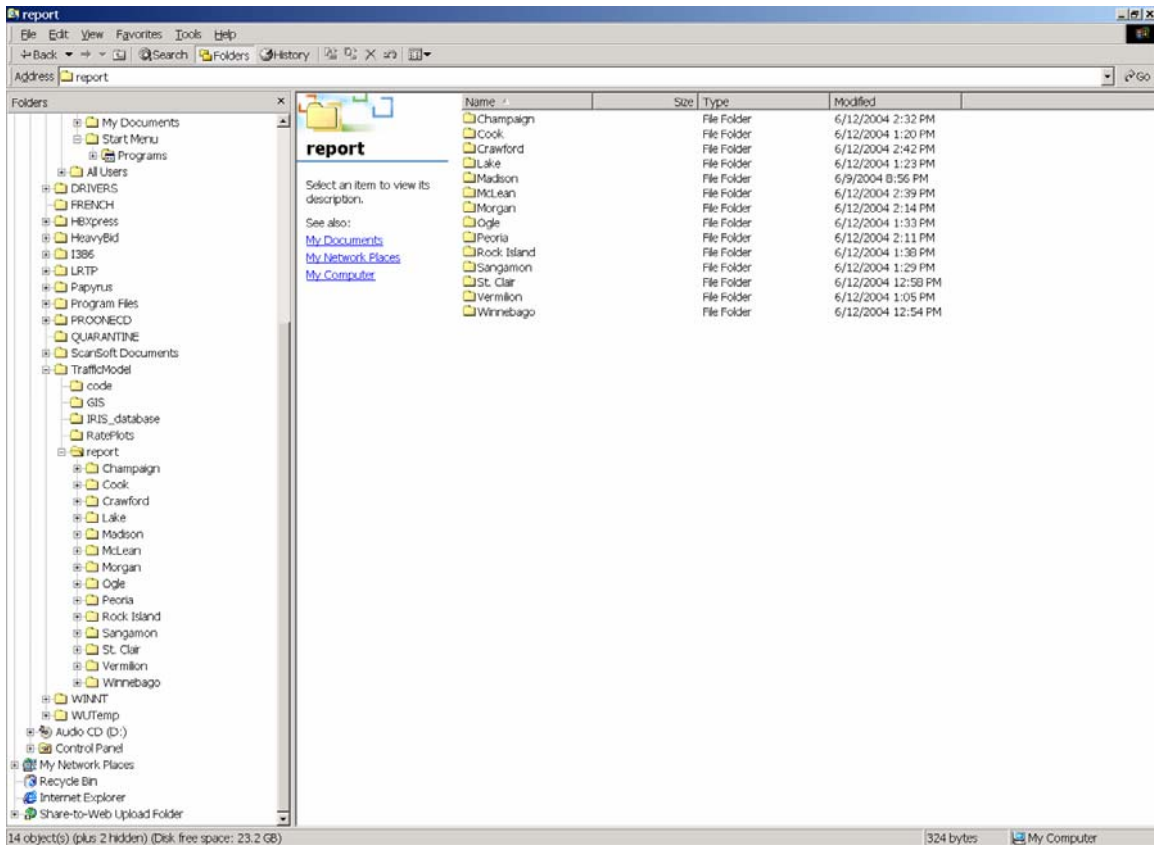
Figure 33. Location of sub-folders containing traffic projections.

Selecting Print Report sends the report form to your default printer, but no file is created to save the report on your hard drive.

Construction Traffic Forecasting Using ITPT

A special case for doing a report is to forecast traffic on a roadway section for a road improvement project or a land development project. The Report view can be used to generate printable reports for 20-year construction forecasts. Click the Report command button at the top of the screen to bring up the Report dialog box, and then check Report-Construction Forecast (Figure 34). Drop-down menus for the construction year and the forecast interval will be activated, allowing you to enter the appropriate information. Forecast Intervals of 2, 5 and 10 years appear on the drop-down menu. Click OK to view the Report (Figure 35).

Figure 34. Construction Forecast Report.
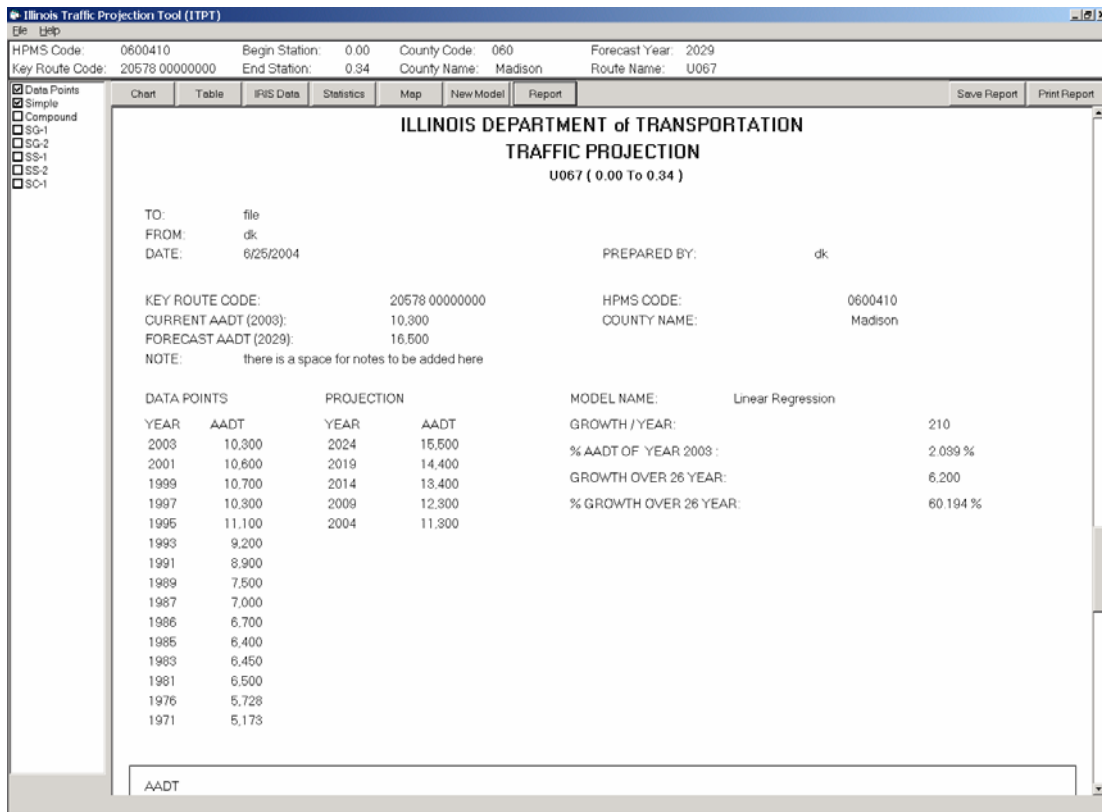
Figure 35. Example Construction Forecast.

Closing a Completed Projection

When you have completed a traffic projection, use the File function on the Menu bar to Close the current projection without closing ITPT. Be sure you have saved the report of the current projection, if desired, before selecting Close.

Starting a New Projection

ITPT remains on your desktop after you close the previous projection. To start a new projection, use the File function on the Menu bar and select New.

Exiting ITPT

To close ITPT, use the File function on the Menu bar and Select Exit. This ends the program, and you will lose any unsaved projections that remain open on the desktop.

APPENDIX B
SEARCH STRATEGIES FOR OBTAINING AADT COUNTS FROM IRIS

This appendix documents the search strategies used to obtain the historical AADT counts from IRIS that are used to project future AADT counts on HPMS sections, structures, and designated mileage points along specified key routes. The following sections discuss the assumptions made about the available IRIS data and its organization, the derived tables used to support the IRIS data searches, the year-to-year maintenance of these tables, and the specific search algorithms used for each type of traffic projection—HPMS, Structure, and Key Route.

Assumptions

In the discussion that follows, a *key route* refers to a particular key route through a specific county or municipality and is uniquely identified by a County code, County-Muni code, and Key-Route code (see below). A *segment* refers to the portion of a key route identified by the mileage at a specific Begin-Station and End-Station.

The starting point for deriving the tables used for historical AADT count searches are a number of *base tables* that are derived from IRIS. The derivation of these tables may required some "clean up" of the IRIS data. The base tables are derived as Microsoft 2000 Access tables. Each table represents IRIS data that was current for a particular year and may contain this data for one county, one district, or the entire state. The tables are named 2003, 2002, ... , 1973. A row in each table represents a segment of a key route. Each table includes all segments that existed in the county, district, or state for the year for which the table is named. Each table should contain the following columns:

Name	Type, Required or Optional, and Description
District	Text, required, a 1-digit District code (not used for search)
County	Text, required, a 3-digit County code
County-Muni	Text, required, a 3 or 4-digit Municipality code if the segment is in a Municipality or the 3-digit County code
Key-Route	Text, required, a 14-character Key Route code containing 5 digits followed by a letter or a space followed by 8 digits
Begin-Station	Number (non-negative), required, Begin station mileage
End-Station	Number (positive), required, End station mileage
HPMS	Text, optional, a 7-digit HPMS code where first 3 digits are the County code. A NULL or empty string implies segment is not part of an HPMS section.
Structure	Text, optional, a 7-digit Structure code where the first 3 digits are the County code. A NULL or empty string implies segment is not a structure
Marked-Rte	Text, optional, route number (not used for search)
Street-Name	Text, optional, street name
AADT-Year	Text, required, a 4-digit year in which an AADT count was taken, '0000' implies no AADT count
AADT	Integer (non-negative), the AADT count, applicable iff AADT-Year is not '0000'

Other columns may we included but are not currently used in searching for AADT counts.

Derived Tables

A number of tables are derived from the above base tables in order to make the search for relevant, historical AADT counts more efficient and fruitful. This section documents these tables and provides the SQL queries needed for their derivation.

HPMS_Section. The HPMS_Section table contains one row for each HPMS section that is present in the most current base table, i.e., the table for the latest year. The primary key is the HPMS code . The columns are as follows:

Name	Description
HPMS	HPMS code
County	County code for HPMS in the most current table (not currently used)
County-Muni	County or Municipality code for HPMS in the most current table (not currently used)
Key-Route	Key Route code for HPMS in most current table
First-Begin-Station	the first Begin-Station for the HPMS section in the most current table
Last-End-Station	the last End-Station for the HPMS section in the most current table
Key-Route-81	Key Route code for HPMS in the 1981 base table if HPMS was recorded in this table, else NULL
First-Begin-Station-81	the first Begin-Station for the HPMS section in the 1981 base table if this HPMS is recorded in this table, else NULL
Last-End-Station-81	the last End-Station for the HPMS section in the 1981 base table if this HPMS is recorded in this table, else NULL

The table is used to validate a given HPMS code, find its current Key-Route code and first [Begin-Station] and last [End-Station], and obtain the relevant Key-Route, Begin-Station, and End-Station parameters needed to search, if possible, for relevant AADT counts prior to 1981, the first year that HPMS codes were recorded in IRIS.

The query to make this table is:

```
SELECT tc.*, t81.[Key-Route] AS [Key-Route-81], [First-Begin-Station-81], [Last-End-Station-81]
INTO HPMS_Section
FROM View_HPMS_Section_Current AS tc LEFT JOIN View_HPMS_Section_1981
        AS t81 ON tc.HPMS=t81.HPMS
ORDER BY tc.HPMS;
```

The query View_HPMS_Section_Current forms a view that contains one row for each HPMS section present in the most current table.   The HPMS code is the primary key. The query to form this view is:

```
SELECT HPMS, County, [County-Muni], [Key-Route],
        MIN([Begin-Station]) AS [First-Begin-Station], MAX([End-Station]) AS [Last-End-Station]
FROM <year of the most current base table>
WHERE HPMS<>"
(Note that a NULL HPMS returns False.)
GROUP BY HPMS, County, [County-Muni], [Key-Route];
```

The query View_HPMS_Section_1981 forms a view that contains one row for each HPMS section present in the base table for the year 1981.   The HPMS code is the primary key. The query to form this view is:

```
SELECT HPMS, [Key-Route], MIN([Begin-Station]) AS [First-Begin-Station-81],
            MAX([End-Station]) AS [Last-End-Station-81]
FROM 1981
WHERE HPMS <> "
GROUP BY HPMS, [Key-Route];
```

Structure_Segment. The Structure_Segment table contains one row for each key route segment that traverses a structure in the most current base table. The primary key is the combination of Structure code and Key Route code. The columns are as follows:

Name	Description
Structure	Structure code for the structure segment
County	County code for the structure segment in most current table
County-Muni	County or Municipality code for the structure segment in most current table
Key-Route	Key Route code for the structure segment in most current table
Mid-Station	Mileage midway between Begin-Station and End-Station in most current table
Begin-Station-93	Begin station mileage for the structure segment in the 1993 base table if this segment is recorded in this table with the given Structure code and Key-Route, else NULL
End-Station-93	End station mileage for the structure segment in the 1993 base table if this segment is recorded in this table with the given Structure code and Key-Route, else NULL

The table is used to validate a Structure code; find its applicable current Key-Route codes so that, if needed, the user can select the desired key route; and obtain the relevant County, County-Muni, Key-Route, Begin-Station, and End-Station parameters needed to search, if possible, for relevant AADT counts prior to 1993, the first year that Structure codes were recorded in the database. It is also used to do surveys of county growth rates using as sample key route points the mid station mileage points of all current structures in a county.

The query to make this table is:

```
SELECT ssc.*, [Begin-Station-93], [End-Station-93]
INTO Structure_Segment
FROM View_Structure_Segment_Current AS ssc LEFT JOIN
                View_Structure_Segment_1993 AS ss93
          ON (ssc.[Key-Route]=ss93.[Key-Route]) AND (ssc.Structure=ss93.Structure);
ORDER BY ssc.Structure, ssc.[Key-Route];
```

The query View_Structure_Segment_Current forms a view that contains one row for each structure segment present in the most current base table. The primary key is the combination of Structure code and Key Route code. The query to form this view is:

```
SELECT DISTINCT Structure, County, [County-Muni], [Key-Route],
                ([Begin-Station]+[End-Station])/2 AS [Mid-Station]
FROM <year of the most current base table>
WHERE Structure <> ''
ORDER BY Structure, [Key-Route];
```

The query View_Structure_Segment_1993 forms a view that contains one row for each structure segment present in the table for 1993. The primary key is the combination of Structure code and Key Route code. The query to form this view is:

```
SELECT DISTINCT Structure, County, [County-Muni], [Key-Route],
                [Begin-Station] AS [Begin-Station-93],[End-Station] AS [End-Station-93]
FROM 1993
WHERE Structure <> ''
ORDER BY Structure, [Key-Route];
```

KeyRoute_MRLC. The table KeyRoute_MRLC contains one row for each key route that is present in the most current base table and whose length has changed in a prior year from its length as computed from the most current base table. For each such key route, the table provides the year in which the length most recently changed. The primary key is the combination of County, County-Muni, and Key-Route. The columns are as follows:

Name	Description
County	County code for the key route
County-Muni	County or Municipality code for the key route
Key-Route	Key Route code for the key route
MRLC_Year	the year of the Most Recent Length Change in the key route prior to the most current year

The table is used to inform the user of the most recent year prior to the current year in which a change of length occurred in a key route (assuming some degree of tolerance, e.g., .05), which likely means that a change of stationing has occurred. For Key Route projections, such a change renders AADT counts for the MRLC_Year and preceding years suspect since the search for these counts is based solely on the key route code and the mileage stations recorded in the most current base table.

The query to make this table is:

```
SELECT kry.County, kry.[County-Muni], kry.[Key-Route], MAX(Year) AS [MRLC-Year]
INTO KeyRoute_MRLC
FROM KeyRoute_Year AS kry, View_KeyRoute_Length_Current AS krlc
WHERE kry.Year<YearOfMostCurrentTable AND ABS(kry.Length - krlc.Length_Current) > .05
        AND kry.County=krlc.County AND kry.[County-Muni]=krlc.[County-Muni] AND
        kry.[Key-Route]=krlc.[Key-Route]
GROUP BY kry.County, kry.[County-Muni], kry.[Key-Route];
```

The query View_KeyRoute_Length_Current forms a view that contains one row for each key route that is present in the most current base table. The row gives the length of the key route as recorded in the most current base table. The primary key is the combination of County, County-Muni, and Key-Route. The query to form this view is:

```
SELECT County, [County-Muni], [Key-Route], Length AS Length_Current
FROM KeyRoute_Year
WHERE Year=YearOfMostCurrentTable
ORDER BY County, [County-Muni], [Key-Route];
```

KeyRoute_Year. The KeyRoute_Year table is a temporary, derived table used only to create the tables KeyRoute_MRLC, KeyRoute_MRLC_pre1993, and KeyRoute_MRLC_pre1981. Each row of the KeyRoute_Year table represents a key route and a year and gives the derived length of that key route in that particular year. Any key route present in any base table will appear in the KeyRoute_Year table, and for that key route each year appears for which the key route was recorded in the base table for that year. The primary key is the combination of County, County-Muni, Key-Route, and Year. The columns are as follows:

Name	Description
County	County code
County-Muni	County or Municipality code
Key-Route	Key Route code
Year	year for which length is derived
Length	mileage representing length of key route

The query to make this table is:

```
SELECT * INTO KeyRoute_Year
FROM View_KeyRoute_Year_Union;
```

where View_KeyRoute_Year_Union is the query:

```
(SELECT County, [County-Muni], [Key-Route], '<year of most current base table>' AS [Year],
            MAX([End-Station]) AS Length
FROM <year of most current base table>
GROUP BY County,[County-Muni], [Key-Route])
UNION
(SELECT County, [County-Muni], [Key-Route], '<year of most current base table - 1>' AS [Year],
            MAX([End-Station]) AS Length
FROM <year of most current base table - 1>
GROUP BY County,[County-Muni], [Key-Route])
UNION
...
UNION
(SELECT County, [County-Muni], [Key-Route], '1973' AS [Year], MAX([End-Station]) AS Length
FROM 1973
GROUP BY County,[County-Muni], [Key-Route])
ORDER BY County, [County-Muni], [Key-Route], Year DESC;
```

KeyRoute_MRLC_Pre1993. The table KeyRoute_MRLC_Pre1993 contains one row for each key route that is present in the 1993 base table and whose length has changed in a prior year from its length as computed from the 1993 base table. For each such key route, the table provides the year in which the length most recently changed prior to 1993. The primary key is the combination of County, County-Muni, and Key-Route. The columns are as follows:

Name	Description
County	County code for the key route
County-Muni	County or Municipality code for the key route
Key-Route	Key Route code for the key route
MRLC-Year-Pre1993	the year of the Most Recent Length Change in the key route prior to 1993

The table is used to inform the user of the most recent year prior to 1993 in which a change of length occurred in a key route (assuming some degree of tolerance, e.g., .05), which likely means that a change of stationing has occurred. For Structure projections, such a change renders AADT counts for the MRLC_Year_Pre1993 and preceding years suspect since for years prior to 1993 the search for these counts is based solely on the key route code recorded in the most current table and the mileage stations recorded for this key route in the 1993 base table rather than on the Structure code.

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This table need only be built once, i.e., it does not need to be updated every year. The query to make this table is:

```
SELECT kry.County, kry.[County-Muni], kry.[Key-Route], MAX(Year) AS [MRLC-Year-Pre1993]
INTO KeyRoute_MRLC_Pre1993
FROM KeyRoute_Year AS kry, View_KeyRoute_Length_1993 AS krl93
WHERE kry.Year<'1993' AND ABS(kry.Length - krl93.Length_1993) > .05 AND
          kry.County=krl93.County AND kry.[County-Muni]=krl93.[County-Muni] AND
          kry.[Key-Route]=krl93.[Key-Route]
GROUP BY kry.County, kry.[County-Muni], kry.[Key-Route];
```

The query View_KeyRoute_Length_1993 forms a view that contains one row for each key route that is present in the 1993 base table. The row gives the length of the key route as computed from the 1993 base table. The primary key is the combination of County, County-Muni, and Key-Route. The query to form this view is:

```
SELECT County, [County-Muni], [Key-Route], Length AS Length_1993
FROM KeyRoute_Year
WHERE Year='1993'
ORDER BY County, [County-Muni], [Key-Route];
```

KeyRoute_MRLC_Pre1981. The table KeyRoute_MRLC_Pre1981 contains one row for each key route that is present in the 1981 base table and whose length has changed in a prior year from its length as computed from the 1981 table. For each such key route, the table provides the year in which the length most recently changed prior to 1981. The primary key is the combination of County, County-Muni, and Key-Route. The columns are as follows:

Name	Description
County	County code
County-Muni	County or Municipality code
Key-Route	Key Route code
MRLC-Year-Pre1981	the year of the Most Recent Length Change in the key route prior to 1981

The table is used to inform the user of the most recent year prior to 1981 in which a change of length occurred in a key route (assuming some degree of tolerance, e.g., .05), which likely means that a change of stationing has occurred. For HPMS projections, such a change renders AADT counts for the MRLC_Year_Pre1981 and preceding years suspect since for years prior to 1981 the search for these counts is based solely on the key route code and the mileage stations recorded in the 1981 base table rather than on the HPMS code.

This table need only be built once, i.e., it does not need to be updated every year. The query to make this table is:

```
SELECT kry.County, kry.[County-Muni], kry.[Key-Route], MAX(Year) AS [MRLC-Year-Pre1981]
INTO KeyRoute_MRLC_Pre1981
FROM KeyRoute_Year AS kry, View_KeyRoute_Length_1981 AS krl81
WHERE kry.Year<'1981' AND ABS(kry.Length - krl81.Length_1981) > .05 AND
            kry.County=krl81.County AND kry.[County-Muni]=krl81.[County-Muni] AND
            kry.[Key-Route]=krl81.[Key-Route]
GROUP BY kry.County, kry.[County-Muni], kry.[Key-Route];
```

The query View_KeyRoute_Length_1981 forms a view that contains one row for each key route that is present in the 1981 base table. The row gives the length of the key route as computed from the 1981 base table. The primary key is the combination of County, County-Muni, and Key-Route. The query to form this view is:

```
SELECT County, [County-Muni], [Key-Route], Length AS Length_1981
FROM KeyRoute_Year
WHERE Year='1981'
ORDER BY County, [County-Muni], [Key-Route];
```

Segment_AADT_Count. The Segment_AADT_Count table contains one row for each AADT count taken on a particular key route segment for a particular year, i.e., AADT-Year, 1970 or later. The primary key is (County, [County-Muni], [Key-Route], [Begin-Station], [End-Station], [AADT-Year]). Alternative unique keys are (HPMS, [Begin-Station], [End-Station], [AADT-Year]) and (Structure, [Key-Route], [Begin-Station], [End-Station], [AADT-Year]). The columns are as follows:

Name	Description
District	District code
County	County code
County-Muni	County or Municipality code
Key-Route	Key Route code, indexed (Duplicates OK)
Begin-Station	Begin station mileage
End-Station	End station mileage
HPMS	HPMS code
Structure	Structure code
Marked-Rte	route number
AADT	AADT count
AADT-Year	year in which AADT count was taken

The table is used to obtain the historical counts, i.e., data points or (AADT-Year, AADT count)'s, that are plotted and used to make HPMS, Structure, and Key Route projections for future traffic.
Indexing Key-Route notably improves response time on Key Route and Structure projections.

The query to make this table is:

```
SELECT * INTO Segment_AADT_Count
FROM View_Segment_AADT_Count_Union
ORDER BY District, County, [County-Muni], [Key-Route], [Begin-Station], [AADT-Year] DESC;
```

where View_Segment_AADT_Count_Union is the query

```
(SELECT * FROM <year of most current base table> WHERE AADT >= 0 AND [AADT-Year] >=
'1970')
UNION
(SELECT * FROM <year of most current base table - 1> WHERE AADT >= 0 AND [AADT-Year]
>=  '1970' )
UNION
...
UNION
(SELECT * FROM 1973 WHERE AADT >= 0 AND [AADT-Year] >=  '1970');
```

After the query is executed to create the table, the DUPLICATES OK index should be
added on the Key Route column using the Design View on the table.

Once the Segment_AADT_Count table is built, it can be updated with the base table for a
new year by changing its name—for example to Old_Segment_AADT_Count—and then
union'ing it with the base table for the new year. The query to make an updated
Segment_AADT_Count table is:

```
SELECT * INTO Segment_AADT_Count
FROM View_Updated_Segment_AADT_Count;
```

where View_Updated_Segment_AADT_Count is the query

```
(SELECT * FROM <year of most current base table> WHERE AADT >= 0 AND [AADT-Year] >=
'1970')
UNION
(SELECT * FROM Old_Segment_AADT_Count)
ORDER BY District, County, [County-Muni], [Key-Route], [Begin-Station], [AADT-Year] DESC;
```

Search Algorithms

The algorithms given in this section describe the database searches that are performed on
the derived tables, as defined above, to obtain relevant historical AADT counts. From
these counts, data points, i.e., (AADT-Year, AADT count)'s, are derived that are used to
project future AADT counts. Projections can be made given an HPMS code, an HPMS
Projection; a Structure code and Key-Route code, a Structure Projection; or a County
code, Key-Route code, and mileage point, a Key Route Projection. Each type of
projection involves a slightly different database search.

HPMS Projection

The search algorithm for an HPMS projection is as follows.

Given an HPMS code, identified as *HPMScode*, query the HPMS_Section table to ensure that the *HPMScode* is valid, get current information about the HPMS section, and get information needed for any pre-1981 search for the HPMS section.

SELECT * FROM HPMS_Section WHERE HPMS = *HPMScode*

If no row results from this query, display an error message and end the search; otherwise, get the Key-Route, Key-Route-81, First-Begin-Station-81, and Last-End-Station-81 for the *HPMScode* and identify these as *KeyRoute*, *KeyRoute81*, *FirstBeginStation81*, and *LastEndStation81*, respectively. Also, get the First-Begin-Station and Last-End-Station to display them to the user.

If *KeyRoute81* is not NULL, query the KeyRoute_MRLC_Pre1981 table to obtain the MRLC-Year-Pre1981, if any, for this key route so that derived data points prior to that year can be displayed differently.

SELECT * FROM KeyRoute_MRLC_Pre1981
WHERE [Key-Route] = *KeyRoute81* AND County = $<1^{st}$ *3 digits of HPMScode>*

Query the Segment_AADT_Count table to obtain relevant, historical AADT counts for the HPMS section. If *KeyRoute81* is NULL, indicating that the HPMS section did not exist in 1981, select AADT counts based only on *HPMScode*.

SELECT DISTINCT [Key-Route], [Begin-Station], [End-Station], AADT, [AADT-Year],
                           [Street Name], [Marked-Rte]
FROM Segment_AADT_Count
WHERE HPMS = *HPMScode*
ORDER BY [AADT-Year] DESC, [Begin-Station]

If the *KeyRoute81* is not NULL, select AADT counts based on the *HPMScode* from 1981 onward, but prior to 1981 select them based on the HPMS's Key Route code in 1981, *KeyRoute81*, and its extent in 1981 as defined by its *FirstBeginStation81* and *LastEndStation81*.

SELECT DISTINCT [Key-Route], [Begin-Station], [End-Station], AADT, [AADT-Year],
                           [Street Name], [Marked-Rte]
FROM Segment_AADT_Count
WHERE ([AADT-Year] >= '1981' AND HPMS = *HPMScode*) OR
          ([AADT-Year] < '1981' AND [Key-Route] = *KeyRoute81* AND
          County = $<1^{st}$ *3 digits of HPMScode>* AND [Begin-Station] < *LastEndStation81* AND
          [End-Station] > *FirstBeginStation81*)
ORDER BY [AADT-Year] DESC, [Begin-Station]

Note that any pre-1981 segments that overlap with the HPMS section as defined in 1981 will be selected by this query. Also, [Key-Route] is included in the selected columns so

that it can be included in the IRIS Data display, allowing the user to see any key route changes that may have occurred.

If no rows result from the query, display an error message.

Structure Projection

The search algorithm for a Structure projection is as follows.

Given a Structure code, identified as *Structure*, query the Structure_Segment table to ensure that the *Structure* is valid and to obtain relevant Key-Route codes for the structure.

    SELECT * FROM Structure_Segment WHERE Structure = *Structure*

If no rows result from this query, display an error message and end the search.

If multiple rows result, display the Key-Route codes in each row to the user and force the user to selection one of them.

Get the Key-Route code, County code, County-Muni code, Begin-Station-93, and End-Station-93 for the selected or unique key route and identify these as *KeyRoute*, *County*, and *CountyMuni*, *BeginStation93*, and *EndStation93*, respectively.

If the *BeginStation93* for the *Structure* and *KeyRoute* is not NULL, query the table KeyRoute_MRLC_Pre1993 to obtain the MRLC-Year-Pre1993, if any, for this key route so that derived data points prior to that year can be displayed differently.

        SELECT * FROM KeyRoute_MRLC_Pre1993
        WHERE [Key-Route] = *KeyRoute* AND County = *County* AND [Count-Muni] = *CountyMuni*

Query the Segment_AADT_Count table to obtain relevant, historical AADT counts for the structure and key route. If *BeginStation93* is NULL, indicating that the structure and key route did not exist in 1993, select AADT counts based only on the *Structure* and *KeyRoute*.

        SELECT DISTINCT [Key-Route], [Begin-Station], [End-Station], AADT, [AADT-Year],
                                     [Street Name], [Marked-Rte]
        FROM Segment_AADT_Count
        WHERE Structure = *Structure* AND [Key-Route] = *KeyRoute*
        ORDER BY [AADT-Year] DESC, [Begin-Station]

If the *BeginStation93* is not NULL, select AADT counts based on the *Structure* and *KeyRoute* from 1993 onward, but prior to 1993 select them based only on the structure's Key Route code, *KeyRoute*, and its extent in 1993 as defined by its *BeginStation93* and *EndStation93*.

```
SELECT DISTINCT [Key-Route], [Begin-Station], [End-Station], AADT, [AADT-Year],
                          [Street Name], [Marked-Rte]
FROM Segment_AADT_Count
WHERE [Key-Route] = KeyRoute AND
        (([AADT-Year] >= '1993' AND Structure = Structure) OR
         ([AADT-Year] < '1993' AND County = County AND
          [County-Muni] =CountyMuni AND
          [Begin-Station] < EndStation93 AND [End-Station] > BeginStation93))
ORDER BY [AADT-Year] DESC, [Begin-Station]
```

Note that any pre-1993 segments that overlap with the structure segment as defined in 1993 will be selected by this query. [Key-Route] is included in the selected columns so that it can be included in the IRIS Data display.

If no rows result from the query, display an error message.

Key Route Projection

The search algorithm for a Key Route projection is as follows.

Given a County code, identified as *County*, a Key-Route code, identified as *KeyRoute*, and a mileage point, identified as *Point*, query the table KeyRoute_MRLC to obtain the MRLC-Year, if any, for this key route so that derived data points prior to that year can be displayed differently.

```
SELECT * FROM KeyRoute_MRLC_Pre1993
WHERE [Key-Route] = KeyRoute AND County = County AND [Count-Muni] = CountyMuni
```

Query the Segment_AADT_Count table to obtain relevant, historical AADT counts for the given mileage point on the key route.

```
SELECT DISTINCT [Key-Route], [Begin-Station], [End-Station], AADT, [AADT-Year],
                          [Street Name], [Marked-Rte]
FROM Segment_AADT_Count
WHERE [Key-Route] = KeyRoute AND [County-Muni] = County AND
              [Begin-Station] <= Point AND [End-Station] > Point
ORDER BY [AADT-Year] DESC, [Begin-Station]
```

If no rows result from this query, display an error message. [Key-Route] is included in the selected columns so that it can be included in the IRIS Data display.

Processing of Segment AADT Counts

The segment AADT counts and related data resulting from the above database searches are processed in a similar fashion to derive the data points used to project future AADT counts. Essentially, the resulting rows (again, each representing a relevant segment

AADT count) are grouped by AADT-Year and for each of these years an average AADT count is computed.

For an HPMS projection, multiple segment AADT counts per AADT-Year normally result from the database search since an HPMS section is normally made up of multiple segments. The average AADT count that is computed for each year will be a weighted average based on the lengths of the segments. For example, assume that for a given HPMS code the following segment AADT counts are obtained for AADT-Year 2001:

Begin-Station	End-Station	AADT
2.0	2.1	1000
2.1	2.3	1200
2.3	2.4	1000

The weighted average AADT count for 2001 will be computed as $(.1 \times 1000 + .2 \times 1200 + .1 \times 1000) / .4 = 1100$, and thus the derived data point will be (2001, 1100).

For a Structure or Key Route projection, the average AADT count that is computed for each AADT year will be a standard, unweighted average. Normally for these types of projections only one segment AADT count per AADT-Year results from the database search. For example, assume that for a given Structure only the following segment AADT count is obtained for AADT-Year 2001:

Begin-Station	End-Station	AADT
4.8	4.9	1000

The average AADT count will of course be computed as 1000, and the derived data point will be (2001, 1000).

There are cases, however, for Structure or Key Route projections when multiple segment AADT counts for a specific AADT year may result from a database search, perhaps because of some re-stationing. For example, assume that for a given Structure the following segment AADT counts are obtained for AADT-Year 2001:

Begin-Station	End-Station	AADT
4.8	4.9	1000
4.85	4.98	1200

The average AADT count will be computed as 1100, and the derived data point will be (2001, 1100).

Maintenance of Derived Tables

The final section briefly suggests how the derived tables can be updated each year in an efficient manner.

First, the Segment_AADT_Count table can be updated as already described in the Derived Tables section under Segment_AADT_Count. After the new Segment_AADT_Count table is created, the DUPLICATES OK index should again be added on the Key Route column using the Design View on the table.

The intermediate table KeyRoute_Year can actually be saved from year to year and updated in a similar manner. That is, it can be updated with the needed information from the base table for the new year by changing its name—for example to Old_KeyRoute_Year—and then union'ing it with the appropriate query results obtained for the new year. The query to make an updated KeyRoute_Year table is:

```
SELECT * INTO KeyRoute_Year
FROM View_Updated_KeyRoute_Year;
```

where View_Updated_KeyRoute_Year is the query

```
(SELECT County, [County-Muni], [Key-Route], '<year of most current base table>' AS [Year],
        MAX([End-Station]) AS Length
 FROM <year of most current base table>
 GROUP BY County,[County-Muni], [Key-Route])
UNION
(SELECT * FROM Old_KeyRoute_Year)
ORDER BY County, [County-Muni], [Key-Route], Year DESC;
```

Once the KeyRoute_Year table has been updated, the query to make the new KeyRoute_MRLC table can be run. The KeyRoute_MRLC_Pre1993 and KeyRoute_MRLC_Pre1981 tables do not require updating.

The HPMS_Section and Structure_Segment tables must be updated by running the queries to make these tables based on the newest base table. For maximum efficiency, the View_HPMS_Section_1981 and View_Structure_Segment_1993 queries could actually be made to create intermediate tables that could be reused from year to year; however, the time required to recreate these views is relatively short.

APPENDIX C
COMPARISON OF ITPT AND IRIS FORECAST RESULTS

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
LINCOLN AVE (4.56 To 4.86)

TO:	file				
FROM:	dk				
DATE:	6/27/2004		PREPARED BY:	dk	

KEY ROUTE CODE:	97177 00000000		HPMS CODE:	0101350	
CURRENT AADT (2001):	7,683		COUNTY NAME:	Champaign	
FORECAST AADT (2015):	10,200				
NOTE:	deleted 1970 data point due to possible change in key route				

DATA POINTS

PROJECTION

MODEL NAME: Linear Regression

YEAR	AADT	YEAR	AADT
2001	7,683	2015	10,200
1996	5,417	2010	9,000
1995	4,800	2005	7,700
1994	4,602		
1991	5,533		
1989	1,950		
1986	2,600		
1981	1,600		
1976	1,400		

GROWTH / YEAR:	249
% AADT OF YEAR 2001 :	3.241 %
GROWTH OVER 14 YEAR:	2,517
% GROWTH OVER 14 YEAR:	32.761 %
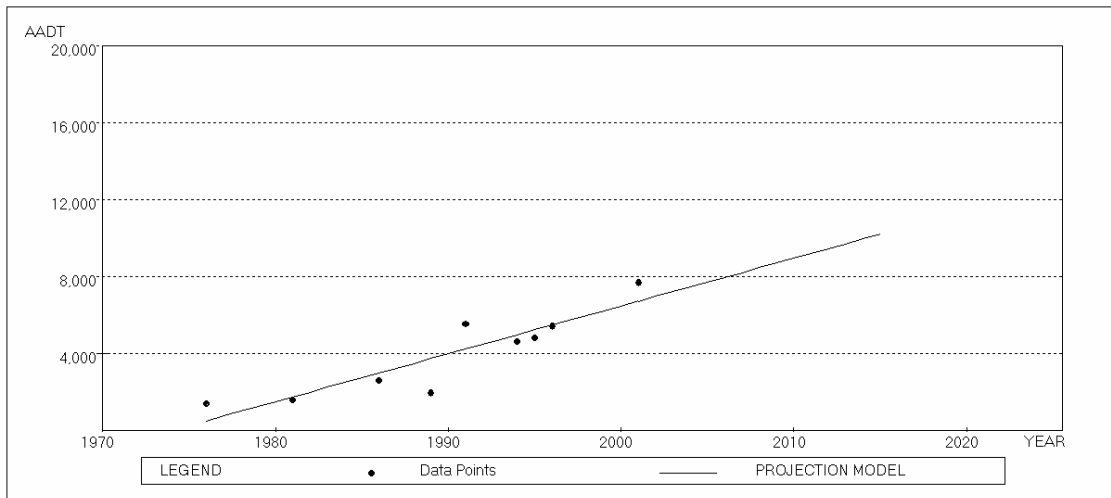
2015 forecast from IRIS: 9,200

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
STATE ST (2.09 To 2.76)

TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 92612 00000000   HPMS CODE: 0168310
CURRENT AADT (2002):   17,600   COUNTY NAME: Cook
FORECAST AADT (2020):   29,500
NOTE:

DATA POINTS   PROJECTION   MODEL NAME: Linear Regression

YEAR	AADT	YEAR	AADT
2002	17,600	2020	29,500
2000	15,500	2015	26,400
1998	19,700	2010	23,300
1991	12,000	2005	20,200
1990	10,200		
1986	5,100		
1978	5,109		

GROWTH / YEAR: 621
% AADT OF YEAR 2002 :   3.528 %
GROWTH OVER 18 YEAR: 11,900
% GROWTH OVER 18 YEAR: 67.614 %

LEGEND   •   Data Points   ———   PROJECTION MODEL

2020 Forecast in IRIS: 17,600

TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 10080 00000000   HPMS CODE: 0160170
CURRENT AADT (2002):   122,789   COUNTY NAME: Cook
FORECAST AADT (2020):   204,000
NOTE:

DATA POINTS		PROJECTION		MODEL NAME:	Linear Regression	
YEAR	AADT	YEAR	AADT	GROWTH / YEAR:		3,424
2002	122,789	2020	204,000	% AADT OF YEAR 2002 :		2.789 %
2001	123,200	2015	186,900	GROWTH OVER 18 YEAR:		81,211
1998	134,800	2010	169,800	% GROWTH OVER 18 YEAR:		66.139 %
1997	146,307	2005	152,700			
1996	117,300					
1995	154,189					
1994	107,389					
1993	102,511					
1992	99,700					
1990	120,948					
1989	103,740					
1988	96,786					
1987	84,986					
1986	83,319					
1985	86,600					
1983	71,344					
1982	68,078					
1981	58,227					
1978	66,262					
1975	49,042					
1973	44,097					

2020 Forecast in IRIS: 166,000

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
159TH ST (3.01 To 3.23)

TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 20351 00000000   HPMS CODE: 0161060
CURRENT AADT (2003):   41,300   COUNTY NAME: Cook
FORECAST AADT (2020):   61,100
NOTE:

DATA POINTS		PROJECTION		MODEL NAME:	Linear Regression	
YEAR	AADT	YEAR	AADT	GROWTH / YEAR:		1,183
2003	41,300	2020	61,100	% AADT OF YEAR 2003 :		2.864 %
2001	37,000	2015	55,200			
2000	43,900	2010	49,200	GROWTH OVER 17 YEAR:		19,800
1998	33,000	2005	43,300	% GROWTH OVER 17 YEAR:		47.942 %
1996	34,300					
1994	28,000					
1993	26,500					
1990	24,900					
1989	24,900					
1986	19,800					
1985	20,700					
1983	15,300					
1982	15,300					
1981	15,300					
1978	12,215					
1975	7,604					
1973	7,688					

2020 Forecast in IRIS: 41,000

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
MARQUETTE RD (6.50 To 6.75)

TO:	file			
FROM:	dk			
DATE:	6/27/2004		PREPARED BY:	dk

KEY ROUTE CODE:	91530 00000000		HPMS CODE:		0161560
CURRENT AADT (2000):	14,000		COUNTY NAME:		Cook
FORECAST AADT (2020):	14,200				
NOTE:	created simple growth model with increase of 10 veh/year				

DATA POINTS		PROJECTION		MODEL NAME:	Simple Growth	
YEAR	AADT	YEAR	AADT	GROWTH / YEAR:		10
2000	14,000	2020	14,200	% AADT OF YEAR 2000 :		0. %
1990	18,500	2015	14,100			
1986	16,300	2010	14,100	GROWTH OVER 20 YEAR:		200
1979	16,300	2005	14,000	% GROWTH OVER 20 YEAR:		1.429 %

2020 Forecast in IRIS: 21,000

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
BALTIMORE ST. (1.29 To 2.02)

TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 31702 00000000   HPMS CODE: 0170040
CURRENT AADT (2000):   550   COUNTY NAME: Crawford
FORECAST AADT (2027):   800
NOTE:

DATA POINTS   PROJECTION   MODEL NAME: Linear Regression

YEAR	AADT	YEAR	AADT
2000	550	2027	800
1998	500	2022	750
1996	500	2017	700
1995	450	2012	650
1992	400	2007	600
1989	400	2002	550
1985	400		
1980	381		
1975	292		
1970	214		

GROWTH / YEAR: 9

% AADT OF YEAR 2000 :   1.636 %

GROWTH OVER 27 YEAR: 250

% GROWTH OVER 27 YEAR: 45.455 %

2027 Forecast in IRIS: 750

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ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
BUCKLEY RD (13.91 To 14.18)

TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 20352 00000000   HPMS CODE: 0490150
CURRENT AADT (2003):   24,107   COUNTY NAME: Lake
FORECAST AADT (2020):   37,500
NOTE:

DATA POINTS   PROJECTION   MODEL NAME: Linear Regression

YEAR	AADT	YEAR	AADT		
2003	24,107	2020	37,500	GROWTH / YEAR:	656
2001	24,926	2015	34,200	% AADT OF YEAR 2003 :	2.721 %
2000	26,378	2010	30,900	GROWTH OVER 17 YEAR:	13,393
1999	22,100	2005	27,600	% GROWTH OVER 17 YEAR:	55.556 %
1996	23,500				
1995	23,963				
1993	22,400				
1992	22,400				
1989	15,800				
1988	14,900				
1987	9,900				
1985	10,800				
1983	9,900				
1981	11,700				
1979	16,800				
1974	8,100				

2020 Forecast in IRIS: 23,000

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
EMPIRE (18.42 To 18.99)

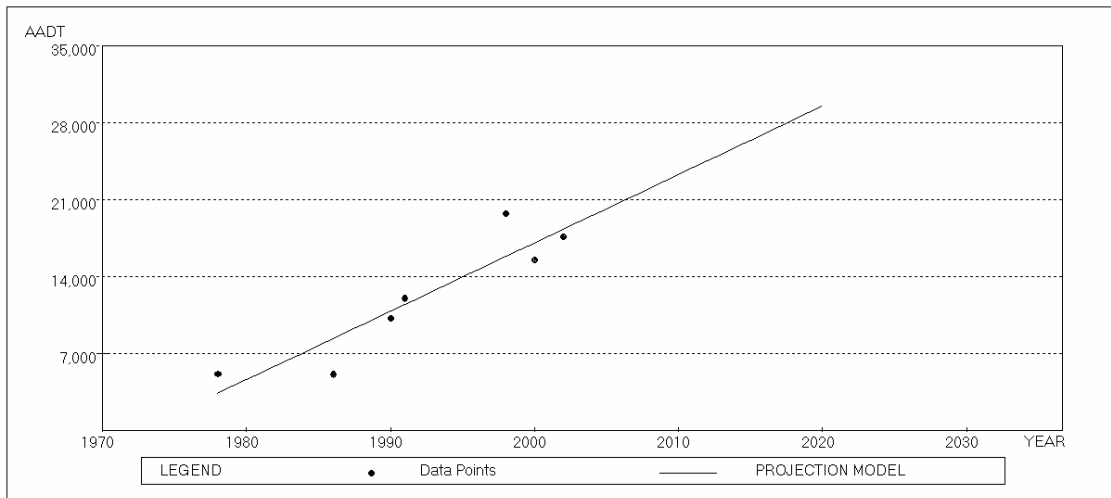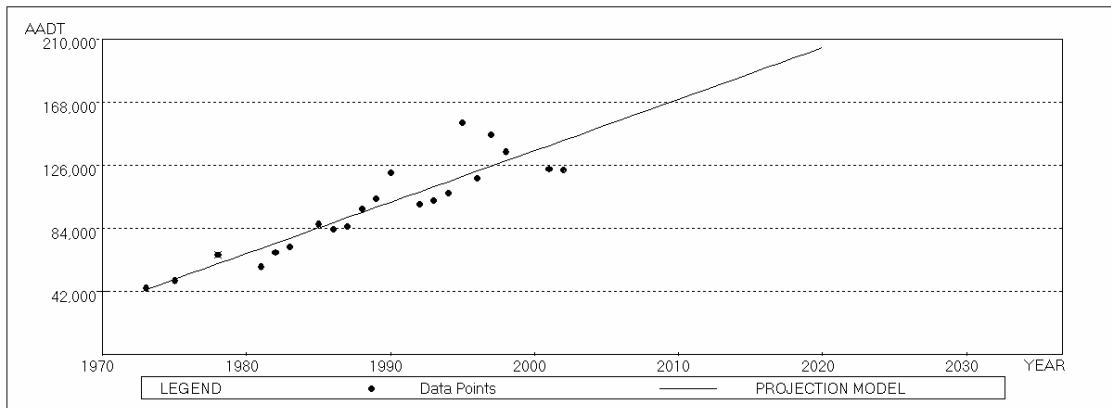TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 20693 00000000   HPMS CODE: 0570260
CURRENT AADT (2003):   23,119   COUNTY NAME: McLean
FORECAST AADT (2027): 31,000
NOTE:

DATA POINTS   PROJECTION   MODEL NAME: Linear Regression

YEAR	AADT	YEAR	AADT		
2003	23,119	2027	31,000	GROWTH / YEAR:	352
2001	22,379	2022	29,300	% AADT OF YEAR 2003 :	1.523 %
1999	20,758	2017	27,500	GROWTH OVER 24 YEAR:	7,881
1997	21,300	2012	25,800	% GROWTH OVER 24 YEAR:	34.089 %
1995	19,839	2007	24,000		
1993	18,814				
1991	18,264				
1990	17,538				
1988	17,482				
1987	18,097				
1986	17,268				
1985	15,864				
1983	15,473				
1981	13,199				
1979	11,747				
1975	9,579				
1971	16,522				

2026 Forecast in IRIS: 36,400

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
I072 (0.00 To 3.78)

TO:	file			
FROM:	dk			
DATE:	6/27/2004		PREPARED BY:	dk

KEY ROUTE CODE:	10072 00000000		HPMS CODE:	0690030
CURRENT AADT (2003):	6,700		COUNTY NAME:	Morgan
FORECAST AADT (2015):	9,700			
NOTE:				

DATA POINTS		PROJECTION		MODEL NAME:	Linear Regression	
YEAR	AADT	YEAR	AADT	GROWTH / YEAR:		222
2003	6,700	2015	9,700	% AADT OF YEAR 2003 :		3.313 %
2001	6,200	2010	8,600	GROWTH OVER 12 YEAR:		3,000
1999	6,700	2005	7,500	% GROWTH OVER 12 YEAR:		44.776 %
1997	7,200					
1995	5,656					
1993	4,842					
1991	4,060					
1989	3,154					
1987	2,351					
1985	1,977					
1983	2,352					
1982	2,181					
1981	2,181					
1979	2,334					
1976	2,000					
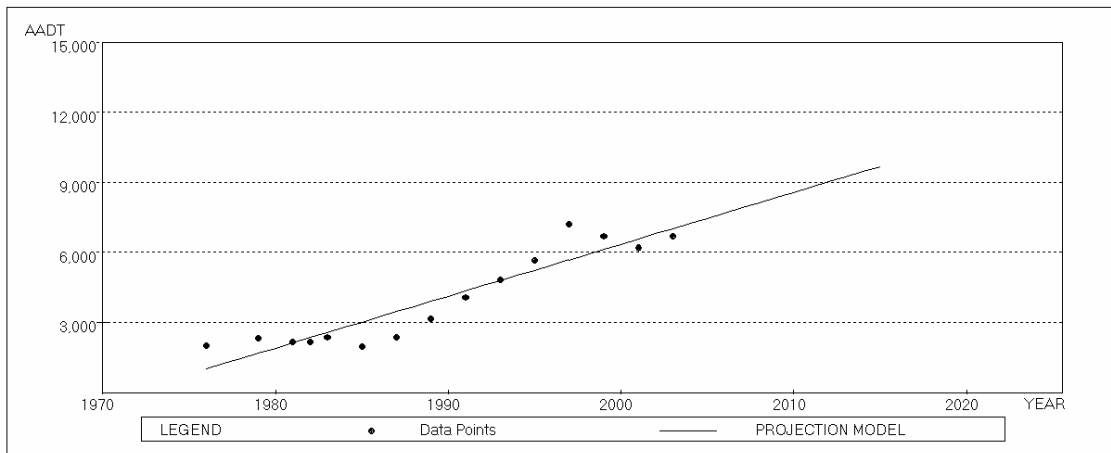
2015 Forecast in IRIS: 7,300

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
RIVER RD (0.00 To 8.06)
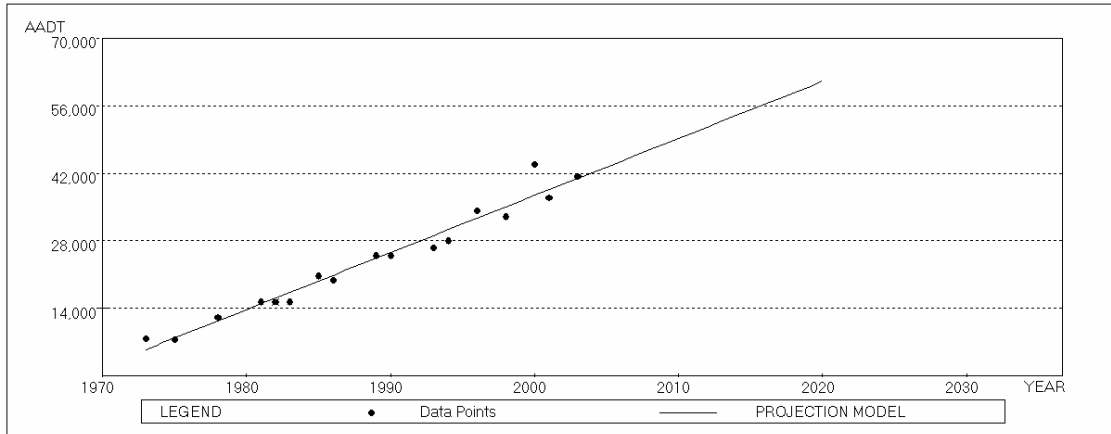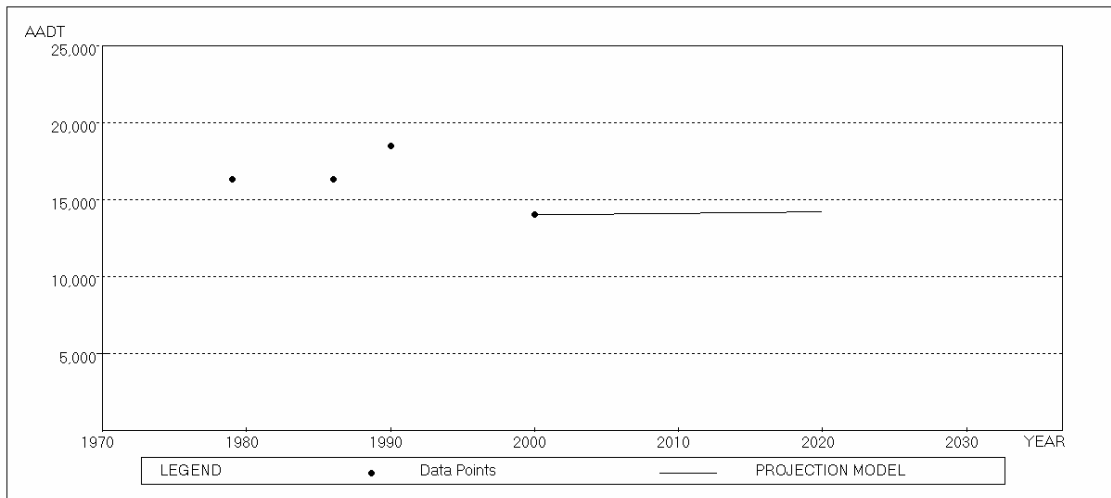
TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 30090 00000000   HPMS CODE: 0710060
CURRENT AADT (2003):   2,789   COUNTY NAME: Ogle
FORECAST AADT (2020): 4,150
NOTE:

DATA POINTS   PROJECTION   MODEL NAME: Linear Regression

YEAR	AADT	YEAR	AADT		
2003	2,789	2020	4,150	GROWTH / YEAR:	59
1999	3,500	2015	3,850	% AADT OF YEAR 2003 :	2.115 %
1998	2,658	2010	3,550	GROWTH OVER 17 YEAR:	1,361
1996	3,550	2005	3,250	% GROWTH OVER 17 YEAR:	48.799 %
1993	2,530				
1990	2,168				
1989	2,154				
1987	1,693				
1984	1,629				
1979	1,636				
1971	1,738				

2020 Forecast in IRIS: 4,700

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
BIG HOLLOW RD (3.77 To 4.06)
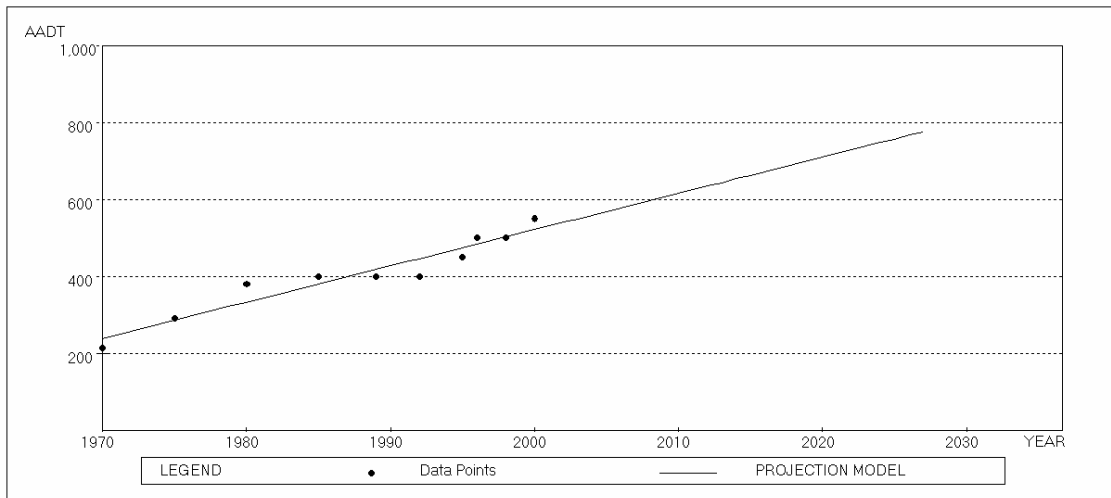
TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 96644 00000000   HPMS CODE: 0720480
CURRENT AADT (2002):   5,534   COUNTY NAME: Peoria
FORECAST AADT (2028):   7,700
NOTE: created simple growth model with increase of 1.5% per year

DATA POINTS		PROJECTION		MODEL NAME:	Simple Growth
YEAR	AADT	YEAR	AADT	GROWTH / YEAR:	83
2002	5,534	2028	7,700	% AADT OF YEAR 2002 :	1.5 %
1999	6,534	2023	7,300		
1996	5,403	2018	6,900	GROWTH OVER 26 YEAR:	2,166
1994	5,338	2013	6,400	% GROWTH OVER 26 YEAR:	39.140 %
1993	5,200	2008	6,000		
1990	4,700	2003	5,600		
1988	5,800				
1987	5,600				
1983	4,701				
1978	4,096				
1972	1,824				
1971	300				
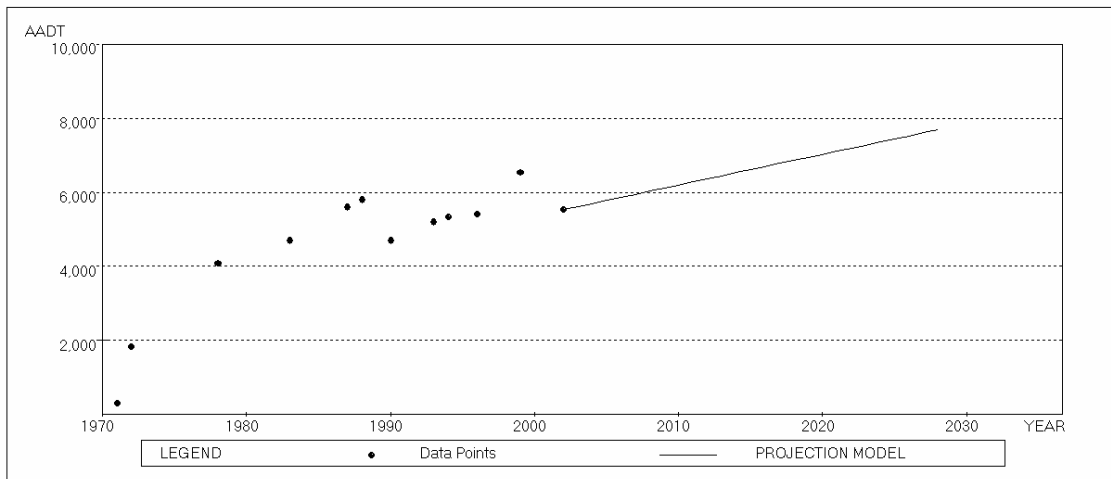
2028 Forecast in IRIS: 7934

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
JOHN DEERE RD (9.84 To 10.01)

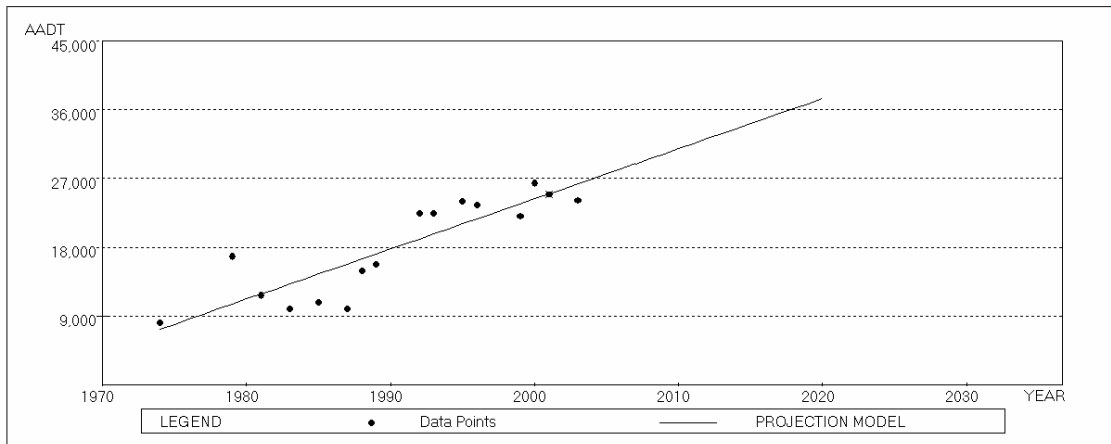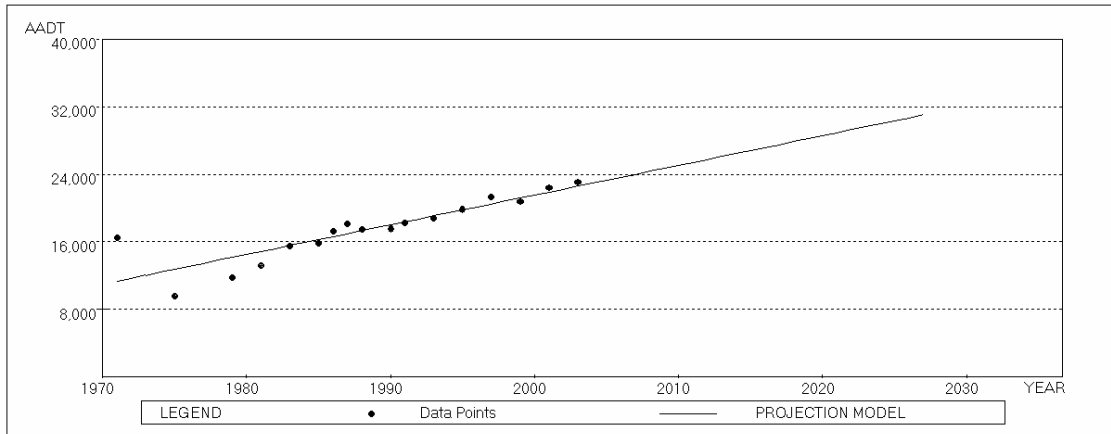TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 20595 00000000   HPMS CODE: 0810420
CURRENT AADT (2003):   14,200   COUNTY NAME: Rock Island
FORECAST AADT (2020):   18,900
NOTE: compound growth model appeared to fit data better

DATA POINTS   PROJECTION   MODEL NAME: Exponential Regression

YEAR	AADT	YEAR	AADT		
2003	14,200	2020	18,900	GROWTH of YEAR 2003 :	260
2001	14,700	2015	17,300	% AADT OF YEAR 2003 :	1.832 %
1999	13,709	2010	15,700	GROWTH OVER 17 YEAR:	4,700
1997	12,773	2005	14,400	% GROWTH OVER 17 YEAR:	33.099 %
1996	12,500				
1995	11,100				
1993	12,200				
1992	10,300				
1991	11,218				
1989	9,300				
1987	9,659				
1986	9,511				
1985	9,359				
1983	9,268				
1980	9,612				
1977	9,500				
1975	9,003				

2020 Forecast in IRIS: 25,000

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
MONROE ST (5.14 To 5.34)

TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 97981 00000000   HPMS CODE: 0848314
CURRENT AADT (2002):   10,505   COUNTY NAME: Sangamon
FORECAST AADT (2015):   11,400
NOTE: deleted 1995 data point 17,000

DATA POINTS   PROJECTION   MODEL NAME: Linear Regression

YEAR	AADT	YEAR	AADT
2002	10,505	2015	11,400
2001	10,800	2010	11,300
1998	11,385	2005	11,200
1992	11,500		
1991	12,009		
1989	10,800		
1985	10,422		
1980	10,300		

GROWTH / YEAR: 18
% AADT OF YEAR 2002 :   0.171 %
GROWTH OVER 13 YEAR: 895
% GROWTH OVER 13 YEAR: 8.520 %

2015 Forecast in IRIS: 14,000

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
15TH ST (0.26 To 0.54)

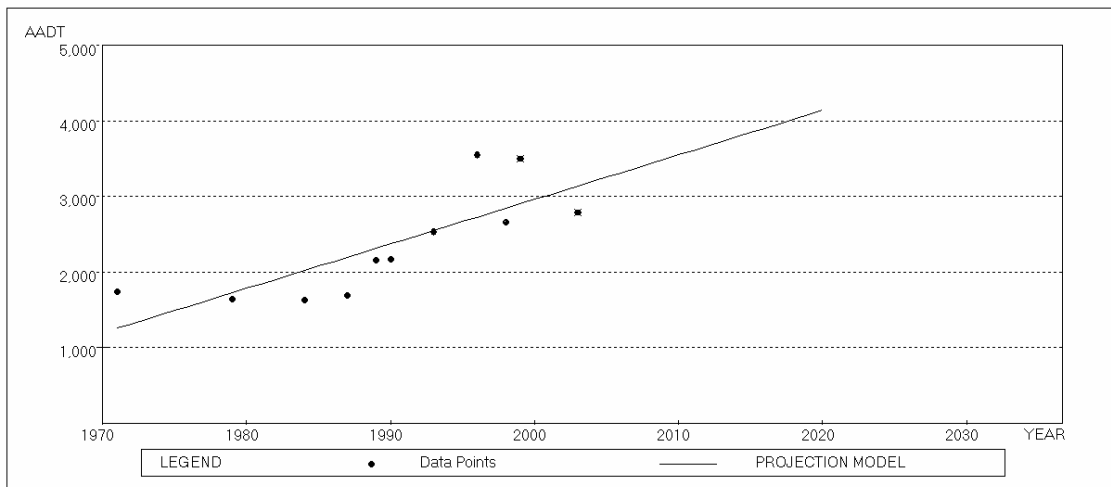TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 98034 00000000   HPMS CODE: 0841480
CURRENT AADT (2002):   2,902   COUNTY NAME: Sangamon
FORECAST AADT (2015):   3,600
NOTE: r squared = 0.14

DATA POINTS   PROJECTION   MODEL NAME: Linear Regression

YEAR	AADT	YEAR	AADT
2002	2,902	2015	3,600
2001	3,580	2010	3,500
1998	2,977	2005	3,400
1995	3,193		
1992	4,007		
1991	3,250		
1989	3,200		
1985	2,914		
1980	2,490		
1976	2,123		
1972	3,400		

GROWTH / YEAR: 20
% AADT OF YEAR 2002 :   0.689 %
GROWTH OVER 13 YEAR: 698
% GROWTH OVER 13 YEAR: 24.052 %

2015 Forecast in IRIS: 3,950

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ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
S 2ND ST (0.00 To 0.50)

TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 98025 00000000   HPMS CODE: 0841360
CURRENT AADT (2002):   6,900   COUNTY NAME: Sangamon
FORECAST AADT (2015):   8,600
NOTE:

DATA POINTS   PROJECTION   MODEL NAME: Linear Regression

YEAR	AADT	YEAR	AADT
2002	6,900	2015	8,600
2001	5,400	2010	7,600
1998	5,171	2005	6,700
1995	4,986		
1992	4,386		
1991	3,424		
1985	2,488		
1980	2,394		
1976	1,200		

GROWTH / YEAR: 190
% AADT OF YEAR 2002 :   2.754 %
GROWTH OVER 13 YEAR: 1,700
% GROWTH OVER 13 YEAR: 24.638 %

2015 Forecast in IRIS: 7,000

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
WALNUT ST (11.37 To 11.84)

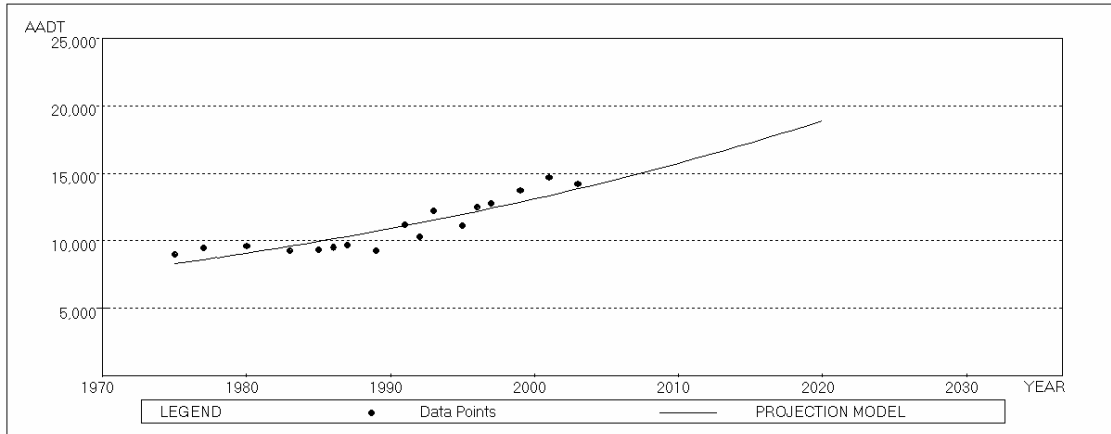TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 20658 00000000   HPMS CODE: 0840250
CURRENT AADT (2003):   9,660   COUNTY NAME: Sangamon
FORECAST AADT (2015):   9,700
NOTE: deleted 1989 data point, AADT 14,446

DATA POINTS		PROJECTION			MODEL NAME:	Simple Growth	
YEAR	AADT	YEAR	AADT		GROWTH / YEAR:		5
2003	9,660	2015	9,700		% AADT OF YEAR 2003 :		0. %
2001	9,770	2010	9,700		GROWTH OVER 12 YEAR:		40
1999	9,000	2005	9,700		% GROWTH OVER 12 YEAR:		0.414 %
1997	10,100						
1995	10,477						
1993	10,085						
1991	10,678						
1987	9,192						
1985	9,534						
1983	8,964						
1981	11,269						
1976	11,477						
1973	9,016						

2015 Forecast in IRIS: 15,700
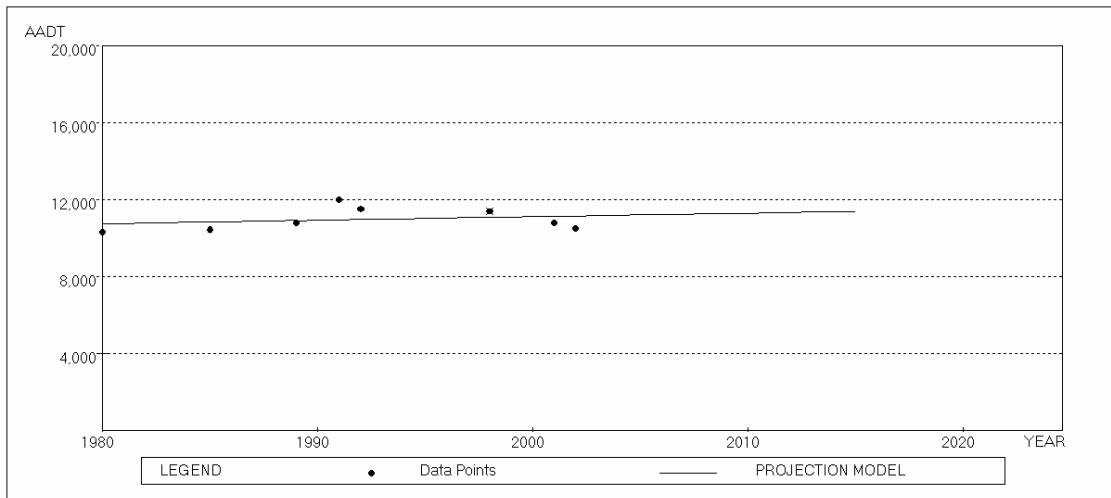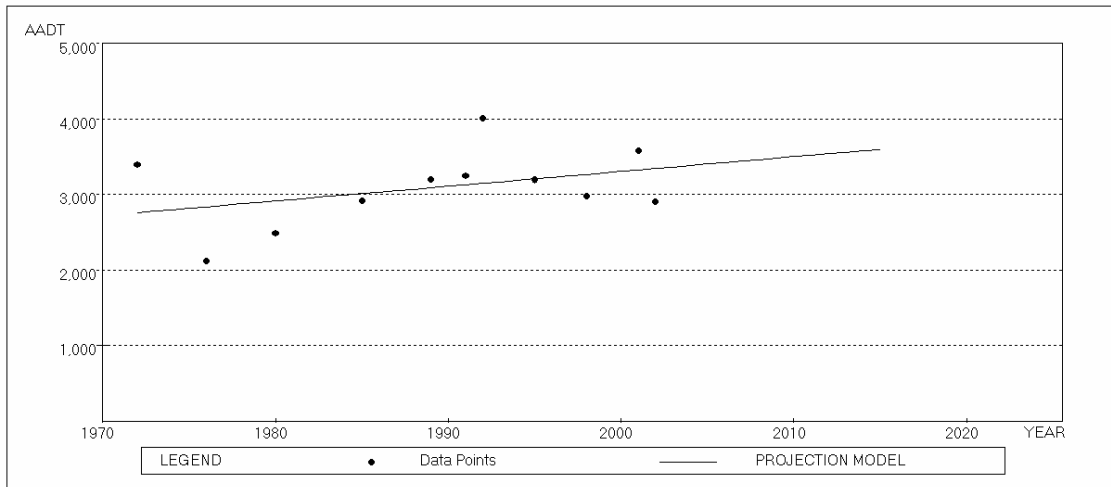
TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 99288 00000000   HPMS CODE: 0821790
CURRENT AADT (2003):   4,250   COUNTY NAME: St. Clair
FORECAST AADT (2020):   4,450
NOTE:

DATA POINTS		PROJECTION		MODEL NAME:	Linear Regression	
YEAR	AADT	YEAR	AADT	GROWTH / YEAR:		16
2003	4,250	2020	4,450	% AADT OF YEAR 2003 :		0.376 %
2001	4,550	2015	4,350			
1998	4,000	2010	4,300	GROWTH OVER 17 YEAR:		200
1995	4,100	2005	4,200	% GROWTH OVER 17 YEAR:		4.706 %
1993	4,250					
1992	3,675					
1989	3,580					
1982	3,275					
1977	3,559					
1972	4,368					
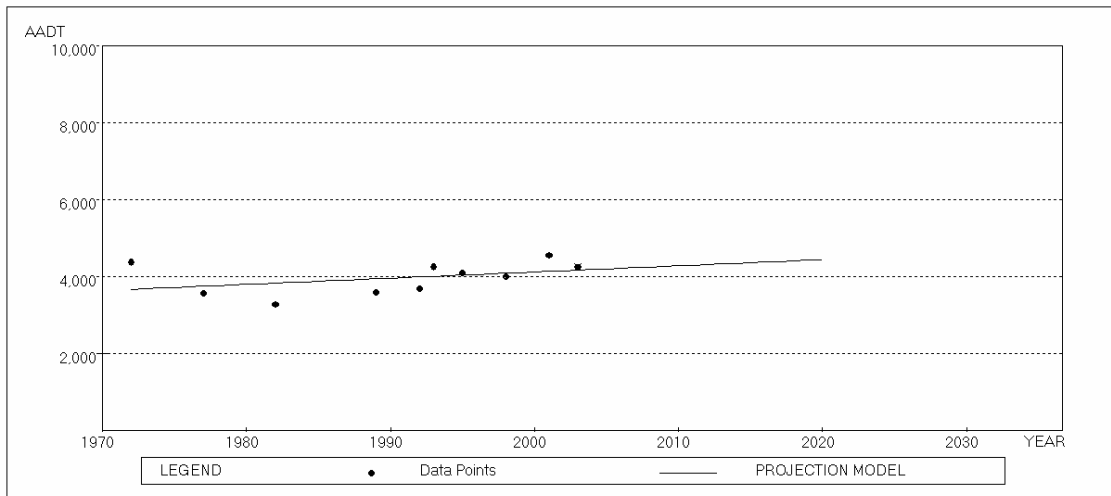
2020 Forecast in IRIS: 5,500

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
BOWMAN AVE (5.72 To 6.61)

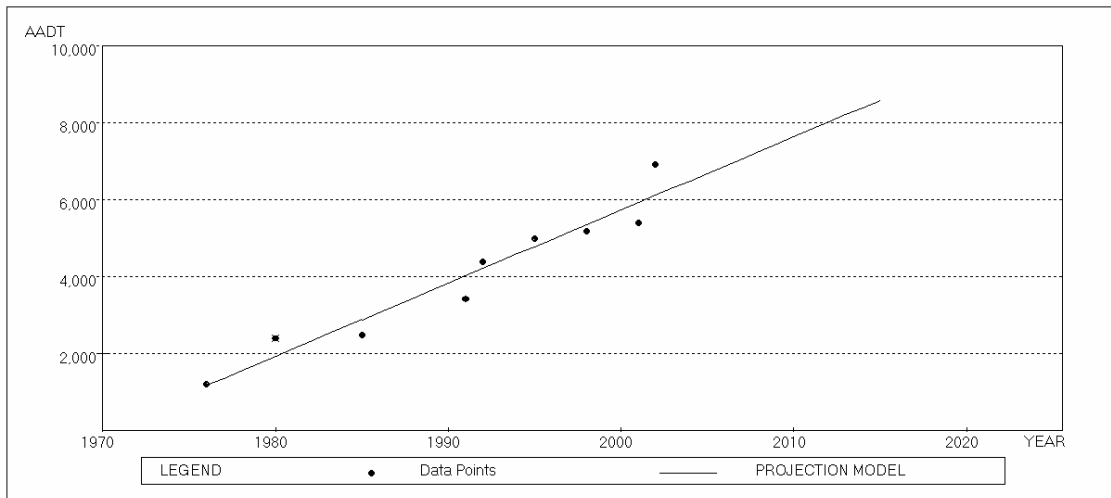TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 30500 00000000   HPMS CODE: 0920240
CURRENT AADT (2003):   5,800   COUNTY NAME: Vermilion
FORECAST AADT (2028):   13,400
NOTE:

DATA POINTS		PROJECTION		MODEL NAME:	Exponential Regression	
YEAR	AADT	YEAR	AADT	GROWTH of YEAR 2003 :		104
2003	5,800	2028	13,400	% AADT OF YEAR 2003 :		1.787 %
1998	10,300	2023	12,300			
1997	7,700	2018	11,200	GROWTH OVER 25 YEAR:		7,600
1994	7,700	2013	10,200	% GROWTH OVER 25 YEAR:		131.034 %
1991	7,900	2008	9,400			
1988	7,300					
1987	6,000					
1982	6,600					
1977	4,871					
1972	4,370					
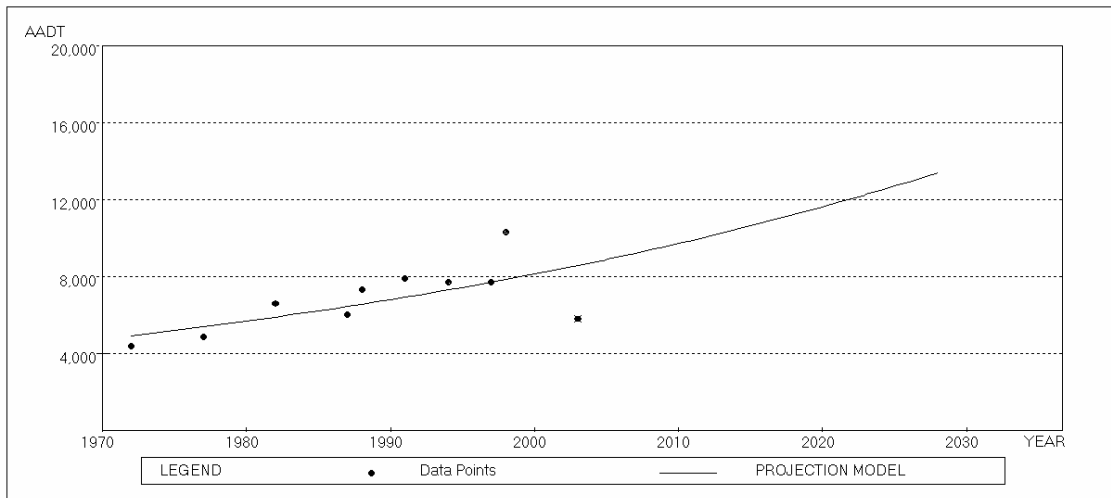
2028 Forecast in IRIS: 12,350

ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
VERMILION ST (22.02 To 22.63)

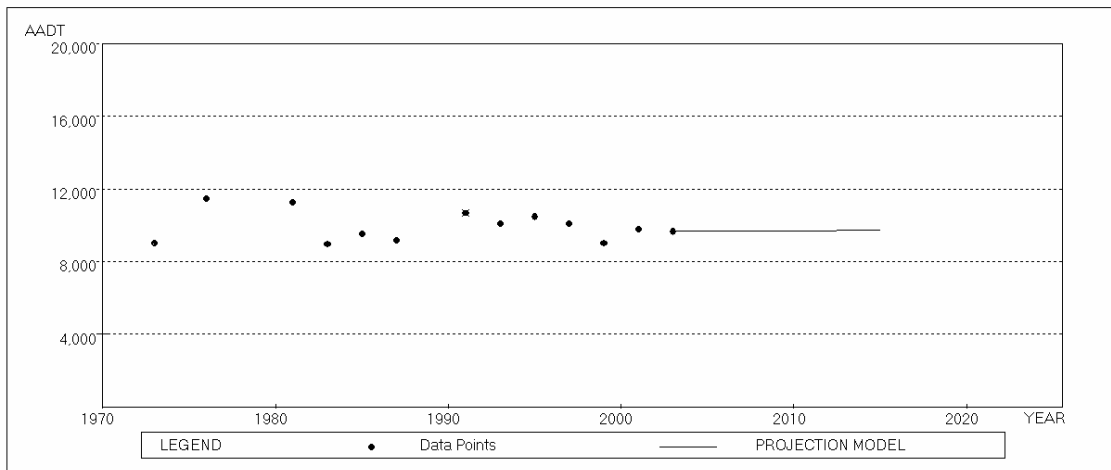TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 20332 00000000   HPMS CODE: 0928302
CURRENT AADT (2003):   22,843   COUNTY NAME: Vermilion
FORECAST AADT (2028):   31,500
NOTE:

DATA POINTS		PROJECTION		MODEL NAME:	Linear Regression	
YEAR	AADT	YEAR	AADT	GROWTH / YEAR:		368
2003	22,843	2028	31,500	% AADT OF YEAR 2003 :		1.611 %
2001	20,989	2023	29,700			
1999	22,392	2018	27,900	GROWTH OVER 25 YEAR:		8,657
1997	23,521	2013	26,000	% GROWTH OVER 25 YEAR:		37.898 %
1995	18,300	2008	24,200			
1993	15,600					
1991	15,100					
1989	16,600					
1987	17,500					
1985	13,000					
1983	19,400					
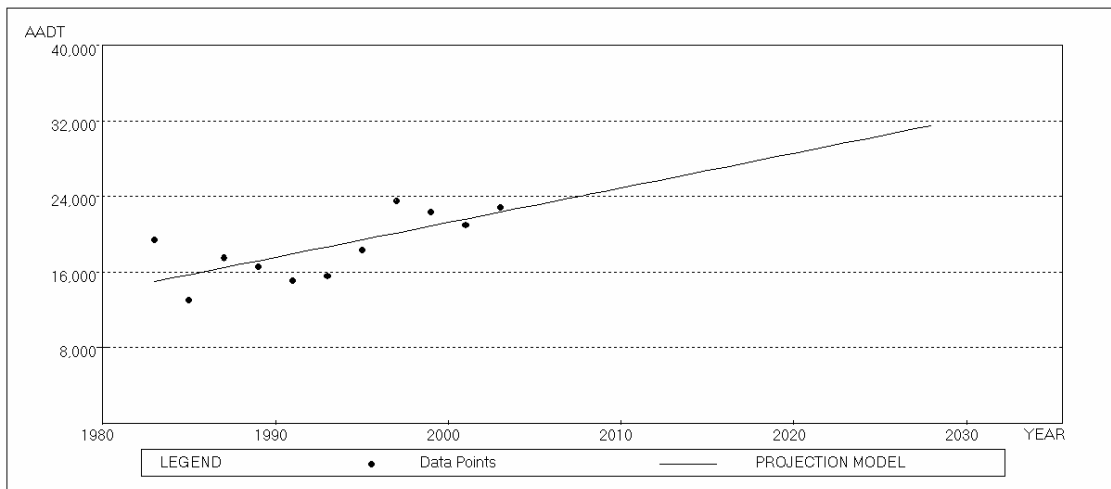
2028 Forecast in IRIS: 25,800

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ILLINOIS DEPARTMENT of TRANSPORTATION
TRAFFIC PROJECTION
N 2ND ST (8.45 To 8.59)

TO: file
FROM: dk
DATE: 6/27/2004   PREPARED BY: dk

KEY ROUTE CODE: 20303 00000000   HPMS CODE: 1018404
CURRENT AADT (2003):   40,600   COUNTY NAME: Winnebago
FORECAST AADT (2020): 44,800
NOTE:

DATA POINTS		PROJECTION		MODEL NAME:	Linear Regression
YEAR	AADT	YEAR	AADT	GROWTH / YEAR:	41
2003	40,600	2020	44,800	% AADT OF YEAR 2003 :	0.101 %
2001	46,000	2015	44,600	GROWTH OVER 17 YEAR:	4,200
2000	35,000	2010	44,400	% GROWTH OVER 17 YEAR:	10.345 %
1999	46,800	2005	44,100		
1997	46,009				
1995	45,900				
1994	45,900				
1993	47,200				
1991	43,900				
1990	44,300				
1989	44,600				
1987	44,600				
1985	44,500				
1983	36,000				
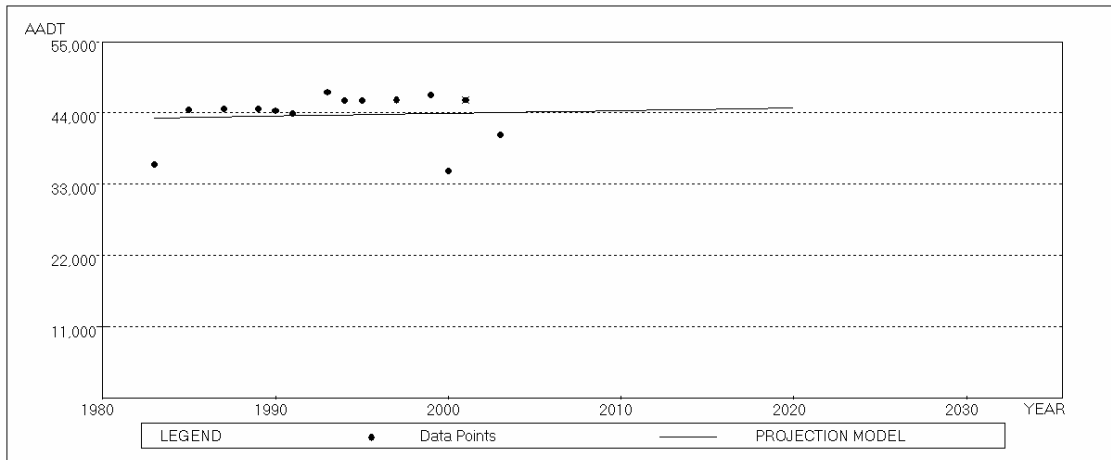
2020 Forecast in IRIS: 58,000

APPENDIX D
SYSTEM ARCHITECTURE, SPECIFICATIONS AND TECHNICAL
DOCUMENTATION

Illinois Traffic Projection Tool (ITPT)

System Architecture, Specifications and Technical Documentation

Table 1:   List of Forms and modules

The ITPT is composed of 9 forms and 2 modules. All form names and a short description is listed in this table.

No.	Form name	Description
1	Dialog_KeyRoute	Allows user to select the key route associated with one structure
2	dialog_new	This form is used to collect the input from user, retrieve IRIS data from database and launch a new projection. (See Table 7 for details)
3	Dialog_report	This form collects input and settings from user then a report is generated. (See Table 6 for more details.)
4	Frm_about	Relevant information about the developers and version of ITPT.
5	Frm_create_model	User can use this form to create a new model or edit an existing model. (See Table 3 for more details.)
6	Frm_growth	Shows the historical data and growth rates for a road section selected from the map.
7	Frm_progress	Indicates progress of county growth rate calculation.
8	Frm_projection	This is the form for each individual projection. User can work on this form, choose appropriate model, and print out report. (See Table 2 for more details about this form.)
9	MDIform_main	This is the main form, which contains menu buttons.
10	Mod_main	Contains global variables.
11	Mod_query	Contains database queries for all projection types.

Table 2:   Frm_projection: list of controls and their descriptions

#	Control name	Control type	Description
1	Grd_data	MSFlexGrid	This table is used to save all data series and relevant information about each series. The first column is the time (year) which ranges from 1970 to 2048. The first row is the name of series. Three default series are generated and saved in this table once a new projection is created successfully: 1. IRIS data: the historical data retrieved from IRIS data base 2. Simple Regression: this series is the estimated AADT by linear regression model. 3. Compound Growth: this series is the estimated AADT by exponential regression model User can create a new model, and the data for each model is saved here. More details about this grd_data can be found in the Table 4: specification of grd_data
2	Grd_info	MSFlexGrid	This table is used to display relevant information about a particular HPMS, Structure or Key Route. The information included in this table is: key route number, begin station, end station, forecast year, route name, county code, and county name.
3	Lvw_series	List view	All series in a projection are listed here. Two options are available: list view and details. For list view, only the name of each series is listed. By clicking the checkbox of each series, user can hide or display a series. Two viewing options are available to the user: list view and detail view. For details view, all relevant information for each series, such as function type, forecast AADT, growth rate, begin year, end year, Root Mean Square Error (RMSE) and series' index, are listed. Detailed layout is available in table: layout of list view. (See Table 5 for more details about this control.)
4	Pic_chart	Picture box	This is a workspace, which allows the user to work on each series. The series can be displayed or hidden. Data points can also be deleted, and the user can highlight and modify a particular series. Growth rate and forecast AADT are also displayed in the picture box.
5	Grd_table	MSFlexGrid	This table can display the selected series in a table format. Actual or estimated AADT for each year is displayed.
6	Grd_statistics	MSFlexGrid	This table is used to display descriptive statistics of the regression models. Two types of regression models are available: linear regression and exponential regression.
7	Pic_report	Picture box	This picture box can generate a printable report. After the user inputs necessary information for the report, a formatted report can be generated. Historical IRIS data, estimated forecast AADT and growth rate are listed in the report. Also a plot of historical IRIS data and the selected model is available at the bottom of the report. User can export the report to MS-Word or print it out directly.

8	Vsb_report	VScrollBar	This vertical scroll bar allows the user to navigate through the entire report.
9	Pic_map	Picture box	This picture box displays the local road map for a particular HPMS, Structure or Key Route. Zoom in, zoom out and other features are available to the user.
10	Fra_frame	Frame	Separates the list view (lvw_series) and other controls
11	Fra_views	Frame	Group of Command buttons which allow user to switch among controls.
12	Cmd_chart	Command Button	Show pic_chart
13	Cmd_table	Command Button	Show grd_table
14	Cmd_statistics	Command Button	Show grd_statistics
15	Cmd_models	Command Button	Displays frm_create_model to allow the user to create a new model.
16	Cmd_report	Command Button	Displays dialog_report to allow the user to create a report.
17	Cmd_map	Command Button	Show local maps
18	Dat_key_route	data	Data connection to GIS database for map
19	Fra_map	Frame	Group of controls for map display
20	Chk_history	Check box	Displays locations of existing forecasts on the map.
21	Chk_label	Check box	Displays route names on map.
22	Cmd_new_ center	Command Button	Allows user to center the map on a selected point.
23	Cmd_update_ View	Command Button	Updates the map plot.
24	Cmd_fit_view	Command Button	Displays the entire county map.
25	Cmd_zoom_in	Command Button	Zoom in by a factor of two.
26	Cmd_zoom_out	Command Button	Zoom out by a factor of two.
27	Cmd_box_zoom	Command Button	Allows user to drag a box around a region of the map to zoom in to that region.
28	Cmd_iris_data	Command Button	Show IRIS data in grd_iris_data table
29	Cmd_save_report	Command Button	Save the report in a MS-Word file
30	Cmd_print_report	Command Button	Print the report to default printer
31	Grd_iris_data	MSFlexGrid	Save the raw data retrieved from IRIS database

Table 3:   frm_create_model: controls and their descriptions

#	Control Name	Control Type	Description
1	Cbo_model	Combo box	This combo box allows user to select appropriate model
2	Txt_model_name	Text box	Allows user to create a new model name or revise an existing model
3	Fra_step	Frame	Group of controls for step functions
4	Cbo_step_year	Combo box	User can select step year
5	Txt_step_growth	Text box	User can enter step growth, this should be vehicles per year
6	Fra_growth_rate	Frame	Group of controls which allow user to set growth rate for simple and compound growth model
7	Opt_simple	Option Button	Gives user option to enter the growth rate in vehicles per year
8	Opt_compound	Option Button	Gives user option to enter the growth rate as a percentage of the last data point.
9	Txt_gr	Text box	User can enter the growth rate here. For simple growth model, the growth rate can be vehicles per year or percent of the latest available AADT. For compound model, it is the percentage growth rate.
10	Opt_step_simple	Option Button	For step simple model, gives user the option to enter the growth rate in vehicles per year
11	Opt_step_compound	Option Button	For step compound model, gives user the option to enter the growth rate in percent
12	Txt_gr_before_step	Text box	For step models, this is the growth rate before the step year. It can be vehicles per year or percent per year.
13	Txt_gr_after_step	Text box	For step models, this is the growth rate after the step year. It can be vehicles per year or percent per year.

Table 4:   Specification: grd_data of frm_projection

Row	Row Name	Description
0	Year/Series Titles	This row lists all series titles
1-79	Year	AADT (IRIS or estimated) of 1970 to 2048
80-89	Blank	Blanks
90	Name	Series Names
91	Model Type	The model used for this series
92	Forecast AADT	This is the forecast AADT for the forecast year
93	Growth Rate	The growth rate for each model: For simple growth models, this is the vehicle / year. For compound growth models, this is the growth rate in percentage.
94	Step-growth	The step growth for the step year. The unit for this growth rate is vehicles/year
95	Begin Year	The begin year of a model
96	End Year	The end year of a model
97	Step Year	The year when the step growth occurs
98	RMSE	Root Mean Square Error, for linear regression and exponential regression models only.
99	Linear%	This is the percentage growth for the linear growth model. Divide growth rate by latest available AADT
100	Is_selected	If the series is checked, the value is 1. Otherwise, it is 0.
101	MRLC	Year of most recent length change.
102	Gr_before_step	Growth rate before step. It is vehicles/year for step simple model and percent/year for step compound
103	Gr_after_step	Growth rate after step. It is vehicles/year for step simple model and percent/year for step compound
104	%gr_before_step	Percentage growth rate before step for step simple model, which is the percent of latest available AADT
105	%gr_after_step	Percentage growth rate after step for step simple model, which is the percent of latest available AADT

Table 5: **Layout of the list view (lvw_series)**

Column	Column Name	Description
0	Series Name	Series title/name and a check box
1	Forecast Method	Model used for this series. Six models are available: Linear Regression, Exponential Regression, Simple Growth, Compound Growth, Step-Simple and Step-Compound
2	AADT at YYYY	This column shows the forecast AADT for the forecast year
3	Growth Rate	The growth rate for each model: For simple growth models, the unit is the vehicles / year. For compound growth models, the unit is the growth rate in percentage. For step growth function, the step growth is in parentheses.
4	Time Range	Both begin year and end year of each series are listed here. The format is YYYY:YYYY. For step function, three years are listed here. The year in the middle is the step year.
5	RMSE	Root Mean Square Error, for linear regression and exponential regression models only.
6	Index	The index for each series. This index is equal to the corresponding series' column number in the grd_data.

Table 6: **dialog_report: controls and their descriptions**

Control name	Control type	Description
Txt_to	Text box	User can input the target reader's name
Txt_from	Text box	Enter organization that created this report.
Txt_location	Text box	The forecasted HPMS, structure or Key route's physical location, it may be a street name or number, user can changed this name according to the report requirements.
Txt_prepared_by	Text box	Enter the name of the person who created the report.
Cbo_model	Combo box	Select the model used for this report.
Txt_note	Text box	Allow user to enter a short note of up to 80 characters.
Fra_construction	Frame	A group of controls for construction
Chk_construction	Check box	User can select if this report is generated for construction. If this check box is checked, the default 20-years' forecast will be created in the report.
Cbo_construction_year	Combo box	Enter the year when the construction will be conducted.
Cbo_year	Combo box	How often the forecast AADT can be listed in the report, the user has 3 options: 2, 5, and 10 years.

Table 7: **dialog_new: controls and their descriptions**

Controls Name	Control Type	Description
Cbo_type	Combo box	User can select what type of forecast to do. Three options are available: HPMS, Structure and Key Route.
Cbo_endyear	Combo box	User should enter the forecast year here. The default forecast year is 25 years from current year.
Cbo_county	Combo box	User can select the county name here, A total of 102 counties are listed here, and all counties are sorted by county code.
Txt_code	Text box	This text box accepts user input. It may be a HPMS or structure code; it can also be a Key Route number.
Fra_key_route	Frame	A group of controls that can accept user's inputs for key route information. These controls provide another option for user to enter key route information.
Txt_type	Text box	Key route type: one character
Txt_num	Text box	Key route number: 4 characters
Txt_suffix	Text box	Key Route Suffix: one character, the default value is blank.
Txt_appurt_type	Text box	Key route appurtenance type: one character, the default value is zero.
Txt_appurt_num	Text box	Key route appurtenance number: 5 characters
Txt_segment	Text box	Key route segment number: 2 numbers and this is used only in Cook County.
Txt_station	Text box	A station in the desired Key Route section.